

RESEARCH ARTICLE

Reproductive disruptions in fertility research: Conceptual re-integration and evidence from Germany

Nadja Milewski¹  and Jasmin Passet-Wittig¹ 

ABSTRACT The risks of infertility and pregnancy loss have been growing as women's ages at birth have been increasing. This raises the question of how such adverse reproductive experiences (ARE) are associated with birth outcomes. We propose an analytical framework to re-integrate infertility, miscarriage and abortion into the demographic study of fertility. It reconnects to the classic framework on the proximate fertility determinants by Davis and Blake and Bongaarts, and it draws on the rather recent approach of reproductive careers proposed by Johnson et al. We use a subsample of 1862 female respondents of the German family panel pairfam who participated in 11 consecutive waves, covering the calendar period from 2008 to 2020. We follow three birth cohorts through 10 years of their reproductive ages. Women aged 35+ years have the highest probability of having multiple ARE, but no births. They also have the lowest risk of having a birth and no adverse experiences. The results suggest that integrating ARE into the analysis of birth behaviour may help to explain age patterns in fertility and the association between desired and realised fertility.

KEYWORDS Pregnancy loss • Miscarriage • Abortion • Infertility • Proximate fertility determinants • Reproductive careers

Introduction

Theoretical and empirical research on fertility has expanded substantially over the past two decades, particularly as scholars seek to explain the persistence of late and low fertility in high-income countries. Rooted in the second demographic transition theory (van de Kaa, 1987), dominant frameworks at the micro and macro levels emphasise socioeconomic and cultural determinants of fertility (e.g. McDonald, 2000; Vignoli et al., 2020) and the role of social policies in shaping fertility change across gender, time and space (e.g. Goldscheider et al., 2015). Within this perspective, delayed parenthood is largely interpreted as a response to broader social change. However, fertility postponement also has physiological consequences.

Higher maternal age is a non-modifiable risk factor for miscarriage and stillbirth (du Fossé et al., 2020). An estimated one in five pregnancies ends in miscarriage (Quenby et al., 2021). Despite its profound effects on women's wellbeing, miscarriage,

✉ Nadja Milewski, nadja.milewski@bib.bund.de

¹ Federal Institute for Population Research (BiB), Wiesbaden, Germany

especially in the first trimester, remains socially trivialised and stigmatised (Coomarasamy et al., 2021). Higher age likewise increases the risk of infertility, reduces the likelihood of natural conception (Dunson et al., 2002; Evers, 2002) and lowers the success rates in assisted reproductive technology (ART) treatments (Habbema et al., 2015). Almost one in five women in high-income countries experiences infertility at some point in her reproductive life (WHO, 2023). These developments have stimulated a new strand of research that examines the “side effects” of late and low fertility by looking at physiological determinants of fertility and their associations with reproductive outcomes (e.g. Aitken, 2024).

At the same time, experiences such as infertility, miscarriage and abortion have received attention within theoretical frameworks concerned with gender and social inequalities in reproduction (e.g. Colen, 1986; Culley et al., 2009), and the reproductive load shouldered predominantly by women (e.g. Johnson et al., 2018; Minello, 2025). This literature emphasises that the burdens and risks of reproduction – psychological, physical, social and economic – should not be reduced to the number of deliveries, and that these burdens are unevenly distributed across social groups. Bringing the bio-demographic and sociological perspectives together creates an opportunity to better understand women’s reproductive patterns in demographic contexts with late and low fertility.

At the aggregate level, research has largely focused on the contribution of ART to overall fertility and on its potential to counteract the effects of postponed childbearing (Hoorens et al., 2007; Leridon and Slama, 2008; Habbema et al., 2009; Tierney, 2022; Lazzari et al., 2023). At the micro level, family demography typically examines infertility, miscarriage/stillbirth or abortion as *separate* and largely unrelated reproductive experiences. Much of this work concentrates on the prevalence and risk factors of one specific type of reproductive experience (e.g. Helström et al., 2003; Väisänen and Murphy, 2014; Compans and Väisänen, 2025). Fewer studies investigate the consequences of such adverse experiences for individuals’ subsequent life courses in other domains, such as union dissolution, employment and wellbeing (e.g. Shreffler et al., 2011; Huss, 2021; Huss and Kaiser, 2021; Minkus and Drobnić, 2021; McQuillan et al., 2022). Only rather recently have fertility researchers begun to examine how reproductive experiences that do not lead to a live birth shape subsequent fertility intentions and behaviour (Shreffler et al., 2016; Beaujouan et al., 2019; Erato et al., 2022; Beringer and Milewski, 2024; Greil et al., 2024).

Johnson et al. (2018, 2023) describe current fertility research as a fragmented landscape in which studies focus either on the “outcome” of birth or fertility barriers like infertility, but rarely on their interrelatedness. They call for an integrative research agenda capable of capturing the reproductive load carried by women and offering a more comprehensive understanding of fertility behaviour. Their concept of the “reproductive career” offers an alternative perspective that views births, infertility and other reproductive experiences as interlinked life course events. Empirical applications of this perspective, however, remain limited, and a deeper understanding of the interrelations between disruptive reproductive experiences and fertility outcomes still needs to be developed.

Our study contributes to this emerging empirical literature by proposing an analytical framework of adverse reproductive experiences (ARE) that re-integrates infertility, miscarriage and abortion into demographic analyses of fertility. We use the term ARE to denote

events that interrupt, prevent or terminate the progression to a live birth. We argue that grouping these three types of experiences is analytically meaningful because each constitutes a departure from the intended or potential reproductive trajectory and has potential implications for subsequent behaviour and outcomes. While infertility and miscarriage are involuntary biological barriers to reproduction, abortion differs in that it involves an element of decision-making. However, abortion – like other ARE – marks a disruption in the reproductive process: it may influence later reproductive behaviour; shape the timing, spacing or likelihood of subsequent births; and often leaves physical, psychological and social “traces” in a woman’s life course (Huss, 2021). Investigating abortion alongside infertility and miscarriage thus allows us to capture a fuller range of disruptions or reorientations in the reproductive phase. Studying ARE in this integrated way is important because these events may help to explain observed fertility patterns, changes in these patterns over time, differences between social groups and the persistent gap between women’s desired and realised number of children.

Conceptually, our approach builds on the reproductive career perspective (Johnson et al., 2018, 2023). It also reconnects to the classic framework of proximate fertility determinants (Davis and Blake, 1956; Bongaarts, 1978, 2015), which originally emphasised reproductive barriers in addition to social factors as determinants of birth patterns. In subsequent theoretical frameworks and empirical studies, however, this focus has largely receded, in part because of the scarcity of reliable data on ARE, and in part because of the increasing emphasis on socioeconomic, cultural and policy-related determinants of fertility. By revisiting this earlier insight, our framework highlights how infertility, miscarriage and abortion are associated with birth outcomes.

Empirically, Germany serves as our study case. The setting is characterised by persistent late and low fertility, high rates of childlessness and pronounced social group differences in fertility (Bujard et al., 2022). We use a subsample of 1862 female respondents of the German family panel pairfam who participated in 11 consecutive waves covering the calendar period from 2008 to 2020. We follow three birth cohorts through 10 years of their reproductive ages. We integrate infertility, miscarriages, abortions and births into analyses of reproductive patterns. Our first research question is: What are the reproductive patterns with respect to ARE and births across the life course? To account for the well-documented age-related decline in fertility, we use age as our main stratifying variable. Given that fertility is socially stratified and that the reproductive load is unequally distributed across social groups, our second research question is: How do social inequalities moderate the associations between age, ARE and births?

Background

In this section, we review how theoretical approaches contribute to our understanding of ARE and birth outcomes. On the macro level, Davis and Blake (1956) laid the foundation with their framework on social structure and fertility, which aimed to explain fertility variation across countries and historical eras, from pre-industrial societies to modern societies undergoing the (first) demographic transition. They conceptualised reproduction as

proceeding in three steps – sexual intercourse, conception and gestation/parturition – and identified 11 intermediate physiological variables affecting these steps. Among these were infecundity and foetal mortality, which they distinguished as voluntary (induced abortion) or involuntary (miscarriage, stillbirth). Davis and Blake were the first to integrate such physiological processes into a systematic framework for understanding fertility variation across space and place as the outcome of the reproductive process.

Bongaarts (1978) built on this foundation and introduced the concept of proximate determinants of fertility, focusing on the behavioural and biological factors that directly influence fertility outcomes. In his formulation, the original 11 intermediate variables were reduced to four main driving forces, including induced abortion, while miscarriage was excluded. Miscarriage is largely perceived as uncontrollable due to chromosomal errors leading to embryo rejection (Brosens et al., 2022), in contrast to the successes of modern medicine in reducing infant and child mortality. The relevance of infertility was at least disputed (e.g. Stover, 1998). However, later on, infertility was reduced to postpartum infecundability because sterility levels were perceived as low and, like miscarriage, irrelevant for explaining cross-country variation (Bongaarts, 2015).

As a result, contemporary fertility theories in ageing societies have tended towards an isolated event perspective in which births are treated primarily as outcomes of social processes, socioeconomic conditions and cultural factors. The most prominent of these theories – i.e. the second demographic transition theory (van de Kaa, 1987; Lesthaeghe and Surkyn, 1988; Lesthaeghe, 1995) and its recent extensions – emphasises the dissociation of marriage (or union formation more generally), sexual intercourse (or sexual orientation and gender identity more generally) and conception (Peri-Rotem, 2025). Broader societal modernisation processes, like continuing changes in values and gender roles, and socioeconomic changes are seen as contributing to the postponement of births. Higher maternal age is recognised as a risk factor only insofar as it shortens the reproductive window, potentially reducing the number of births.

One potential reason for the marginalisation of ARE in demographic theory and empirical research is the scarcity and inconsistency of available data. Miscarriages are often unreported or recorded only when medically attended. While infertility can be captured through self-reports or clinical diagnoses, it is often the case that neither of these potential data sources is available. Induced abortions are documented unevenly across countries due to legal, institutional and political factors (e.g. Sedgh et al., 2016). As a result, reliable population-level data or survey data that capture the wider spectrum of reproductive experiences are rare, fragmented and difficult to compare across settings.

Nevertheless, a few individual-level studies suggest that ARE may contribute to the gap between intended and realised fertility and to high levels of childlessness in Europe (Sobotka and Beaujouan, 2018; Beaujouan and Berghammer, 2019). For example, Greil et al. (2024) showed that experiences of perceived infertility are associated with variation in subsequent fertility: some women with infertility have fewer children, while others have more, highlighting the need to consider interactions among different types of ARE. Miscarriage, particularly recurrent miscarriage, is associated with increased risks in subsequent pregnancies, such as pre-term birth, foetal growth restriction, placental complications and stillbirth, as well as longer-term health consequences (Quenby et al., 2021; Wu et al., 2022).

The level of distress women experience following miscarriage or stillbirth depends on factors such as their pregnancy planning, the timing of the loss, their history of infertility and their subsequent live births (Shreffler et al., 2011). Miscarriage and the accompanying distress and psychological adjustments also influence women's fertility ideals and long-term goals. Empirical evidence suggests that after a miscarriage, the desired number of children declines (Beringer and Milewski, 2024 for Germany), but the importance of motherhood also increases (Erato et al., 2022 for the US).

By contrast, abortion does not show a strong age gradient and is more closely associated with limiting childbearing or adjusting the timing and spacing of births, rather than representing a physiological barrier. Socioeconomic concerns are often cited as reasons for having an abortion (Chae et al., 2017), while attitudes towards abortion in Europe tend to be more accepting when the reasons for the abortion are medical rather than social (Milewski and Carol, 2018). Medically induced abortions may increase with higher maternal age or follow assisted conceptions (Edozien, 1998; ESHRE, 2017). Overall, the limited number of empirical studies on ARE at the individual level highlights the need for greater consideration of ARE in demographic fertility research. In particular, the interrelations among ARE and of ARE with births deserve more attention.

To address this gap, Johnson et al. (2018, 2023) introduced the concept of “reproductive careers”, which proposes that all reproductive events are embedded in and contribute to a larger reproductive pathway in the life course. This notion aligns with the concepts of “sequences” and “trajectories” in the life course framework (Giele and Elder, 1998). Unlike life events that mark transitions between stages (i.e. a birth), such fertility barriers (e.g. infertility, miscarriage and abortion) represent non-transitions, as they do not move individuals between life stages (note: for this reason, we speak in our framework of experiences rather than of events). The reproductive career concept captures the duration of biological and social reproductive processes (the span during which individuals or couples pursue family formation), and the interconnected nature of past, present and future reproductive experiences, attitudes and behaviours.

By considering the frequency (“density”) and types (“complexity”) of reproductive experiences, this perspective allows researchers to describe the reproductive load across the life course (Johnson et al., 2018, 2023). For example, a person who experienced one miscarriage and two births would have a density of three events and a complexity of two event types. Another person with one birth and two abortions would also have a density of three events and a complexity of two event types. With these measures, their framework is also useful for examining how reproductive experiences accumulate differently across social groups. Johnson et al. (2023) found that Black and Hispanic women in the US, particularly those with lower socioeconomic status or limited healthcare access, experience denser and more complex reproductive careers – indicating a higher reproductive load – than their more advantaged peers. However, while the reproductive careers approach captures the total reproductive load through the integration of multiple reproductive experiences and allows for group comparisons, it does not distinguish between ARE and births. Consequently, it does not allow for an analysis of how ARE relate to birth outcomes and whether these associations vary by age and across social groups, leaving an important gap that our proposed framework seeks to fill.

Before describing our analytical approach to implementing ARE in fertility studies, we conclude the background section by outlining a set of analytical aims that guide our empirical work. Because our study introduces a new way of integrating ARE and births within the context of fertility ageing, these aims serve as orienting expectations, rather than as formal hypotheses to be tested.

To address our first research question – What are the reproductive patterns with respect to ARE and births? – we begin by describing age-specific patterns of infertility, miscarriage and abortion. Drawing on Johnson et al. (2018), we consider the “quantity” and “complexity” of reproductive experiences, focusing specifically on the three ARE central to our framework. This allows us to observe how the accumulation and co-occurrence of ARE vary between different age groups. In a second step, and reconnecting to Davis and Blake (1956) and Bongaarts (1978, 2015), we examine how ARE relate to births within individuals. By distinguishing four types of reproductive patterns, based on whether women reported any ARE and/or any birth, we explore how the combination of ARE and births varies across age. Our second research question – How do social inequalities moderate the associations between age, ARE and births? – builds on the concept of “stratified reproduction” (Colen, 1986), which describes marginalising processes in reproductive and perinatal health among less privileged groups, including among migrant women, which are also documented in Europe (e.g. Väisänen et al., 2022; Milewski et al., 2025). Using education and migration background as indicators of social stratification, we examine how the distribution and combination of ARE and births differ across social groups. Rather than predicting the effects of social risk factors, our aim is to explore how social inequalities moderate age patterns of reproductive experiences.

Empirical material

Study context, data and sample

Our study context is Germany, which makes a good case study for several reasons. The country exhibits various characteristics associated with fertility ageing. It has a long-standing low fertility rate. At over 20%, Germany has a high rate of childlessness. The mean age at childbearing is rather high (31.8 years), and it is still rising (Destatis, 2026a). The share of women with perceived infertility is estimated at about 6% (Passet-Wittig et al., 2020). The societal climate allows for a direct question about induced abortion to be asked in a family demographic survey. Germany’s legal context regarding abortion appears to be somewhat mixed, as the country has relatively liberal regulations concerning the reasons for abortion, but rather restrictive conditions in practice. The total number of abortions per year registered in national statistics is about 106,000, corresponding to a rate of about 62 per 10,000 women (Destatis, 2026b). There are differences in fertility quantum and timing based on social determinants, such as differences by education and between majority and migrant subpopulations (Bujard et al., 2022). Germany has been a major destination for migrants in western Europe for decades. Immigrants and their descendants make up about 30% of the population as of 2023. Among younger adults aged 20 to 45, i.e. those

Table 1 Sample structure, by age group

Survey wave	Calendar years ¹	Age year	Pairfam			DemoDiff (subsample)		
			Cohort 1	Cohort 2	Cohort 3	Age year	Cohort 2	Cohort 3
			(born 1991–93)	(born 1981–83)	(born 1971–73)		(born 1981–83)	(born 1971–73)
1	2008/09	0 to 1	15 to 17	25 to 27	35 to 37			
2	2009/10	1 to 2	16 to 18	26 to 28	36 to 38	0 to 1	26 to 28	36 to 38
3	2010/11	2 to 3	17 to 19	27 to 29	37 to 39	1 to 2	27 to 29	37 to 39
4	2011/12	3 to 4	18 to 20	28 to 30	38 to 40	2 to 3	28 to 30	38 to 40
5	2012/13	4 to 5	19 to 21	29 to 31	39 to 41	3 to 4	29 to 31	39 to 41
6	2013/14	5 to 6	20 to 22	30 to 32	40 to 42	4 to 5	30 to 32	40 to 42
7	2014/15	6 to 7	21 to 23	31 to 33	41 to 43	5 to 6	31 to 33	41 to 43
8	2015/16	7 to 8	22 to 24	32 to 34	42 to 44	6 to 7	32 to 34	42 to 44
9	2016/17	8 to 9	23 to 25	33 to 35	43 to 45	7 to 8	33 to 35	43 to 45
10	2017/18	9 to 10	24 to 26	34 to 36	44 to 46	8 to 9	34 to 36	44 to 46
11	2018/19		25 to 27	35 to 37	45 to 47	9 to 10	35 to 37	45 to 47
12	2019/20						36 to 38	46 to 48

¹Data collection in pairfam took place from October of one year to May of the next year.

of reproductive age, the share of immigrants or their descendants is increasing. Socioeconomic characteristics, such as education and income, vary widely between non-migrants and the various migrant groups (Grigoriev & Körner, 2024).

We use data from the German family panel pairfam, release 12.0 (Huinink et al., 2011; Brüderl et al., 2021a). The survey started in 2008/09 with a nationwide representative sample of 12,402 women and men from three birth cohorts (1991–1993, 1981–1983, 1971–1973) who were aged 15–17, 25–27 and 35–37 years, respectively, upon their first interview. Data were collected yearly using computer-assisted personal interviews. We further employ data from DemoDiff, a complementary panel survey of 1489 East Germans from the two older birth cohorts. As the DemoDiff study started one year after pairfam (i.e. 2009/10), DemoDiff wave 1 is matched to pairfam wave 2, and so on. From wave 5 onwards, DemoDiff was fully integrated into pairfam. We do not use data from the pairfam refreshment sample or from cohort 4 (children) because they were not implemented until wave 11 (2018/19). The full merged data set consists of 83,695 observations from 13,891 respondents.

In our study, we compare the reproductive experiences (RE) of women included in pairfam and DemoDiff in a 10-year observation window, i.e. the calendar period from 2008 to 2020. All men were omitted from the sample, leaving 7129 women (42,153 observations). Pairfam data contribute to all three age groups, while DemoDiff data contribute only to the two older age groups. The time period differs slightly for participants from the Demodiff study because it started one year later (see Table 1 for an overview of the sample structure

by age group). As our aim is to cover RE in a complete 10-year observation window, we include only those women who participated in 11 waves. The exclusion of women who participated in fewer than 11 waves reduced the sample to 1863 women. In addition, one case was dropped because the individual did not provide information on abortions and miscarriages in any of the waves. Our analytical sample thus consists of 1862 women (20,493 observations).

The distribution of respondents by age group is as follows: The youngest age group, who were aged 15–17 at the start and aged 25–27 at the end of the observation window, make up about 26% of our sample. The second age group, who were aged 25–28 at the start and aged 35–38 at the end of the observation window, account for about 33% of our sample. Finally, around 41% of the observations come from the oldest age group, who were aged 35–38 at the start and aged 45–48 at the end of the observation window. By including RE occurring among three birth cohort groups in our sample in three 10-year age segments, we gain a picture of the full reproductive life span of women from age 15 to age 48. As the three age groups spent their 10-year segments in the same calendar time, they experienced similar period effects, which supersedes controlling for calendar period.

Measures of adverse reproductive experiences and births

We consider miscarriage, infertility, abortion and births as RE. For the analysis, we use aggregate indicators to describe whether women reported any of these experiences and the number of times each occurred. The information is derived from the data collected in each panel wave. Therefore, we describe in this section for each type of RE how they were surveyed and operationalised before they were aggregated, which is then described in the Independent variables section on methods. Table 2 provides the prevalence for all four types of RE by age group.

Note: In the pairfam survey, the module on “Sexuality and contraception”, which contains all three ARE we use, was asked in CASI mode (computer assisted self-interview), as these are sensitive questions. Therefore, the risk of bias due to interviewer presence or social desirability should be considerably reduced compared to interviews conducted solely in face-to-face mode. It is also noteworthy that the questions were asked in each wave, which should minimise the recall bias.

Information on miscarriage and abortion is based on two questions asking the respondent whether each was experienced in the time since the last interview (starting in wave 2 for the main pairfam sample and in wave 3 for the DemoDiff subsample). Both questions were posed to all women who ever had sexual intercourse. Women who reported that they never had intercourse were grouped as not having had any miscarriage or abortion in that year. We calculate a prevalence in our 10-year observation window by using the information from waves w2 to w11, corresponding to the age years at t1 to t10. The exact number of times a miscarriage and/or an abortion occurred between the waves is unknown. We count each wave in which a miscarriage and/or an abortion was reported as one of these ARE. Thus, our measures of the frequency of miscarriage and of abortion are likely conservative.

Table 2 Frequency of reproductive experiences in 10 consecutive years (%)

	15–27 years		25–38 years		35–48 years		Total	
	lb	ub	lb	ub	lb	ub	lb	ub
Number of times infertility mentioned								
0	92.5	76.0	76.5	64.4	55.8	46.1	72.1	59.9
1	5.2	14.6	8.4	12.2	9.3	11.8	7.9	12.7
2	1.7	3.8	4.7	7.7	5.4	6.6	4.2	6.2
3	0.4	4.0	2.6	4.0	3.9	4.7	2.6	4.3
4+	0.2	1.7	7.9	11.6	25.6	30.8	13.2	16.9
Number of miscarriages								
0	92.9	89.4	87.0	83.3	93.3	87.3	91.1	86.5
1	4.4	6.9	10.0	12.9	4.3	7.7	6.2	9.2
2+	2.7	3.8	3.1	3.9	2.4	5.0	2.7	4.3
Number of abortions								
0	95.0	91.2	92.4	88.7	96.5	90.2	94.7	90.0
1	4.2	6.7	5.8	8.4	2.8	6.4	4.1	7.1
2+	0.8	2.1	1.8	2.9	0.8	3.4	1.1	2.9
Number of live births ¹								
0	85.6		37.2		82.0		68.0	
1	10.6		32.5		14.8		19.7	
2+	3.8		30.3		3.1		12.4	
<i>N</i>	479		621		762		1862	
%	25.7		33.4		40.9		100	

Notes: Calculations based on: pairfam waves 1–12 (2009–2020). lb = lower bound, ub = upper bound.

¹There is no lower and upper bound for the number of live births.

Perception of infertility is based on two questions in which the respondents were asked to assess their own and – if they had a partner – the partner’s “ability to conceive” (women) or “procreate naturally” (men). The questions were asked from wave 1 onwards and referred to the time at interview. Therefore, we used the information on infertility in waves w1 to w10, corresponding to our age observation window t1 to t10. In addition, we were faced with some situations in the data that required us to make decisions. These situations resulted mainly from the filtering in the pairfam questionnaire or from changes in the survey design and are described below:

- Women who were pregnant at the time of the interview were not asked about their own and their partner’s infertility in this wave, assuming that they were fertile. Hence, we categorised these women and their partner as fertile in the respective year. We have no information on whether the pregnancies occurred with or without medical help. However, considering the still low share of children conceived with assisted reproductive technology, assuming that these women were fertile seems reasonable.

- Women who mentioned that they themselves or their current partner were sterilised were not asked about their perceived infertility. We grouped women as infertile in the year when they first mentioned their own sterilisation and in all waves thereafter as they were no longer able to conceive. Women who mentioned that their current partner was sterilised were only grouped as infertile in that year. It should be noted that pairfam data do not allow us to identify the year of sterilisation because in waves 1 to 7, sterilisation was mentioned only as a method of contraception, and only respondents who reported currently using contraception were asked about it. However, people who are sterilised may not consider themselves as contracepting. Starting in wave 8, a separate question on sterilisation status was posed to all respondents.
- The questions on perceived infertility were only posed to women aged 21 and older, presumably because it was assumed that younger women were fertile or, if asked, would not know whether they were fertile because they had not yet tried to conceive. Thus, women under age 21, and their partner (if they had one), were grouped as fertile.
- Women who reported that they had finished menopause were not asked about their own and their partner's infertility; we treated them as infertile.
- In waves 2 and 3, preloaded information was used in pairfam and women who had mentioned being infertile in the previous wave were not asked again, as it was assumed that they were sterile. These cases were grouped as infertile in the wave(s) with missing information.

However, all these coding decisions did not affect the question of whether a respondent was ever infertile (which was captured in our aggregate measure of the complexity of ARE); it affected only its frequency (which was captured in our measure of the quantity of ARE) (see Independent variables section).

Information on a woman's infertility and the infertility of her partner (if she had one) was combined to a couple indicator. Infertility (1) was assigned if infertility was perceived for at least one partner, while fertility (0) was assigned if the woman or both partners were perceived as fertile. Note: Using the available data in pairfam to define the start and the end of infertility was hardly possible for individuals. In many cases, individuals underwent a gradual process starting with the suspicion that they had fertility problems and leading to the recognition that they were infertile. The subsequent process of getting a diagnosis and perhaps receiving treatment may have spanned (at least) several months. For some individuals, infertility may have been temporary, while for others it would have been a recurrent experience (Passet-Wittig et al., 2020). In order to account for the relatively long time dimension of these processes, we count each wave in which infertility was reported as one.

Our fourth indicator of RE is the number of births. It includes all children born reported by women in waves w2 to w11 for the previous year, i.e. our observation window t1 to t10. Note that the number of live births does not necessarily reflect the number of pregnancies/deliveries, as women may have had twins or multiples. In such cases, we count each child born as one birth.

Accounting for uncertainty

Questions on ARE in surveys are not only sensitive, and therefore vulnerable to social desirability bias; they also involve a substantial degree of subjectivity and uncertainty. Infertility and miscarriage, in particular, are experiences that women may define or interpret differently. A common strategy to detect under- or overestimation in survey data is to compare reported prevalence with official statistics. In our case, however, administrative sources or register data do not constitute a more reliable benchmark because they capture only cases that enter the medical system. For both infertility and miscarriage, a considerable share of affected women may never seek medical care, especially when treatment is not required. Moreover, our aim extends beyond documenting “strictly medical” events. We seek to capture the broader experience of reproductive barriers, interruptions and disruptions, recognising that women’s subjective perceptions of these events are central to their wellbeing and decision-making (Minello, 2025).

At the same time, we acknowledge that respondents may have felt uncertain about how to classify their own experiences. For example, if a woman did not seek medical care for an early pregnancy loss, she may have questioned whether it should be considered a miscarriage. Similarly, without a formal diagnosis, she may have hesitated to label her difficulties conceiving as infertility. To account for this, we incorporated response categories that explicitly captured uncertainty and included them in our analyses, i.e. “don’t know” or “I don’t want to answer that”.

Common approaches for dealing with such non-substantive answers or item non-response are listwise deletion or some kind of imputation, including multiple imputation (Young, 2012). However, listwise deletion because of non-substantive responses on one ARE would most likely result in a considerable loss of information, also with respect to other ARE and births. Imputation approaches require assumptions of the researcher about the true value that could be more or less realistic. These assumptions are then applied to all cases with missing values. Our approach, however, is based on the premise that in the case of very sensitive questions such as those on ARE, non-substantive responses are informative. We assume that “don’t know” and “I don’t want to answer that” offer the respondents the option to avoid saying “yes” when “no” would have been wrong (Milewski et al., 2025). Interpreted in this way, such non-substantive answers can be used to create a range of results, i.e. a lower and an upper bound, in a situation where the true prevalence is not known, but it is expected to be in that range. A similar approach has been applied previously (Milewski et al., 2025). For the lower bound, we assumed that all women with non-substantive responses did not have such an experience and assigned a value of zero. For the upper bound, we assumed that women did have this experience and assigned a value of one.¹

1 Non-substantive responses here include “don’t know” and “I don’t want to answer that”, as well as a very few cases with a filter error/incorrect entry. The lower and the upper bound were imputed for 124 observations with item non-response on abortion, 159 observations with item non-response on miscarriages and 787 observations with item non-response on own infertility, as well as for 506 observations with item non-response on partner’s infertility.

Table 3 Independent variables by age group

	15–27 years		25–38 years		35–48 years		Total	
	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>	%	<i>N</i>
Parity (t0)								
No child	100.0	479	61.2	380	20.1	153	54.4	1,012
1 child	0.0	0	25.4	158	28.1	214	20.0	372
2+ children	0.0	0	13.4	83	51.8	395	25.7	478
Level of education (t0)								
≤lower secondary	37.0	177	8.1	50	6.8	52	15.0	279
Higher secondary +	63.0	302	91.9	571	93.2	710	85.0	1,583
Migrant generation								
Non-migrant	81.0	388	80.0	497	76.8	585	78.9	1,470
1st generation migrant	4.6	22	11.6	72	9.3	71	8.9	165
2nd generation migrant	12.5	60	5.3	33	11.0	84	9.5	177
Missing value	1.9	9	3.1	19	2.9	22	2.7	50
<i>N</i>	25.7	479	33.4	621	40.9	762	100	1862

Notes: Calculations based on: pairfam waves 1–12 (2009–2020).

In the total sample, the share of women who reported having an abortion in the 10-year period ranges from 5.3% to 10.0%. The estimated share of women who experienced a miscarriage in 10 years is between 8.9% and 13.5%. The range for infertility is from 27.9% to 40.1% in the full sample (see Table 2).

Independent variables

Knowing the number of children women had at the beginning of the observation window is important for understanding their subsequent reproductive experiences. Therefore, we constructed a measure indicating women's parity at t0. The variable captures biological children in categories (none/one/two or more children) born prior to the respective 10-year observation window. The women in the youngest cohort, who were 15–17 years old at their first observation, were all childless at t0. In the middle group, aged 25–28 at t0, the share of women who were childless at t0 was about 61%. Among the women in the oldest group, aged 35–38 at t0, the share who were childless was about 20% (see Table 3 for a description of the sample using all independent variables). We used the indicator for parity at t0 as a control in the multivariable models. In addition, we carried out an analysis only on the women who were childless at t0.

For the multivariable analysis, we constructed two socioeconomic determinants. Level of education reflects the status at the beginning of the observation window (t0); it is based on a revised version of the International Standard Classification of Education (ISCED) provided

Table 4 Pairwise overlapping of four types of reproductive experiences in 10 consecutive years (%)¹

	Infertility			Miscarriage			Abortion			Birth				
	lb		ub	lb		ub	lb		ub	lb		ub		
	%	%		%	%		%	%		%	%			
Infertility	-	-		10.6	17.3	**	6.7	15.1	**	31.0	**	28.5		
Miscarriage	33.1	51.2	**	-	-		13.3	**	39.3	**	65.7	**	52.0	**
Abortion	35.7	60.4	**	22.5	**	52.9	**	-	-		41.8	*	32.1	
Birth	27.0	35.7	**	18.3	**	22.0	**	6.9	*	10.1	-	-		

Notes: Calculations based on: pairfam waves 1–12 (2009–2020). $N = 1862$ women. lb = lower bound, ub = upper bound. Stars denote results from χ^2 test of correlation: ** $p = 0.01$, * $p = 0.05$.

¹For respondents from the pairfam sample, the corresponding calendar years are 2008/09–2018/19, while for respondents from the Demodiff sample, the corresponding calendar years are 2009/10–2019/20.

in the pairfam dataset, whereby respondents who were currently enrolled were assumed to have completed their education and were assigned the corresponding degree (see Brüderl et al., 2021b). We use a two-category indicator, which differentiates between women with lower secondary education or lower schooling (ISCED 1–3) and women with at least higher secondary education (ISCED 4–8). Eleven women with missing information on level of education were grouped together with women with lower education. The share of women with higher education in our sample is considerably larger in the two older age groups than in the youngest one. In order to account for migrant background, we constructed an indicator for migrant generation based on the generated variable migstatus provided in the data set. We distinguish between the first migrant generation, consisting of individuals who were born abroad and whose parents were born abroad; the second migrant generation, consisting of the children of migrants who were born in Germany; and non-migrant German-born women. The share of migrant women varies across age groups. Overall, about 19% of the sample are migrant women with only minor differences between the age groups.

Methods

While Table 2 displays the frequency of each ARE by age group, Table 4 provides a description of the pairwise overlapping of the four types of RE in the full sample. This gives us a first impression of to what extent women reported a combination of distinct types of RE. For instance, of the women who reported having at least one miscarriage, about 13% also reported having an abortion, about 33% indicated that they had infertility and about 66% said that they had one or more births in the 10-year observation window (using the lower bound). Table 4 highlights the heterogeneity in women’s reproductive experiences with regard to the combinations of ARE and their interrelation with births.

In order to capture these different aspects of *heterogeneity* of RE, we proceed in three steps:

Table 5 Combinations of infertility, miscarriage and abortion, and shares with live births in 10 consecutive years¹

Combinations of ARE	Lower bound			Upper bound		
	<i>N</i>	%	% with live births	<i>N</i>	%	% with live births
Infertility	439	23.6	27.1	575	30.9	25.4
Miscarriage	99	5.3	70.7	94	5.1	71.3
Abortion	51	2.7	39.2	45	2.4	40.0
Infertility and abortion	25	1.3	40.0	43	2.3	34.9
Miscarriage and abortion	12	0.6	58.3	29	1.6	41.4
Miscarriage and infertility	45	2.4	62.2	59	3.2	62.7
Infertility and miscarriage and abortion	10	0.5	40.0	70	3.8	21.4
None	1181	63.4	28.6	947	50.9	30.2
Total	1862	100	32.0	1862	100	

Notes: Calculations are based on: pairfam waves 1–12 (2009–2020). Combinations of infertility, miscarriage and abortion reflect whether women have ever experienced none, one, two or all types of events.

¹For respondents from the pairfam sample, the corresponding calendar years are 2008/09–2018/19, while for respondents from the Demodiff sample, the corresponding calendar years are 2009/10–2019/20.

First, we look at the “quantitative dimension” of ARE, i.e. miscarriage, abortion and infertility, by summing up the number of times each of them was reported. This procedure is similar to that suggested by Johnson et al. (2018), but excludes births:

$$\begin{aligned} \text{Quantity}_{\text{ARE}} &= \# \text{miscarriages} + \# \text{abortions} \\ &+ \# \text{infertility (with values ranging from 0 to 15)}. \end{aligned}$$

Second, we are interested in the “qualitative dimension” of these experiences, i.e. how many types of these ARE occurred in the observation window. We define complexity of ARE as the sum of distinct types, i.e. miscarriage, abortion and infertility. We count each type as one, independently of the number of waves in which it was reported. This approach bears similarities to that of Johnson et al. (2018) with respect to summing up the occurrence of each type. Our approach differs from theirs by not further differentiating the intendedness of pregnancies, and we do not include births in the measure of complexity because our measure of complexity refers only to ARE:

$$\text{Complexity}_{\text{ARE}} = \text{miscarriage} + \text{abortion} + \text{infertility (with values ranging from 1 to 3)}.$$

Third, we relate the complexity of ARE to having a birth. This is different from Johnson et al. (2018) but connects to the framework of the proximate determinants of fertility (Davis and Blake, 1956; Bongaarts, 1978). Table 5 shows the frequency and share of eight empirical variations of complexity of ARE in relation to also having a birth. Out of the eight complexity patterns, the women in the group without any ARE have a chance of having a birth of between 29% in the lower bound and 30% in the upper bound. The women with the highest chance of having a birth are those who reported only experiencing miscarriage, as their

probability of having a birth is about 71% in the lower and the upper bound. The women who experienced miscarriage and infertility have the next-highest chance of having a birth, of between 62% and 63% (lower and upper bound).

While Table 5 suggests overall heterogeneity in RE in our sample, it also becomes clear that we need to combine the three types of ARE due to small sample sizes for individual ARE and combinations. We construct an indicator for the reproductive pattern capturing whether any ARE and any births were reported in the 10-year observations window.

Our indicator of reproductive pattern across 10 years has the following four categories:

- (1) adverse experience/no birth;
- (2) adverse experience/birth;
- (3) no adverse experience/no birth;
- (4) no adverse experience/birth.

We use the reproductive pattern variable as the outcome in multivariable regression models. As the four categories are not ordered, we can estimate multinomial regression models to assess group differences in reproductive patterns with age group as the main predictor. In the base model, we control for parity at t0 (M1). In the second model, we add migrant generation and education at t0 (M2). Note: We use parity at t0, migrant generation and education at t0 primarily as moderators for the main association of interest, i.e. between age and reproductive patterns. Previous research demonstrates significant variation in the quantity and the timing of fertility between and within these social groups (Bujard et al., 2022; Milewski and Adserà, 2023). Thus, women belonging to different social groups may be in different life course stages when observed in the same age group.

We carry out all described steps for the analytical sample once using the lower bound and once using the upper bound. Thus, all results will be described as a range rather than as a point estimate, based on the assumption that the true value lies somewhere between the lower and the upper bound. We believe that this procedure is appropriate especially for research topics like this one, which are associated with sensitivity and uncertainty. To display the results, average marginal effects (AME) are shown. In contrast to coefficients and relative risk ratios, AME can be interpreted as predicted probabilities. Stata/SE 19.0 was used for all analyses.

Data limitations and robustness

Ideally, we would have data covering the complete reproductive life course of about 30 years for each woman, from age 15 onwards, covering all types of ARE and births. However, we are not aware of recent data that are available for our research purposes in Germany. Our demands on the data are rather large, in particular with respect to the ARE. The frequency of the three types of ARE is relatively low compared to that of births. Therefore, we would actually need a large data source, such as register data. It is, however, likely that the three types of ARE are under-recorded in such data or national statistics. Like in the case of miscarriage, not every affected individual will need or seek treatment.

Moreover, some individuals who are infertile may have a feeling that they cannot have a child but have not (yet) received a diagnosis. Although such cases would not be recognised in, for example, health care data, they contribute to the lived experiences of women.

At the same time, there are some drawbacks to using survey data. Our dataset is not only smaller than population data would be, it becomes even smaller after applying our sample selection criteria. The decline in cases resulted mainly from our criterion that we needed 11 consecutive observations for each woman. We compared the occurrence of reproductive experiences in the full sample (all women before our selection criteria were applied) and in the analytical sample of women who participated in all waves (not shown, available upon request). As would be expected, all types of reproductive experiences are mentioned less often in the full sample than in the sample with complete cases. By using the full sample, i.e. including incomplete cases, we would considerably underestimate the occurrence of reproductive experiences, including births, in the 10-year observation window.

Regarding the sociodemographic indicators, [Table S.3](#) shows the distribution of age groups and covariates used in the full sample and the analytical sample. For age groups, the analytical sample has fewer women in the youngest age group and more women in the oldest one, while the share of respondents in the middle age group is similar across samples. For the number of children at t0, we see a lower share of women without children in the analytical sample than in the full sample and a larger share of women with one child. Furthermore, those women who participated in all waves, i.e. our analytical sample, have higher education and are somewhat more likely to not have a migration background than those in the full sample. To conclude, we believe that the level of selectivity in our analytical sample is at most moderate, and that it represents the sociodemographic structure of the full pairfam sample quite well. In the multivariable analyses, we use social group belonging mainly as a control in the analysis of the association of age and reproductive pattern; thus, we do not perceive these deviations to be problematic in terms of introducing bias into our analysis.

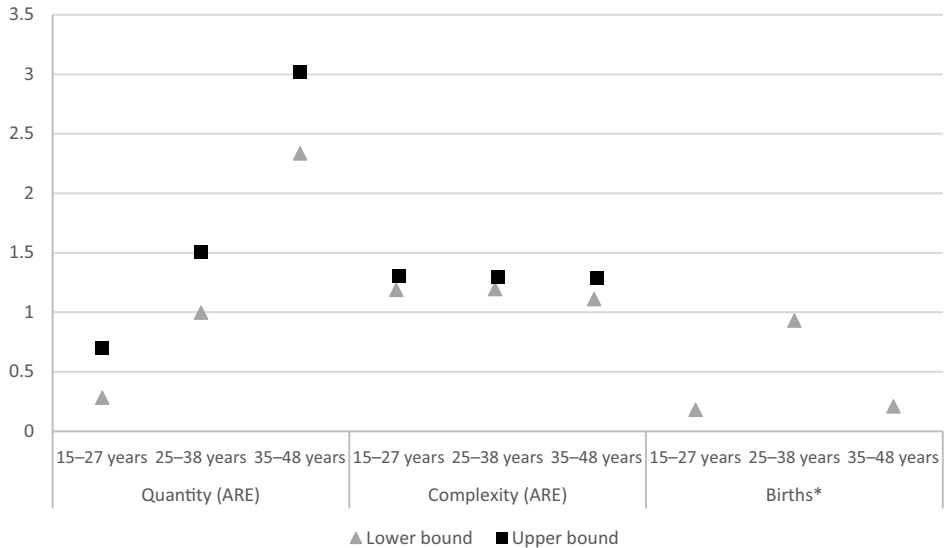
In addition, we carried out all analyses for women who were childless at t0 only. The overall results for this group are similar to those for the full sample and for mothers (results available upon request).

Results

Quantity and complexity of ARE

[Table 2](#) provides a descriptive overview of the quantity of the three types of ARE by age group. For infertility, we find the expected pattern of prevalence increasing with age. In the 35–48 age group, infertility prevalence ranges from about 44% (lower bound) to 54% (upper bound). The number of times infertility was reported increases with age, as well. This demonstrates that infertility is a rather common experience, and that it tends to be long-term in nature, or a recurrent condition. For miscarriage, we see a somewhat different, inverted U-shaped age pattern (see [Table 2](#)). Up to 5% of the women in our sample reported having a miscarriage two or more times over the 10-year period. For abortion, there is little

Figure 1 Average quantity of ARE, complexity of ARE and number of births in 10 consecutive years, by age group



Notes: Calculations based on: pairfam waves 1–12 (2009–2020). *N* = 1862 women.
* There are no lower and upper bounds for the number of live births

variation across age groups. The quantity of ARE appears to be partially driven by our operationalisation of infertility, because we counted each year of its reporting as one “time” to account for the temporal nature of infertility. However, taken together, the lower frequencies of miscarriage and abortion in this oldest age group, among whom infertility is also relatively common, is indicative of the age-related decline in the probability of conceiving. The prevalence of both infertility and miscarriage suggests that a considerable share of women in our sample may have attempted to get pregnant and to have a child, and that this share is highest between the mid-twenties and mid-thirties.

Table 5 displays overlapping patterns of all three types of ARE, thus accounting for the complexity of ARE. The share of women who did not report any ARE over the 10-year period is only about 63% in the lower bound and as low as 51% in the upper bound. In other words: almost every second woman in this sample reported experiencing at least one of the three ARE over 10 years. We find that 32% to 38% of the respondents experienced one type of ARE while about 5% to 11% experienced several types of ARE over 10 years. Patterns consisting of infertility (either with miscarriage or abortion) appear more likely than patterns consisting of miscarriage and abortion.

Figure 1 shows the quantity of ARE, i.e. the sum of all reported infertility episodes, miscarriages and abortions. We see the expected continuous increase in ARE across age groups, with women in the 35–48 age group reporting up to three ARE over 10 years. For the complexity of ARE, which is calculated only for the women who reported any ARE,

no such increase can be observed by age. The average number ranges between 1.2 and 1.3, with hardly any differences between the lower and the upper bound or between the age groups. These slight differences may be partially attributable to statistical reasons, e.g. we take only three distinct types of ARE into account, and two of these tend to occur rather infrequently. Our results may also be related to the different “natures” of the ARE. Our finding of a higher coincidence of infertility/miscarriage than of infertility/abortion and miscarriage/abortion (see Table 5) seems plausible in a family demographic context with widespread contraceptive use, like Germany. This may explain why the joint occurrence of all three ARE is rare.

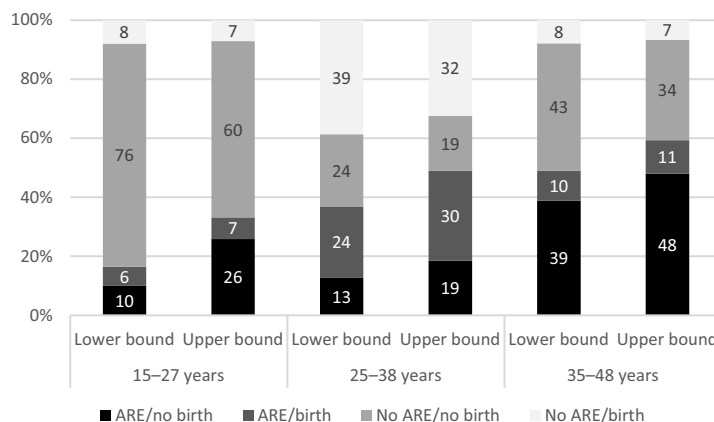
ARE in relation to birth

Table 5 also displays the patterns of ARE in relation to having a birth. Women who experienced a miscarriage in any combination of the types of ARE were also relatively likely to have also had a birth, with the probability ranging from about 21% to 71%, while those who reported only having infertility had the lowest probability of having a birth, ranging from 27% to 25%. Among the respondents who reported having an abortion (with or without experiencing other types of ARE), rather large shares also had a birth over the observation window (ranging from roughly 21% to 58%). Note: About 38% of our sample in the 25–38 age group already had children at t_0 , as did as much as 80% in the 35–48 age group (see Table 3). These two age groups likely used abortion to limit their number of children. In the youngest age group, by contrast, abortion may have also had a fertility timing component.

In Figure 1, we compare the quantity of ARE and births by age group. Note that the number of ARE is at least as high as the number of births in all age groups. The quantity of ARE increases by age. Up to their mid-twenties, women reported having less than one ARE. At the same time – and as expected – the number of births in the observation window was rather low, with an average of about 0.2. When using the upper bound, women are three times as likely to have had an ARE than a birth in the youngest age group. In the middle age group, the quantity of ARE is considerably higher, ranging from one to 1.5. Among the women in the oldest age group, for whom the quantity of ARE increased sharply while the number of births decreased, the number of ARE they experienced was up to 15 times higher (upper bound) than the number of births, indicating that their reproductive load was much higher than would be inferred from birth statistics only.

Reproductive patterns

After exploring the heterogeneity of ARE, Figure 2 reduces the information to four patterns of reproductive experiences accounting for having an ARE (or not) and a birth (or not), by age group. Note that the estimates for the lower bound are higher than those for the upper

Figure 2 Reproductive patterns over 10 consecutive years, by age group (in %)

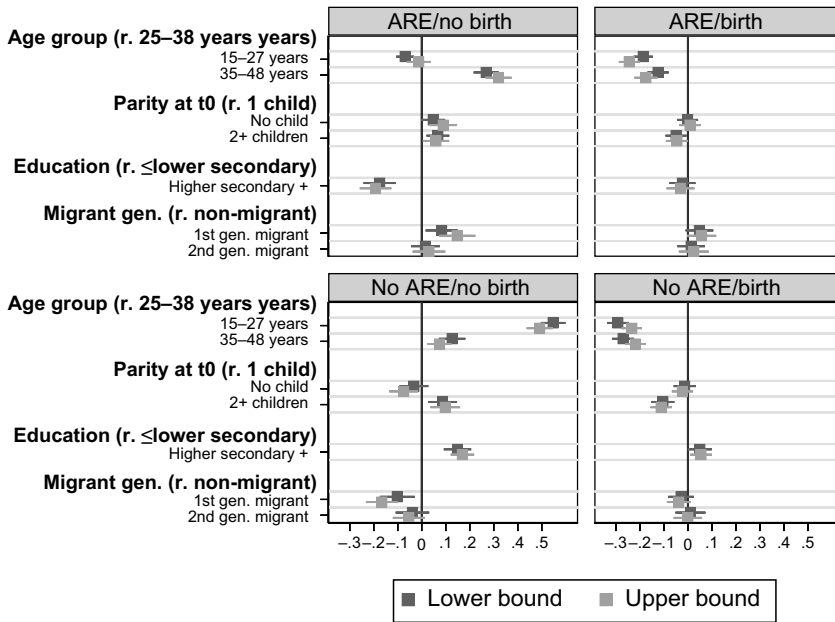
Notes: Calculations based on: pairfam waves 1–12 (2009–2020). $N = 1862$ women

bound for patterns including births. This is because patterns with ARE are more common in the upper bound, resulting from our operationalisation.

Clearly, the age window with the lowest number of any reproductive experiences is up to the mid-twenties. For this age group, 76% to 60% of our sample reported having neither ARE nor births. The share without any RE is only 24% to 19% in the 10-year period up to the mid-thirties, indicating that this age window has the highest reproductive load. At the same time, the middle age group has the highest share of women who had no ARE, but who had a birth, ranging from 39% to 32%. However, already in the middle age group, the share of women who had both ARE and at least one birth is about four times greater than that in the youngest age group, ranging from 24% to 30%. In the oldest age group, the pattern of having only ARE but no births is almost as likely as that of having no RE at all, ranging from 39% to 48%.

In the final step of our analysis, we use this variable of reproductive patterns for the multinomial regression with age group as the main predictor. In the base model, we control for parity at t_0 (M1). In the second model, we also use migrant generation and education (M2). Full regression tables are available in supplementary Table S2. Notably, the association of age with reproductive pattern is virtually the same in the base model and the model adjusting for social indicators, which is why Figure 3 shows only results from the latter. The middle age group – from the mid-twenties to the mid-thirties – who have the highest share of births, serves as our reference group. In multivariable analyses, this age group has the lowest risk of having no ARE and no births, and their risk of having no births but any type of ARE is relatively low. Compared to the middle age group, women from their mid-thirties to mid-forties have the highest risk of having only ARE and no births, and this risk increases from 27 percentage points to 32 percentage points. Similarly, among women in the oldest group, the chances of having any ARE and at least one birth are decreased by 12 percentage points (lower bound) to 18 percentage points (upper bound), and their chances of

Figure 3 Results from the multinomial model of reproductive patterns, average marginal effects (95% confidence intervals)



Notes: Calculations based on: pairfam waves 1–12 (2009–2020). $N = 1862$ women. Results of Model 2. r = reference group. Migrant generation (gen.) contains a category with missing values that is not displayed (see supplementary Table S2).

having no ARE but at least one birth are even lower, ranging from minus 22 percentage points to 27 percentage points compared to the middle age group.

The likelihood of having no reproductive experience at all is highest in the youngest age group. But from their mid-thirties to mid-forties, women's risk of having no RE also increases by seven percentage points to 13 percentage points, compared to the middle age group. Many of the oldest women in our sample have finished their childbearing. Moreover, for those who want children, their reproductive experiences are accompanied by adversity or consist only of adverse experiences.

Finally, we turn to our second research question on the association between social stratification and reproductive patterns. Supplementary material Table S1 (available online at <https://doi.org/10.1553/p-3fdh-k3g2>) displays a bivariate description of the reproductive patterns by our explanatory variables. Our multivariable results (see Figure 3) are mostly in line with what was expected from the theoretical considerations and previous evidence on stratified patterns in reproduction. Women with higher education have lower probabilities of having any ARE and no births compared to women with lower education. Higher educated women are also more likely to have no reproductive experiences at all. First-generation migrants have a higher probability of experiencing ARE, either with or without

births, compared to non-migrant natives. Women of the first migrant generation also have the lowest probability to have no RE at all, while women of the second generation do not differ from non-migrant women in a statistically significant way. As controlling for these variables hardly changes the main associations between age and reproductive patterns, it appears that higher age is a primary driver of ARE and their associations with births in our analyses. This conclusion is also supported by the rather large effect magnitudes of higher age.

Discussion

Summary of the main findings

This study set out to advance research on late and low fertility in Europe by re-integrating infertility, miscarriage, abortion and births into a joint analytical framework. Rather than examining these experiences in isolation, we conceptualised them as interconnected components of women's reproductive life courses, drawing on the earlier frameworks of the proximate fertility determinants and the more recent concept of reproductive careers. Using data from 1862 female respondents in the German family panel pairfam, we estimated the patterns of adverse reproductive experiences and their associations with births in three 10-year age segments. Germany represents a good setting for this analysis, given its persistently late and low fertility, high levels of childlessness and pronounced social stratification in fertility patterns. By examining the full spectrum of reproductive experiences in this context, the study provides a comprehensive understanding of the heterogeneity of women's reproductive patterns and their variation by age.

Our analysis shows that adverse reproductive experiences are a widespread component of women's reproductive life courses. Within a 10-year window, 5% to 10% of respondents reported having at least one abortion, 9% to 14% reported having at least one miscarriage and 28% to 40% reported experiencing infertility, which clearly indicates that none of these types of ARE are rare. To address age-specific reproductive patterns, we employed a step-wise estimation strategy that captured both the quantity and the complexity of these experiences and then related them to births. The results reveal substantial heterogeneity across the age segments. The overall frequency of AREs is roughly three times higher after the mid-thirties than in the preceding decade. After age 35, the ratio of AREs to births reaches its lowest point, indicating diminishing returns on reproductive efforts as reproductive attempts increasingly result in adverse outcomes. These developments coincide with the well-documented cumulation of risks and side effects for the mother and the child associated with advanced maternal age.

Our analysis of social stratification adds important nuance to the interpretation of reproductive patterns. Consistent with theoretical expectations and prior research on stratified reproduction, women with higher levels of education exhibit lower probabilities of experiencing any ARE without a birth and are more likely to report having no reproductive events at all. First-generation migrants have elevated risks of AREs – both with and without subsequent births – relative to non-migrants, while women in the second migrant generation

occupy an intermediate position. These patterns reflect well-documented differences in reproductive intentions, timing and constraints to reproduction across these social groups. However, adjusting for socioeconomic and migration-related characteristics has only minimal impact on the age gradient in ARE. The pronounced increase in the occurrence of ARE after the mid-thirties remains largely unchanged and the magnitude of the age effects is clearly greater than that of other predictors. This suggests that sociodemographic characteristics may partially operate through selection into attempting reproduction, i.e. educational and migration backgrounds shape whether and when women engage in reproductive “trying”. At the same time, lower education and having a migration background are associated with higher risks of experiencing adverse outcomes and no births once attempts occur. This may be indicative of economic and health disadvantages, as well as lower rates of help-seeking or less effective medical or non-medical interventions in these groups (Milewski et al., 2025).

Reflection

This study also has limitations that should be acknowledged. First, our measures rely on self-reported reproductive experiences, which have elements of subjectivity and uncertainty, particularly regarding early miscarriages or periods of unconfirmed infertility that did not involve medical consultation. To address this, we explicitly included response categories that capture uncertainty and incorporated them into the analysis rather than omitting these cases from analyses or forcing classification. Second, while our data cannot be cross-validated against medical or administrative records, the aim of this study is to capture women’s lived and perceived reproductive experiences – not solely cases that were clinically treated. In this context, personal reports are not merely a second-best substitute, but the most appropriate source for understanding how women experience, interpret and act upon reproductive barriers. The prospective design of pairfam with annual interviews further supports good recall of sensitive experiences. Third, although we explored social inequalities as part of the analysis, this was not the central focus of the study. Future research could examine in greater depth how education, migrant status or belonging to an ethnic minority group, as well as other socioeconomic factors, shape exposure to adverse reproductive experiences and their associations with births. Constraints related to sample size and cohort structure also limited the detail in which subgroup patterns could be examined. We conducted several sensitivity checks to ensure the robustness of key patterns.

Another limitation concerns the somewhat static nature of our typology. While the 10-year observation window allowed us to capture combinations of adverse reproductive events and births over a substantial period of the reproductive life course, our typology did not account for the timing, ordering or sequencing of these experiences. As a result, qualitatively different trajectories, such as adverse events occurring before versus after a (first) birth, or repeated adverse experiences followed by a later birth, were necessarily grouped together. Such trajectories may have different meanings and implications from a life course perspective, including potentially distinct psychological and behavioural

consequences. However, the aim of this paper was not to model reproductive trajectories dynamically, but to develop an analytical framework for assessing the cumulative burden of adverse reproductive experiences in late fertility contexts. Given current data constraints, particularly the limited number of cases for specific combinations of ARE, more detailed sequence-based analyses would lack sufficient statistical power and risk overinterpretation. Our approach therefore prioritised simple, analytical clarity and comparability across age segments, offering an aggregated view of how reproductive efforts increasingly translate into disruptions rather than births at later ages. Future research could apply the suggested framework to explicitly address timing, sequencing and trajectory heterogeneity using larger samples or life course-based methods such as event history or sequence analysis.

Outlook

Our study has documented the prevalence, accumulation and age gradient of adverse reproductive experiences. Although individual findings may align with existing expectations, the joint analysis of adverse reproductive experiences and births provides insights that go beyond isolated event perspectives. In this final section, we outline the implications of our integrated approach and highlight promising directions for future research. Most importantly, adverse reproductive experiences should be more systematically incorporated into data collections, empirical research and theory on fertility. These experiences appear today to be largely peripheral to demographic research on fertility. Infertility has received growing attention and can be seen as a forerunner in re-introducing physiological and biological constraints into the study of the proximate determinants of fertility. Our findings demonstrate that extending this perspective to include miscarriage and abortion is essential for a more complete understanding of reproductive behaviour, particularly in contexts characterised by delayed childbearing and heightened exposure to reproductive barriers.

Along these lines, our results suggest that the commonly cited notion of “fertility postponement” does not fully capture the range of reproductive experiences observed in ageing societies. At the individual level, postponement typically implies deliberate timing decisions and assumes that postponed childbearing will eventually be realised. The results point to substantial heterogeneity in reproductive processes that challenges this assumption. The absence of a birth over a 10-year period does not necessarily indicate a lack of reproductive activity. Many women – and their partners – may have actively attempted to conceive but experienced only adverse reproductive events. In our sample, a notable pattern consists of childless women who reported infertility or pregnancy loss without any subsequent birth; in the oldest age group, this applies to up to one-quarter of respondents. For these women, the concept of postponement appears insufficient. Instead, their experiences are better described as forms of “fertility disruption”, as their reproductive outcomes reflect physiological and psychological barriers rather than deliberate delay. This distinction raises important questions for future research, including about how fertility “postponers” differ from those who experience fertility disruption.

Current demographic theories of fertility predominantly emphasise social, institutional and policy-related factors, such as gender equity, work-family reconciliation and family support policies, while giving comparatively limited attention to biological and health-related constraints. However, empirical evidence shows that infertility does not automatically translate into having fewer children than intended, which raises questions about who is able to compensate for infertility and under what conditions, and what role ART plays in this context. These questions are closely linked to micro-level processes: adverse reproductive experiences such as infertility or miscarriage can act as life course disruptions that affect wellbeing and shape subsequent trajectories, e.g. through union instability, altered partnership dynamics or a reduced willingness to pursue parenthood due to anticipated psychological or physical burdens. At the same time, infertility and miscarriage share many risk factors, and the use of ART may itself be intertwined with subsequent adverse reproductive experiences, and be shaped by physiological, financial, ethical, cultural or personal considerations.

At the macro level, our findings highlight age as a central risk factor for the occurrence of adverse reproductive experiences and their associations with birth outcomes. While much demographic research continues to focus on policy levers aimed at facilitating childbearing, a more systematic integration of reproductive barriers into fertility theory may help to explain why such policies often have limited effects on fertility levels in late fertility societies. Incorporating these dimensions would refine existing models of the proximate determinants of fertility and provide a more realistic account of reproductive decision-making under conditions of delayed childbearing. Further theoretical and empirical progress in this direction critically depends on the availability of data that capture adverse reproductive experiences. The pairfam study and recent data collections in other European countries (Beaujouan et al., 2025; Minello, 2025) demonstrate that respondents in demographic surveys are willing to report on these sensitive experiences and may even value their recognition.

Supplementary material

Available online at <https://doi.org/10.1553/p-3fdh-k3g2>

Supplementary file 1. Table S1–S.3



Acknowledgement

We thank two anonymous reviewers for their constructive comments, which helped to improve this manuscript. An earlier version of this study was presented at the Wittgenstein Centre for Demography and Global Human Capital Conference 2024 on “Delayed Reproduction” (Vienna) and at the PAA Annual Meeting 2025 (Washington, DC). We are grateful for the valuable feedback received from participants at both events.

ORCID iDs

Nadja Milewski  <https://orcid.org/0000-0003-1272-8990>

Jasmin Passet-Wittig  <https://orcid.org/0000-0001-8572-4646>

References

- Aitken, R. J. (2024). Population decline: Where demography, social science, and biology intersect. *Reproduction*, 168(1). <https://doi.org/10.1530/REP-24-0070>
- Beaujouan, É., Reimondos, A., Gray, E., Evans, A., and Sobotka, T. (2019). Declining realisation of reproductive intentions with age. *Human Reproduction*, 34(10), 1906–1914. <https://doi.org/10.1093/humrep/dez150>
- Beaujouan, E., Singh, S., Šťastná, A., Kreidl, M., Dvořák, D., Hubatková, B., Kmentova, D., Slabá, J., Passet-Wittig, J., Goisis, A., and Väisänen, H. (2025). First reproductive experience: A survey module. *Demographic Research*, 53, 1173–1206. <https://doi.org/10.4054/DemRes.2025.53.37>
- Beringer, S., and Milewski, N. (2024). A crisis in the life course? Pregnancy loss impacts fertility desires and intentions. *Advances in Life Course Research*, 60, 100612. <https://doi.org/10.1016/j.alcr.2024.100612>
- Bongaarts, J. (1978). A framework for analyzing the proximate determinants of fertility. *Population and Development Review*, 4(1), 105–132. <https://doi.org/10.2307/1972149>
- Bongaarts, J. (2015). Modeling the fertility impact of the proximate determinants: Time for a tune-up. *Demographic Research*, 33, 535–560. <https://doi.org/10.4054/DemRes.2015.33.19>
- Brosens, J. J., Bennett, P. R., Abrahams, V. M., Ramhorst, R., Coomarasamy, A., Quenby, S., Lucas, E. S., and McCoy, R. C. (2022). Maternal selection of human embryos in early gestation: Insights from recurrent miscarriage. *Seminars in Cell & Developmental Biology*, 131, 14–24. <https://doi.org/10.1016/j.semcdb.2022.01.007>
- Brüderl, J., Drobnič, S., Hank, K., Neyer, Franz, J., Walper, S., Alt, P., Borschel, E., Bozoyan, C., Garrett, M., Geissler, S., Gonzalez Avilés, T., Gröpler, N., Hajek, K., Herzig, M., Huyer-May, B., Lenke, R., Lorenz, R., Lutz, K., Minkus, L., ... Wetzel, M. (2021a). *The German Family Panel (pairfam) Beziehungs- und Familienpanel (pairfam)*. GESIS Data Archive. <https://doi.org/10.4232/PAIRFAM.5678.12.0.0>
- Brüderl, J., Garrett, M., Hajek, K., Herzig, M., Lenke, R., Lorenz, R., Lutz, K., Phan, T., Schütze, P., and Schumann, N. (2021b). pairfam data manual, Release 12.0. (ZA5678 Data File Version 12.0.0.) LMU Munich. <https://doi.org/10.4232/pairfam.5678.12.0.0>
- Bujard, M., Milewski, N., and Passet-Wittig, J. (2022). Fertilität. In O. Arránz Becker, K. Hank, and A. Steinbach (Eds.), *Handbuch Familiensoziologie* (pp. 1–28). Springer. https://doi.org/10.1007/978-3-658-35215-8_14-1
- Chae, S., Desai, S., Crowell, M., and Sedgh, G. (2017). Reasons why women have induced abortions: A synthesis of findings from 14 countries. *Contraception*, 96(4), 233–241. <https://doi.org/10.1016/j.contraception.2017.06.014>
- Colen, S. (1986). With respect and feelings: Voices of West Indian child care and domestic workers in New York City. In J. B. Cole (Ed.), *All American women: Lines that divide, ties that bind* (pp. 46–70). Free Press.
- Compans, M. C., and Väisänen, H. (2025). Social patterns of miscarriage reporting and risk: Insights from survey data in France. *European Journal of Public Health*, 35(5), 954–959. <https://doi.org/10.1093/eurpub/ckaf099>
- Coomarasamy, A., Gallos, I. D., Papadopoulou, A., Dhillon-Smith, R. K., Al-Memar, M., Brewin, J., Christiansen, O. B., Stephenson, M. D., Oladapo, O. T., Wijeyaratne, C. N., Small, R., Bennett, P. R., Regan, L., Goddijn, M., Devall, A. J., Bourne, T., Brosens, J. J., and Quenby, S. (2021). Sporadic miscarriage: Evidence to provide effective care. *The Lancet*, 397(10285), 1668–1674. [https://doi.org/10.1016/S0140-6736\(21\)00683-8](https://doi.org/10.1016/S0140-6736(21)00683-8)
- Culley, L., Hudson, N., and Floor van Rooij (Eds.). (2009). *Marginalized reproduction: Ethnicity, infertility and reproductive technologies*. Routledge.
- Davis, K., and Blake, J. (1956). Social structure and fertility: An analytic framework. *Economic Development and Cultural Change*, 4(3), 211–235. <https://doi.org/10.1086/449714>
- Destatis. (2026a). Geburten: Durchschnittliches alter der eltern bei geburt nach der geburtenfolge [Births: Average age of parents at birth according to birth order]. <https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Geburten/Tabellen/geburten-eltern-biologischesalter.html>

- Destatis. (2026b). Schwangerschaftsabbrüche: Anzahl der schwangerschaftsabbrüche in Deutschland nach rechtlicher begründung [Abortions: Number of abortions in Germany by legal basis]. <https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Gesundheit/Schwangerschaftsabbrueche/Tabellen/03-schwangerschaftsabbruechliche-begrueendung-schwangerschaftsdauer-zvab2012.html>
- du Fossé, N. A., van der Hoorn, M.-L. P., van Lith, J. M. M., le Cessie, S., and Lashley, E. E. L. O. (2020). Advanced paternal age is associated with an increased risk of spontaneous miscarriage: A systematic review and meta-analysis. *Human Reproduction Update*, 26(5), 650–669. <https://doi.org/10.1093/humupd/dmaa010>
- Dunson, D. B., Colombo, B., and Baird, D. D. (2002). Changes with age in the level and duration of fertility in the menstrual cycle. *Human Reproduction*, 17(5), 1399–1403. <https://doi.org/10.1093/humrep/17.5.1399>
- Edozien, L. (1998). Why do some women undergo termination of pregnancy after successful IVF treatment? *Human Reproduction*, 13(9), 2377–2378. <https://doi.org/10.1093/humrep/13.9.2377>
- Erato, G., Ciciolla, L., Shreffler, K. M., and Greil, A. L. (2022). Changes in Importance of Motherhood Following Pregnancy Loss. *Journal of Family Issues*, 43(3), 741–751. <https://doi.org/10.1177/0192513X21994138>
- ESHRE Capri Workshop Group, Cameron, S., Glasier, A., Lohr, P. A., Moreau, C., Munk-Olsen, T., Oppengaard, K. S., Templeton, A., Van Look, P., Baird, D. T., Crosignani, P. G., La Vecchia, C., Negri, E., and Volpe, A. (2017). Induced abortion. *Human Reproduction*, 32(6), 1160–1169. <https://doi.org/10.1093/humrep/dex071>
- Evers, J. L. (2002). Female subfertility. *The Lancet*, 360(9327), 151–159. [https://doi.org/10.1016/S0140-6736\(02\)09417-5](https://doi.org/10.1016/S0140-6736(02)09417-5)
- Giele, J. Z., and Elder Jr., G. H. (1998). *Methods of life course research: Qualitative and quantitative approaches*. Sage. <https://doi.org/10.4135/9781483348919>
- Goldscheider, F., Bernhardt, E., and Lappegård, T. (2015). The Gender Revolution: A framework for understanding changing family and demographic behavior. *Population and Development Review*, 41(2), 207–239. <https://doi.org/10.1111/j.1728-4457.2015.00045.x>
- Greil, A. L., Wallace, D. D., Passet-Wittig, J., McQuillan, J., Bujard, M., and Lowry, M. H. (2024). Self-perceived infertility is not always associated with having fewer children: Evidence from German panel data. *European Journal of Population*, 40(1), 8. <https://doi.org/10.1007/s10680-023-09692-1>
- Grigoriev, O., and Körner, T. (2024). Eingewanderte und ihre Nachkommen in Deutschland seit dem Jahr 2005 [Immigrants and their descendants in Germany since 2005]. bpb. <https://www.bpb.de/kurz-knapp/zahlen-und-fakten/sozialbericht-2024/553032/ingewanderte-und-ihre-nachkommen-in-deutschland-seit-dem-jahr-2005/>
- Habbema, J. D. F., Eijkemans, M. J. C., Leridon, H., and te Velde, E. R. (2015). Realizing a desired family size: When should couples start? *Human Reproduction*, 30(9), 2215–2221. <https://doi.org/10.1093/humrep/dev148>
- Habbema, J. D. F., Eijkemans, M. J. C., Nargund, G., Beets, G., Leridon, H., and Te Velde, E. R. (2009). The effect of in vitro fertilization on birth rates in western countries. *Human Reproduction*, 24(6), 1414–1419. <https://doi.org/10.1093/humrep/dep004>
- Helström, L., Odland, V., Zätterström, C., Johansson, M., Granath, F., Correia, N., and Ekborn, A. (2003). Abortion rate and contraceptive practices in immigrant and native women in Sweden. *Scandinavian Journal of Public Health*, 31(6), 405–410. <https://doi.org/10.1080/14034940210165181>
- Hoorens, S., Gallo, F., Cave, J. A. K., and Grant, J. C. (2007). Can assisted reproductive technologies help to offset population ageing? An assessment of the demographic and economic impact of ART in Denmark and UK. *Human Reproduction*, 22(9), 2471–2475. <https://doi.org/10.1093/humrep/dem181>
- Huinink, J., Brüderl, J., Nauck, B., Walper, S., Castiglioni, L., and Feldhaus, M. (2011). Panel analysis of intimate relationships and family dynamics (pairfam): Conceptual framework and design. *Journal of Family Research*, 23(1), 77–101.
- Huss, B. (2021). Well-being before and after pregnancy termination: The consequences of abortion and miscarriage on satisfaction with various domains of life. *Journal of Happiness Studies*, 22(6), 1–26. <https://doi.org/10.1007/s10902-020-00350-5>
- Huss, B., and Kaiser, F. (2022). Induced abortion and life satisfaction in Germany: The role of selection processes and short-term effects. *Zeitschrift für Soziologie*, 51(4), 404–419. <https://doi.org/10.1515/zfsz-2022-0022>

- Johnson, K. M., Greil, Arthur L., Shreffler, Karina M., and McQuillan, Julia. (2018). Fertility and infertility: Toward an integrative research agenda. *Population Research and Policy Review*, 37, 641–666. <https://doi.org/10.1007/s11113-018-9476-2>
- Johnson, K. M., Shreffler, K. M., Greil, A. L., and McQuillan, J. (2023). Bearing the reproductive load? Unequal reproductive careers among U.S. Women. *Population Research and Policy Review*, 42(1), 14. <https://doi.org/10.1007/s11113-023-09770-6>
- Lazzari, E., Potančoková, M., Sobotka, T., Gray, E., and Chambers, G. M. (2023). Projecting the contribution of assisted reproductive technology to completed cohort fertility. *Population Research and Policy Review*, 42(1), 6. <https://doi.org/10.1007/s11113-023-09765-3>
- Leridon, H., and Slama, R. (2008). The impact of a decline in fecundity and of pregnancy postponement on final number of children and demand for assisted reproduction technology. *Human Reproduction*, 23(6), 1312–1319. <https://doi.org/10.1093/humrep/den106>
- Lesthaeghe, R. (1995). The second demographic transition in western countries: An interpretation. In K. Oppenheim Mason and A.-M. Jensen (Eds.), *Gender and family change in industrialized countries* (pp. 17–62). Clarendon Press. <https://doi.org/10.1093/oso/9780198289708.003.0002>
- Lesthaeghe, R., and Surkyn, J. (1988). Cultural dynamics and economic theories of fertility change. *Population and Development Review*, 14(1), 1. <https://doi.org/10.2307/1972499>
- McDonald, Peter. (2000). Gender equity, social institutions and the future of fertility. *Journal of Population Research*, 17(1), 1–16. <https://doi.org/10.1007/BF03029445>
- McQuillan, J., Passet-Wittig, J., Greil, A. L., and Bujard, M. (2022). Is perceived inability to procreate associated with life satisfaction? Evidence from a German panel study. *Reproductive Biomedicine & Society Online*, 14, 87–100. <https://doi.org/10.1016/j.rbms.2021.09.004>
- Milewski, N., and Adserà, A. (2023). Introduction: Fertility and social inequalities in migrant populations: a look at the roles of selection, context of reception, and employment. *Journal of International Migration and Integration*, 24(S1), 1–21. <https://doi.org/10.1007/s12134-022-01003-7>
- Milewski, N., and Carol, S. (2018). Attitudes toward abortion for medical and non-medical reasons among the Turkish second generation in Europe – The role of the family and societal contexts. *Comparative Population Studies*, 43, 307–342. <https://doi.org/10.12765/CPoS-2019-05>
- Milewski, N., Passet-Wittig, J., and Bujard, M. (2025). Infertility and seeking medical help to have a child vary across migrant origin groups in Germany. *Population Research and Policy Review*, 44(2), 25. <https://doi.org/10.1007/s11113-024-09921-3>
- Minello, A. (2025). From childbirth as an event to childbirth as an experience: The “embodied motherhood penalty” as a new perspective in fertility studies. *AG About Gender - International Journal of Gender Studies*, 14(28). <https://doi.org/10.15167/2279-5057/AG2025.14.18.2427>
- Minkus, L., and Drobnič, S. (2021). Abortion: Life-course stages and disruptive life events. *Zeitschrift Für Soziologie*, 50(3–4), 259–273. <https://doi.org/10.1515/zfsoz-2021-0018>
- Passet-Wittig, J., Bujard, M., McQuillan, J., and Greil, A. L. (2020). Is perception of inability to procreate a temporal phenomenon?: A longitudinal exploration of changes and determinants among women and men of reproductive age in Germany. *Advances in Life Course Research*, 45, 100339. <https://doi.org/10.1016/j.alcr.2020.100339>
- Peri-Rotem, N. (2025). 10 Rethinking demography: Assisted reproduction and the “proximate determinants of fertility” reexamined. In Franklin, S. and Inhorn, M. C. (eds.). *The New Reproductive Order* (pp. 199–218). New York University Press. <https://www.degruyterbrill.com/document/doi/10.18574/nyu/9781479832668.003.0014/html>
- Quenby, S., Gallos, I. D., Dhillon-Smith, R. K., Podeseck, M., Stephenson, M. D., Fisher, J., Brosens, J. J., Brewin, J., Ramhorst, R., Lucas, E. S., McCoy, R. C., Anderson, R., Daher, S., Regan, L., Al-Memar, M., Bourne, T., MacIntyre, D. A., Rai, R., Christiansen, O. B., . . . Coomarasamy, A. (2021). Miscarriage matters: The epidemiological, physical, psychological, and economic costs of early pregnancy loss. *The Lancet*, 397(10285), 1658–1667. [https://doi.org/10.1016/S0140-6736\(21\)00682-6](https://doi.org/10.1016/S0140-6736(21)00682-6)
- Sedgh, G., Bearak, J., Singh, S., Bankole, A., Popinchalk, A., Ganatra, B., Rossier, C., Gerdt, C., Tunçalp, Ö., Johnson, B. R., Johnstone, H. B., and Alkema, L. (2016). Abortion incidence between 1990 and 2014: Global,

- regional, and subregional levels and trends. *The Lancet*, 388(10041), 258–267. [https://doi.org/10.1016/S0140-6736\(16\)30380-4](https://doi.org/10.1016/S0140-6736(16)30380-4)
- Shreffler, K. M., Arthur L. Greil, and McQuillan, J. (2011). Pregnancy loss and distress among U.S. women. *Family Relations*, 60(3), 342–355. <https://doi.org/10.1111/j.1741-3729.2011.00647.x>
- Shreffler, K., Tiemeyer, S., Dorius, C., Spierling, T., Greil, A., and McQuillan, J. (2016). Infertility and fertility intentions, desires, and outcomes among US women. *Demographic Research*, 35, 1149–1168. <https://doi.org/10.4054/DemRes.2016.35.39>
- Sobotka, T., and Beaujouan, É. (2018). Late motherhood in low-fertility countries: Reproductive intentions, trends and consequences. In D. Stoop (Ed.), *Preventing Age Related Fertility Loss* (pp. 11–29). Springer International Publishing. https://doi.org/10.1007/978-3-319-14857-1_2
- Stover, J. (1998). Revising the proximate determinants of fertility framework: What have we learned in the past 20 years? *Studies in Family Planning*, 29(3), 255. <https://doi.org/10.2307/172272>
- Tierney, K. (2022). The future of assisted reproductive technology live births in the United States. *Population Research and Policy Review*, 41(5), 2289–2309. <https://doi.org/10.1007/s11113-022-09731-5>
- Väisänen, H., and Murphy, M. (2014). Social inequalities in teenage fertility outcomes: Childbearing and abortion trends of three birth cohorts in Finland. *Perspectives on Sexual and Reproductive Health*, 46(2), 109–116. <https://doi.org/10.1363/46e1314>
- Väisänen, H., Remes, H., and Martikainen, P. (2022). Perinatal health among migrant women: A longitudinal register study in Finland 2000–17. *SSM – Population Health*, 20, 101298. <https://doi.org/10.1016/j.ssmph.2022.101298>
- Van De Kaa, D. J. (1987). Europe's second demographic transition. *Population Bulletin*, 42(1), 1–59.
- Vignoli, D., Guetto, R., Bazzani, G., Pirani, E., and Minello, A. (2020). A reflection on economic uncertainty and fertility in Europe: The narrative framework. *Genus*, 76(1), 28. <https://doi.org/10.1186/s41118-020-00094-3>
- WHO. (2023). *Infertility prevalence estimates 1990–2021*. <https://iris.who.int/bitstream/handle/10665/366700/9789240068315-eng.pdf?sequence=1>
- Wu, C. Q., Nichols, K., Carwana, M., Cormier, N., and Maratta, C. (2022). Preterm birth after recurrent pregnancy loss: A systematic review and meta-analysis. *Fertility and Sterility*, 117(4), 811–819. <https://doi.org/10.1016/j.fertnstert.2022.01.004>
- Young, R. (2012). *Don't know responses in survey research*. Ph.D. Thesis, The Pennsylvania State University. <https://etda.libraries.psu.edu/catalog/13934>