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SYMPOSIUM: FAMILIES THROUGH ASSISTED REPRODUCTIVE TECHNOLOGY
ORIGINAL ARTICLE

Is perceived inability to procreate associated with life satisfaction? Evidence from a German panel study

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Abstract Most studies of the psychosocial consequences of infertility have focused on those who seek medical treatment, leaving a research gap regarding the psychosocial consequences of perceived inability to procreate in the general population. Moreover, most studies are cross-sectional and the results are thus likely affected by omitted variable bias. Inspired by aspects of the Theory of Conjunctural Action, this study analysed 10 waves of data from the German Family Panel (pairfam) for women and men using fixed effects panel regression and including time-varying control variables suggested by theory and research. This study found that both women and men experienced lower life satisfaction in years when they perceived an inability to procreate. This association was not affected by the inclusion of relevant time-varying control variables. Furthermore, the association between perceived barriers to procreation and life satisfaction was found to differ depending on life circumstances and gender. Women with partners and men without partners had lower life satisfaction when they perceived an inability to procreate compared with when they did not. Women and men who intended to have a(nother) child had lower life satisfaction when they perceived an inability to procreate compared with when they did not. The association, however, was only significant for men. Somewhat surprisingly, women who perceived an inability to procreate also had lower life satisfaction when they were not intending to have a(nother) child. This study makes an important contribution to research on the psychosocial consequences of perceived infertility, and provides insights into why some people may pursue assisted reproductive technology for family creation. 

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KEYWORDS: Perceived inability to procreate, Gender, Life satisfaction, Infertility, Life course, Fixed effects regression

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Introduction

Many people are able to make families in ways that they consider 'natural', but some people perceive barriers to conceiving naturally and may consider assisted reproductive technology (ART) to help them have a child. In European countries, most people have a personal ideal of one or more children, with two being the most common desired number (Testa, 2012). Around 20% of women in the early 1970s cohorts, however, have experienced permanent childlessness, and others have fewer children than they desire, indicating the existence of a 'fertility gap' (Kreyenfeld and Konietzka, 2017). Becoming a parent is a central life course goal for many people (Johnson-Hanks et al., 2011), and parents across different cultures indicate that they place a high value on children (Nauck, 2014).

Recent evidence shows that German adults perceive an ability to have a child naturally most of the time, but a substantial minority (~5%) experience periods when they perceive an inability to procreate naturally (Passet-Wittig et al., 2020). For adults who want children, infertility is often experienced as a major goal blockage (Loftus and Andriot, 2012). Analyses of cross-sectional data indicate that US adults with perceived fertility barriers report higher distress (McQuillan et al., 2020) and that women with involuntary childlessness report lower life satisfaction (McQuillan et al., 2007) than adults with no perceived fertility barriers or those who are 'child-free' (Blackstone and Stewart, 2016).

Most studies of the psychosocial consequences of infertility have focused on those who seek medical treatment (Greil et al., 2011), leaving a distinct research gap regarding the psychosocial consequences of perceived inability to procreate in the general population. Moreover, because most of these studies are cross-sectional, the results are vulnerable to misattributing elevated distress to fertility barriers when they could reflect other experiences that are not measured and included in the model (i.e. omitted variable bias). A strength of longitudinal analysis is the ability to account for all stable individual characteristics.

This study used data from the German family panel study (pairfam), which allows a unique opportunity to analyse the perceived inability to procreate and life satisfaction over 10 waves. Germany was a low-fertility country with a total fertility rate (TFR) < 1.5 children from the 1970s until the mid-2010s. Recently, the TFR has increased slightly to > 1.5 children in 2015 and has remained at this level (most recent data 2019) (Destatis, 2020a). In East Germany, the mean age of first childbearing was approximately 22 years before German reunification (1990), and has since increased. As of 2019, the average age at first birth of mothers in West Germany and East Germany was similar (30.2 and 29.3 years, respectively). On average, fathers in Germany are older than mothers (33.1 years; ages are not broken down by West/East Germany for the fathers) (Destatis, 2020b). The percentage of those who are permanently childless is 21% among women born in the late 1960s and early 1970s. The rate of permanent childlessness is higher in West Germany (22%) than East Germany (15%) (Destatis, 2019). German fertility patterns are comparable with those

of other Western European countries, but childlessness rates are higher (Kreyenfeld and Konietzka, 2017). One reason for the higher rate of childlessness in Germany is the challenge of reconciling work and family because of the lack of childcare facilities in West Germany. Recently, however, publically funded childcare reforms helped to triple childcare enrolment rates for children aged 0–2 years from 9.4% to 27.1% between 2007 and 2017 (Neuberger et al., 2020). The use of ART is increasing in Germany, and the range of treatments and costs in Germany is comparable with several other European countries (Passet-Wittig and Bujard, 2021). In Germany, in contrast to other European countries and the USA, egg donation and surrogacy are not allowed (Passet-Wittig and Bujard, 2021).

The aim of this study was to assess whether perceived infertility was associated with life satisfaction in women and men in the general population. To do this, the study investigated whether, in comparison with times when a subject perceived an ability to procreate, times when they perceived an inability to procreate were associated with lower life satisfaction. The study controlled for variables measuring changes in life course context, schemas and values suggested by the Theory of Conjunctural Action (TCA) (Johnson-Hanks et al., 2011). The pairfam data provides 10 waves of individual-level panel data with information on perceived inability to procreate and life satisfaction available for every year. These data allow estimation using linear fixed effects panel regression, which accounts for all stable individual characteristics (i.e. time-constant unobserved heterogeneity).

Literature review

Infertility and perceived (in)ability to procreate

According to medical criteria, infertility is defined as the failure to become pregnant within 1 year of regular intercourse without contraception (Zegers-Hochschild et al., 2017). Perceived inability to procreate provides a subjective proxy for infertility that is useful in population-based surveys (Lowry et al., 2020). People can perceive barriers to procreation even if they do not meet medical criteria for infertility, and they can meet medical criteria without perceiving a problem (Chandra et al., 2013). Furthermore, people's perceptions of their (in)ability to procreate can change over time as they move back and forth from perceiving a problem to not perceiving a problem (Passet-Wittig et al., 2020). It is possible to assess whether life satisfaction differs when the same people do or do not perceive an inability to procreate because there is considerable change over time. One in 20 people in the German pairfam data experienced a perceived inability to procreate, and, of these, over one-third of the women and nearly half of the men with perceived inability to procreate in a certain year changed to not perceiving an inability to procreate in the subsequent year (Passet-Wittig et al., 2020).

An analysis of perceptions of procreative ability can shed light on the personal experiences of infertility, irrespective of an external classification as infertile (Benyamini, 2011; Greil et al., 2011). Thus, focusing on perceived infertility

can provide insights into why some people may pursue ART for family creation or pursue counselling to cope with infertility. Therefore, self-reports of perceived procreative ability provide important information for understanding the social and behavioural dimensions of infertility, and this measure was used in the present study.

Life satisfaction and fertility

Life satisfaction is a subjective appraisal of the quality of one's life compared with other possible situations (Diener, 1984; Lucas et al., 1996). A large body of research indicates that structural variables (e.g. inequality) and external events (e.g. losing a job, divorce or bereavement) can change people's baseline life satisfaction (Diener et al., 2018; Luhmann et al., 2012; Tay and Kukendahl, 2013; Veenhoven, 1994). One important life event that can have an impact on life satisfaction and subjective well-being is having a child. Most research on the association between fertility and subjective well-being is focused on the consequences of having children on happiness and life satisfaction, and on the factors that modify that relationship (Aassve et al., 2015; Margolis and Myrskylä, 2011; Pollmann-Schult, 2013, 2014).

Few studies have focused on the effects of not being able to have children (or believing this to be the case) for subsequent well-being compared with prior well-being. The 'baseline' or 'set-point' hypothesis posits that even after experiencing major life changes (e.g. getting married), subjective well-being returns to previous levels (Brickman and Campbell, 1971; Diener and Diener, 1996). In contrast, longitudinal studies provide evidence of decreases or increases in life satisfaction associated with negative (e.g. losing a job or the death of a spouse) or positive (e.g. getting married) experiences (for a review, see Diener et al., 2018). No studies have examined the association between perceived (in)ability to procreate and subjective well-being for the same people over multiple observations. Given that many individuals experience the loss of procreative ability as a loss or barrier to achieving a highly valued goal (even if the experience is temporary), it is worth examining this association.

Although perceived inability to procreate and medically defined infertility are not identical, research on infertility is nonetheless instructive for understanding the relevance of perceived inability to procreate for well-being. Several studies have found that fertility problems are a distressing experience for many women. This experience may include anxiety, challenges to identity, feelings of loss of control, a strong sense of stigmatization, feelings of social isolation, a sense of being in 'limbo', and strain on romantic and social relationships (see Chachamovich et al., 2010; Greil et al., 2010; Mousavi et al., 2013 for reviews). In general, studies have found that women with infertility have lower quality of life, subjective well-being and global life satisfaction than women without infertility. Wischmann et al. (2001) found that 275 women at a German infertility clinic scored slightly lower than norms on a number of subscales of life satisfaction. A population-based study in the USA (McQuillan et al., 2007) found that women with infertility and without children had lower life

satisfaction than women in the other fertility and motherhood categories.

Most studies of infertility and life satisfaction are cross-sectional, thus limiting the ability to draw causal inferences. Some studies have followed people who sought treatment for infertility and re-assessed their well-being a number of years after the baseline study. The goal of such studies is to estimate whether a birth after treatment (i.e. 'success') is associated with changes in life satisfaction (Schanz et al., 2011; Wischmann, et al., 2012). The strength of these studies is their ability to account for time order (i.e. by measuring life satisfaction before and after treatment), but they include only those individuals who sought treatment for infertility. Studying only those individuals with a formal diagnosis of infertility limits the analyses to those who medicalize fertility barriers, but people vary in the extent to which they consider an inability to procreate to be a medical problem (Bell, 2016). Therefore, using a subjective measure of infertility works as well or better than using a measure using medical criteria alone (Lowry et al., 2020).

Potential confounding and modifying life course, values and schemas

Guided by two important foci of the TCA – life course perspective and the sociology of culture – this study also explored whether other time-varying characteristics are associated with perceived procreative ability and life satisfaction. From the life course perspective, reproductive experiences are contingent upon the pattern of life course events and prior reproductive histories. The life course perspective stresses the importance of social cues for guiding expectations regarding the timing and meaning of life events, such as having children or being childless (Abma and Martinez, 2006; Morgan and Rackin, 2010). The sociology of culture stresses the importance of shared schemas in shaping responses to social cues (Cerulo, 2015; Johnson-Hanks et al., 2011). Schemas are relatively stable and abstract representations of the meaning of an object or event that provide the 'motivational frame' for action (Bachrach, 2014; Brehm and Schneider, 2019). Schemas include concepts (e.g. perceived inability to procreate) and appropriate actions associated with concepts (e.g. what to do in order to become pregnant). Therefore, the present study paid particular attention to changing life circumstances, values and schemas.

One would expect both the meaning of perceived inability to procreate and responses to it to be associated with whether or not one already has children. Some studies have reported that women who experience infertility after having children (i.e. secondary infertility) have higher levels of life satisfaction than involuntarily childless women (Abbey et al., 1994; McQuillan et al., 2007), but others have failed to find an association (Bakhtiari et al., 2014; Ben Shlomo et al., 2016). Therefore, this study assessed whether the direct association between perceived inability to procreate and life satisfaction persists after controlling for parity, and whether the association differs by parity group.

One would also expect both perceptions of procreative ability and life satisfaction to vary with partnership status.

Compared with those who are single, those who cohabit (Zimmermann and Easterlin, 2006) and who are married have higher life satisfaction (Mikucka, 2016). At the same time, many people consider having a stable partnership to be a prerequisite to trying to have a child (Sassler and Cunningham, 2008), and couples who are trying to become pregnant are more likely than other couples to perceive an inability to procreate (Passet-Wittig et al., 2020).

Partnership status may also have a moderating effect on the relationship between perceived inability to procreate and life satisfaction. On the one hand, marriage is strongly associated with the expectation to have children (Elder et al., 2003; Townsend et al., 2001); thus, being in a marriage could strengthen the association between perceived inability to procreate and life satisfaction. On the other hand, Greil (1991) found that partners with high relationship satisfaction suffer less from infertility than couples with low relationship satisfaction; this suggests that being in a relationship (especially a satisfying relationship) may weaken the relationship between partnership status and perceived inability to procreate.

Age is another variable that is likely to be associated with both life satisfaction and perceived inability to procreate. Increased age is strongly correlated with a decline in reproductive ability, particularly for women (American College of Obstetricians and Gynecologists Committee on Gynecologic Practice and Practice Committee, 2014), and especially after 35 years of age. Women approaching the end of their reproductive years are more likely than younger women to become infertile and to seek infertility treatment (Chandra et al., 2013, 2014). Life course norms dictate that women 'ought to have children' by a certain age (Koropecj-Cox et al., 2007). According to Billari et al. (2011), the social age deadline for women to have children in Europe is approximately 40 years. Thus, because of the normative pressure that women experience, one would expect the perception of fertility problems to become more salient with increasing age for women, but it is less clear if the same associations hold for men. Accordingly, several studies have found that psychological distress tends to be higher for older women with infertility compared with younger women with infertility (Greil et al., 2011; Vizheh et al., 2015).

Perceived health status is associated with life satisfaction (Köots-Ausmees and Realo, 2015). It is unclear whether better subjective health contributes to higher life satisfaction, or whether higher life satisfaction leads to better subjective health (Diener et al., 1999; Van der Weele et al., 2019). People who receive a medical diagnosis may associate infertility with worse subjective health. If perceived inability to procreate is associated with lower life satisfaction because of an association with subjective health, then including a measure for subjective health would show that the focal association is actually spurious. It is also possible that experiencing good general health may counteract the association between perceived inability to procreate and life satisfaction. Thus, controlling for subjective health should help to better isolate the unique contribution of perceived inability to procreate to changes in life satisfaction.

Measuring and incorporating the perceived value of children (e.g. costs and benefits) has been a part of fertility

studies for over two decades in an attempt to assess whether these perceptions matter for the timing of having children and for the decision to have additional children (Liefbroer, 2005; Nauck, 2007, 2014). Perceived inability to procreate may have implications for life satisfaction only when it is perceived as a barrier to a valued goal; fertility desires or perceptions of the value of children could thus modify the association between perceived inability to procreate and life satisfaction. It may also be the case, however, that women who assign greater value to having children may be more likely to perceive an inability to procreate than women who do not. It is therefore appropriate to include costs and benefits of children as control variables.

Women who report more traditional gender attitudes (Barber, 2001) tend to have a greater desire to have a baby. Thus, it is likely that perceived inability to procreate will be more salient for individuals with more traditional gender attitudes, and that perceived inability to procreate may have a stronger association with life satisfaction among such people. As it is likely that those who have traditional gender schemas are more likely to value children, they may also be more likely to perceive an inability to procreate. Thus, it is important to control for gender attitudes. Given that schemas for behaviour are gendered (Knight and Brinton, 2017), separate questions were used in this study to measure what is expected of men and women.

This study was particularly interested in whether the relationship between perceived inability to procreate and life satisfaction varies by gender. A great deal of research has explored gender differences in levels of distress and well-being among those with fertility problems. Most studies have concluded that infertility is more distressing for women than it is for men (Benyamini et al., 2009; Wichman et al., 2011). Barnes (2014) found that most of the men she studied did not experience infertility as a threat to masculine identity. Edelmann and Connolly (1998), however, argued that the higher distress levels among infertile women compared with men simply reflect general higher distress among women. McQuillan et al. (2020) found that both men and women in heterosexual couples who perceive a fertility problem have higher average distress compared with those who do not perceive a problem, and, in couples in which only one partner perceives a problem, men tend to have even higher distress than women. Therefore, this study assessed whether gender moderates the association between perceived inability to procreate and life satisfaction (two-way interaction of gender by perceived inability to procreate), and whether life course indicators, values and schemas modify the association between perceived inability to procreate and life satisfaction differently for men and women (three-way interactions).

Materials and methods

Sample

This study analysed data from the German Family Panel (pairfam), Release 10.0, covering the years 2008/2009 to

2017/2018 (Brüderl et al., 2016; see also Huinink et al., 2011 for details on the study). Pairfam is a multi-disciplinary study that consists of a nationwide random sample of 12,402 women and men living in Germany from three birth cohorts (cohort 1: 1991–1993, cohort 2: 1981–1983; cohort 3: 1971–1973). Data are collected annually by computer-aided personal interviews. Modules which cover potentially sensitive topics such as infertility are conducted as computer-aided self-interviews. All waves up through Wave 10 were used in this study. Data from a complementary panel study (Demo-Diff) were not used because this study consists of East Germans alone. As the present study was not interested in studying East Germans specifically, their over-representation could have biased the coefficients of some variables.

The 10-wave data set (without DemoDiff) contains 66,700 person-years (12,042 people). Had all respondents participated in all 10 waves, 120,420 person-years were mathematically possible. Thus, 53,270 person-years were lost due to non-participation for any reason in one or more waves. If panel attrition is defined as any pattern with at least three missing waves at the end of the series, 11,351 of these 53,270 person-years are missing due to panel attrition. In total, 18,332 person-years (27.5%) were excluded based upon the inclusion criteria (respondents with sex change: 15 person-years; sterilization of respondents in any wave: 1776 person-years; respondents identified as homosexual: 579 person-years; respondents aged < 21 years at the time of the interview: 15,962 person-years), yielding a sample size of 48,368 person-years. The age restriction was necessary because some relevant questions were not asked of respondents aged < 21 years. Next, the analytical sample was reduced by 55 person-years due to missing data on the dependent variable. An additional 12.9% of person-years were removed (6248 person-years) due to missing data on any of the other variables in particular waves of the analyses. The analytic sample thus consisted of 42,065 person-years, of which women contributed 22,584 person-years and men contributed 19,481 person-years. The panel data are unbalanced; therefore, gaps in individual panels due to unit-nonresponse may exist.

Concepts and measures

The dependent variable was life satisfaction. Respondents were asked, 'All in all, how satisfied are you with your life at the moment?' Allowed responses ranged from 0 (very dissatisfied) to 10 (very satisfied). Such single-item life satisfaction measures perform as well as the Satisfaction with Life Style scale, a well-validated and generally used scale (Cheung and Lucas, 2014; Jovanovic, 2016).

The focal independent variable, perceived inability to procreate, was based on the question: 'Some people are not able to conceive a child or to procreate naturally. As far as you know, is it physically possible for you to conceive a child or to procreate naturally?' Answering options were 'definitely yes', 'probably yes', 'probably not', 'definitely not', 'don't know' and 'I don't want to answer that'. A binary indicator was constructed which classified those who chose 'probably not' or 'definitely not' as per-

ceiving an inability to procreate naturally, and those who chose 'definitely yes' or 'probably yes' as perceiving the ability to procreate naturally. Respondents who were pregnant or whose partner was pregnant in any wave were not asked about their perceived procreative ability. These cases were treated as perceiving the ability to procreate in that wave.

Parity refers to the number of biological children a person had in a given year (0, 1, 2 or ≥ 3 children). Partnership status is a categorical variable where 1 indicates being in a heterosexual relationship and 0 indicates being single. Age was measured in years. Sensitivity analyses were undertaken to assess whether the association between life satisfaction and perceived inability to procreate and gender was modified by age by re-running the model with age treated as a categorical variable (i.e. < 30, 31–35, 26–40 and ≥ 41 years). The same patterns were found to persist across age categories. Therefore, age was treated as a continuous variable. Subjective health was measured on a five-point scale from 'bad' (1) to 'very good' (5) health in the last 4 weeks.

A measure of fertility intent was also included in this study. This was based on the question, 'Assuming ideal circumstances, how many children would you like to have altogether?' Unfortunately, respondents who perceived an inability to procreate were not asked about their short-term fertility intentions. Intention to have a(nother) child or not was estimated by subtracting the actual number of children a respondent had from their ideal number of children. Responses were categorized into indicator variables for desire of a(nother) child, no (further) children desired (reference), and don't know.

In addition, two scales for the benefits and costs of having children based on the Value of Children concept (Nauck, 2007) were included in this study. Each scale consists of five items such as 'How strongly do you expect that adult children will be there for you when you are in need?' (benefits) or 'How strongly do you expect that children will limit your personal freedom?' (costs). For each expectation, respondents were asked to express their degree of consent on a five-point scale from 'not at all' to 'very strongly'. The mean of available items was taken if at least three of five items were answered. The benefits scale and the costs scale ranged from 1 to 5, with higher scores indicating greater perceived costs or benefits. Cronbach's alpha was 0.63 for the benefits of children and 0.76 for the costs of children, indicating adequate reliability (Taber, 2018). Analyses of items that could be removed to increase reliability indicated that Cronbach's alpha was lower if any variables were removed. The questions were asked in Waves 1, 2, 4, 6 and 8. Missing values on the final scale were filled in by forwarding information from the previous wave, if available.

Two variables were used to measure gender-specific traditional sex-role schemas: 'Men should participate in housework to the same extent as women' (reverse-coded to indicate 'traditional') and 'Women should be more concerned about their family than about their career'. Degree of consent was measured using a five-point scale from 1 ('disagree completely') to 5 ('agree completely'). Questions were asked in every odd numbered wave. Missing values on

the final scale were filled in by forwarding information from the previous wave, if available.

Plan of analysis

Linear fixed effects regression models were used to estimate the association between perceived inability to procreate and life satisfaction. Fixed effects analysis effectively reduces bias from unobserved time-constant confounders that are often present in cross-sectional analyses (Allison, 2009). Another asset of within-person estimates is that they are not biased by panel attrition from exclusively time-constant characteristics of respondents (Wooldridge, 2002). Having multiple years of data for the same individuals enabled the authors to rely on within-person changes in life satisfaction, perceived fertility status and other explanatory variables to measure associations. It was not possible, however, to estimate the association between fixed independent variables (e.g. gender) and the dependent variable directly; therefore, interaction terms were used. The life course perspective suggests that changes in social statuses (e.g. education, social class) or religiosity could be associated with changes in perceived inability to procreate and changes in life satisfaction, but sensitivity analysis indicated that measures of these concepts were mainly time-invariant, and adding them to the model did not change the results.

Three sets of analyses were conducted. First, using bivariate analyses, the characteristics (proportions and means) of people at times when they reported perceived ability to procreate were compared with characteristics at times when they reported a perceived inability to procreate for both men and women (Table 1). Next, a series of fixed effects regression models were run on the full sample using xtreg in Stata (Stata Corp., College Station, TX, USA) to assess the association between perceived inability to procreate and life satisfaction (Table 2). Model 1 shows the association between perceived inability to procreate and life satisfaction without covariates. Model 2 controlled for time-varying measures of life course indicators, values and schemas (Model 2), and Model 3 controlled for these measures separately for women and men (Model 3). As there were theoretical and empirical reasons to consider that gender could moderate the associations between all control variables and life satisfaction, a model with interaction terms for all of the independent variables was estimated using an indicator for women (1, compared with 0 for men) (model not shown). In Table 2, the final column indicates whether there are significant differences by gender. Finally, using three-way interactions, this study investigated whether the association between perceived inability to procreate and life satisfaction is modified by any of the time-varying covariates and gender. The results (Appendix A) are presented by providing separate models for women and

Table 1 Descriptive statistics by perceived (in)ability to procreate and gender for the German pairfam data.

	Perceived ability to procreate				Perceived inability to procreate				Total	
	Women		Men		Women		Men			
	<i>n</i> = 21,350		<i>n</i> = 18,688		<i>n</i> = 1234		<i>n</i> = 793		<i>n</i> = 42,065	
Number of person-years	M/P	SD	M/P	SD	M/P	SD	M/P	SD	M/P	SD
Life satisfaction (0–10)	7.58	1.67	7.48	1.65	7.21	1.97	7.05	2.16	7.51	1.69
Number of children (biological)										
0 (0/1)	0.41		0.59		0.32		0.57		0.49	
1 (0/1)	0.22		0.17		0.21		0.19		0.20	
2 (0/1)	0.26		0.18		0.30		0.16		0.22	
3 (0/1)	0.10		0.06		0.17		0.08		0.09	
Has a partner (0/1)	0.80		0.70		0.82		0.73		0.75	
Age (21–47 years)	32.58	6.87	32.07	6.94	37.14	6.25	35.09	6.92	32.53	6.95
Subjective health (1–5)	3.80		3.80	0.95	3.29	1.05	3.53	1.05	3.70	0.97
Intention to have a(nother) child										
No intention to have a(nother) child (0/1)	0.33		0.23		0.53		0.35		0.29	
Intend to have a(nother) child (0/1)	0.66		0.74		0.46		0.64		0.69	
Don't know (0/1)	0.01		0.02		0.01		0.02		0.02	
Value of children										
Costs of having children (1–5)	2.46	0.80	2.36	0.75	2.37	0.89	2.39	0.88	2.41	0.79
Benefits of having children (1–5)	3.54	0.65	3.57	0.64	3.51	0.77	3.61	0.76	3.55	0.65
Schemas about gendered roles										
Traditional values men (1–5)	1.63	0.85	1.87	0.91	1.64	0.89	1.86	0.97	1.74	0.89
Traditional values women (1–5)	2.70	1.08	2.71	1.05	2.91	1.18	2.85	1.20	2.72	1.08

M, mean; P, proportion; SD, standard deviation. Numbers in parentheses indicate the range of a variable. Cases are person-years. Source: Pairfam waves 1–10.

Table 2 Fixed effects regression of life satisfaction by perceived (in)ability to procreate, life course, values and schemas.

	Model 1		Model 2		Models 3 A and B				Gender interaction sign.
	Coef.	S.E.	Coef.	S.E.	Women (A)		Men (B)		
					Coef.	S.E.	Coef.	S.E.	
Perceived procreative ability	Ref.		Ref.		Ref.		Ref.		
Perceived inability to procreate	-0.19	0.07 ^c	-0.17	0.04 ^c	-0.19	0.05 ^c	-0.15	0.06 ^a	
Number of children									
0			-0.12	0.04 ^b	-0.20	0.05 ^c	-0.07	0.05	
1			Ref.		Ref.		Ref.		
2			-0.08	0.04 ^a	-0.12	0.05 ^a	-0.03	0.06	
≥3			-0.01	0.07	-0.16	0.09	0.17	0.11	^a
No partner			Ref.		Ref.		Ref.		
Has a partner			0.57	0.03 ^c	0.55	0.04 ^c	0.61	0.03 ^c	
Age (mean-centred)			-0.01	0.00 ^a	0.00	0.00	-0.02	0.00 ^c	^c
Subjective health (mean-centred)			0.30	0.01 ^c	0.31	0.01 ^c	0.29	0.01 ^c	
Intention to have a(nother) child									
Do not intend to have a(nother) child			Ref.		Ref.		Ref.		
Intend to have a(nother) child			-0.02	0.02	-0.02	0.03	0.00	0.04	
Don't know			0.02	0.06	-0.03	0.09	0.07	0.08	
Costs of children (mean-centred)			-0.15	0.01 ^c	-0.16	0.02 ^c	-0.14	0.02 ^c	^c
Benefits of children (mean-centred)			0.06	0.02 ^c	0.05	0.02 ^a	0.07	0.02 ^b	
Traditional schemas men (mean-centred)			0.00	0.01	-0.02	0.02	0.01	0.02	
Traditional schemas women (mean-centred)			0.00	0.01	0.02	0.01	-0.02	0.01	^a
Constant	7.52	0.01 ^c	7.17	0.04 ^c	7.30	0.05 ^c	7.03	0.05 ^c	
R-square within	0.00		0.06		0.06		0.06		

Coef., coefficient; Ref., reference.

Women versus men comes from another model that tested interactions.

^aP < 0.05. ^bP < 0.01. ^cP < 0.001.

Source: Pairfam waves 1–10; n = 42,065 observations and 9476 participants.

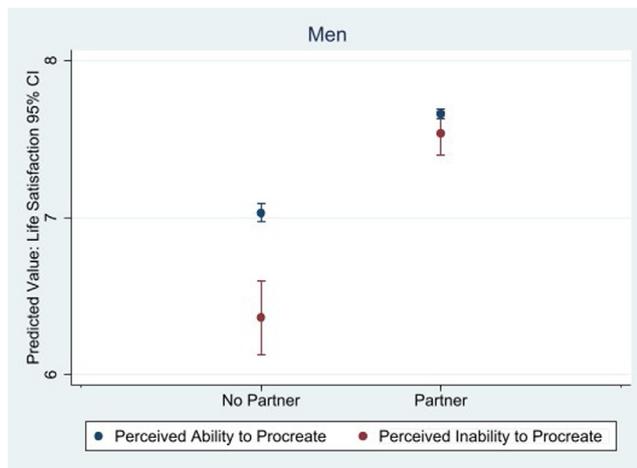
men – including the interaction terms for all of the variables by perceived inability to procreate – and by reporting the significance of gender by perceived inability to procreate coefficients in separate columns. In order to facilitate interpretation, illustrations of the significant three-way associations are presented (Figs. 1 and 2). Full models are available in Appendix A.

Results

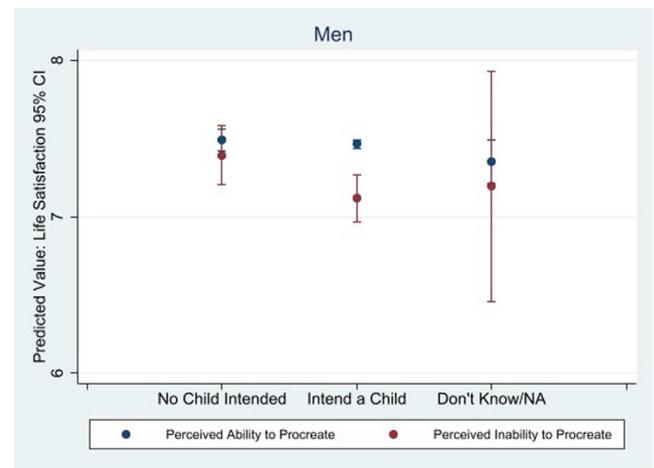
Descriptive statistics

Table 1 provides means and standard deviations for continuous variables, and proportions for categorical variables for waves when people reported perceived inability to procreate or not for men and women. In 95.5% of all person-years for women and 95.9% of all person-years for men, people did not perceive an inability to procreate. All of the independent variables in Table 1 differ by perceived inability to procreate and gender (calculated based on Chi-squared tests for proportions and analysis of variance F-tests for means).

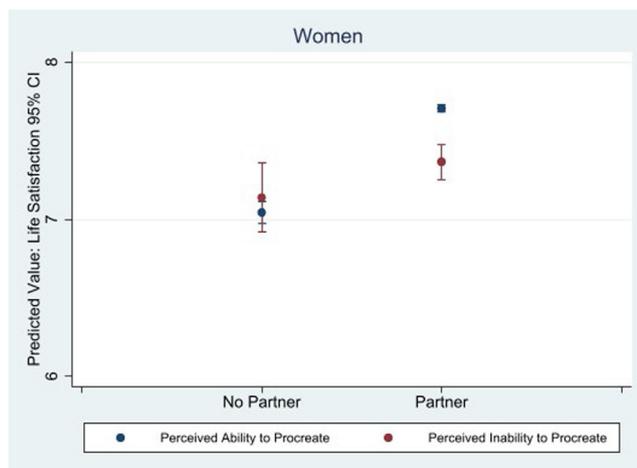
The descriptive statistics indicate that average life satisfaction was lowest for men in years when they perceived an inability to procreate, and highest for women in years when they perceived an ability to procreate. The proportion of subjects with no children was highest among men who perceived an ability to procreate, and lowest among women who perceived an inability to procreate. In most years, subjects had no children, and in most years, subjects had a partner. The average age was 32 years for those who perceived an ability to procreate, and 35 years (for men) and 37 years (for women) who perceived an inability to procreate. Subjective health was higher for those with perceived ability to procreate than those with perceived inability to procreate, and was lowest for women with perceived inability to procreate. The proportion of subjects with the intention to have a (nother) child was highest for men with perceived ability to procreate, and lowest for women with perceived inability to procreate. The average scores for costs and benefits of having children were similar by gender and perceived inability to procreate status. Traditional schemas about men were higher among men who perceived an inability to procreate, and traditional schemas



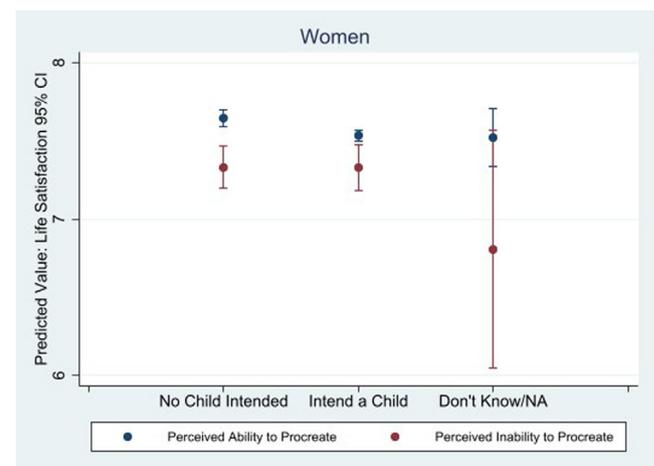
(a)



(a)



(b)



(b)

Fig. 1 Predicted life satisfaction by perceived (in)ability to procreate by gender and relationship status. (A) Men. (B) Women. All continuous control variables set to mean values; all categorical control variables set to reference category. Bars indicate the 95% confidence interval (CI). See Appendix A for full regression table.

about women were higher among women who perceived an inability to procreate. Next, multi-variate analyses were used to analyse whether the focal association between perceived (in)ability to procreate and life satisfaction persisted when controlling for other variables, and whether this differed by gender, and differed by gender and life course indicators.

Multi-variate analysis

Model 1 of Table 2 displays the relationship between perceived inability to procreate and life satisfaction without controlling for other independent variables. As expected, life satisfaction was lower in years when people perceived an inability to procreate ($B = -0.17$, or approximately 10% of a standard deviation) than in years when they perceived an ability to procreate. The association between perceived inability to procreate and life satisfaction

Fig. 2 Predicted life satisfaction by perceived (in)ability to procreate by gender and intention to have a(nother) child status. (A) Men. (B) Women. All continuous control variables set to mean values; all categorical control variables set to reference category. Bars indicate the 95% confidence interval (CI). See Appendix A for full regression table.

remained relatively stable when variables were added to the model. The fraction of the variance (ρ) in life satisfaction that resulted from within-person change over time was 0.41, indicating considerable variation within people.

In the next step, shown in Model 2, all other explanatory variables were added. Importantly, the focal association persisted; German adults still reported significantly lower life satisfaction in years when they perceived an inability to procreate compared with years when they perceived an ability to procreate. Additionally, some of the time-varying covariates were also associated with changes in life satisfaction. Person-years in which people had no children or two children were associated with lower life satisfaction compared with person-years in which they had one child. Each additional year of age was associated with a slight decrease in life satisfaction. Having a partner and better

subjective health were associated with higher life satisfaction. Seeing the benefits of children was associated with higher life satisfaction, and seeing the costs of children was associated with lower life satisfaction.

Model 3 of Table 2 compares results separately by gender, and includes tests for the difference in the coefficients that were estimated in the model with interaction terms (see Appendix A). Perceived inability to procreate was associated with reduced life satisfaction for both women and men. The coefficient was slightly larger for women than it was for men, but the gender interaction was not significant. The model for women was similar to that for the entire sample, except that age was no longer significantly related to life satisfaction. The model for men was also similar to that for the entire sample, except that number of children was no longer significantly related to life satisfaction. Significant gender differences were observed for number of children, age and traditional schemas on women's roles (indicated in the last column of Table 2). Men had more of a decline in life satisfaction with age than women. Years in which people had three or more children were associated with lower life satisfaction for women and higher life satisfaction for men, but within each group, the coefficients were not statistically significant. Traditional schemas about women were associated with higher life satisfaction for women and lower life satisfaction for men, but within each group, the coefficients were not statistically significant.

In the next step, three-way interactions were used to analyse whether any of the life course indicators, values or attitudinal variables modified the association between perceived inability to procreate and life satisfaction differently for men and women (see Appendix A). Only partnership status and intention for a(nother) child modified the association between perceived inability to procreate and life satisfaction by gender. Fig. 1 shows predicted life satisfaction (from Model 4 A and B; see Appendix A) by perceived (in)ability to procreate and partnership status, separately for women and men. Partnership status modified the association between perceiving an inability to procreate and life satisfaction differently for women and men. Women with a partner experienced lower life satisfaction when they perceived an inability to procreate compared with times when they perceived an ability to procreate. There was no difference in life satisfaction between women at times when they did or did not perceive an inability to procreate if they did not have a partner. The opposite was true among men. When men perceived an inability to procreate and did not have a partner, they had the lowest life satisfaction of all of the groups.

Intention to have a(nother) child also modified the association between perceived inability to procreate and life satisfaction differently by gender (see Fig. 2). When women did not intend to have a(nother) child and perceived an inability to procreate, they had lower life satisfaction than women who perceived an ability to procreate; there were no differences in life satisfaction by procreative ability among women who intended to have a(nother) child. Among men, however, there was only a difference in life satisfaction by procreative ability status when they intended to have a(nother) child. When men perceived an inability to

procreate and intended to have a(nother) child, they had lower life satisfaction than men who perceived an ability to procreate and intended to have a(nother) child.

Discussion

This study used the first 10 waves of the pairfam data to estimate linear fixed effects regression models of the relationship between perceived procreative ability and life satisfaction over time. To the authors' knowledge, this is the first study to use panel data to assess whether perceiving an inability to procreate is associated with lower life satisfaction compared with times when one perceives an ability to procreate, among a population-based sample. The answer is an unequivocal 'yes'. Life satisfaction was substantially lower when people perceived an inability to procreate, and this relationship persisted after controlling for a number of variables which theory and previous research suggested might influence the relationship. These findings are consistent with some findings of previous research that used data from people seeking help for infertility, cross-sectional population data or two-wave population data (Greil et al., 2019; McQuillan et al., 2007; Schanz et al., 2011; Wischmann, et al., 2001, 2012). Using 10-wave panel analysis with a population-based sample provided a stronger test of the relevance of procreative ability for life satisfaction.

The associations for both men and women suggest that they experienced perceived inability to procreate as relevant for life satisfaction. Some previous research had suggested that this relationship would be stronger among women than men (Barnes, 2014; Benyamini et al., 2009; Wichman et al., 2011). Culley et al. (2013), however, found that the research regarding gender differences in the experience of infertility is inconclusive. The present study contributed to this research by using a representative sample, longitudinal data and an appropriate modelling strategy. This study found that perceiving fertility problems was similarly problematic for women and men. The coefficient for women was slightly higher than the coefficient for men, but the difference was not statistically significant.

The TCA, which includes insights from life course theory and cultural sociology, suggests that the meaning of perceiving barriers to procreation for life satisfaction will depend upon factors such as childbearing norms, expectations associated with age and marital/cohabiting status. Studying such moderating effects, and especially those that concern gender differences, is important to better understand how women and men differ in their experience of fertility problems. As cultural norms associate fertility and parenting with women more than men, it was expected that gender and life course, attitude and values indicators would modify the association between procreative ability and life satisfaction. However, only partner status (having a partner) and child intention status were found to modify life satisfaction by perceived procreative ability by gender associations.

Single men who perceived an inability to procreate had very low life satisfaction compared with partnered men who perceived an inability to procreate. It might be that

single men who perceive an inability to procreate constitute a special group of men who discover a problem earlier in their lives, perhaps due to cancer treatment or other toxic exposures. More would need to be known about the specific situation of single men, regarding their health history, relationship history and infertility history, before an explanation for this finding can be proposed with confidence. The results regarding single men highlight the need for further exploration of this understudied group.

Among partnered men, life satisfaction is not associated with whether or not they perceive an ability or inability to procreate. In other words, having a partner appears to protect men from the negative effects of infertility on their well-being. Women, however, do not gain the same benefit from having a partner. This finding might be explained by gender-based schemas regarding relationships and childbearing. Being a parent is generally viewed as being more central to women's identity than men's identity. Furthermore, having a stable relationship may act as a social trigger for thinking about childbearing. There is some evidence that women experience infertility as a direct challenge to identity, whereas men respond more in terms of their overall relationship (Greil 1991; Greil et al., 2018).

With regard to intention to have a(nother) child, it was expected that those who currently intend to have a(nother) child would suffer more from perceiving an inability to procreate. For those who do not intend to have a(nother) child, infertility should not matter much, because – unlike the case for other health issues – it is a condition that one can live with very well if no further children are intended. As expected, in years when men intended to have a(nother) child and perceived an inability to procreate, they had significantly lower life satisfaction compared with years in which they perceived an ability to procreate. Among women, the same pattern appeared, but it was not statistically significant. It may be that the measure of intent that is available in pairfam for all respondents – which is based on the ideal number of children desired – is rather crude for the purpose of measuring current intent. Unfortunately, respondents who perceived an inability to procreate were not asked about their short-term fertility intentions. Future studies should ask everyone about short-term fertility intentions.

It is also worth pointing out some three-way interactions that were expected to exist but were not found in this study. The relationship between perceived inability to procreate and life satisfaction was not found to be more strongly associated with age for women compared with men, despite the fact that age is more strongly connected to subfecundity among women. It may be that both men and women are aware of the relationship between age and fertility among women, and therefore respond to the aging of women in similar ways. In addition, placing a higher value on having children was not found to modify the relationship between perceived inability to procreate and life satisfaction differently for women and men, despite the fact that having children is generally presumed to be more important for women than it is for men. Thus, it may be that the most important finding of this study is that the association between

perceived inability to procreate and life satisfaction is similar for men and women.

This article is not without limitations. Fixed effects regression compared individuals in years when they perceived an inability to procreate with those same individuals in years when they did not perceive an inability to procreate. Thus, individuals whose perception of an inability to procreate did not change over time did not contribute to the analysis. Future research could compare people who always or never perceived an inability to procreate. Another limitation of this study is that it did not take time order into account. A change from perceived inability to procreate to perceived ability to procreate was treated the same as vice versa. Thus, the actual trajectory of change was not modelled; modelling whether or not there are longer-term trajectories of life satisfaction following perceived inability to procreate is potentially a fruitful avenue of future research.

Moreover, the available data did not show whether the subjects had ever been diagnosed with a medical fertility problem. It would be interesting to see whether having a medical diagnosis moderates the effect of perceived inability to procreate on life satisfaction. For future demographic surveys which include infertility and treatment, it is recommended that such questions should be asked. Additionally, limited information was available about the association between pregnancies with live births, on the one hand, and life satisfaction, on the other, in part because of skip patterns in the data. Therefore, it is not known, for example, whether those who are reported as parity '0' actually see themselves as parents, and whether this might be the reason why they do not have lower life satisfaction when they have perceived inability to procreate. Future research should explore the role of pregnancies with various outcomes in the experience of infertility in the German context.

The analysis of this paper was situated in Germany, a European country where most people intend to have children. As in many Organisation for Economic Co-operation and Development (OECD) countries, fertility is considerably below replacement level, and fertility postponement among people of higher ages is common. In comparison with other OECD countries, however, childlessness in Germany is relatively high. The authors would expect similar negative associations between perceived inability to procreate and life satisfaction. Due to cultural and demographic variations among OECD countries, it is likely that some associations will be stronger or weaker, and may also vary more or less by gender. It will be valuable to undertake future research exploring cross-national differences in the association between perceived inability to procreate and life satisfaction.

Even with its limitations, as far as is known, this is the first study to investigate changes in life satisfaction over time among both women and men who perceive an inability to procreate, and it therefore makes an important contribution to research on the psychosocial consequences of perceived infertility. It is important for researchers, physicians and counsellors to be aware that perceived inability to procreate is associated with lower life satisfaction, not only for women but also for men.

Appendix A. Fixed effects regression of life satisfaction by perceived (in)ability to procreate, life course characteristics and values for men and women, including interaction effects.

	Model 4				Three-way interaction	
	(A) Women		(B) Men		xG	xGxPIP
	Coef.	S.E.	Coef.	S.E.		
Perceived ability to procreate	Ref.		Ref.			
Perceived inability to procreate	0.18	0.17	−0.35	0.21		
x No children	−0.08	0.05	0.22	0.18		
x Two children	0.18	0.15	−0.15	0.20		
x Three or more children	0.23	0.18	−0.15	0.26		
x Has a partner	−0.52	0.13	0.46	0.15	b	c
x Age (mean-centred)	0.00	0.01	0.01	0.01		
x Subjective health (mean-centred)	0.16	0.04	0.12	0.05	a	
x Intend to have a(nother) child	0.12	0.11	−0.32	0.13	a	a
x Intend to have a(nother) child: don't know	−0.63	0.41	−0.09	0.40		
x Costs of children (mean-centred)	0.02	0.06	−0.03	0.07		
x Benefits of children (mean-centred)	0.09	0.06	−0.05	0.08		
x Traditional schemas men (mean-centred)		0.05	−0.01	0.06		
x Traditional schemas women (mean-centred)	−0.06	0.04	−0.03	0.05		
Number of children						
No children	−0.19	0.05	−0.08	0.05		
One child	Ref.		Ref.			
Two children	−0.13	0.05	−0.02	0.06		
Three or more children	−0.17	0.09	0.18	0.11	a	
Partner status						
No partner	Ref.		Ref.			
Partner	0.57	0.04	0.59	0.04	c	
Age (range 21–47 years) (mean-centred)	0.00	0.00	−0.02	0.00	c	a
Subjective health (mean-centred)	0.30	0.01	0.28	0.01	c	
Intention to have a(nother) child						
Do not intend to have a(nother) child	Ref.		Ref.			
Intend to have a(nother) child	−0.03	0.03	0.02	0.04		
Don't know	0.00	0.10	0.08	0.08		
Costs of children (mean-centred)	−0.16	0.02	−0.14	0.02	c	
Benefits of children (mean-centred)	0.04	0.02	0.07	0.02	b	
Traditional schemas men (mean-centred)	−0.02	0.02	0.01	0.02		
Traditional schemas women (mean-centred)	0.02	0.01	−0.02	0.01		a
Constant	70.28	0.05	70.03	0.06	c	
R ² within	0.06		0.06			

Ref., reference; G, gender; PIP, perceived (in)ability to procreate; Coef., coefficient.

^a*P* < 0.05.

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