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Does health influence fertility?

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Abstract
Poor health may constrain women's capacity for active leisure, including family life and childrearing, for participation in the labor market and potentially affect preferences. Still, health remains remarkably understudied as a fertility determinant. We explore the association between health and fertility, using uptake of doctor-certified sickness absences and long-term health-related benefits as proxies for health. We examine whether compositional changes in health distributions and/or changes in the health-fertility association have contributed to the distinct fall in the total fertility rate in Norway since 2009. We use nationwide registry data on women aged 16-45 from 2004-2018. We analyse first, second and third births separately, and use annual observations with lagged time-varying covariates for education, sickness absence and long-term benefits. Income, employment and partnership status are also included in some subanalyses.

Long-term benefit uptake is negatively associated with fertility, and the association weakens over time. In addition, such uptake is relatively rare, but increases slightly over time. The use of sickness absence is positively associated with fertility, and the association strengthens over time. Sickness absence uptake is common but decreases over time. It is thus unlikely that changes in women's health and/or changes in the health-fertility association can help explain the observed decline in fertility observed after 2009. However, if the decrease in sickness absence uptake reflects a stronger labor market preference among women in fertile ages, it might help explain parts of the observed decline. Overall, the decline in fertility is most pronounced for healthy women. Health as a fertility determinant warrants further research, from other countries and with other proxies for health.

Keywords: fertility, health, sick leave, TFR, total fertility rate

JEL classification: I14, J10, J11, J13

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Sammendrag

Folks helse kan antas å påvirke hvor mange barn de får, men det finnes lite kunnskap om dette. Alvorlig sykdom kan minske sannsynligheten for at man finner en partner, eller til og med øke sannsynligheten for samlivsbrudd. Noen sykdommer, eller behandlingen av dem, kan også redusere den biologiske muligheten til å få barn. Og selv om det skulle være mulig å få barn, kan det være flere grunner til at folk med dårlig helse kanskje ikke *ønsker* seg barn: De kan være engstelige for at de ikke skal greie å ivareta barna godt nok eller at det å ha barn kanskje vil være så slitsomt at ulempene oppleves som for store i forhold til gledene. De kan ha større vanskeligheter med å kombinere arbeid og barneomsorg enn andre foreldre og helseproblemer kan føre til lavere inntekt. Imidlertid er det også mulig at sykdom kan bidra til høyere barnetall: Som syk kan man få litt andre oppfatninger om hva som er viktig i livet, og kanskje bli mer positiv til å bruke tid og penger på å få et barn (til). Om helsen gjør at man uansett deltar mer begrenset i arbeidslivet, kan også inntektstapet ved å få barn bli mindre.

Vi benytter registerdata om alle kvinner født i Norge som var i fruktbar alder fra 2004-2018 for å undersøke om dårlig helse påvirker fruktbarhet, og om dårlig helse kan være en forklaring på fruktbarhetsfallet etter 2009. Som indikatorer på helseproblemer bruker vi legemeldt sykefravær (ikke graviditetsrelatert) og mer langvarige helserelaterte trygdeytelser (arbeidsavklaringspenger, uføre-, grunn- og hjelpestønad). Indikatorene fanger opp en blanding av helseproblemer, om det søkes profesjonell hjelp for dette, om legen gir sykemelding (som også delvis avhenger av forholdene på arbeidsplassen), og om legen og de rette myndigheter oppfatter plagene som noe som gir rett til mer langvarige helserelaterte ytelser. I perioden vi undersøker har det vært en svak økning i andelen som mottar langvarige ytelser, selv om det er gitt insentiver for å unngå langvarige ytelser og isteden utnytte restarbeidsevne, særlig blant yngre. Samtidig har legemeldt sykefravær sunket noe.

Kvinner som mottar langvarige helseytelser har den laveste sannsynligheten for å få (flere) barn. De har generelt dårligere helse enn andre kvinner. Kvinner som i løpet av et år har vært sykemeldt minst én gang har imidlertid en høyere sannsynlighet for å få barn enn øvrige kvinner. Sykemeldte kvinner er ikke blant de aller sykeste, og det kan være at de på grunn av fravær opplever lavere engasjement for arbeidet og har lavere lønn, slik at det er mindre å tape på å være hjemme med barn. De kan ha strevsomme eller mindre interessante arbeidsoppgaver, som kan øke sykeligheten og senke terskelen for å gå til lege og fremme ønske om sykemelding når helsen oppleves som dårlig.

Fruktbarhetsfallet etter 2009 har vært sterkest for kvinner som *ikke* har vært sykemeldt eller mottatt langvarige ytelser, altså de som kan antas å være de friskeste. De som sliter med dårlig helse, målt enten ved sykefravær eller langvarige helseytelser, har ikke hatt en spesielt stor nedgang i fruktbarheten. Andelen kvinner som benytter langvarige helseytelser har økt de siste ti årene, men denne økningen har vært svak og forklarer svært lite av landets fruktbarhetsfall i perioden.

1. Introduction

Extensively analysed fertility determinants such as income, educational attainment and enrollment are thought to influence fertility because they structure the time and money available to individuals, and to some extent also proxy preferences (Berrington et al. 2015; d'Albis et al. 2017; Jalovaara et al. 2019; Lappegård & Rønsen 2005). Health might, in a comparable way, be viewed as a resource or an obstacle for fertility. Beside temporary or permanent infecundity or sterility, suboptimal or poor health may constrain the individual's capacity for participating in leisure activities, including family life and childrearing, for earning money in the labor market, and also potentially affect preferences. Still, health remains remarkably understudied as a fertility determinant.

The primary aim of this paper is to explore the extent to which women's health is associated with fertility. More specifically, we use nationwide registry data to examine whether suboptimal health matters for whether women choose to have children or not, and whether it influences their decision to have another child. Instead of subjective self-reported health measures, we investigate if uptake of doctor-certified sickness absences and more long-term health-related benefits are correlated with childbearing among women in Norway.

The total fertility rate (TFR) in Norway has decreased continuously since 2009, from 1.98 to a historic low value of 1.56 in 2018 (Statistics Norway 2019). In light of this development, we also examine whether compositional changes in health distributions and changes in the impact of health proxies on fertility may have contributed to the distinct fall in the TFR in Norway since 2009. Next, women's educational attainment has increased further in the past decade, concurrent with declining fertility rates. As there is a strong correlation between education and health, we investigate whether associations between health and fertility differ across educational characteristics and thus influence fertility differently in various groups. As health and education are associated also with income and partnership status, we assess such possible confounding in robustness checks.

Poor health may make it more challenging to conceive and carry a pregnancy to term. Older women have, on average, more pregnancy-related health problems than younger women (Bhasin et al. 2019). With a steadily rising birth age (Statistics Norway 2019), pregnancy and birth-related health problems can be expected to continue to increase in the years to come. Furthermore, treatment, follow-up care and the prognosis for many medical conditions and disabilities are steadily improving, and more women reach fertile ages in suboptimal health today compared to the situation decades ago (Johnson & Tough 2012). This may imply that an increasing proportion of women in fertile ages must consider their health and that of their offspring, when deciding whether they want children, when they want children, and how many they would like to have, and the extent to which their childbearing-wishes may be fulfilled. The theoretical framework and factors potentially affecting fertility choices, are outlined in more detail below, along with results from previous studies.

2. Norwegian setting

From 2004 to 2009, the TFR in Norway increased slightly, from 1.83 to 1.98. Since 2009, the TFR has declined steadily, and reached 1.56 in 2018. This is the lowest TFR ever reported in Norway. At the same time, recent cohorts of Norwegian women have surpassed men in terms of educational attainment and almost as many women as men participate actively in the labor market (Statistics Norway 2019). After the global economic and financial crisis that began in 2008 and hit Norway a bit later and less hard than many neighbouring countries (Comolli et al. 2019), the Norwegian labor market has changed somewhat. Laws have been reformed to facilitate an increasing share of temporary jobs (Nøkleby et al. 2015). Since 2011, there has been other minor economic downturns, and there is a general perception that the labor market is becoming increasingly demanding – as young people compete for interesting jobs after having invested heavily in education (Dommermuth & Lappegård 2017).

Norway is a welfare state with several social security measures in place, to promote health and gender equality. Persons are entitled to health-related benefits if poor health limits their ability to participate fully in the labor market. In this study, we use data on doctor-certified sickness absence and health-related long-term benefits.[1] Sickness absence is generally compensated fully for a maximum of one year, whereas long-term benefits may be used for longer time periods and may in some cases be granted permanently (Norwegian Ministry of Labour and Social Affairs 2019). Long-term benefits are commonly only used once the maximum period for sickness absence has been reached, as the compensation rate is lower, usually set at 66% of the wage the year before health benefits were first granted.

[1]Long-term benefits comprise four different benefits in this study: Work assessment allowance benefits, disability benefits, basic benefits and attendance benefits. In general, the size of the work assessment allowance and disability benefits depend on previous wages. However, also individuals with no or limited work experience may be granted such benefits. In such cases, the size of the benefits is determined according to predetermined values. In addition, persons are entitled to a sickness absence based on self-report. Self-reported sickness absence can only be used for a limited number of days for each spell, and for a limited number of spells per year. It is typically used for sickness absence due to a cold or other temporary illness unlikely to require any medical treatment. It comprises only around 12% of the total sickness absence for the period under study. We have no data on such use.

According to the Norwegian Labour and Welfare Administration (2019), the uptake of sickness absence has decreased slightly over the past decade for women in fertile ages. On the other hand, there has been a slow but steady increase in the uptake of long-term benefits. At the same time, a decreasing number of women report good health (Statistics Norway 2016). Among women in fertile ages, the most common reasons for receiving health benefits relate to mental and musculoskeletal problems, which together account for more than half of all the benefit uptake (Norwegian Labour and Welfare Administration 2019). Other frequent conditions include pregnancy-related problems, respiratory-related problems, problems related to the nervous system (e.g. multiple sclerosis) and digestive problems. For long-term benefits, also certain congenital conditions comprise a marked share, especially among the youngest women.[2]

In 2010, major changes were enforced in the Norwegian welfare system concerning health-related benefits (Frøyland et al. 2018). The aim was to reduce the number of younger individuals on long-term benefits, in part to increase work force participation but also based on research that has shown that labor market attachment might be positive for mental and physical health, as well as economic welfare, even for individuals in suboptimal health (see e.g. Nøkleby et al. 2015). Along the same lines, efforts have been made to reduce sickness absence, especially full-time absences over extended time periods. An increased focus has been directed toward the importance of work and work attachment, both at an individual and a societal level. As a result, relatively strong incentive structures have been established to utilize residual work capacity and avoid reliance on long-term benefits.

Even in a robust welfare state such as Norway, slight changes in labor market regulations accompanied by a temporary economic downturn, might increase the perceived economic uncertainty of individual employees. Previous research indicates, that individuals perceiving insecurity tend to postpone or abolish intentions in different life spheres, including childbearing intentions (Pailhé & Solaz 2012). Individuals in poor health may struggle more to combine work and family under such conditions, and hence be quicker to abandon or postpone fertility intentions. Further, uncertainty in combination with increasing pressure to participate in the labor market, also in temporary jobs, might lead to the emergence of new health problems.

[2] For general information, see www.nav.no/no/person/innhold-til-person-forside/nyheter/flest-uforetrygdede-med-psykiske-lidelser-og-atferdsforstyrrelser (available only in Norwegian). However, we were interested in figures that pertain to women in fertile ages, i.e. < age 45. These were provided directly from the Norwegian Labour and Welfare Administration in table format and are available upon request.

3. Theoretical framework and previous studies

Theoretically, there are numerous possible links between individuals' health and their fertility. We apply an economic-demographic framework, in which supply, regulation costs and demand are considered important fertility determinants (Easterlin & Crimmins 1987). *Supply* is defined as the number of children one would have without regulation and depends on the chance of conceiving and the likelihood of women to bring a pregnancy to term and give birth to a live child (Bongaarts 1983). *Regulation costs* refer to the availability, affordability and acceptability of contraception and abortion. Contraceptives are widely available in Norway and women may choose to have an abortion up to the 12th week of pregnancy. It is not likely that poor health has operated through this channel in Norway in recent years, although some women might have health issues limiting their contraceptive choices (see e.g. Benagiano et al. 2019). Thus, possible implications of changing regulation costs are not discussed further here. *Demand* or fertility desires is defined as the number of children one would ideally like to have. Beside norms and values, this depends on purchasing power, costs of childbearing and the preferences for spending time and money on raising children rather than on alternatives.

While there is an abundance of studies examining the possible impact of fertility on health, scarce research interest is directed at the reverse relationship. A review of the existing literature on the possible influence of health on fertility suggests that the majority is directed at the *supply* side and centred primarily around specific illnesses and conditions and whether they keep individuals from reaching their intended family size. It appears less well explored in terms of general health issues or self-reported health. On the *demand* side, distinctions are made between intended and unintended pregnancies, fertility desires and intentions for women in various states of health or with specific health conditions. This includes also counselling processes directed at women with certain specific conditions that might affect conception, pregnancy outcomes or the subsequent health of women and their offspring. The primary aim of this analyses is to explore the extent to which women's health is associated with fertility, and on the demand side we thus consider studies that examine the influence of health both directly or indirectly.

Firstly, poor health may lower supply at a population level in various ways. A recent Swedish study use administrative data on sickness absence and disability pension before and after first childbirth (Björkenstam et al. 2019). They find that sickness absence increases in the year preceding the first birth, but overall, mothers have less sickness absence than women without children. This suggests that some sickness absence is directly related to pregnancy. It further suggests that there is an overall positive health selection of women into childbirth. However, the study does not account for the potential confounding link between pregnancy and sickness absence. In summary, fecundity and fertility appears understudied for common conditions affecting the health of women in fertile ages.

Other studies focus on specific health issues and their impact on fertility or childbearing decisions. A decrease in sexual desire among persons with certain specific illness, such as for instance cancer, may be linked to hormonally induced changes, but also to fatigue, chronic weakness, and nausea related to both illness and treatment (Schover 2005; Wenzel et al. 2005). This may influence fecundity negatively. However, of greater concern is subfecundity, either related to difficulties conceiving or carrying a pregnancy to term in patients with serious illness, either due to the illness itself or due to treatment influencing fecundity, such as hormonal therapy, chemotherapy, surgery or ablative therapy, and radiation (van den Berg et al. 2018; Daraï et al. 2017; Meirow & Nugent 2001; Wenzel et al. 2005). Studies from the Nordic countries suggest that reproductive cancer forms reduce fertility substantially (Armuand et al. 2017; Syse et al. 2007; Weibull et al. 2018), presumably related to subfecundity. However, also cancer forms unrelated to reproductive function are associated with reduced fertility, perhaps suggesting underlying psychological and/or social mechanisms, further supported by the difference in the probability between first and subsequent births observed for women with cancer (Baxter et al. 2013; Syse et al. 2007).

Several studies examine fertility after disabilities, mental health problems, and nervous system disorders (Bartel & Taubman 1986; Houtchens et al. 2018; Prunty et al. 2008). However, when such health issues are considered, the focus is usually directed at fertility intentions (e.g. Bloom et al. 2017), as well as possible adverse effects on the health of mothers and offspring (e.g. Khajehpour et al. 2013). Whereas earlier studies (see e.g. Bartel & Taubman 1986; Nijs et al. 1984) investigate mental health and psychological stress as a cause for infertility, newer studies suggest that adverse mental health is a consequence rather than a cause of infertility (see e.g. HMHL 2009).

Given that musculoskeletal disorders (MSD) account for a large share of health-related benefit uptake in many countries, and particularly among women (Mastekaasa 2000), the lack of attention diverted to this group in terms of fertility appears inadequate, and we were not able to find many studies examining this aspect. An older Norwegian study showed that among otherwise healthy individuals, persons with MSD were more likely to report subfertility (Skomsvoll et al. 2000), whereas a recent study from the UK states that autoimmune rheumatic diseases (e.g. inflammatory arthritis) and many of their treatments can have a detrimental impact on fertility and pregnancy outcomes and warrant further research (Phillips et al. 2018).

Poor health may also influence the chance of finding (and keeping) a partner (Lillard & Panis 1996; Syse & Kravdal 2007; Syse 2008), with links to fertility, although in a causally complex way. On the one hand, a sexual relationship is usually necessary to conceive a child, and those with a partner are typically in better positions economically and have someone to share the joys and distresses of childrearing with. On the other hand, pregnancy or birth may trigger consensual unions or lead cohabitants to marry. This is especially true for first births, where the direction of causality is particularly ambiguous. While some studies find that people with poor health are less likely to enter a union (Wiik & Dommermuth 2014), and more often experience disruption (Lillard & Panis 1996), other studies do not find this to the same extent (Syse & Kravdal 2007; Syse 2008). However, most studies in this area consider only marriages and do not account for cohabitations, except for the study by Wiik and Dommermuth (2014). We account for the possible mediating effect of having a partner in analyses of higher-order births.

Poor health often results in a reduced income, which could impact negatively on purchasing power and fertility desires. Poor health in younger ages might also result in a lower education than one would otherwise have obtained, thus also influencing income negatively, with a similar result. More specifically, income may be reduced after serious illness due to changes in both work ability and opportunities (Bartel & Taubman 1986; Chirikos 1993). High costs of treatment and rehabilitation may have the same effect in countries where health care must be bought in the open market, like for instance the US (Mellon & Northouse 2001). In Norway, this may have lesser relevance than in countries with less extensive public welfare systems, as health care is provided virtually free of charge and economic benefits compensate for income losses resulting from poor health.

People having stable high incomes do not necessarily want more children than those having stable low incomes, because the former may also feel obliged to spend more on each child and may have developed stronger preferences for their career or other competing activities and investments (Becker 1991). However, income drops are likely to result in fertility declines. Men are the main wage earners in the family even in contemporary Norway (Statistics Norway 2019), and a decline in men’s income may have a pronounced effect (see e.g. Comolli 2017; Kravdal 2002). Whether this is the case also for women is less clear, as women with poor work possibilities or low earning potentials face low opportunity costs of childbearing and may thus be more likely to display high fertility. Nevertheless, some women may have suffered or foresee a loss of income that will make it difficult to support a family, and thus limit the number of children they choose to have.

Educational level, or socio-economic resources more generally, is widely known to have a sharp effect on birth rates (Kravdal 2001). It may also affect women's health, but the causality may well also run in the opposite direction. On the one hand, serious illness in adolescent years is likely to reduce the chances of getting a higher education. On the other hand, women in suboptimal health may have to prioritize their time and resources more carefully than healthier women. If they have invested heavily in education, they may feel that they must choose between raising a family or having a career. Suboptimal health may also have implications for the type of work one can do, and the number of hours one can work. Career jobs where prospects are tied to full-time effort might thus not be an option for someone with poor or reduced health, irrespective of educational attainment.

Women in poor health might perceive that they have less energy to cope with the distresses of childrearing or opt to spend their time and energy otherwise. Depending on the cause and prognosis, women may fear that a pregnancy might adversely influence their health (see e.g. Prunty et al. 2008), they may have concerns related to not being able to live to see their children grow up, or not being able to be sufficiently resourceful and present parents (Schmidt et al. 2016). Concerns regarding the health of potential children may also influence desires negatively, especially if there are hereditary factors to consider (Schover 2005). It should be noted, though, that harmful effects of childbearing after serious illnesses are notoriously difficult to identify, as there may be a highly selected group of relatively healthy women with supposedly good prognosis who go on to have children (Kravdal 2003).

Poor health may also influence preferences, either negatively or positively. Bloom et al. (2017) find that although the attitudes toward motherhood in the US is similar for women with and without disabilities, women with disabilities were less certain whether they would be able to achieve their intentions. Along the same lines, Shandra et al. (2014) find that mothers with disabilities were more likely to want another child, but less likely to intend to have one, as compared to mothers without disabilities. Research on fertility intentions considering self-reported health status provides ambiguous findings. In Norway, a study focusing on individuals with positive long-term fertility intentions finds that childless men and women reporting poor health are also more likely to express an immediate fertility intention compared to respondents without self-reported health problems. This might be due to concerns that their health status will make it even more difficult to have children later in life (Dommermuth et al. 2011). Comparing fertility intentions of couples in Italy and Britain, Fiori et al. (2011) found that poor self-reported health of women is correlated with a lower level of positive fertility intentions in Britain, while in Italy only the partner's health status has a similar impact.

Heiland et al. (2008) found no significant correlation between self-reported health status and desired family size in West-Germany.

Poor health may also have a positive impact on women's fertility through other mechanisms. In general, high income and career ambitions are associated with high opportunity costs, usually found to supress fertility. However, suboptimal health might reduce such costs. For instance, if poor health has resulted in an education with fewer prospects for interesting tasks, women might be more likely to prioritize family over work. Similarly, suboptimal health might inhibit some high-earning career trajectories, thus positively influencing fertility. Furthermore, suboptimal health, and especially poor health, might be hypothesized to increase persons' family orientation and their consciousness of the positive emotional value of having children, thus altering preferences for parenthood in a positive direction. Having experienced and lived through a serious illness may increase the value that is placed on children and family life (Schmidt et al. 2016; Schover 2005). Norms and values concerning childbearing after disabilities and illnesses, such as for instance HIV and cancer, are generally more positive today compared to earlier. This is reflected both in clinical practice of various illnesses and disabilities, as well as in a steadily growing research interest in this topic (Oktay et al. 2018; World Health Organization 2017).

In summary, poor health or disability may cause various physical, psychological, social, and financial effects. It may influence the possibility to establish and maintain a family life, to have and raise children, and it may have consequences for employment and earnings. For some health conditions, especially those in reproductive organs, considerations such as these may add to mechanisms operating through fecundity, defined as the ability to conceive and for women to bring a pregnancy to term. For other health conditions, the impact on fertility may be primarily socially mediated. Our primary hypothesis is that poor health affects fertility negatively, primarily through social mediation. Long-term benefits are likely to indicate poorer health than sickness absence, since such benefits are commonly only granted when individuals have been unable to participate in the labour market due to health reasons over a prolonged period. At the initial onset of an illness, sickness absence is commonly used, but sickness absence also covers less severe and passing health problems. Thus, we expect a stronger negative correlation between long-term benefits and fertility than between sickness absence and fertility. Further, as working life has become more difficult and stressful in the aftermath of the 2008 economic crisis (Comolli et al. 2019) and since women postpone childbearing decisions to older ages resulting in additional health problems (Bhasin et al. 2019), we hypothesize that the negative influence of health on fertility has increased over time. Alternatively, suboptimal health may reduce the opportunity cost of childrearing, and an individual's utility from other leisure activities, contributing to a positive effect on fertility.

As we read the literature, most studies focus on aspects related to fecundity and infertility in women whose reproductive organs have been directly involved or adversely affected by treatment. The vast majority of studies concern cancer, although some studies also consider other conditions and disabilities more generally. Women with cancer comprise a relatively small share compared to other groups of women in suboptimal health in fertile ages, and as such there appears to be a mismatch between the research interest in this group as compared to other groups. Having said that, the research interest is well founded, as cancer in early life is shown to have a negative impact on fecundity and fertility. While some studies of fertility intentions account for self-reported health, it is commonly not their main focus. Furthermore, persons reporting health problems directly linked to reproductive issues are usually excluded from analyses of fertility intentions. To our knowledge, very few studies have looked at correlations between general health and fertility (for an exception, see Björkenstam et al. 2019). As such, this study contributes new knowledge.

4. Data and method

The primary aim of this paper is to explore the extent to which women's health is associated with fertility. As women's health varies across the life course and the link between health and fertility might be different depending on previous births, our dependent variable is parity-specific probability of birth rather than completed fertility. Discrete-time logistic regression models for conceptions leading to live births, hereafter called fertility, were used to estimate possible health effects separately for first, second and third births in nationwide registry data covering the entire population of women aged 16-45 from 2004 through 2018. We opted to backdate the time of birth to create an index of conception, i.e. nine months prior to the live birth, to avoid capturing ill health associated with pregnancy and/or births in the health indicators which were available only at a yearly basis.

We established parity-specific data where each woman is represented with person-years for the period she is at risk for the specific birth (i.e. parity) in question. In analyses of first births, each woman contributed a series of annual observations from age 16 (or earliest age at inclusion in 2004) to age 45, unless conception, emigration, death or December 2018 occurred earlier. The outcome variable took 1 if a child was conceived in the given year, otherwise 0. In analyses of first births, we used data on nearly 434,000 childless women, who gave birth to a total of 286,000 children. For second and third births the starting point was set to the birth of the previous child. In analyses of second births, 295,000 women with one child were followed from the birth of their first child. These women had a total of 250,000 children. In analyses of third births, we followed close to 260,000 women with two children from their last birth. These women gave birth to nearly 100,000 children.

For each woman-year observation, explanatory variables are included. These variables refer either to the situation at the beginning of the year under risk for a conception (e.g. age, time since previous birth, educational activity, level and type, labor market participation, income and partnership status) or the beginning of the previous year for the health variables, i.e. doctor-certified sickness absence and long-term benefits, the latter being an aggregate measure comprising work assessment allowance benefits, disability benefits and basic or attendance benefits.[3] We opted to lag the health indicators with an additional year, to avoid including health issues and especially sickness absence directly linked to pregnancies and births as a predictor for fertility. As we aggregate measures over a whole calendar year, some women may receive both sickness absence and long-term benefits. In these instances, the women are included in the long-term benefits category.

While administrative population data have the advantage that all residents can be included in analyses, one shortcoming is that commonly only events occurring within the country are captured. This means that data for immigrants are likely to be incomplete, as many of them have completed their education somewhere else, have had a work history abroad, and also may have had children elsewhere. Thus, we include only women born in Norway in this study. Classifications and descriptive statistics for the explanatory variables for the three parity transitions are shown in Tables 1 and 2.

Logistic regression models were estimated using the logit command in Stata. In the main models, we controlled for age, calendar period, education, and additionally for higher-order births, time since last birth, as shown in Table 3.[4] Interaction terms between health characteristics and calendar period were included in additional models to assess possible changes over time. When the interaction term suggested statistical significance, average marginal effects and adjusted predictive margins, i.e. predicted probabilities, of conceptions leading to live births at different time periods were calculated and plotted to facilitate comparisons across models, using the margins command (Mood 2010; Williams 2012). The statistical significance level was set at 5%.

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[3] There has been changes in the benefit system during the period we consider. To ensure that we have comparable results over time, the benefits were thus aggregated. Sensitivity analyses show that the fertility associations are similar for the individual benefits. Overall results for the individual benefits are available upon request.

[4] In additional models, we controlled also for income, employment and partnership status (Appendix Table A2).

Health status, and its combination with education, was our primary independent variable of interest. Three main specifications were used: General health (1); Health and educational level (2); and Health and educational type (3). As a robustness check, two additional specifications were set up: Health and income (4); and Health and partnership status (5). The latter specification was used only for higher-order parities.

5. Results

5.1 Descriptive results

Table 1 shows that there are pronounced differences in characteristics between women at risk for a first, second or third birth. This is especially true for educational activity and level of education. Enrollment in education is more common among women without children than among mothers, which means that women in the latter group usually have completed their education. In line with this, mothers have, on average, a higher education than those women (still) without a child. Similarly, a larger proportion of mothers have educational types aimed at specific occupations or labor market sectors. Compared to women without or with only one child, two-child mothers more often have an education directed toward female dominated professions in the public and private sector, as well as highly specific professions. This may be important for our study, because sickness absence is closely related to labor participation. However, it is common in Norway to work some hours while enrolled in education, as is evident in the relatively large share of women with an active labor market participation across parities. As such, most women were entitled to such benefits.[5] The mean income is, however, much larger among mothers compared to those who are childless. The differences in mean income are minor for mothers with one child versus two children.

[5] As a robustness check we control for labor market participation and enrollment in education in some analyses. We also run separate analyses excluding women enrolled in education. Neither change our results in any significant way (Table 3 and Appendix Table A2).

Table 1. A summary of background characteristics of women included in the analyses of first, second and third births

	First birth		Second birth		Third birth	
	Pyrs/N/mean	%	Pyrs/N/mean	%	Pyrs/N/mean	%
Total person-years (pyrs)	6.8 million		2.5 million		3.7 million	
Number (N) of women	433,854		295,224		259,802	
Number (N) of births	286,482		246,847		98,400	
Mean age (years)	26.3		35.1		37.8	
Birth=yes	27.7		30.4		32.6	
Birth=no	26.2		35.6		37.9	
Labor market participation[a]	5,566,056	82.1	2,270,718	89.6	3,412,972	92.3
Mean labor market income (NOK)	192,900		332,700		370,700	
Birth=yes	304,800		337,400		350,700	
Birth=no	188,000		332,200		371,200	
Enrolled in education[b]	2,548,810	37.6	106991	4.2	65,543	1.8
Higher education[c]	1,952,548	28.8	994430	39.3	1,583,201	42.8
Educational type						
Female dom., public sector	903,600	13.3	657,592	26.0	1,067,115	28.9
Female dom., private sector	432,045	6.4	247,292	9.8	370,767	10.0
Mixed gender, high specificity	993,734	14.7	488,973	19.3	809,646	21.9
Male dom.	340,585	5.0	163,977	6.5	260,223	7.0
Other, general education[d]	4,107,356	60.6	975,309	38.5	1,189,016	32.2

[a] Includes women with any income from labor market activities, also those self-employed. As it is common to work part-time while enrolled in education, most women have some attachment to the labor market. [b] Enrollment in education is the primary activity. [c] Higher education refers to any education beyond high school, i.e. at college or university level. [d] Women with missing education are also included here, but they are relatively few since immigrants have been excluded.

The main health variables used in this study are shown in Table 2. In terms of general health, the share receiving long-term benefits is relatively stable across parities, whereas the share who uses sickness absence benefits is almost threefold for mothers as compared to childless women. While selection mechanisms may be at work, it is also likely that having (young) children increases women's use of sickness absence. If we compare women with a low and high education, we see that the uptake of both types of benefits is less common among those with a high education. Childless women are almost equally likely to receive sickness absence and long-term benefits, whereas the relative share of mothers with long-term benefits is lower, about half that of sickness absence. One of the most interesting aspects of Table 2 is that the proportion who have received health-related benefits is lower among mothers of two (at risk of third birth) than mothers of one (at risk of second birth). Potentially, mothers of only children are negatively selected on health. Further descriptive analyses indicate that births are most common among women with a sickness absence the year before conception. This may capture that these women participate more fully in the labor market rather than that they have a poorer health (Appendix Table A1).

Table 2. A summary of health characteristics of women included in the analyses of first, second and third births

	First birth		Second birth		Third birth	
	Pyrs	**%**	**Pyrs**	**%**	**Pyrs**	**%**
General health[a]						
Healthy	5,674,939	83.7	1,681,065	66.4	2,517,831	68.1
Only sickness absence (SA)[b]	510,154	7.5	557,231	22.0	794,340	21.5
Long-term benefits (LTB)[c]	592,227	8.7	294,847	11.6	384,596	10.4
Health and educational level[d]						
Healthy, low education	3,991,113	58.9	962,571	38.0	1,352,627	36.6
Healthy, high education	1,683,826	24.9	718,494	28.4	1,165,204	31.5
SA[b], low education	331,300	4.9	332,606	13.1	456,218	12.3
SA[b], high education	178,854	2.6	224,625	8.9	338,122	9.2
LTB[c], low education	502,359	7.4	243,536	9.6	304,721	8.2
LTB[c], high education	89,868	1.3	51,311	2.0	79,875	2.2
Health and educational type[e]						
Healthy, general education	3,476,037	51.3	617,435	24.4	758,014	20.5
Healthy, female dom.	1,049,758	15.5	591,595	23.4	968,468	26.2
Healthy, high-specificity, gender-mixed or male dom.	1,149,144	17.0	472,035	18.6	791,349	21.4
SA[b], general education	206,468	3.1	185,314	7.3	233,292	6.3
SA[b], female dom.	189,460	2.8	238,249	9.4	354,667	9.6
SA[b], high-specificity, gender-mixed or male dom.	114,226	1.7	133,668	5.3	206,381	5.6
LTB[c], general education	424,851	6.3	172,560	6.8	197,710	5.4
LTB[c], female dom.	96,427	1.4	75,040	3.0	114,747	3.1
LTB[c], high-specificity, gender-mixed or male dom.	70,949	1.1	47,247	1.9	72,139	2.0

[a] Health variables are coded so that the groups are mutually exclusive. [b] This group comprises women who receive only sickness absence benefits. [c] This group comprises women who receive long-term benefits, which is an aggregate measure of work assessment allowance benefits, disability benefits and basic and/or attendance benefits. Some of these women may also receive sickness absence benefits, but since they also receive long-term benefits they are grouped in this category. [d] This variable is a composite measure of educational level and health, and high education includes all women with education beyond high school, whereas the low education group includes all other women. [e] This variable is a composite measure of educational type and health. General education includes also women with only high school or missing education.

Figure 1 shows trends in uptake of health-related benefits over time for the women included in our study. The uptake of sickness absence of women in fertile ages has decreased during the observation period and especially after 2010, while long-term benefits remained on a stable level or increased to some degree. Overall, the uptake of health benefits is lower among childless women (who on average are younger than women with children), and the relative decline is also most pronounced for this group, i.e. the uptake is almost halved toward the end of the period. For women at risk for a second or third birth, the uptake of such benefits was much higher and increased throughout the first half of the period. The decrease over time is sharp for the latter half of the period, and similar for both groups of women. For long-term benefits we see much more modest changes over time. However, a slight increase can be observed for women of all parities across time. Changes over time in educational characteristics and health are shown in Appendix Figures A1-A3.

Figure 1. Changes over time in per cent sickness absence (SA) and long-term benefits (LTB) for women at risk for first, second and third births

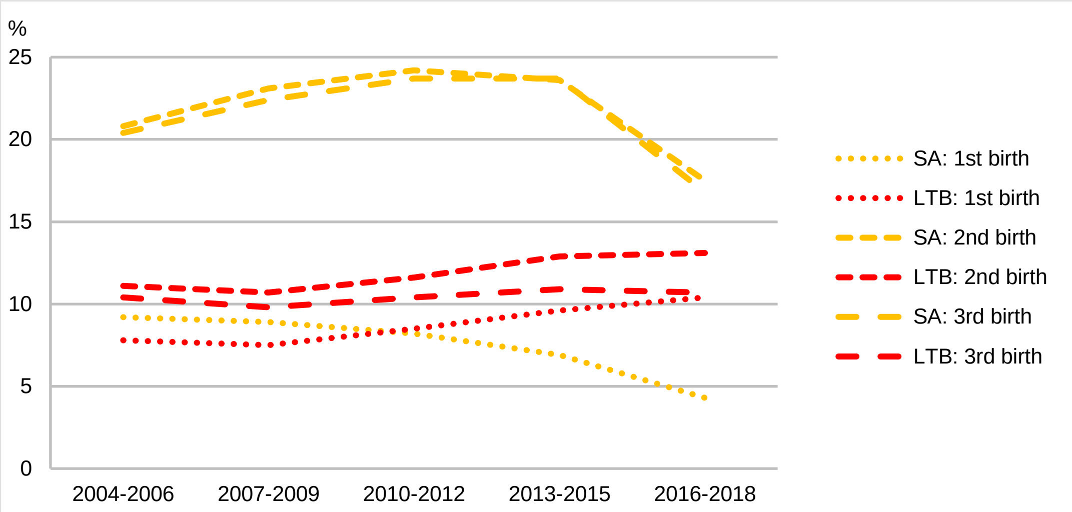

Figure 1 suggests that the incentive structures put in place after 2010 to reduce the uptake of health-related benefits appear to have worked well in the long-term for the uptake of sickness absence but not for long-term benefits. Whether the changes represent actual developments in health or reflects underlying changes in the welfare system, or both, is not clear, and this issue warrants further research.

5.2 Main results

Table 3 shows fully adjusted results for the risk of a first, second or third birth by health- and health- and educational-related characteristics. Altogether, three model specifications are shown for each parity, and the respective control variables accounted for are indicated with an 'X' in the lower part of the table. In general, the magnitude of estimates is fairly pronounced, and the confidence intervals are relatively narrow.

Model 1 shows that the uptake of any long-term benefit lowers the chance of a birth, across all three parities, although most pronounced for a first or a second birth. This may imply that the women who go on to have a first or a second child despite poor health are positively selected on characteristics unobserved in our data.[6] On the other hand, sickness absence uptake appears to increase the chance of having a child. The association is strongest for a first child, and weakest, albeit statistically significant, for a third child.

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[6] This is especially true for childless women on *disability benefits* (not shown, available upon request), whose odds to get a first child is reduced by 75%. This selection appears to be present also for second births, where a more than 50% reduction in the odds for a second birth is observed among women receiving such benefits.

Table 3. Odds ratios with 95% confidence intervals from three models describing the associations between health, education and fertility, for first, second and third births

	First birth, incl. students		First birth, excl. students		Second birth		Third birth	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Model 1: General health[a]								
Healthy	1	ref	1	ref	1	ref	1	ref
Only sickness absence (SA)[b]	1.32	1.31-1.34	1.28	1.27-1.30	1.17	1.15-1.18	1.06	1.04-1.07
Long-term benefits (LTB)[c]	0.52	0.51-0.53	0.49	0.48-0.50	0.57	0.56-0.59	0.73	0.71-0.75
Model 2: Health and educational level[d]								
Healthy, low education	1	ref	1	ref	1	ref	1	ref
Healthy, high education	1.36	1.34-1.37	1.42	1.41-1.44	1.98	1.95-2.00	1.88	1.85-1.91
SA[b], low education	1.40	1.38-1.43	1.35	1.33-1.37	1.28	1.26-1.30	1.16	1.14-1.19
SA[b], high education	1.67	1.64-1.71	1.72	1.69-1.75	2.12	2.08-2.15	1.82	1.78-1.87
LTB[c], low education	0.50	0.49-0.51	0.47	0.46-0.48	0.57	0.56-0.59	0.77	0.74-0.80
LTB[c], high education	0.84	0.81-0.87	0.84	0.81-0.87	1.20	1.15-1.25	1.25	1.18-1.33
Model 3: Health and educational type[e]								
Healthy, general education	1	ref	1	ref	1	ref	1	ref
Healthy, female dom.	1.46	1.44-1.47	1.43	1.41-1.45	1.17	1.16-1.19	0.98	0.96-0.99
Healthy, high-specificity, gender-mixed or male dom.	1.17	1.15-1.18	1.22	1.21-1.24	1.31	1.30-1.33	1.05	1.02-1.07
SA[b], general education	1.56	1.53-1.59	1.46	1.43-1.49	1.30	1.27-1.32	1.12	1.08-1.15
SA[b], female dom.	1.69	1.65-1.72	1.67	1.64-1.70	1.31	1.28-1.33	**1.03**	**0.99-1.05**
SA[b], high-specificity, gender-mixed or male dom.	1.57	1.53-1.61	1.57	1.53-1.61	1.47	1.44-1.51	1.06	1.03-1.10
LTB[c], general education	0.50	0.49-0.51	0.46	0.45-0.47	0.57	0.55-0.59	0.77	0.74-0.81
LTB[c], female dom.	0.78	0.75-0.81	0.76	0.73-0.79	0.70	0.68-0.73	0.67	0.64-0.71
LTB[c], high-specificity, gender-mixed or male dom.	0.74	0.71-0.77	0.74	0.70-0.77	0.74	0.70-0.78	0.74	0.69-0.79
Control variables								
Age group	X		X		X		X	
Period	X		X		X		X	
Time since last birth					X		X	
Educational variables	X		X		X		X	
Model information								
Log likelihood/Pseudo R2[f]	-1,036,874/0.13		-822,761/0.11		-684,919/0.20		-389,613/0.14	
Number of observations/events	6.8 million/286,4825		4.2 million/242,184		2.5 million/246,847		3.7 million/98,400	

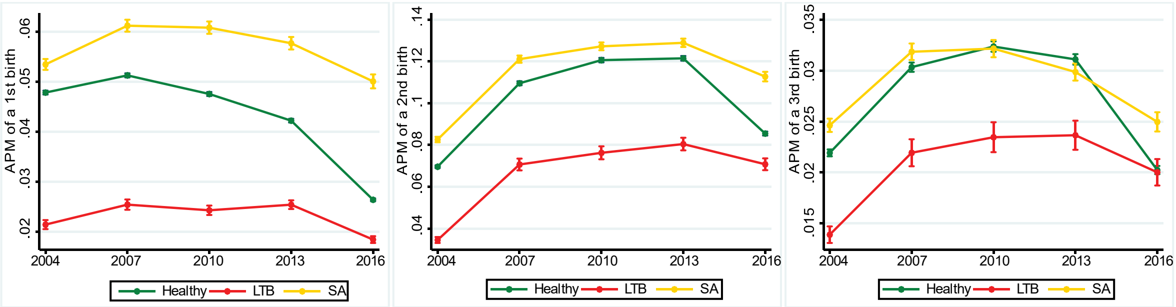
Note: OR is odds ratio, CI is confidence interval. Estimates not in bold, $p < 0.05$. [a] The categories are mutually exclusive. [b] This group comprises women who receive only sickness absence benefits. [c] A measure of whether one receives any long-term benefits. Some may also receive sickness absence benefits. [d] Education is dichotomized. Low education comprises those with education limited to high school. The few women with missing education are also included here. High education comprises those with any education beyond high school. [e] General education includes also women with only high school or missing education. [f] Results for Model 1 are shown. Pseudo R2 is similar for Models 2 and 3. Virtually identical log likelihood figures pertain to Models 2 and 3.

Model 2 compares women in similar health with a high versus a low education. It shows that fertility is higher among the highly educated, across all parities, but that the difference is most pronounced for second births. Further, the results indicate that the higher educated have higher birth probabilities than the lower educated, and this holds both among the healthy, those with sickness absence, and those with long-term benefits. Model 3 compares individuals with different types of education. The odds ratios differ across health status and types of education for first and second births, whereas the differences in general are more modest for third births. The general trends of lowered fertility for women on long-term benefits and higher fertility for women with sickness absence are, however, consistent across parities, independent of type of education.

5.3 Changes over time

Next, we investigate if the described development in the uptake of health benefits explains changes in birth risks for different parities. Figure 2 portrays changes over time in fertility, shown as adjusted predictive margins, among healthy women (green lines), women with sickness absence (yellow lines) or on long-term benefits (red lines). The estimates may be interpreted as annual average predicted probabilities of a birth, net of the other covariates from Model 1, Table 3. Appendix Figure A4 shows the corresponding average marginal effects for women with sickness absence and long-term benefits relative to healthy women. The general pattern observed in Table 3 is evident also in these figures: Compared to healthy women, fertility is higher among women with sickness absence, whereas it is clearly lower among women who receive long-term benefits and thus likely to have the poorest health. Interestingly, Figure 2 shows that healthy women have experienced the most pronounced decline in birth risks for all parities. The onset of the fall was delayed for second births and is pronounced only after 2013. The importance of especially poor health, as indicated by long-term benefit uptake, has diminished over time: Even though women with long-term benefits still have the lowest birth risks, they were less affected by the general decline in fertility than healthy women. On the other hand, women with suboptimal health, as indicated by sickness absence benefit uptake, have increased their fertility advantage over time (see also Appendix Figure A4). These general patterns and observed developments are contrary to our hypothesis, expecting a negative association between suboptimal health and birth risks over time.

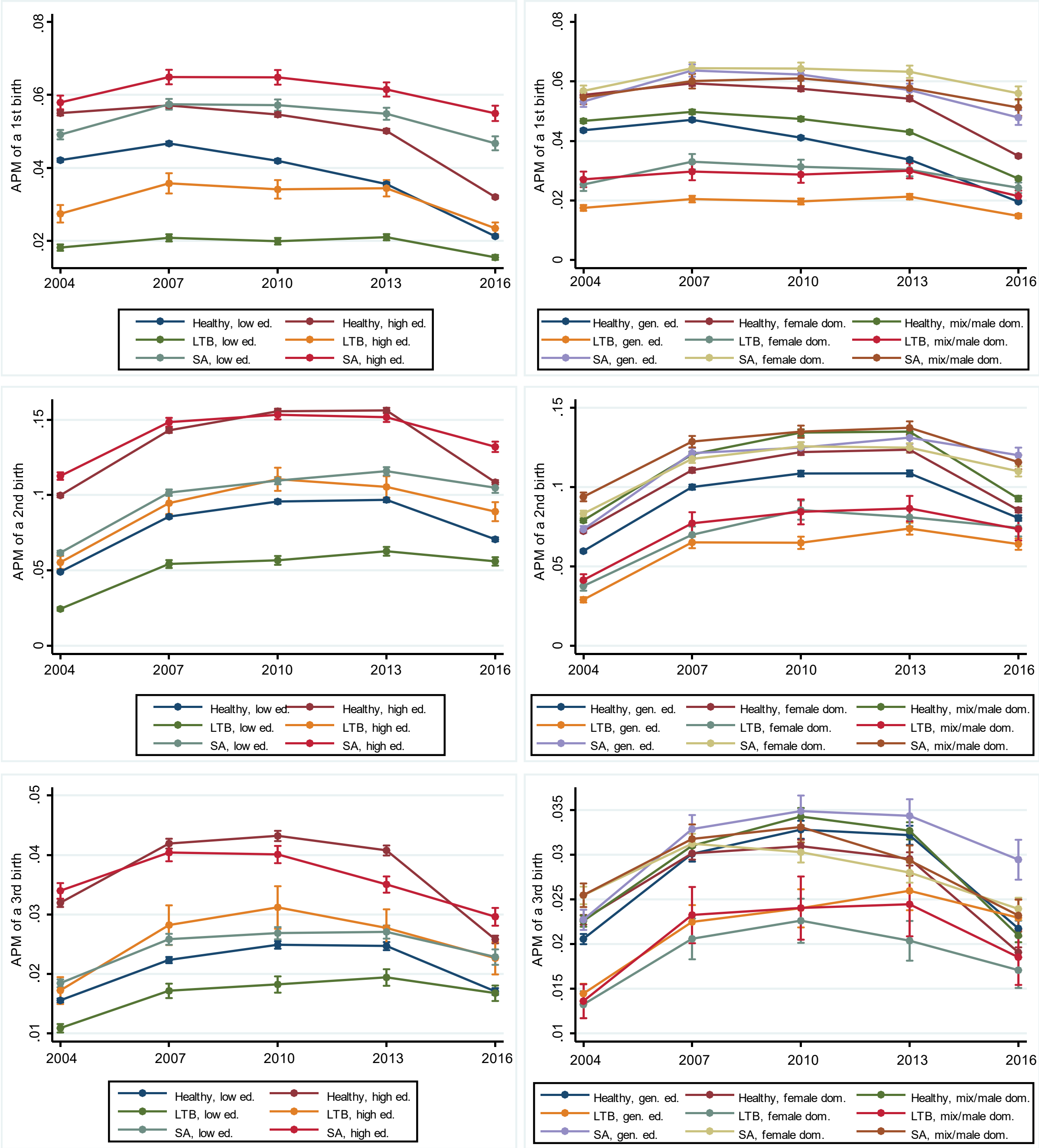
Figure 2. Adjusted predictive margins (APM) of a first (left panel), second (mid-panel) or third (right panel) birth for women by proxies for general health



Note: The groups are mutually exclusive. Women who receive long-term benefits (LTB) are shown in red, and women who receive only sickness absence benefits (SA) are shown in yellow. The reference group, shown in green, does not receive any health benefits. Margins were calculated by including an interaction term between health status and calendar period in the fully adjusted models (Table 3). As such, the portrayed effects are net of averaged covariates. 95% CIs are shown at the predicted values. The axes vary between the parity transitions.

We now turn our attention to changes over time in the associations between education, health and fertility. We included interaction terms in Models 2 and 3 (Table 3) between health/education status and calendar period and calculated adjusted predictive margins displaying changes over time (Figure 3). The left panel of this figure shows that the most pronounced decline in fertility over time is observed for healthy women with a high education. The right panel, portraying differences across educational types, shows a more mixed pattern, both between the educational types within parities and that observed across parities. As is evident from this panel, we find the most pronounced decline for women with educations relevant for female-dominated public sector, especially for third births. Women with sickness absence and education aimed at female-dominated occupations have the highest fertility of all groups, but the importance of sickness absence is less for this group than for other groups (i.e. less difference). For long-term benefits, the trends over time are relatively similar for the different educational types, but also here the differences have become somewhat smaller throughout the period.

Figure 3. Adjusted predictive margins (APM) for a first (upper panel), second (mid-panel) or third (bottom panel) birth for women by uptake of health benefits and education



Note: The margins were calculated by including an interaction term between health/education status and calendar period in the fully adjusted models (Table 3). As such, the portrayed effects are net of averaged covariates. 95% CIs are shown at the predicted values. The axes vary between the parity transition, and between educational level (left panels) og type (right panels). The health categories are mutually exclusive. Low education is defined as any education through high school, whereas high education is defined as any education at college or university level. General education includes educational types other than the female, mixed or male dominated ones.

5.4 Robustness checks

We checked to see if the results would be different if we aggregated the health indicator variable three or five years earlier to account for long-standing health problems. The trends were very similar (results available on request). Similarly, we ran analyses of the individual long-term benefits, i.e. work assessment allowance, disability, basic and attendance benefits, but as the trends were similar across the respective benefits we only show overall results, although some references are made above to the results for disability benefits. A pronounced share of women at risk for a first birth was primarily students (37%).[7] We thus also ran models excluding students, but the results changed very little (Table 3 and Appendix Figure A5). Students were thus retained in the sample in analyses of changes over time.

In Appendix Table A3 we show the joint effects of income and health (Model 1), as well as stratified analyses of women with high and low incomes (Models 2 and 3). As income may be viewed as a proxy for purchasing power, we might expect higher fertility among women with higher incomes. At the same time, opportunity costs for childbearing and -rearing are higher for this group. We find that the risk of a first birth is clearly lower among healthy women with a low income, as compared to healthy women with a high income. Otherwise, the differences between income groups are generally minor across the various health categories. The smallest influence is observed for third births. When we compare estimates with and without controls for income (i.e. Model 1 in Table 3 and Model D in Appendix Table A2), we see that the results are very stable, especially for higher-order births. Thus, the impact of purchasing power (and to some extent opportunity costs) on Norwegian women's fertility does not seem to differ across various health conditions. Furthermore, the impact of health identified in our models are not due to differences in earned income between the healthy and the less healthy women.

Marital or cohabiting status was not included in models for first-births, where the direction of causality is particularly ambiguous. In models for higher-order births, information on partnerships turned out to be an unimportant mediator related to health status (Appendix Table A2). Using the same approach as for income (Appendix Table A3, Model 4), we found that having a partner increased the likelihood for a second and a third birth, across all health categories. However, when we examined partnered and non-partnered separately (Models 5 and 6), only minor differences in the impact of health status could be observed, indicating that health has a similar relevance for fertility regardless of partnership status.

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[7] We restricted the definition of students to include only those enrolled in full-time education and with annual work incomes <20 000 Euros in 2018-values.

6. Discussion

We have examined whether sickness absence or other indicators of poor health are negatively correlated with childbearing among women in Norway, and whether this association has become stronger in recent years and thus might have contributed to the distinct fall in the TFR in Norway since 2009. Our results show that long-term health benefits were negatively associated with fertility, whereas the opposite was true for sickness absence, in line with recent Swedish findings (Björkenstam et al. 2019). Long-term benefits are indicative of poorer health than sickness absence, and thus might be negatively correlated with finding (and keeping) a partner which many may consider a prerequisite for starting or continuing to build a family. However, our results for higher-order births did not change when we accounted for partnership status, suggesting that the impact of health does not vary by partnership status. Furthermore, poor health may interfere with the chance of conception, as well as the likelihood of completing a successful pregnancy. It might also affect the desire for a family, or impact on the desired number of children. Our study cannot distinguish between these mechanisms.

Poor health was also expected to reduce fertility as it may reduce persons' perceived ability to be healthy and caring parents, economically and otherwise. This could not be directly explored by our data. The results were robust to controls for earned income, indicating that (current) income differences do not explain the differences between the more and less healthy. The difference between women using sickness absence as opposed to long-term benefits, suggesting that primarily the 'healthiest' women in suboptimal health opted to have children. This is in line with findings from a study focusing on the uptake of sickness absence and disability pensions before and after a childbirth in Sweden (Björkenstam et al. 2019). The authors also point out an increase in sickness absence in the year preceding a first childbirth. In our approach we anticipated this pattern, as a pregnancy itself can increase the uptake of sickness absence. To avoid that pregnancy related sickness absence is included in our estimations of birth risks, we lagged the health variables one year prior to conception. Still, we find a positive impact of sickness absence on birth chances. One possible reason for this may be that women with sickness absence may have a somewhat weaker attachment to the labor market than those without such absences. As such, they may have a stronger preference for family formation than careers, and thus face lower opportunity costs of childbearing. The higher fertility of women with sickness absence resonates with the idea that having more children, or having them earlier, is an alternative source of identity and meaning for women who do not want, or are unable to, invest heavily in the labor market.

The decrease in fertility due to health problems shown in this unselected national material is perhaps less pronounced than what could be expected, based on what is known of poor health and based on what previous medical research has suggested. On the other hand, as age of first, as well as subsequent births, continues to increase, parenthood will remain an issue for many women in suboptimal health in the years to come. As such, possible social and psychological mechanisms influencing fertility warrant further study, perhaps also utilizing various tools to influence such mechanisms in women in suboptimal health (Prunty et al. 2008).

In terms of changes over time, we cannot determine whether the change over time in the use of sickness absence and long-term health-related benefits represents altered health or reflects underlying changes to the welfare system. Most likely, it is a combination of both conditions. The health indicators we use capture a mixture of whether the person has a health problem, whether professional help is sought for this problem, whether the doctor certifies sickness absence (which also partly depends on conditions at the workplace), or whether the doctor and the appropriate authorities perceive the health complaints as serious enough to grant rights to more long-term health-related benefits. In general, incentives to remain in or re-enter into the labor market have been strengthened somewhat over the period, and incentive structures have been established to avoid long-term benefits and to promote the utilization of residual work capacity, especially among younger people. Overall, this should have led to a decline in the use of long-term benefits, while we find the opposite. However, when we look at the importance of health for subsequent fertility over time, it may seem that the importance of both good and poor health has remained stable or even diminished in recent years and thus had a greater significance earlier in the 2000s, which contrasts with our hypothesis.

Our registry-based study contributes interesting but limited information on an entire population of women in fertile ages in different states of health. It is likely that the results may pertain to other countries with similar population structures, illness burdens, health systems, and welfare structures, particularly the other Nordic countries. Research from other countries is needed to determine to which extent these findings are valid for women in suboptimal health in different settings and welfare systems. Like all registry-based studies, we do not have information on *why* persons act the way they do. We lack information on the reason for the uptake of sickness absence and long-term benefits. However, as we lagged both indicators, they are at least not directly linked to the outcome, i.e. the conception and pregnancy resulting in a live birth. Still, further research including information on the uptake of health benefits may provide informative insight.

Whether our findings show minor or modest associations between fertility and health depends on the perspective one chooses to take. The estimates shown in Table 3 have pronounced magnitudes and appear robust with narrow confidence intervals. However, the use of long-term health-related benefits is fairly uncommon among women in fertile ages, pertaining to around 10% of the person-years analysed for each parity transition. Thus, on an absolute scale, the impact of very poor health is likely to be minor for overall fertility in a population. Sickness absence, on the other hand, is relatively common, accounting for more than a fifth of the person-years among mothers. As such, sickness absence is a measure used by a substantial part of women in fertile ages, and is thus likely to matter, also at a societal level. However, on an absolute scale, the health-related impact on fertility is less strong than that of education or income.

The fact that we use health indicators on the use of sickness absence and more long-term health-related benefits could be problematic since many of the benefits people in poor health are entitled to are closely related to labor market participation. Thus, such benefits may be less relevant for subgroups like for instance students. However, as female labor participation is comparatively high in Norway and even most students are attached to the labor market, our health indicators should capture parts of this ‘morbidity’ as well. In line with this, only minor differences were observed overall as well as for changes over time when we compared first birth risks among women including and excluding students.

Our measures capture different degrees of suboptimal health. There will, however, be substantial variation in *how* sick people are and how *long-lasting* their problems may be. At the same time, there are people in poor health outside the labor market who do not meet the requirements for health-related benefits and thus rely on alternative benefits, such as financial social assistance, as their main source of income. This is a very small group comprising less than 2-3% of the women included in this study, and it will thus not influence the large group without health-related benefits. It is thus of minor significance for our comparison. Nevertheless, studies using other health measures are clearly needed to validate our findings.

Finally, Kravdal (2001) has shown that results of parity specific analyses should be interpreted with caution, as they do not account for the selection into motherhood or different parities. However, as we use time-varying covariates, this should reduce the drawbacks associated with the chosen method. Further, the results are still valid, if one keeps in mind that the population under observation is different for each parity, i.e. childless women, mothers with one child, and mothers with two children.

However, women who go on to have children are included in the analyses of successive parities, and as such the same woman may be included in the different data sets.

7. Conclusions and further work

Our results show that long-term health benefit uptake is negatively associated with fertility, and that the association weakens over time. In addition, such uptake is relatively rare, but increases slightly over time. The use of sickness absence is positively associated with fertility, and the association strengthens over time. Sickness absence uptake is common but decreases over time. It is thus unlikely that changes in women's health and/or changes in the health-fertility association can help explain the observed decline in fertility observed after 2009.

Suboptimal health, and especially poor health, might be hypothesized to increase persons' family orientation and their consciousness of the positive emotional value of having children, thus altering preferences for parenthood in a positive direction. Furthermore, suboptimal health may reduce the ability to invest heavily in education and careers, making earlier childbearing and larger families a comparatively more attractive option. In this study, we could not test these hypotheses directly. A next step would be to compare the impact of poor health among men (e.g. Barclay & Kolk 2019) and women, and ideally also within couples. If we find that poor health impacts equally on childless men and women although women are 'burdened' by pregnancies and subsequent nursing periods, this may indicate that women value parenthood more strongly.

On the other hand, poor health was expected to reduce fertility as it may reduce persons' perceived ability to be healthy and caring parents, economically and otherwise. This could not be directly explored by our data. However, the difference between women using sickness absence benefits as opposed to long-term benefits showed that primarily the 'healthiest' of the women in suboptimal health chose to have children. This may indicate that women take health considerations into account when they decide to opt for parenthood. Furthermore, the association between poor health appears to be particularly strong for firstborns. Whether this might relate to the fact that these women are doing worse in the partner market should be examined further. The association is somewhat weaker for second births, and again weaker for third births. In other words, health status appears to matter the least for higher order births. This might imply that there is a selection of relatively healthy women into motherhood. Women with poorer health who *do* become mothers are more likely to raise single children, which could be an adaptation, since they may have less energy and money due to suboptimal health. However, the mother's health status matters little for the choice between two and three childen.

The share of women in fertile ages who uses long-term benefits – negatively related to birth chances – has *increased* to some degree, while the share of women with sickness absence – positively related to birth chances – has *decreased* over time. However, we are reluctant to conclude that these changes are a decisive factor behind the observed decline in fertility in Norway, as the decline in fertility is strongest among healthy women. Still, we have shown that the use of both short-term benefits, i.e. sickness absence, and longer-term health-related benefits has a bearing on fertility, for all parity transitions. And most important, there are marked differences between short-term and longer-term benefits: While the use of sickness absence is positively associated with childbirth, the opposite is the case for longer-term benefits. Long-term benefits are likely to indicate a worse health than sickness absence and are normally only granted if health is *really* poor and unlikely to improve. Such benefits are, however, relatively rare, and thus unlikely to explain much of the observed decline in fertility. On the other hand, such uptake is increasing in Norway. The use of sickness absence, positively associated with fertility is, however, decreasing over time. If this decrease indicates a stronger labor market attachment and a preference for careers over motherhood among women in fertile ages, it might help explain part of the observed decline.

The impact of health as well as the uptake of various health-related benefits among women in fertile ages deserves more attention, to help ensure that women in various states of health can reach their desired family size. Health as a fertility determinant warrants further research, from other countries and with other proxies for health.

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Appendix

Table A1. Proportion of women with a first, second or third birth by education and health characteristics[a]

	First birth (%) (N=286,482)	Second birth (%) (N=246,847)	Third birth (%) (N=98,400)
Education			
Enrolled in education[b]	1.7	10.6	3.8
Not enrolled in education	5.7	9.7	2.6
High school or below	2.8	7.0	2.1
Higher education	7.7	14.0	3.4
General education	2.5	7.4	2.3
Female dom.	7.5	11.1	3.0
Mixed gender, high specificity or male dom.	6.2	11.4	2.6
General health			
Healthy	4.2	10.7	2.8
Only sickness absence (SA)[c]	7.5	10.2	2.9
Long-term benefits (LTB)[d]	2.1	3.4	1.3
Health and educational level[e]			
Healthy, low education	2.7	7.7	2.2
Healthy, high education	7.7	14.8	3.5
SA[c], low education	6.4	8.2	2.5
SA[c], high education	9.5	13.2	3.4
LTB[d], low education	1.8	2.9	1.2
LTB[d], high education	3.8	5.7	1.6
Health and educational type[f]			
Healthy, general education	2.4	8.3	2.5
Healthy, female dom.	7.8	12.0	3.1
Healthy, high-specificity, gender-mixed or male dom.	6.3	12.3	2.7
SA[c], general education	6.3	8.4	2.7
SA[c], female dom.	8.5	11.1	3.2
SA[c], high-specificity, gender-mixed or male dom.	7.8	11.2	2.7
LTB[d], general education	1.7	3.0	1.3
LTB[d], female dom.	3.2	4.0	1.3
LTB[d], high-specificity, gender-mixed or male dom.	3.0	3.9	1.2

[a] All variables are coded so that the groups are mutually exclusive. The variables pertain to the situation the year before conception. [b] This group comprises women where enrollment in education is their primary activity, and the remaining are included in the 'not enrolled in education' category. [c] Comprises women who receive sickness absence benefits. [d] Comprises women who receive long-term benefits. Some of these women may also receive sickness absence benefits. [e] This variable is a composite measure of educational level and health, and high education includes all women with education beyond high school, whereas the low education group includes all other women. [f] This variable is a composite measure of educational type and health. General education includes also women with only high school or missing education.

Table A2. Odds ratios with 95% confidence intervals from models with different covariates, for first, second, and third births

	Model A		**Model B**		**Model C**		**Model D**		**Model E**		**Model F**	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
First births: General health[a]												
Healthy	1	ref	1	ref	1	ref	1	ref	N/A	N/A	1	ref
Only sickness absence (SA)[b]	1.43	1.41-1.44	1.39	1.38-1.40	1.27	1.26-1.29	1.27	1.26-1.29	N/A	N/A	1.27	1.25-1.28
Long-term benefits (LTB)[c]	0.48	0.47-0.49	0.58	0.57-0.59	0.49	0.48-0.50	0.54	0.53-0.55	N/A	N/A	0.53	0.52-0.54
Second births: General health												
Healthy	1	ref	1	ref	1	ref	1	ref	1	ref	1	ref
Only sickness absence (SA)[b]	1.12	1.11-1.13	1.08	1.07-1.09	1.12	1.11-1.13	1.18	1.16-1.19	1.18	1.16-1.19	1.18	1.16-1.19
Long-term benefits (LTB)[c]	0.47	0.46-0.48	0.57	0.56-0.59	0.50	0.49-0.51	0.58	0.56-0.59	0.59	0.57-0.60	0.58	0.57-0.60
Third births: General health												
Healthy	1	ref	1	ref	1	ref	1	ref	1	ref	1	ref
Only sickness absence (SA)[b]	1.02	1.00-1.03	1.02	0.99-1.03	1.02	1.00-1.04	1.06	1.05-1.08	1.07	1.05-1.08	1.07	1.05-1.08
Long-term benefits (LTB)[c]	0.64	0.62-0.66	0.66	0.63-0.68	0.66	0.64-0.68	0.74	0.71-0.76	0.75	0.73-0.77	0.74	0.72-0.77
Control variables												
Age group	X		X		X		X		X		X	
Period	X		X		X		X		X		X	
Time since last birth[d]	X		X		X		X		X		X	
Interaction between health and calendar period[e]											X	
Employed			X									
Partnership									X			
Income (quartiles)[f]					X		X		X		X	
Educational variables							X		X		X	

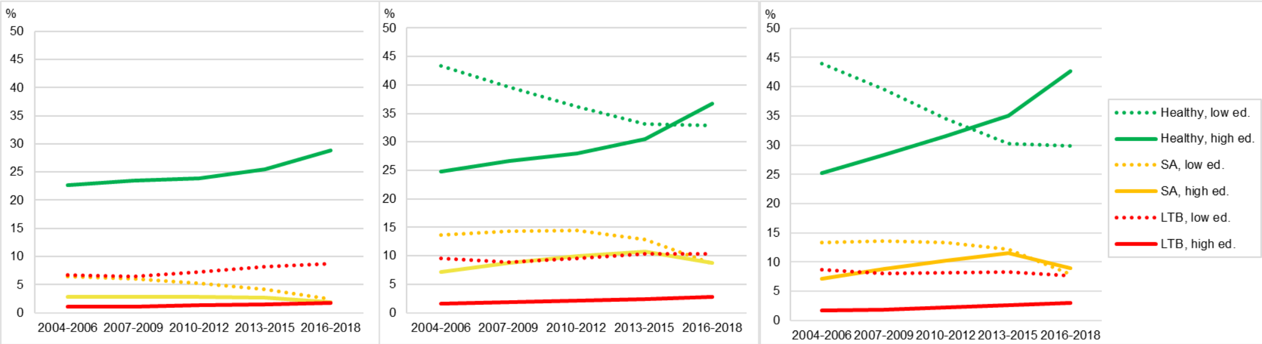
Note: OR is odds ratio, CI is confidence interval. Estimates not in bold, p <0.05. [a] The categories are mutually exclusive. [b] Comprises women who receive sickness absence benefits. [c] Comprises women who receive any long-term benefits. Some may also receive sickness absence benefits. [d] Only relevant for second and third births. [e] The reference period is the first calendar period, i.e. 2004-2006. [f] The results are virtually identical if the sample is restricted to women with income, or if one considers only women without income.

Table A3. Odds ratios with 95% confidence intervals from six models describing the associations between health, income, partnership status, and fertility, for first, second and third births

	First birth		Second birth		Third birth	
	OR	95% CI	OR	95% CI	OR	95% CI
Model 1: Health and income[a]						
Healthy, high income	1	ref	1	ref	1	ref
Healthy, low income	0.52	0.51-0.53	0.88	0.87-0.89	0.98	0.96-0.99
SA, high income	1.19	1.17-1.20	1.06	1.04-1.07	1.06	1.04-1.09
SA, low income	1.14	1.10-1.19	1.15	1.13-1.17	**1.02**	**1.00-1.05**
LTB, high income	0.44	0.43-0.45	0.56	0.53-0.58	0.69	0.65-0.73
LTB, low income	0.51	0.49-0.53	0.53	0.52-0.54	0.73	0.70-0.75
Model 2: Stratified, only high income						
Healthy	1	ref	1	ref	1	ref
Only sickness absence (SA)[b]	1.21	1.19-1.22	1.11	1.10-1.13	1.08	1.06.1.11
Long-term benefits (LTB)[c]	0.45	0.44-0.46	0.56	0.53-0.58	0.70	0.66-0.74
Model 3: Stratified, only low income						
Healthy	1	ref	1	ref	1	ref
Only sickness absence (SA)[b]	2.02	1.94-2.11	1.23	1.21-1.25	1.03	1.01-1.06
Long-term benefits (LTB)[c]	0.92	0.88-0.96	0.60	0.59-0.62	0.74	0.72-0.77
Model 4: Health and partnership status[d]						
Healthy, unpartnered	N/A	N/A	1	ref	1	ref
Healthy, partnered	N/A	N/A	1.65	1.63-1.67	1.41	1.39-1.43
SA[b], unpartnered	N/A	N/A	1.22	1.20-1.24	1.15	1.12-1.18
SA[b], partnered	N/A	N/A	1.85	1.83-1.88	1.42	1.39-1.46
LTB[c], unpartnered	N/A	N/A	0.58	0.56-0.59	0.82	0.79-0.86
LTB[c], partnered	N/A	N/A	**0.98**	**0.95-1.01**	0.95	0.91-0.99
Model 5: Stratified, only partnered						
Healthy	N/A	N/A	1	ref	1	ref
Only sickness absence (SA)[b]	N/A	N/A	1.17	1.15-1.19	1.04	1.02-1.06
Long-term benefits (LTB)[c]	N/A	N/A	0.61	0.59-0.63	0.70	0.68-0.74
Model 6: Stratified, only unpartnered						
Healthy	N/A	N/A	1	ref	1	ref
Only sickness absence (SA)[b]	N/A	N/A	1.16	1.14-1.18	1.10	1.07-1.13
Long-term benefits (LTB)[c]	N/A	N/A	0.56	0.54-0.58	0.77	0.73-0.80
Control variables						
Age group	X		X		X	
Period	X		X		X	
Time since last birth			X		X	
Educational variables	X		X		X	

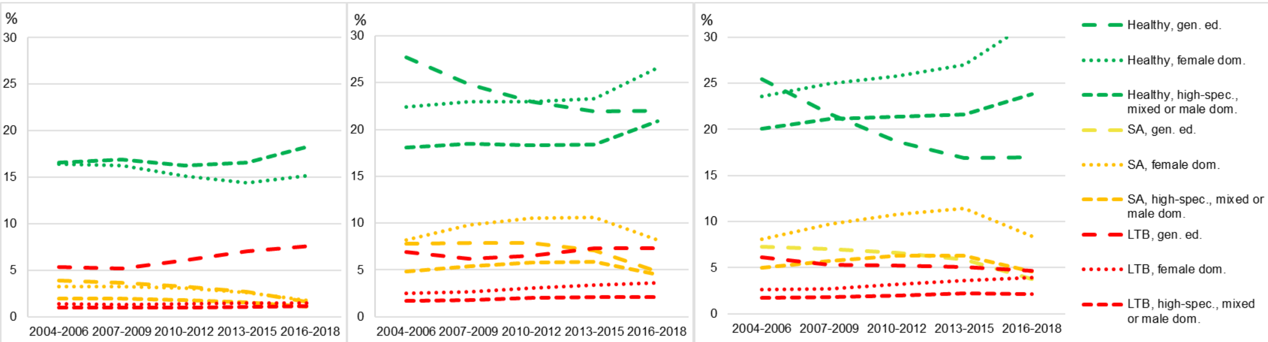
Note: OR is odds ratio, CI is confidence interval and N/A is short for not applicable. Estimates not in bold, p <0.05. [a] The categories are mutually exclusive. Income is dichotomized according to the median income for women at risk for the parity transition. The few women with missing income are included in the low income group. [b] Comprises women who receive sickness absence benefits. [c] Comprises women who receive any long-term benefits. Some may also receive sickness absence benefits. [d] The categories are mutually exclusive.

Figure A1. Changes over time in health (%) by educational level for women at risk for first, second and third births (left to right)



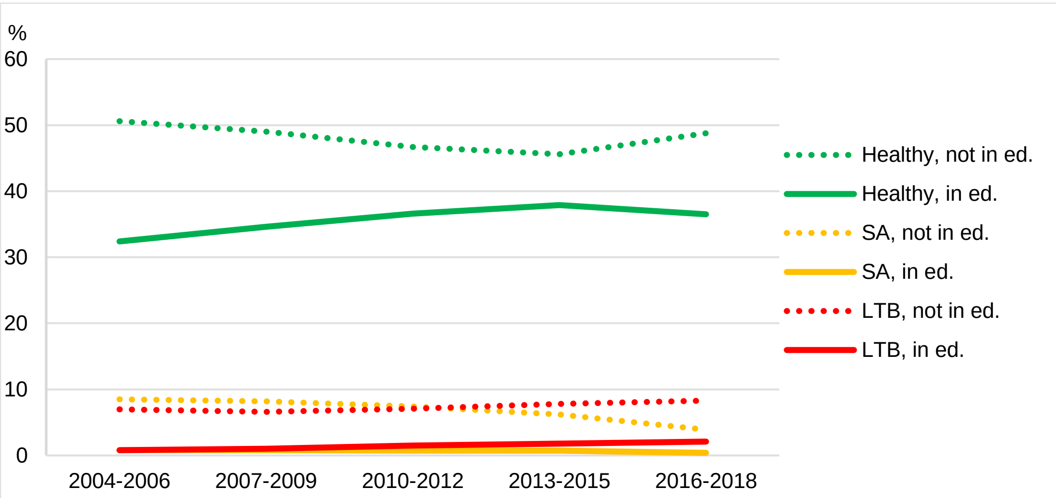
Note: The groups are mutually exclusive. Healthy women with a low education are not shown in the left panel (first births). They comprise 60% in 2004-2006, and the share declines throughout the period. In 2016-2018, the group comprised 56%. SA is short for sickness absence, whereas LTB is short for long-term benefits. The healthy women receive no such benefits.

Figure A2. Changes over time in health by educational type for women at risk for first, second and third births (left to right)



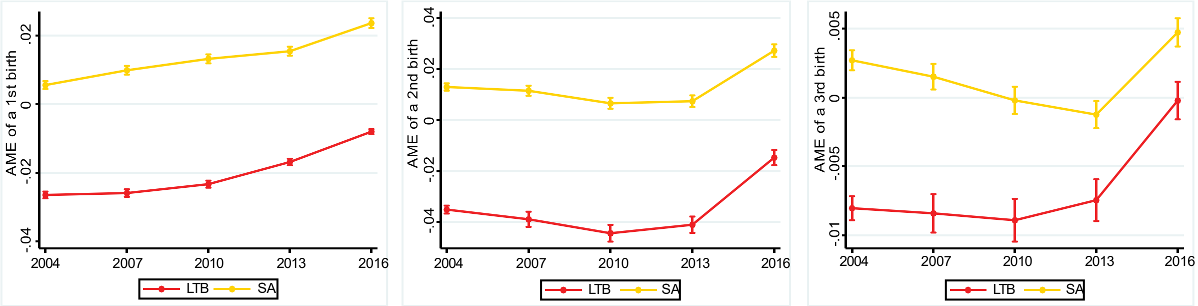
Note: The groups are mutually exclusive. Healthy women with a general education are not shown in the left panel. The group comprises 50% in 2004-2006, and increases to 53% in 2010-2012, before it declines to 52% in 2016-2018. SA is short for sickness absence, whereas LTB is short for long-term benefits. The healthy women receive no such benefits.

Figure A3. Changes over time in health by educational enrollment for women at risk for a first birth



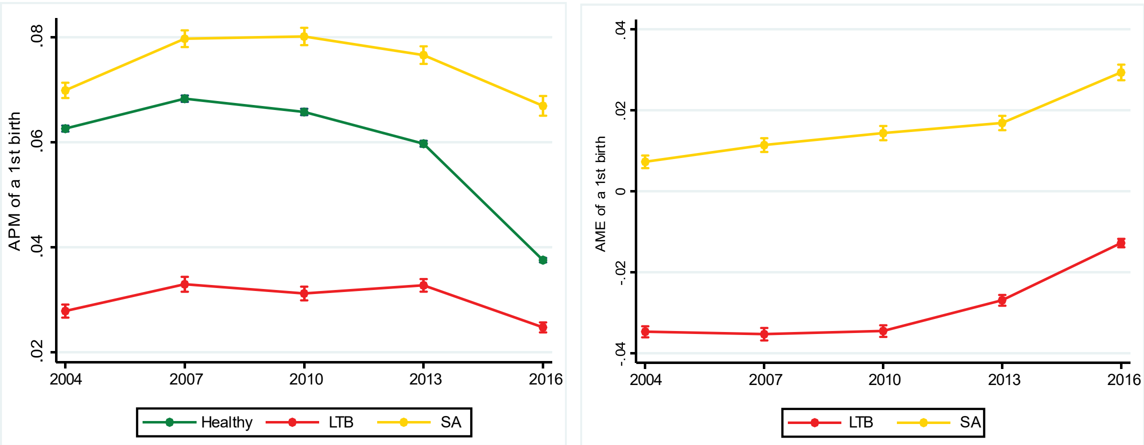
Note: The groups are mutually exclusive. SA is short for sickness absence, whereas LTB is short for long-term benefits. The healthy women receive no such benefits.

Figure A4. Average marginal effects (AME) for a first (left panel), second (mid-panel) or third (right panel) birth for women by general health proxies relative to women who are healthy



Note: The groups are mutually exclusive. Women who receive long-term benefits (LTB) are shown in red and women who receive only sickness absence benefits (SA) are shown in yellow. Long-term benefits comprise an aggregate measure of whether one has received work assessment allowance benefits, disability benefits and/or basic or attendance benefit payments the previous year. The reference group of healthy women, i.e. women not receiving any health-related benefits, is not shown but may be presented as a horizontal line through 0.

Figure A5. Adjusted predictive margins (APM, left panel) and average marginal effects (AME, right panel) for the risk of a first birth by health status, not including students



Note: The groups are mutually exclusive. Women who receive long-term benefits (LTB) are shown in red and women who receive only sickness absence benefits (SA) are shown in yellow. Long-term benefits comprise an aggregate measure of whether women have received work assessment allowance benefits, disability benefits and/or basic or attendance benefit payments the previous year. In the left panel, the healthy women (shown in green) do not receive any such benefits. In the right panel, the reference group of healthy women is not shown, but may be presented as a horizontal line through 0.