

# Mental Health Around the Transition to First Birth: Does Medically Assisted Reproduction Matter?

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**ABSTRACT** Previous research has shown that childbearing is associated with short-term improvements in women’s subjective well-being but that these effects depend on the timing and quantum of the birth as well as on the parents’ education and socioeconomic status. These studies did not address whether and, if so, how this effect varies according to the mode of conception. This represents an important knowledge gap, given that conceptions through medically assisted reproduction (MAR) have been increasing rapidly in recent decades, exceeding 5% of live births in some European countries. Drawing on nine waves (2009/2010–2017/2018) of the UK Household Longitudinal Study, we use distributed fixed-effects linear regression models to examine changes in women’s mental health before, during, and after natural and MAR conceptions. The results show that the mental health of women who conceived naturally improved around the time of conception and then gradually returned to baseline levels; comparatively, the mental health of women who conceived through MAR declined in the year before pregnancy and then gradually recovered. The findings also indicate that women’s happiness decreased both two years and one year before an MAR conception and then increased above the baseline in the year of pregnancy. We further show that the deterioration in mental health and subjective well-being before an MAR conception affects both partners, which could be part of a longer process in which the partners potentially suffer from stress related not solely to the MAR treatments themselves but also to the experience of subfertility.

**KEYWORDS** Fertility • Subfertility • Mental health • Medically assisted reproduction

## Introduction

During the last decade, demographic research examining the link between fertility and well-being has flourished. This literature has shown that parenthood tends to have a positive effect on subjective well-being and that the quest for happiness is a key determinant of childbearing in societies where childbearing is generally regarded as a deliberate choice (Balbo and Arpino 2016; Billari 2009; Margolis and Myrskylä 2015; Mencarini et al. 2018). The spread and development of reproductive technology have further increased individuals’ control over fertility decisions by providing

infertile couples with the opportunity to have and raise children. The use of medically assisted reproduction (MAR) techniques—for example, ovulation induction, artificial insemination, and in vitro fertilization (IVF)—has increased rapidly in advanced societies since the 1980s, with more than 8 million MAR-conceived children born as of 2018 (Bitler and Schmidt 2012; International Committee Monitoring ART and ESHRE 2018). In Europe, the proportion of children born through MAR nearly doubled during the first decade of the new millennium (Ferraretti et al. 2017). This increase is attributable to technological advancements that have improved the MAR cumulative delivery rate over time and increased the availability of MAR treatments.<sup>1</sup> Denmark has been a forerunner in this trend: in 2018, 9% of births in Denmark were conceived through MAR (Martins et al. 2018). However, even though the number of people undergoing and conceiving through MAR is rising, little is known about the effect that the transition to parenthood has on the well-being of this growing subgroup of the population.

The majority of previous studies on parents' well-being have shown that, on average, parents' happiness and life satisfaction increase in the years around the birth and then gradually return to previous baseline levels or dip below pre-pregnancy levels (Clark and Georgellis 2013; Kohler et al. 2005; Kohler and Mencarini 2016; Myrskylä and Margolis 2014). This pattern has been observed for the first birth and—albeit to a lesser extent—for the second birth; the third birth, by contrast, does not appear to increase happiness levels. Previous demographic research has analyzed extensively the effect of childbearing on parental well-being and how this effect differs by parity, parental age, and socioeconomic status (SES). However, these studies have not examined whether and, if so, how this effect varies according to the mode of conception. This is a limitation, given that undergoing MAR can greatly affect the process leading up to and following the transition to parenthood. Undergoing infertility treatments can be stressful, especially when they involve invasive procedures, such as hormonal therapy and laparoscopic surgery (surgery to retrieve oocytes) (Klonoff-Cohen 2008; Klonoff-Cohen and Natarajan 2004). Additionally, the low success rates of infertility treatments may generate feelings of anxiety and stress that persist throughout the treatment cycles and perhaps longer (Hjelmstedt et al. 2003). Therefore, the short-term positive effects of parenthood on well-being that the demographic literature has documented *on average* might not reflect the experiences of women and couples who conceive through MAR.

In this study, we use a British longitudinal survey to examine changes in women's mental health before and after pregnancy by distinguishing between women who conceived naturally and those who conceived through MAR. Examining how women cope with the process leading up to an MAR pregnancy is important not only because the proportion of women conceiving through MAR is increasing but also because increased stress can affect women's birth outcomes and relationships with their children—and, by extension, their children's well-being (Goisis, Remes, et al. 2019; Martin et al. 2017).

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<sup>1</sup> In the United Kingdom, the live birth rate for one IVF cycle increased from 7% in 1991 to 21% in 2017 (HFEA 2019). Delivery rates increase with the number of treatment cycles. The cumulative live birth rate is around 50% after three cycles and is between 50% to 70% after six cycles (Malizia et al. 2009; Troude et al. 2016).

More specifically, our contribution is threefold. First, women who conceive through MAR are a selected group, and their characteristics can be both positively (e.g., high SES) and negatively (e.g., subfertility) associated with mental health. Any observed association between MAR and women's mental health could, therefore, reflect different selection factors with varying effects on mental health. In this study, using extremely rich longitudinal data, we are able to analyze for the first time individual changes in mental health among women who conceived through MAR, thus removing the bias introduced by unobservable time-invariant characteristics.

Second, our estimation strategy enables us to evaluate the anticipation as well as the short- and longer-term effects of MAR conception on women's mental health. Studying the process leading up to an MAR conception is important because struggling with subfertility is highly distressing (Domar et al. 1993; Greil 1997). Therefore, the mental health of couples undergoing MAR may decline well before the start of the MAR treatment. For those couples who are able to conceive and have a live birth after MAR, the joy of becoming a parent may help them recover, and their mental well-being may increase to their baseline levels or higher.

Third, our empirical investigation aims to shed light on the mechanisms that may explain potential differences in the mental health trajectories associated with natural and MAR conceptions. As well as negatively affecting the partners' relationship, the stress associated with undergoing infertility treatments can seep into the partners' mental health through different mechanisms, such as empathy and mood contagion (Nicoloso-SantaBarbara et al. 2018). Moreover, undergoing MAR treatments can increase the time and financial costs of having children for both partners. In addition to dealing with the costs of the treatments themselves, MAR patients may find that the quality and the quantity of the time they can devote to work and to leisure have been reduced.

## Background

### Childbearing, Subjective Well-being, and Mental Health

Parenthood can be both rewarding and burdensome. Becoming a parent satisfies basic human needs and elicits feelings of pride, self-realization, and personal fulfillment (Hansen 2012). According to the set-point theory, every individual has a certain level of well-being determined by genetic and personality traits, which can be altered by childbearing, even if only temporarily. Longitudinal studies have shown that, on average, men's and women's subjective well-being at least temporarily improves around the time they have children (Clark and Georgellis 2013; Dyrdal and Lucas 2013; Frijters et al. 2011; Kohler et al. 2005). However, other studies have indicated that after the birth of a child, well-being decreases and falls below previous levels (Nomaguchi and Milkie 2003; Pollmann-Schult 2014). Some scholars have suggested that a decrease in well-being might occur because for some women, the emotional benefits of motherhood are outweighed by the economic and time burdens and decreased relationship satisfaction associated with parenthood (Luhmann et al. 2012; Matysiak et al. 2016). In a recent longitudinal study based on data from the German Socio-Economic Panel Study, Giesselmann et al. (2018) found that women's mental health declined steadily after the birth of the first child. The authors observed

that the conflict between societal expectations about intensive mothering and the reality of being a working mother may result in feelings of guilt and stress. Hence, the positive or negative effect of parenthood on well-being may vary substantially depending on the cultural and institutional context as well as on individual sociodemographic characteristics. This variation might partially explain the inconsistencies in the prior findings.<sup>2</sup> In a study using German and British longitudinal data, Myrskylä and Margolis (2014) found that the short-term increase in happiness observed among couples around the time of a birth was mainly driven by women and men who conceived their first child at older ages and by those with higher SES (see also Kohler et al. 2005). Although most previous studies have focused on women, some studies have also examined the impact of fatherhood on men's well-being. These studies have produced inconsistent results, with some showing that fatherhood has no impact on men's subjective well-being (Clark and Georgellis 2013; Roeters et al. 2016) and others finding that fatherhood has a positive and short-lived effect on men's life satisfaction (Balbo and Arpino 2016; Matysiak et al. 2016).

Despite the heterogeneity in the observed effects of parenthood on well-being, previous studies focusing specifically on the United Kingdom have shown that, on average, men's and women's well-being tends to improve around the time of a first birth and then to decline after the birth, when the economic and social costs of child-rearing rise (Clark et al. 2008; Myrskylä and Margolis 2014). Hence, we also expect to find that the mental health of British couples who conceive naturally increases around the birth of the first child and then returns to or falls below pre-pregnancy levels.

### Medically Assisted Reproduction and Mental Health

The existing (largely) medical literature has investigated the link between MAR and mental health. Several studies have shown that women can experience negative effects on mental health when undergoing MAR treatments, regardless of whether the treatments are successful (Klemetti et al. 2010; Milazzo et al. 2016; Nicoloro-SantaBarbara et al. 2018; Verhaak, Smeenk, Evers et al. 2006; Verhaak, Smeenk, Nahuis et al. 2006). At least part of the decline in mental health around MAR treatment is attributed to suffering from subfertility, which can have a long-lasting effect on anxiety, stress, and depression (King 2003; Klemetti et al. 2010). The relationship between MAR and mental health appears to be stronger for women who fail to conceive after undergoing MAR, although evidence suggests that their mental health improves over time as they adjust to subfertility/childlessness (Baldur-Felskov et al. 2013; Johansson et al. 2010; Milazzo et al. 2016; Yli-Kuha et al. 2010). Some studies have found that women who are not able to conceive through MAR fully recuperate, whereas other studies have shown that they remain at higher risk of poorer mental health outcomes (Milazzo et al. 2016; Peterson et al. 2011; Peterson et al. 2009; Vikstrom et al. 2015). Although prior studies have largely focused on women's mental health, evidence suggests that while undergoing MAR, women are more negatively affected than men in

<sup>2</sup> Inconsistencies in previous findings are also explained by differences in study methodology (i.e., cross-sectional vs. longitudinal) and choice of baseline (i.e., the pre-pregnancy period vs. the pregnancy period).

terms of happiness, life satisfaction, and mental health (Holter et al. 2006; Peterson et al. 2009). Male partners are seen as important sources of support to bring marital relationships closer and manage the stressful experiences of infertility and MAR (Peterson et al. 2011; Peterson et al. 2009). Despite a greater effect of MAR on women's mental health, partners share similar experiences and may influence each other's psychological reactions to MAR (Boivin et al. 1998).

Despite this extensive literature, our knowledge about couples' mental health responses as they undergo the various stages of MAR treatment is limited. The few longitudinal studies on this topic did not examine women's long-term mental health trajectories before, during, and after they underwent MAR treatments (Verhaak et al. 2001; Verhaak, Smeenk, Nahuys et al. 2006). These studies have two main limitations. First, they provide limited insight into the extent to which the mental health levels of women who undergo MAR diverge from their *baseline* or *pre-subfertility* levels during treatment. The baseline used in most of these studies is around the time the MAR treatment started, when the women and men were already struggling with subfertility (Greil 1997). Although a few studies have found that before the start of treatment and after the birth of a child, women who undergo MAR have mental health outcomes similar to those of women who conceive naturally (Joelsson et al. 2017; Milazzo et al. 2016; Yli-Kuha et al. 2010). These findings should not be interpreted as evidence that the trajectories of these women in the years preceding and following the birth are similar. Indeed, women who undergo MAR may have different (higher) baseline mental health levels than women who conceive naturally, given that the former tend to be socioeconomically advantaged (Barbuscia et al. 2019), which reduces their risk of poor mental health outcomes.

Second, knowledge about the (direct and indirect) mechanisms that potentially underlie the MAR–mental health association is limited. The *direct* mechanisms include the stress women experience before and during MAR treatments, which may stem from both being infertile and feeling uncertain given the low success rates of MAR treatments (ESHRE Task Force on Ethics and Law 2003, 2010). Thus, the association between undergoing MAR and poor mental health may be due to the fear of being unable to conceive or of experiencing a miscarriage. After treatment has started, women might face high levels of stress because, for example, they are faced with frequent medical tests, surgery to retrieve oocytes, or being forced to wait for fertilization or pregnancy results. Undergoing MAR could also *indirectly* affect women's and men's mental health. The treatments are often expensive (Bitler and Schmidt 2012), and the loss of financial resources can negatively affect couples' mental health, especially if the partners are no longer able to afford their previous lifestyle (Benzeval and Judge 2001). Because fertility treatments can be time-consuming and emotionally draining, undergoing MAR may also intervene in other life domains, such as employment. Thus, women might work less while undergoing treatment, which could harm their mental health (Strully 2009). Other potential effects of undergoing MAR are feelings of loneliness and social isolation, which may be related to the stigma surrounding infertility and to having less time to spend on social relationships and leisure (Nicoloro-SantaBarbara et al. 2018).

In this study, we address these gaps in knowledge by providing the first comprehensive longitudinal analysis of the mental health trajectories of women and men who conceive through MAR. We expand on the existing literature by investigating the association between undergoing MAR and mental health before, upon, and after

conception by using a significantly larger window of observation than prior studies and by taking into account selected characteristics of women and men who undergo MAR. We are also able to test some of the mechanisms that may underlie the association between undergoing MAR and mental health outcomes.

## Data and Methods

### Sample

We use data from the nine waves (2009/2010–2017/2018) of the UK Household Longitudinal Study (UKHLS). The UKHLS is an annual survey of 40,000 households that are representative of the population. It collects information on many aspects of life, including health and well-being, from all household members aged 16 or older. This survey is a continuation of the British Household Panel Survey (1991–2008), but it includes new questions on pregnancy outcomes and modes of conception (Jäckle et al. 2019).

For our study sample, we select childless women aged 18–50 who became pregnant throughout the observation window. We exclude respondents who had a child before entering the survey or who had no pregnancies by the end of the follow-up period. We select women who were childless at baseline because most women who undergo fertility treatment are attempting to conceive a first child (Goisis, Remes, et al. 2019) and are less likely than women who conceive naturally to have a second child.<sup>3</sup> We include women who conceived regardless of whether the pregnancy ended in a live birth, partly because of sample size issues and partly because it allows us to capture the experiences of women who wanted to have a child, underwent MAR, and became pregnant but did not have a live birth. Five lesbian couples were excluded from the analysis because the process leading up to pregnancy and the reasons for using MAR may be different for this subgroup.

Of the 2,334 respondents (15,312 observations) selected in this study, 2,297 (98.4%) had valid and complete information for the variables used in the analysis. The analytical sample includes 2,297 women who were followed, on average, more than 5.8 points in time, resulting in 13,401 observations. Attrition was 4.6%, on average, ranging from 24.2% between Waves 1 and 2 to 1.0% between Waves 7 and 8. In a further step of the analysis, we link each woman's information to that of her cohabiting partner. Of 2,297 women who became pregnant throughout the observation window, 1,993 were living with a partner, and 1,717 had a partner who reported valid information on mental health (9,452 observations). In the subsample of partners, average attrition was 6.2%.

### Dependent Variable

The dependent variable is the Mental Component Summary score computed from the SF-12 health questionnaire, which consists of six questions regarding mental

<sup>3</sup> In the UKHLS, 43 women conceived their second child through MAR.



health: “During the last four weeks, how much of the time (1) have you accomplished less than you would like as a result of any emotional problems, such as feeling depressed or anxious? (2) Did you work or perform other regular daily activities less carefully than usual as a result of any emotional problems, such as feeling depressed or anxious? (3) Have you felt calm and peaceful? (4) Did you have a lot of energy? (5) Have you felt downhearted and depressed? (6) Have your physical health or emotional problems interfered with your social activities like visiting friends or relatives?” The response options are presented on a 5-point Likert scale ranging from 1 = all of the time to 5 = none of the time. The measure converts these items into a single mental functioning score, resulting in a continuous scale with a range of 0 (low functioning) to 100 (high functioning). The scale is standardized (to a mean of 0 and a standard deviation of 1) on the overall sample of all respondents available in the UKHLS data.

The Mental Component Summary has been validated as an indicator of mental health and a screening tool for detecting mental disorders, such as depression or anxiety (Ware et al. 1996). The scale is particularly well suited for our purposes, given its focus on objective aspects of well-being. Measures of life satisfaction or happiness often focus on affection, which might be biased by social desirability—that is, the social pressure to be happy when having a child. Social desirability bias may be particularly relevant for women undergoing MAR, for whom desires and expectations concerning motherhood might be especially strong, and could be reinforced by the decision to undertake MAR. Nevertheless, given that previous research focused on subjective well-being (e.g., Myrskylä and Margolis 2014; Perelli-Harris et al. 2019), we also analyze general happiness as the outcome variable. In the survey, the question is formulated as follows: “Have you recently been feeling reasonably happy, all things considered?” The scale, ranging from 0 = much less than usual to 4 = much more than usual, is standardized on the average score of the overall sample to facilitate the interpretation of the magnitude of the coefficients.

## Independent Variables

The main independent variable identifies women who became pregnant between two consecutive waves and is derived from the question, “Since [date of the last interview] have you been pregnant at all, even if this did not result in a live birth?” Because women could become pregnant more than once during the nine-year period, we consider the birth of the first child or, for those whose first pregnancy did not result in a live birth, any second pregnancy during this period ( $N=20$  MAR conceptions and 58 natural conceptions). This approach enables us to capture at least some of the attempts and failures before having a child through MAR ( $N=10$  women who had the second pregnancy through MAR). We distinguish women who conceived naturally from those who underwent fertility treatment by responses to the following question: “Did you receive any form of fertility treatment before becoming pregnant?” Given the formulation of the question, it is not possible to identify the beginning of the infertility workup or to analyze the mental health of women who underwent fertility treatment but did not become pregnant. The sample includes 2,151 women with a natural pregnancy (12,421 observations) and 146 women who

**Table 1** Average score of SF-12 mental health by mode and timing of conception

|                               | MAR Conception |       |                                   | Natural Conception |       |                                   |
|-------------------------------|----------------|-------|-----------------------------------|--------------------|-------|-----------------------------------|
|                               | <i>N</i>       | %     | SF-12 Mental Health (z score; SD) | <i>N</i>           | %     | SF-12 Mental Health (z score; SD) |
| Months Before/After Pregnancy |                |       |                                   |                    |       |                                   |
| 25 or more before             | 286            | 29.2  | 49.6 (+0.02; 8.5)                 | 2,331              | 18.8  | 48.1 (−0.13; 9.9)                 |
| 24 to 13 before               | 96             | 9.8   | 48.1 (−0.13; 9.7)                 | 1,128              | 9.1   | 47.5 (−0.19; 9.9)                 |
| 12 to 1 before                | 119            | 12.1  | 47.1 (−0.23; 9.6)                 | 1,668              | 13.4  | 48.3 (−0.11; 9.9)                 |
| 0 to 12 after                 | 137            | 14.0  | 48.8 (−0.05; 9.2)                 | 1,875              | 15.1  | 47.9 (−0.15; 9.9)                 |
| 13 to 24 after                | 83             | 8.5   | 48.8 (−0.05; 9.0)                 | 1,427              | 11.5  | 47.0 (−0.23; 10.6)                |
| 25 or more after              | 259            | 26.4  | 47.7 (−0.17; 8.8)                 | 3,992              | 32.1  | 46.3 (−0.31; 10.5)                |
| Year-Observations             | 980            | 100.0 |                                   | 12,421             | 100.0 |                                   |
| Number of Women               | 146            | 100.0 |                                   | 2,151              | 100.0 |                                   |

underwent MAR to conceive (980 observations).<sup>4</sup> Among women who underwent MAR, 66% used IVF to conceive.

To examine the women's mental health scores before, upon, and after pregnancy, we compute the number of months that elapsed between the date of conception and the date of interview. In case of missing dates (405 natural conceptions and 0 MAR conceptions), we use the number of months elapsed between interview dates. The observation window allows us to observe couples for a maximum of 108 months before and after pregnancy. The variable is coded into six categories capturing 12-month intervals in the pre- and post-pregnancy periods (for a similar categorization, see Clark and Georgellis 2013): (1) 25 or more months before; (2) between 24 and 13 months before; (3) between 12 months and 1 month before; (4) between 0 and 12 months after; (5) between 13 and 24 months after; and (6) 25 or more months after (see Table 1). The

<sup>4</sup> Fertility treatments are available through the National Health System (NHS) in the United Kingdom, but there are large regional disparities. For example, the NHS provides funding for up to three cycles of IVF in Scotland, up to two cycles in Wales, and up to one cycle in Northern Ireland. In contrast, in England, funding depends on the area where a couple lives. Thus, in England, the provision of fertility treatments is subject to the so-called postcode lottery. For example, whereas three IVF cycles are funded in Camden (London), the Clinical Commissioning Group does not offer any IVF cycle in North East Essex. Moreover, in addition to varying by region and (in England) area of residence, whether funding for IVF is granted depends on the woman's age (usually whether she is younger than 40); her length of infertility (usually whether she has had at least two years of regular and unprotected intercourse), lifestyle factors, such as her BMI, smoking status, and relationship length; whether she or her partner has children from previous relationships (ESHRE 2017 European Audit Policy on Fertility). The eligibility criteria vary from area to area. The provision of other MAR treatments, such as intrauterine insemination, also varies by area. The UKHLS does not provide information as to whether a given MAR treatment took place in the private or public sector. We estimate, however, that most MAR treatments in our data took place in the private sector because in the United Kingdom, a larger proportion of such treatments are provided in the private sector. In 2013, 41.3% of IVF cycles were funded by the NHS, whereas 58.7% were funded privately (ESHRE 2017 European Audit Policy on Fertility). Because the proportion of NHS-funded MAR treatments remained stable in the United Kingdom from 2012 to 2017, we do not expect to observe systematic changes in the composition of MAR couples in our data.



category related to 25 or more months before pregnancy is the reference category, based on the assumption that the childbearing process started approximately two years before pregnancy. This assumption is likely to be realistic for most women who conceived naturally because their time to pregnancy may have been relatively short. In contrast, for women undergoing fertility treatment, the time to pregnancy was likely longer or varied considerably, depending on when they started the infertility workup after attempting to conceive naturally and on the number of MAR cycles they underwent. Two years before conception could represent a moment in the middle of a long process that started with trying to conceive naturally and was followed by being unable to conceive naturally, deciding to undergo MAR, and ultimately succeeding or not succeeding in having a live birth through MAR. The baseline is, therefore, a point in time when some of these women had already been affected by infertility, which could have caused their level of mental health to be lower than their baseline (Domar et al. 1993; Stanton et al. 1992). Although we are unable to determine the point in the process when each woman in our sample was at baseline, no study has observed women who underwent MAR for such a long period before conception.

This variable allows us to capture changes in mental health before and after pregnancy but not to identify the effect of the MAR treatment in itself. Because the data do not provide us with information about when each woman started trying to conceive or started undergoing MAR cycles, or about the number of cycles each woman underwent before she became pregnant, we cannot isolate the effect of each treatment cycle from the experience of subfertility. Therefore, the effect we identify captures the combined effects of struggling to conceive naturally, experiencing subfertility, and coping with the stress of MAR.

### Control Variables and Mediators

In our baseline models, we control for the respondent's age and age squared.<sup>5</sup> In subsequent models, we adjust for mediators (the possible mechanisms noted in the Background section). First, we add a dummy variable for whether the pregnancy ended in a live birth. This variable is derived from a question about the outcome of the pregnancy: a live birth (normal delivery or cesarean section) or not a live birth (miscarriage, stillbirth, termination, or ectopic or tubal pregnancy). This time-varying variable is set equal to 0 before conception and to 1 in the years after conception for respondents whose pregnancy ended in a live birth. Second, we adjust for changes in economic resources, employment, and marital status. Financial resources are captured by the respondent's total net monthly income. The marital status variable indicates whether the respondent was living with a partner (married or cohabiting) or was never married, divorced, or separated. In the final model, we also include a continuous variable capturing individual satisfaction with the amount of leisure time, ranging from 1 = completely dissatisfied to 7 = completely satisfied. In the descrip-

<sup>5</sup> Additional analyses show that the results are not affected by the functional form of age, the time intervals to or from pregnancy, or the inclusion in the control group of all couples aged 18–50 who were childless and in a heterosexual partnership at baseline and who did not experience a pregnancy during the study period.

**Table 2** Descriptive statistics for women with MAR conceptions and natural conceptions (NC)

|  | Average |      |        |      | Baseline |       |
|--|---------|------|--------|------|----------|-------|
|  | MAR     |      | NC     |      | MAR      | NC    |
|  | Mean    | SD   | Mean   | SD   | Mean     | Mean  |
| Age                                    | 33.30   | 6.25 | 29.30  | 6.33 | 30.10    | 25.60 |
| No Live Birth                          | 0.22    | 0.39 | 0.07   | 0.23 | 0.22     | 0.07  |
| Personal Net Income (log)              | 6.79    | 1.65 | 6.66   | 1.66 | 6.59     | 6.42  |
| Single or Divorced                     | 0.11    | 0.32 | 0.28   | 0.45 | 0.15     | 0.36  |
| Unemployed                             | 0.04    | 0.20 | 0.06   | 0.24 | 0.03     | 0.06  |
| Not in the Labor Force                 | 0.11    | 0.31 | 0.17   | 0.38 | 0.12     | 0.18  |
| Satisfaction With Leisure Time         | 4.57    | 1.51 | 1.41   | 1.55 | 4.57     | 1.41  |
| High SES (professional occupation)     | 0.43    | 0.49 | 0.33   | 0.46 | 0.43     | 0.33  |
| High Education (above A level)         | 0.53    | 0.50 | 0.37   | 0.48 | 0.54     | 0.37  |
| Number of Individual-Year Observations | 980     |      | 12,421 |      |          |       |
| Number of Women                        |         |      |        |      | 146      | 2,151 |

tive analyses, we also look at women's education (university degree or less) and SES (management and professional occupations according to the National Statistics Socio-economic Classification). Descriptive statistics for the dependent and control variables are reported in [Table 2](#).

### Analytical Strategy

We use longitudinal, distributed fixed-effects linear regression models (as defined by Dougherty 2006; Dribe and Nystedt 2013) to examine changes in mental health before and after pregnancy. The estimates are based on within-person changes in the Mental Component Summary score, which allows us to account for time-invariant characteristics that may bias the association between pregnancy and mental health (Allison 2009). Fertility is socially patterned by education, family orientation, and SES (Kravdal and Rindfuss 2008). These characteristics are related to mental health issues and may introduce a source of bias in conventional estimates. Addressing selection due to unobservable factors or difficult-to-measure characteristics is important, particularly for women undergoing MAR. Although these women generally have substantial socioeconomic resources, which are positively associated with mental health (Barbuscia et al. 2019), they also suffer from subfertility, which is negatively associated with psychological well-being (Greil 1997). Whether positive or negative, the time-invariant selection effects are accounted for by individual fixed effects in the statistical models.

In our modeling strategy, each time point before and after pregnancy has a specific meaning. For women who conceived naturally, the pre-pregnancy period captures a time when the couple increased their sexual activities to have a child. For women who underwent MAR, the estimates related to the pre-pregnancy period capture a set of stressful experiences, which include discovering that they are unable to con-

ceive naturally, undergoing MAR treatments, and worrying about the pregnancy test results. The year of pregnancy captures the effect of successful conception for both groups and the effect of becoming a parent for women who have a live birth. Post-pregnancy effects refer to the years when the parents have new commitments and adjust their lifestyles. Adjustments that we observe in post-pregnancy estimates are interpreted with respect to the baseline level measured two years before pregnancy. The baseline level is not estimated in the models because, as a time-invariant effect, it is indistinguishable from the individual-specific constant. Therefore, the choice of the reference category for one of the two groups does not affect the results for the other.

More specifically, mental health is modeled as indicated in the following equation:

$$MH_{it} = \beta_{1-5} MAR_{it}^k + \beta_{6-10} NC_{it}^k + \beta_{11} Age_{it} + \beta_{12} Age\_Squared_{it} + \alpha_i + \varepsilon_{it}.$$

$MH$  is the mental health of person  $i$  at time point  $t$ .  $MAR$  and  $NC$  are two sets of dummy variables capturing the time to or time since the MAR or natural ( $NC$ ) conception of individual  $i$  at time  $t$ . The superscript  $k$  denotes the five dummy variables for the  $NC$  and  $MAR$  groups, and  $\beta_{1-5}$  and  $\beta_{6-10}$  indicate the respective coefficients associated with the 12-month intervals in the pre- and post-pregnancy periods. In contrast to standard fixed-effects models, our specification includes the categories  $k$  that allow the  $NC$  and  $MAR$  conception to have a distributed effect before, upon, and after the actual date of pregnancy.  $Age$  refers to individual age. We add a quadratic term to account for potential nonlinearity in the effect of increasing age ( $Age\_Squared$ ).  $\alpha$  is an individual-specific constant (or the individual fixed effect) that varies across individuals but is fixed over time.  $\alpha$  is not estimated in the models and captures any time-invariant characteristic of the individual  $i$  (including baseline differences in mental health between  $MAR$  and  $NC$ ). As part of the fixed-effects strategy, the mean score for person  $i$  over all time points for the variables  $MH$ ,  $MAR$ ,  $NC$ , and  $Age$  has been deducted from person  $i$ 's score on those variables at time point  $t$ . Similar modeling specifications have been used in previous studies to separate the effects of life course events for the pre- and post-event periods (e.g., Dougherty 2006; Goisis, Özcan, and Van Kerm 2019; Tosi and van den Broek 2020).

After a brief description of the dependent and independent variables, our analytical strategy consists of three steps. First, we examine women's mental health trajectories before, upon, and after an MAR or natural pregnancy (Model 1). Then, we test whether these trajectories change following the progressive inclusion of the time-varying mediators in the model. Model 2 adjusts for whether the pregnancy ended in a live birth; Model 3 (in addition to the controls included in Model 2) adjusts for employment status; and Model 4 (in addition to the controls included in Model 3) adjusts for income, marital status, and satisfaction with leisure time. Second, we estimate the same types of models for a subgroup of partners to analyze the effects of the pregnancy and the mode of conception on the partners' mental health. Third, we analyze associations between  $NC$ ,  $MAR$ , and couples' subjective well-being, measured through happiness. To ease the interpretation of the results, we plot the predicted changes in mental health and happiness for  $NC$  and  $MAR$  conceptions estimated from (unadjusted) fixed-effects models in Figures 1–4.

## Results

### Descriptive Trajectories in Mental Health

In [Table 1](#), we report the average mental health score of women who conceived naturally and those who underwent MAR. The baseline score of mental health was higher for women who conceived through MAR than for those who conceived naturally. The average mental health score decreased from 49.6 to 47.1 in the two years before an MAR conception and then increased during pregnancy (to 48.8). Among women who conceived naturally, the average mental health score declined in the two years before pregnancy (from 48.1 to 47.5), returned to the baseline level in the year before pregnancy, and decreased again during and after pregnancy (from 48.3 to 46.3). In both groups, women's mental health decreased by approximately 2 points during the years around pregnancy (for men, see [Table A6](#) in the online appendix).

The baseline differences in mental health may reflect the relatively high socioeconomic positions of the women who underwent MAR. [Table 2](#) shows that compared with women who conceived naturally, women who conceived through MAR were, on average, older ( $p$  value = .000), wealthier ( $p$  value = .010), and less likely to divorce or remain unpartnered ( $p$  value = .000). Women who conceived through MAR were overrepresented in the highly educated ( $p$  value = .000) and professionally employed ( $p$  value = .000) groups. The share of women who did not have a live birth was 22% for those who conceived through MAR and 7% for those who conceived naturally.

### Changes in Women's Mental Health Before and After Pregnancy

[Table 3](#) presents results from fixed-effects linear regression models predicting changes in SF-12 mental health scores. [Figure 1](#) shows the results from Model 1. In Model 1 (unadjusted), mental health increased in the year before pregnancy and gradually returned to baseline levels for women who conceived naturally. This increase was equal to 0.12 and 0.11 standard deviations in the year before and during pregnancy, respectively. Two years after pregnancy, the mental health of women was indistinguishable from baseline levels (coefficient = 0.02). Conversely, the mental health of women who conceived through MAR decreased by 0.18 ( $p$  value = .03) standard deviations in the year before pregnancy. [Figure 1](#) shows that after a decrease in mental health scores, women who conceived through MAR returned to pre-pregnancy mental health levels during the year of pregnancy. Hence, the mental health of both groups returned to baseline levels before conception or approximately two years after conception, but the trajectories went in opposite directions: that is, the associations were U-shaped for women who conceived through MAR and were inverse U-shaped for women who conceived naturally. The  $t$  test (11.5;  $p$  value = .00) and additional models with interaction effects confirm that the health trajectories of women differed significantly in the year before pregnancy depending on whether they conceived naturally or through MAR ([Table A1](#), online appendix).

In Model 2, we adjust for the time-varying variable capturing whether the pregnancy ended in a live birth. Having a pregnancy that did not end in a live birth was

**Table 3** Fixed-effects linear regression models predicting changes in women’s mental health around natural and MAR conceptions (z score)

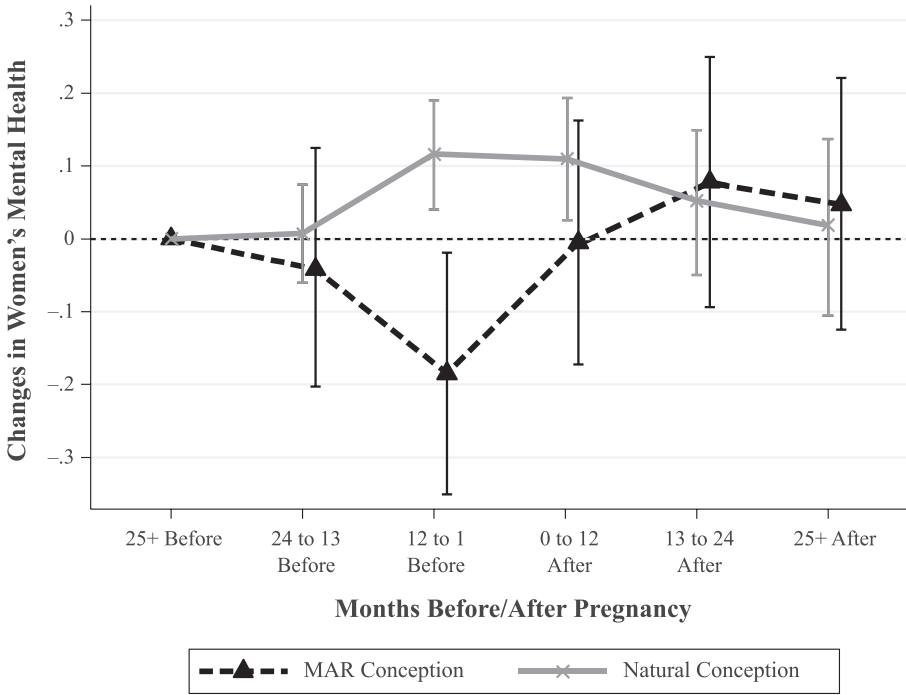
|  | Model 1 |      | Model 2 |      | Model 3 |      | Model 4 |      |
|--|---------|------|---------|------|---------|------|---------|------|
|  | Coef.   | SE   | Coef.   | SE   | Coef.   | SE   | Coef.   | SE   |
| Months Before/After Pregnancy                |         |      |         |      |         |      |         |      |
| Natural pregnancy (ref. = 25 or more before) |         |      |         |      |         |      |         |      |
| 24 to 13 before                              | 0.01    | 0.03 | 0.01    | 0.03 | 0.01    | 0.03 | 0.01    | 0.03 |
| 12 to 1 before                               | 0.12**  | 0.04 | 0.12**  | 0.04 | 0.11**  | 0.04 | 0.09*   | 0.04 |
| 0 to 12 after                                | 0.11**  | 0.04 | 0.13**  | 0.04 | 0.13**  | 0.04 | 0.11**  | 0.04 |
| 13 to 24 after                               | 0.05    | 0.05 | 0.07    | 0.05 | 0.07    | 0.05 | 0.08†   | 0.05 |
| 25 or more after                             | 0.02    | 0.06 | 0.03    | 0.06 | 0.03    | 0.06 | 0.06    | 0.06 |
| MAR pregnancy (ref. = 25 or more before)     |         |      |         |      |         |      |         |      |
| 24 to 13 before                              | -0.03   | 0.08 | -0.03   | 0.08 | -0.03   | 0.08 | -0.06   | 0.08 |
| 12 to 1 before                               | -0.18*  | 0.08 | -0.17*  | 0.08 | -0.18*  | 0.08 | -0.17*  | 0.08 |
| 0 to 12 after                                | -0.00   | 0.09 | 0.04    | 0.08 | 0.04    | 0.09 | 0.01    | 0.08 |
| 13 to 24 after                               | 0.08    | 0.09 | 0.11    | 0.09 | 0.11    | 0.09 | 0.12    | 0.08 |
| 25 or more after                             | 0.05    | 0.09 | 0.08    | 0.09 | 0.08    | 0.09 | 0.10    | 0.09 |
| Age  | -0.05** | 0.02 | -0.05** | 0.02 | -0.05** | 0.02 | -0.07** | 0.02 |
| Age Squared                                  | 0.00    | 0.00 | 0.00    | 0.00 | 0.00    | 0.00 | 0.01*   | 0.00 |
| No Live Birth                                |         |      | -0.22** | 0.06 | -0.22** | 0.07 | -0.22** | 0.06 |
| Log of Personal Net Income                   |         |      |         |      | 0.01†   | 0.01 | 0.01    | 0.01 |
| Employment (ref. = working)                  |         |      |         |      |         |      |         |      |
| Unemployed                                   |         |      |         |      | -0.15** | 0.05 | -0.17** | 0.05 |
| Not in the labor force                       |         |      |         |      | -0.04   | 0.04 | -0.05   | 0.04 |
| Single or Divorced                           |         |      |         |      |         |      | -0.10** | 0.03 |
| Satisfaction With Leisure Time               |         |      |         |      |         |      | 0.11**  | 0.01 |
| Year-Observations                            | 13,401  |      | 13,401  |      | 13,401  |      | 13,401  |      |
| R <sup>2</sup>                               | .02     |      | .02     |      | .02     |      | .05     |      |
| Number of Women                              | 2,297   |      | 2,297   |      | 2,297   |      | 2,297   |      |

Note: Robust standard errors are shown.

†*p* < .10; \**p* < .05; \*\**p* < .01

associated with a mental health decline of 0.22 standard deviations. As expected, adjustment for this variable does not reduce the anticipation effect of MAR conception on mental health, given the difficulty of predicting pregnancy outcomes one year before the event. Compared with Model 1, we observe no relevant changes in the coefficients related to natural and MAR conceptions when accounting for live births.

In Model 3, we test work-related mechanisms by accounting for changes in personal income and employment status. Although becoming unemployed was associated with a decrease in women’s mental health, including these variables in the model does not explain the changes in mental health associated with MAR and natural conception. Because the average effects of income and employment may hide variations across the two groups, we estimated models with interactions between these work-related factors and the mode of conception. The results (available upon request) were equivalent to those presented in the text.



**Fig. 1** Predicted changes in women’s mental health around natural and MAR conceptions. Estimates are from Model 1 in Table 3.

The anticipation effect of MAR conception does not change when we control for marital status and satisfaction with leisure time in Model 4 (see Table A7 in the online appendix for associations between childbearing and mediators). The coefficients associated with the years before and during natural pregnancy decrease from 0.11 and 0.13, respectively, in Model 3 to 0.09 and 0.11 in Model 4, indicating that the positive effect of childbearing was partly due to increased satisfaction with free time. For women who conceived through MAR, we observe no significant changes in the coefficients of Model 4. The declining trend in mental health started roughly 24–13 months before pregnancy, which suggests that the mental health deterioration of these women was part of a longer process (see Figure A1 in the online appendix for the predicted changes in mental health). Importantly, the mental health trajectories of women who conceived through MAR converged over time with those of women who conceived naturally. One year after pregnancy, the mothers had similar adjustment levels, regardless of their mode of conception.

### Changes in Men’s Mental Health Before and After Pregnancy

In Table 4, we analyze whether MAR and natural conceptions were associated with changes in men’s mental health. Model 1 shows that men with a partner who conceived naturally experienced a small decline in mental health starting one year after



**Table 4** Fixed-effects linear regression models predicting changes in men's mental health score around natural and MAR conceptions (*z* score)

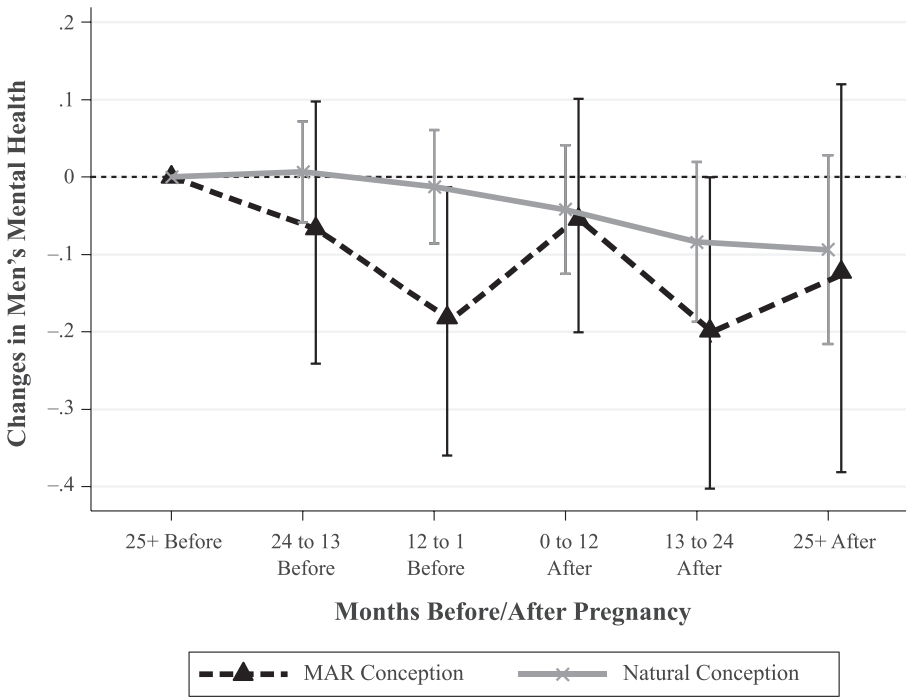
|  | Model 1 |      | Model 2 |      | Model 3 |      | Model 4 |      |
|--|---------|------|---------|------|---------|------|---------|------|
|  | Coef.   | SE   | Coef.   | SE   | Coef.   | SE   | Coef.   | SE   |
| Months Before/After Pregnancy                |         |      |         |      |         |      |         |      |
| Natural pregnancy (ref. = 25 or more before) |         |      |         |      |         |      |         |      |
| 24 to 13 before                              | 0.01    | 0.03 | 0.01    | 0.03 | 0.01    | 0.03 | 0.00    | 0.03 |
| 12 to 1 before                               | -0.01   | 0.04 | 0.00    | 0.04 | 0.00    | 0.04 | -0.00   | 0.04 |
| 0 to 12 after                                | -0.04   | 0.04 | -0.03   | 0.04 | -0.02   | 0.04 | -0.01   | 0.04 |
| 13 to 24 after                               | -0.08   | 0.05 | -0.07   | 0.05 | -0.07   | 0.05 | -0.03   | 0.05 |
| 25 or more after                             | -0.09   | 0.06 | -0.08   | 0.06 | -0.08   | 0.06 | -0.04   | 0.06 |
| MAR pregnancy (ref. = 25 or more before)     |         |      |         |      |         |      |         |      |
| 24 to 13 before                              | -0.07   | 0.08 | -0.07   | 0.08 | -0.07   | 0.08 | -0.06   | 0.08 |
| 12 to 1 before                               | -0.18*  | 0.09 | -0.18*  | 0.09 | -0.18*  | 0.09 | -0.18*  | 0.08 |
| 0 to 12 after                                | -0.05   | 0.08 | -0.01   | 0.08 | -0.00   | 0.08 | 0.01    | 0.08 |
| 13 to 24 after                               | -0.20*  | 0.10 | -0.18†  | 0.10 | -0.18†  | 0.10 | -0.11   | 0.10 |
| 25 or more after                             | -0.11   | 0.12 | -0.09   | 0.12 | -0.09   | 0.12 | -0.04   | 0.12 |
| Age  | -0.07** | 0.02 | -0.07** | 0.02 | -0.08** | 0.02 | -0.08** | 0.02 |
| Age Squared                                  | 0.01*   | 0.00 | 0.01*   | 0.00 | 0.01**  | 0.00 | 0.01**  | 0.00 |
| No Live Birth                                |         |      | -0.19*  | 0.07 | -0.18*  | 0.07 | -0.20** | 0.07 |
| Log of Personal Net Income                   |         |      |         |      | 0.01    | 0.01 | 0.01    | 0.01 |
| Employment (ref. = working)                  |         |      |         |      |         |      |         |      |
| Unemployed                                   |         |      |         |      | -0.15*  | 0.06 | -0.19** | 0.06 |
| Not in the labor force                       |         |      |         |      | -0.01   | 0.06 | -0.03   | 0.06 |
| Single/Divorced                              |         |      |         |      |         |      | -0.09*  | 0.04 |
| Satisfaction With Leisure Time               |         |      |         |      |         |      | 0.08**  | 0.01 |
| Year-Observations                            | 9,452   |      | 9,452   |      | 9,452   |      | 9,452   |      |
| <i>R</i> <sup>2</sup>                        | .03     |      | .03     |      | .03     |      | .05     |      |
| Number of Men                                | 1,717   |      | 1,717   |      | 1,717   |      | 1,717   |      |

Note: Robust standard errors are shown.

†*p* < .10; \**p* < .05; \*\**p* < .01

pregnancy. However, the decline in men's mental health scores was not significantly different from the baseline level. Conversely, the partners of women who conceived through MAR experienced a mental health decrease of 0.18 standard deviations one year before pregnancy. The anticipation effect was significantly larger for the partners of women who conceived through MAR than for those who conceived naturally (*t* test = 3.9; *p* value = .04; see Table A1 in the online appendix for models with interactions). Men's mental health increased to approximately baseline levels during pregnancy and decreased by 0.20 standard deviations in the following year (Figure 2). After an MAR conception, men's mental health fluctuated, indicating an incomplete recovery.

In Model 2, we adjust for the time-varying variable capturing whether the pregnancy ended in a live birth. This allows us to examine whether the decline in mental health associated with MAR conception was due to a high proportion of miscar-



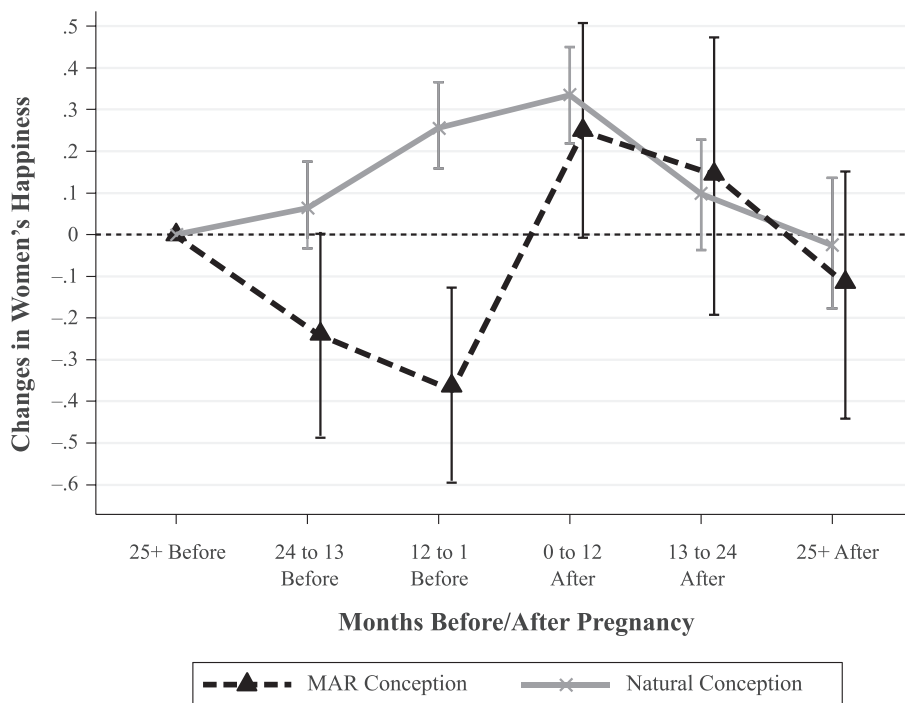
**Fig. 2** Predicted changes in men’s mental health around natural conception and MAR conception. Estimates are from Model 1 in Table 4.

riages. However, men’s mental health decreased by 0.18 standard deviations in the year before pregnancy, even when we account for no live births.

In Model 3, we adjust for personal income and employment status. Mental health trajectories associated with natural and MAR conceptions do not change after this adjustment, indicating that the effect of MAR on mental health is not explained (in any substantive way) by changes in economic resources. Similarly, Model 4 shows that changes in mental health associated with pre-MAR conception are not explained by a reduction in leisure time. The anticipation coefficient of MAR remains equal to  $-0.18$  standard deviations in both Model 3 and Model 4. Conversely, the coefficients related to post-MAR conception change and become nonsignificant, suggesting that fathers’ mental health decrease in part because of a decline in satisfaction with leisure time after childbirth (see also Figure A2 in the online appendix). Fathers’ mental health generally remained stable over time, but it decreased in the year before an MAR conception. During pregnancy, the partners’ mental health returned to approximately baseline levels, regardless of the mode of conception.

**Changes in Subjective Well-being (Happiness) Before and After Pregnancy**

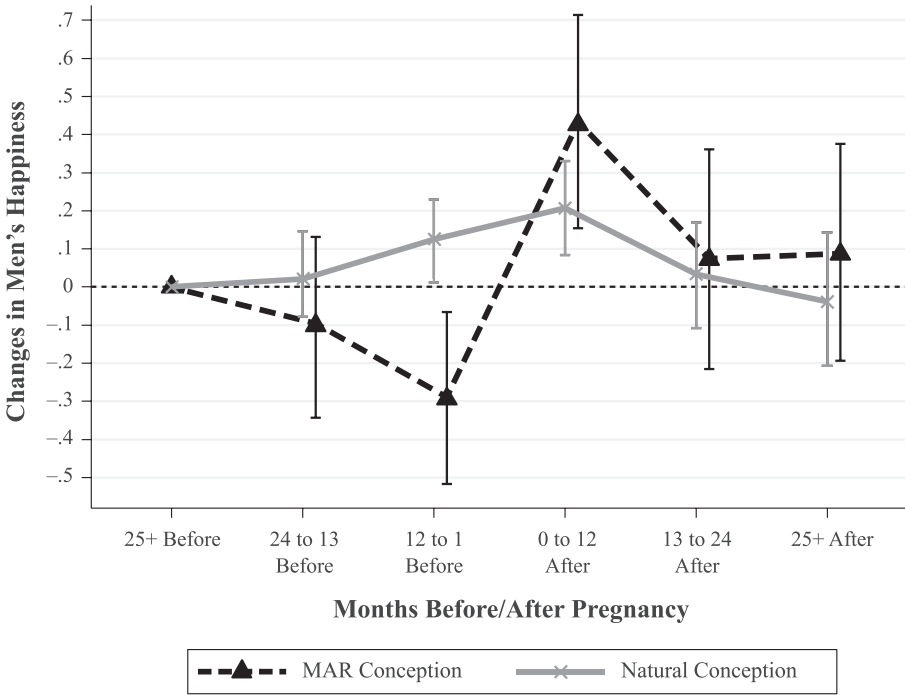
Figures 3 and 4 show results using happiness as the dependent variable for women and men, respectively (estimates in Table A2, online appendix). In line with the findings on mental health described earlier, women’s happiness significantly increased



**Fig. 3** Predicted changes in women's happiness around natural and MAR conceptions. Estimates are from the model shown in Table A2, online appendix.

by 0.25 and 0.32 standard deviations before and during natural pregnancy, respectively, but a statistically significant negative anticipation effect occurred for women who underwent MAR. Happiness decreased by 0.24 and 0.36 standard deviations, respectively, two years and one year before an MAR conception; happiness increased by 0.24 standard deviations in the year of pregnancy. The negative effect observed 24–13 months before an MAR conception suggests that for this group of women, the process leading up to pregnancy included not only MAR treatments occurring in the year before conception but also potentially negative experiences associated with infertility and repeated attempts to conceive through MAR. Although the estimates associated with the post-pregnancy years indicate that women's happiness adjusted regardless of the mode of conception, the differences are not statistically significant compared with baseline levels.

Trajectories of men's happiness were stable before and after a natural conception, with small and statistically significant increases of 0.13 standard deviations one year before pregnancy and 0.21 standard deviations during the pregnancy. Conversely, happiness decreased by 0.29 standard deviations for partners of women undergoing MAR in the year before conception. After a decline, subjective well-being rapidly increased by 0.44 standard deviations in the year of MAR conception and returned to the baseline in the following years. These results confirm that among both men and women, subjective well-being decreased in the year preceding an MAR conception and increased above the baseline during pregnancy.



**Fig. 4** Predicted changes in men’s happiness around natural and MAR conceptions. Estimates are from the model shown in Table A2, online appendix.

### Sensitivity Analyses

We conducted sensitivity analyses to check the robustness of our results. First, we disaggregated the category “25 or more” and considered 36 months before pregnancy as a baseline category (Figures A3–A6 in the online appendix). Extending the window of observation did not change the results: the findings show that both women’s and men’s mental health increased around the year of pregnancy for those who conceived naturally, but mental health declined substantially in pre-pregnancy period for couples who conceived through MAR. The decline in mental health started approximately two and three years before MAR conception for women and men, respectively.

Second, we estimated the model excluding women whose pregnancy did not end in a live birth (Table A3, online appendix). Differences in the mental health trajectories of the two groups could be due to differences in live birth rates, given that having no live births was more common for women who conceived with MAR than for those who conceived naturally. However, the results of our sensitivity analysis were consistent with those presented earlier: the mental health of women who conceived through MAR decreased by 0.16 standard deviations in the year before pregnancy (although the coefficient was only marginally significant, most likely because of the smaller sample used). The results for men showed a mental health decline of 0.19 standard deviations and a happiness decline of 0.28 standard deviations.

Third, the group of women who conceived naturally was more heterogeneous in terms of education and SES than their counterparts undergoing MAR. The differences in these mental health patterns could decrease when we compare couples with

similar socioeconomic backgrounds. Therefore, we added interactions between natural conceptions, education, and SES to the models (online appendix, Table A4 and Figures A7–A10) and found no significant variations in the effect of pregnancy on mental health by education and SES. Conversely, consistent with Myrskylä and Margolis (2014), we found that women with high SES and highly educated men were happier than those with lower SES in the year of natural conception (Tables A11–A14 in the online appendix). Because women undergoing MAR were overrepresented in the socioeconomically advantaged groups and the sample size was small, we could not stratify the effect of MAR pregnancy by education and occupation.

Finally, we replicated our analysis for the GHQ depression score<sup>6</sup> (online appendix, Table A5 and Figures A15 and A16). We found that for both men and women, symptoms of depression were stable around the time of natural conception, but depressive symptoms increased in the short term in the year before MAR conception. Given that women's depression scores started increasing well before an MAR conception, it appears that they were suffering from negative experiences and feelings of failure associated with infertility.

## Discussion

Several studies have analyzed how individuals' subjective well-being changes before, upon, and after the birth of the first child (e.g., Clark and Georgellis 2013; Myrskylä and Margolis 2014). These studies did not consider whether the effect of becoming a parent varied according to the mode of conception, which is an important gap in knowledge given that the utilization of medically assisted reproduction has increased substantially in recent decades and is projected to increase further (Raymer et al. 2020). Although the medical literature has examined the impact of MAR treatment on couples' mental health, very few studies have analyzed this association longitudinally and with respect to their levels of mental health before they experienced subfertility. Thus, our understanding of how mental health and well-being more generally develop for this subgroup of the population in the pre- and post-pregnancy periods is limited. Moreover, relatively little attention has been devoted to selection factors that may affect the links among MAR, parenthood, and mental health. In this study, we addressed this gap by using British longitudinal data to analyze the mental health trajectories of couples who conceived naturally and those who conceived through MAR. We controlled for unobserved time-invariant characteristics that might affect subfertility and mental health.

Our findings show that the process leading up to parenthood was associated with distinct mental health trajectories depending on the mode of conception. Couples who conceived through MAR and couples who conceived naturally followed opposite mental health and happiness trajectories. Consistent with most previous studies,

<sup>6</sup> The GHQ depression score is assessed by summing 12 items, ranging from 0 to 3: "Have you recently (1) been able to concentrate on whatever you're doing? (2) Lost much sleep over worry? (3) Felt that you were playing a useful part in things? (4) Felt capable of making decisions about things? (5) Felt constantly under strain? (6) Felt you couldn't overcome your difficulties? (7) Been able to enjoy your normal day-to-day activities? (8) Been able to face up to problems? (9) Feeling unhappy or depressed? (10) Been losing confidence in yourself? (11) Been thinking of yourself as a worthless person? (12) Been feeling reasonably happy, all things considered?" The overall GHQ scale ranges from 0 (less distressed) to 36 (most distressed).

we found that women who conceived naturally experienced a short-term increase in mental health and happiness around the time of pregnancy (Dyrdal and Lucas 2013; Kohler et al. 2005; Myrskylä and Margolis 2014); women who conceived through MAR, however, experienced a decline in mental health and happiness in the year before pregnancy but then recovered. This negative effect can be considered large ( $-0.18$  standard deviations): it corresponds to nearly 60% of the negative effect of divorce/separation on mental health (see Table A8 and Figure A17 in the online appendix).<sup>7</sup> This deterioration in mental health may be part of a long-term decline in mental health in the pre-pregnancy period caused by the MAR treatments, repeated MAR cycles, and negative experiences associated with infertility, such as anxiety about the success of the treatments and feelings of failure about being unable to conceive naturally. However, the mental health of these women returned to previous baseline levels approximately one year after medically assisted conception.

Undergoing MAR can affect the male partner as well. We found that the mental health and subjective well-being of both partners decreased to a similar extent in the year before an MAR pregnancy. The partners' mental health might have been affected indirectly through different mechanisms, such as empathy, stress, and declines in relationship quality. Existing studies have suggested that undergoing MAR has an adverse impact on relationship quality (e.g., Holter et al. 2006), which might explain why both women's and men's mental health decreases before an MAR conception. After an initial decline, men's mental health fluctuated depending on the pregnancy outcome and the amount of free time they had. In the adjusted models, men returned to their previous mental health levels in the year of pregnancy, which could indicate that net of leisure time, successful treatments were associated with faster recovery. Following an MAR conception, men's and women's mental health returned to the baseline, and their happiness increased above pre-pregnancy levels. These improvements in happiness may be due to the fulfillment of the desire to become parents that couples who underwent MAR may have long harbored.

To explain changes in mental health before and after pregnancy, we analyzed time-varying changes in personal income, satisfaction with leisure time, and employment and marital status. These factors could explain why couples' mental health improved around the time of natural conception but declined two years later. We found that women's increased satisfaction with leisure time was associated with better mental health in the year before pregnancy, consistent with the hypothesis that couples' happiness tends to increase before conception due to increased sexual activity (Myrskylä and Margolis 2014). This increase in happiness may also reflect partners' intentions to become parents in subsequent years. However, most of the positive effect that we observed for women who conceived naturally was not mediated by these factors. A potential explanation (which we were unable to test) is that pregnancy produces stress-protective hormones, such as oxytocin, which has a positive influence on women's health and well-being (Myrskylä and Margolis 2014). Consistent with this hypothesis, we found that men's mental health did not improve around the time of pregnancy and that happiness gains were smaller for men than for women. For women who conceived through MAR, the anticipation effect of pregnancy on mental health was not (to a significant extent) explained by the mediators included in the

<sup>7</sup> The effect of divorce is estimated for all women aged 18–50 who were childless at baseline and in heterosexual partnerships.



analysis. Therefore, we can reasonably reject the claim that MAR procedures affect mental health because of reduced economic resources or changes in employment and marital status. Decreases in women's mental health might be attributable to other factors, such as the social stigma associated with infertility and MAR, or the stress of combining work with undergoing MAR treatments. Because the United Kingdom currently has no employment legislation covering infertility treatments, British employees do not have a statutory right to take time off to undergo MAR treatments.<sup>8</sup> Further research is needed to test other mechanisms that might explain the decline in mental health before an MAR pregnancy.

Our study has four main limitations. First, the sample of couples who underwent MAR was small, which produced large confidence intervals around the estimates and prevented us from analyzing longer-term trajectories in mental health and happiness. Despite this limitation, we observed well-being outcomes for two and three years before and after conception—a long period compared with that observed in previous studies. Second, because the UKHLS data do not provide information about the beginning of women's infertility problems and MAR treatments, we could not determine how long couples had been struggling with infertility before conceiving through MAR. The couples in this group were highly heterogeneous in terms of the length of time it took them to discover their fertility problems and when they decided to attempt to conceive through MAR, which would have affected how long MAR influenced their mental health before conception. Third, the couples who used MAR to conceive strongly wanted to have a child, whereas the group of women who conceived naturally were heterogeneous in terms of their fertility intentions and may have included women who had unplanned births or terminated pregnancies. Although fertility intentions may affect pregnancy experiences, our estimates are likely more conservative than those based on a subsample of planned natural conceptions and planned MAR conceptions. We could not test this hypothesis because the data do not include information on whether the pregnancy was planned. Fourth, the data do not provide information about infertile couples who did not undergo MAR or about those who underwent MAR but were unable to conceive. Therefore, it was not possible to analyze all couples who underwent infertility treatments and to isolate the effects of the MAR treatment per se. However, by focusing on successful treatments, our analysis provides conservative estimates of the MAR effect, given that the mental health consequences are likely more detrimental for those who underwent MAR but were not able to conceive (Johansson et al. 2010).

These limitations are largely offset by several strengths of our study—in particular, by the use of UKHLS data, which enabled us to examine longitudinal changes in couples' mental health before, during, and after natural pregnancy and MAR pregnancy. Our findings have important implications. First, from a research point of view, they show that the effects of family transitions on mental health (and potentially well-being more generally) vary according to the mode of conception. As the utilization of MAR becomes more widespread, it is crucial that family scholars increase their efforts to test for and highlight potential differences in how the mode of conception affects demographic and health outcomes. Our results clearly show that cou-

<sup>8</sup> The Equality Act 2010 Code of Practice (Employment Statutory Code of Practice) recommends that employers be sympathetic to employees' requests for leave to undergo MAR treatment.

ples who conceive naturally have different experiences than couples who conceive through MAR. In the future, the increased availability of MAR might create a false perception that it is possible to conceive at any age (Sobotka et al. 2008) and thus to postpone childbearing to later ages. This belief could, in turn, exacerbate the differences between couples who conceive naturally and those who conceive through MAR because the mental health implications are presumably more detrimental for older women and men, given that their chances of conceiving through MAR are considerably lower (Holter et al. 2006). Second, from a methodological point of view, researchers must pay more attention to confounding factors and the timing of measurements when studying the mental health women who undergo MAR. We found that the estimation of the MAR effect on mental health is sensitive to the choice of the baseline and follow-up levels. For example, if we had used as the baseline 24 to 13 months before pregnancy and followed up at 0 to 12 months after pregnancy, we would have underestimated changes in mental health for women who conceived after MAR. Ideally, the pre-subfertility levels should capture a point in time when women's mental health and subjective well-being are not affected by the experiences of subfertility and undergoing MAR treatments. Third, the findings shed new light on the health implications of MAR. On the one hand, they indicate that experiencing subfertility and undergoing MAR treatments to conceive are associated with a deterioration in mental health. This finding could help explain the increased risk of poor birth outcomes among MAR-conceived children, given prior research showing that maternal stress and birth outcomes are linked (Turney 2011). Thus, it appears that MAR-conceived children are born to families with levels of mental health that differ from those of families with children conceived naturally, and these differences may have profound consequences for the well-being of children. On the other hand, we found that couples who undergo MAR return to their previous levels of mental health. This finding would seem to indicate that, on average, the stress associated with MAR does not have severe or long-term implications for parents' mental health or, by extension, for the well-being of MAR-conceived children. ■

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