Extended Abstract

Educational differences in ART: Disentangling access, need & timing

Authors: Jenny Chanfreau (presenting) & Alice Goisis & Øystein Kravdal

Introduction

The use of Assisted Reproductive Technologies (ART) continues to increase with time. It is well-established that ART is patterned by socio-economic position even in contexts with highly subsidized provision (e.g. Goisis et al, 2020; Brautsch et al, 2023; Martins et al, 2018; Lazzari et al, 2021; Choi et al, 2022). The parents of children conceived by ART tend to be older, more highly educated and more socio-economically advantaged, on average, than parents of children conceived without fertility treatments. Competing explanations for this socio-economic patterning can be put forward.

On the one hand, it is well known both that fertility declines with age, and that postponement of childbearing is socio-economically patterned (Beaujouan, 2020; Beaujouan & Sobotka, 2022; Leridon, 2004; 2017; Ní Bhrolchain & Beaujouan, 2012). With more highly educated individuals tending to postpone the start of trying to conceive a first child to older ages when chances of natural conception are reduced, the socioeconomic patterns observed may simply reflect the greater need for treatment, on average, among more privileged groups. In addition, in Norway, the first three cycles of ART treatment are available to infertile couples without a prior joint child at a highly subsidized cost, perhaps suggesting that economic inequality ought not to be a main explanation for the socio-economic difference.

On the other hand, a number of potential barriers to ART treatment exist which may mean that less privileged individuals face greater challenges to start treatment or successfully conceive through ART. Examples include geographical distance to treatment facilities and the cost of travel to appointments, access to time off work for appointments, the cost of additional rounds of treatment if the highly subsidized initial rounds were unsuccessful, as well as cultural or knowledge disadvantages and discrimination (Lazzari et al, 2021; Lazzari et al, 2022; Passet-Wittig & Greil, 2021; Brautsch et al, 2023). Inequality in access or success may thus also underlie the socio-economic patterns observed.

A key limitation in much research on socio-economic differences in ART use and ART births generally lack information on *need* for ART. Comparing the maternal age at birth by conception type does allow researchers to infer need using age as a proxy given its strong association with declining fecundity. However, the fact that the process of seeking diagnosis, referral, testing and treatment itself constitutes a mechanical delay for ART-conceived births means that using age at birth may overestimate the role of postponement in explaining the patterns observed. We contribute to the literature by identifying 'need' for fertility treatment based on primary care diagnosis information.

The aim of this paper is to examine one of the pathways into having an ART birth to increase understanding of educational differences between parents by conception type among those who have been assessed by their primary care doctor as being subfertile. Whilst we acknowledge that there are multiple different pathways to having a birth by ART, including directly approaching a private provider, given the availability of highly subsidised ART to eligible infertile couples by referral through the public health system, we argue that this is an important pathway to research in the Norwegian context.

In this paper, we examine first whether diagnosis of subfertility differs by education. Then we investigate whether, given a subfertility diagnosis, having an ART conception differs by education and if so whether this is explained by age and/or resources.

Data and Methods

We use data from the Norwegian Population Register, which has been linked using anonymized personal identifiers to the Medical Birth Register (MBR) and the Norwegian Control and Payment of Health Reimbursements Database (KUHR) and national databases with information on education and income.

Our main analysis focuses on women with a fertility diagnosis, specifically on women aged 25-49 and nulliparous at time of first (observed) diagnosis. The Norwegian Control and Payment of Health Reimbursements Database (KUHR) includes patient diagnoses made in primary care settings between 2006-2018, recorded using International Classification of Primary Care (2nd Edition) system. We derived an indicator of fertility diagnosis based on any mention of female sub/infertility; amenorrhoea or symptoms/illness or female genital organs. Overall, some 227,963 women had at least one mention of one of these symptoms, including 86,405 nulliparous women of reproductive age. Among nulliparous women who went on to have a first birth by ART by 2018, 69% had a fertility diagnosis. This compares with a much lower diagnosis prevalence among women overall (16%), suggesting that this indicator captures one of the pathways into ART treatment. The indicator of fertility symptoms is our variable identifying need for treatment.

The MBR contains a record of every birth in Norway and allows us to differentiate between naturally conceived (NC) births and pregnancies and births following conception by ART.[1] By way of context, longstanding Norwegian legislation restricts treatment provision to licenced private and public clinics, and all ART clinics in Norway are required to notify the MBR of every ultrasound-verified pregnancy following IVF or ICSI treatment. Births in Norway following treatments received abroad are also recorded as ART conceptions in the MBR if the mode of conception is reported by the mother to medical staff at the time of the delivery. The indicator of ART birth or confirmed pregnancy is our main outcome of interest.

Our main explanatory variable of interest is education. We group women by their highest level of education, which we have categorised as Low (corresponding to up and including completion of Secondary education), Middle (some tertiary education), or High (completed higher education at Masters/PhD level).

We also include as covariates in our model the woman's age at the time of diagnosis, individual income and estimated travel time to the closest municipality with a fertility clinic, as well as her partnership status. We exclude women aged under 25 from the analysis based on the age guidance in Norwegian ART policy and use five-year age groupings (25-29, 30-34, 35-39, 40+). We derived income quintiles based on the mean of individual earnings over the observation period for the women and used the travel time estimates made available with the data, based on the distance between the woman's home municipality at the time of the diagnosis and the nearest municipality with an ART facility (hospital or private provider).[2] Finally, we use the woman's partnership status in the year prior to diagnosis (coded as single, cohabiting or married). We note that although ART provision in Norway was restricted to infertile couples without a child together, we do not restrict our analysis to women known to be partnered at the time of, or prior to diagnosis, due to concerns about the reliability of the cohabitation indicator in the register data among unmarried couples who do not (yet) have a child together.

[1] We use the term natural conception throughout to mean conception without the use of ART, where fertilization occurs inside the body. The MBR does not allow for identification of non-ART Medically Assisted Reproduction (MAR) conceptions, such as assisted insemination.

[2] List of municipalities with an ART facility compiled by the authors using publicly available information in 2023.

First, we present descriptive analyses of the prevalence of fertility diagnosis by education and the age and regional distribution of women with a diagnosis compared with all nulliparous women of reproductive age in Norway. We then use piecewise exponential event history analysis with competing risk to investigate whether having an ART conception differs by education among those who have received a fertility diagnosis. The analysis time is months since diagnosis and the outcome is a first birth (or other pregnancy outcome in very rare cases of confirmed pregnancy conceived by ART that did not result in a live birth) disaggregated by the type of conception: ART or natural, or remaining childless. Transition-specific effects are included by specifying an interaction term between education and the conception type. Cases are censored if they are no longer resident in Norway or no birth has occurred by the end of the observation period (2019). The analysis sample is women in Norway aged 25-49 and nulliparous at time of first (observed) diagnosis, excluding women without known level of education.

Findings

To address the first research aim, we use descriptive analysis to investigate whether the percentage of women with a diagnosis differs by education group. We find the prevalence is similar across groups, with about a fifth of nulliparous women of reproductive age (15-49) in the low (20.4%), middle (20.3%) and high educated groups (19.0%) having an infertility diagnosis.

The regional distribution of nulliparous women of reproductive age with a fertility diagnosis is similar to that of all nulliparous women (e.g. 37.3% of women with a diagnosis and 37.8% of all women lived in Oslo or the neighbouring county Viken), whereas age profile of those with an infertility diagnosis differs substantially from that of all nulliparous women in Norway. In particular, half of all nulliparous women in Norway (49.5%) are aged under 25, whereas 15.3% among those with a diagnosis are in this age group. Although we do not have direct data on fertility intentions, when women started trying to conceive, the difference in age distribution is compatible with this diagnosis coming about for many through visiting the doctor because of having trouble conceiving. In particular, we note that among nulliparous women with a diagnosis, the mean age at diagnosis (30.8 years; 28.1% are aged 25-29 and 29.2% are aged 30-34) is similar to the average age at first birth in Norway among all women (30.2 years in 2022, up from 28.1 years in 2006).

Among women with a diagnosis, however, having an ART conception differs by education. Table 1 below summarizes the main findings from the event history analysis. Model 1 is unadjusted, including only education, Model 2 controls for the woman's age at the time of diagnosis and Model 3 further controls for income, distance to the nearest municipality with a fertility clinic and partnership status. Given a fertility diagnosis, the hazard of an ART birth is more than double for middle educated women compared with low educated (HR 2.07), and the hazard ratio of high educated is even higher (HR 2.35), when adjusting for all covariates (Model 3).

Comparing the results of Models 1 and 2 shows that age at the time of diagnosis does attenuate the effect of education. The hazard ratio is 2.05 for the middle educated group when adjusting for age compared with the unadjusted hazard ratio of 2.21, and the hazard ratio is 2.29 for high education controlling for age - down from unadjusted hazard ratio of 2.54 for high education in Model 1. Notably, however, while further controlling for partnership status, income and distance to a fertility clinic has a relatively smaller influence on the effect of middle education on the hazard of having an ART pregnancy outcome, accounting for these additional variables appears to accentuate the positive effect of high education on the hazard of having an ART conception. Initial checks indicate that this is not driven by the inclusion of a specific one of these variables.

Table 1 Piecewise exponential model with competing risk: Hazard of first birth by conception type

Conception type:	Model 1			Model 2			Model 3		
Education	HR	95%	CI	HR	95%	CI	HR	95%	CI
ART: Low (ref)	1			1			1		
ART: Middle	2.21	2.08	2.33	2.05	1.94	2.17	2.07	1.96	2.19
ART: High	2.54	2.37	2.71	2.29	2.14	2.44	2.35	2.20	2.52
NC: Low	15.86	15.1	16.66	12.26	12.06	12.91	12.32	11.69	13.00
NC: Middle	16.53	15.75	17.35	12.69	11.42	13.36	12.87	12.22	13.57
NC: High	15.71	14.94	16.52	12.04	12.64	12.7	12.43	11.76	13.13
Covariates:	None			Age			All		

Notes: Time is months since diagnosis; N=49,995 women. Conception type ART= Assisted reproductive technology conceived birth/pregnancy; NC= naturally conceived birth. Model 1 includes the interaction effect of level of education with conception type only; Model 2 additionally includes the woman's age group at the time of diagnosis; Model 3 additionally includes earnings quintile, travel time to nearest municipality with ART provision and partnership status (single/ cohabiting/ married) in the year prior to the diagnosis.

Preliminary discussion

In this study we aim to contribute to the existing literature on the socioeconomic patterning of ART births by including primary care diagnosis of subfertility as an indicator of 'need for treatment'. Like many other studies on this topic, the fact that we are unable to identify which women are actively trying to conceive is a limitation of our study that needs to be acknowledged. However, diagnosis of subfertility is a closer proxy of need for treatment than merely age at birth.

We found that despite the proportion of nulliparous women receiving a diagnosis not differing by education in Norway, among those with a diagnosis, the hazard of having an ART conception is related to level of education. This is consistent with other research on socioeconomic differentials in healthcare use in Norway, finding that women's probability of visiting a general practitioner did not vary by socio-economic status, but the probability of visiting a specialist increased with income and education (Hansen et al, 2012).

We found that the hazard of having an ART conception/birth is greater among middle and high educated women, compared with low educated women and this association is not explained by age or other resources such as income or residential proximity to a municipality with ART provision. In fact, while adjusting for age at the time of first observed diagnosis attenuates the effect of both middle and higher education, including the other covariates in the model strengthens the effect of high education especially.

This result appears consistent with recent research on distance to ART facility in Australia being compounded for women also resident in more socioeconomically disadvantaged areas (Lazzari et al, 2022). Overall, our findings are also consistent with recent work by Brautsch et al (2023) on treatment use in Denmark who concluded that, given the absence of a difference in need for treatment, the socioeconomic differences observed in use is indicative of inequality and potentially the existence of unmet need among less privileged groups.

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