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Descriptive Finding

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Descriptive Finding

The COVID-19 pandemic and fertility responses: TFR simulation analysis using parity progressions in South Korea

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Abstract

BACKGROUND
The COVID-19 pandemic has had a notable impact on marriage and fertility intentions. Existing research has found that the impact of the pandemic on childbearing intentions and outcomes has varied across countries. Yet it remains unclear what the post-COVID-19 fertility rate would be if the changes in childbearing intentions observed during the pandemic translated into corresponding behavioral changes.

OBJECTIVES
This study centered on the experience of South Korea, where an unprecedented decline in the total fertility rate (TFR) was recorded. We aim to examine changes in individuals' marriage and childbearing intentions during the COVID-19 pandemic, and the implications of these changes for fertility rates.

METHODS
We used a combination of population census, vital statistics, and online survey data to examine shifts in marriage and fertility intentions among women of childbearing age during the COVID-19 pandemic. Simulation analysis was employed to explore various scenarios of intention changes regarding marriage and childbearing by parity. It was assumed that childbearing followed a sequential progression: from never married to high parities.

RESULTS
We found that during the COVID-19 pandemic, Korean women experienced a downward shift in their marriage and childbearing intentions on average. If these intention changes translate into corresponding behaviors, the TFR is estimated to fall to 0.754, using the TFR value from the base year of 2019.

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CONCLUSIONS
The results suggest that the TFR in South Korea is likely to decrease further if the intention changes translate into corresponding behavioral changes.

CONTRIBUTION
This study advances the existing literature by taking a life course approach and integrating survey results into a simulation to examine the pandemic-related effects on fertility. It provides a better understanding of shifts in individuals' reproductive decisions during the crisis and the potential consequences on marriage and fertility patterns thereafter.

1. Background

The COVID-19 pandemic has had a notable impact on marriage and fertility intentions. However, previous studies on the impact of the COVID-19 pandemic on fertility have yielded mixed findings across countries. A negative shift in childbearing intentions, such as postponing or forgoing childbearing plans, has been observed in several countries, including Italy, Germany, France, Spain, the United Kingdom (Luppi, Arpino, and Rosina 2020), Poland (Malicka, Mynarska, and Świderska 2021), and Japan (Matsuda, Sasaki, and Leung 2022). In highly developed European countries and the United States, a rapid fertility fall has been observed (Sobotka et al. 2021). Nevertheless, there is limited understanding of how changes in childbearing intentions will influence changes in fertility outcomes after the pandemic.

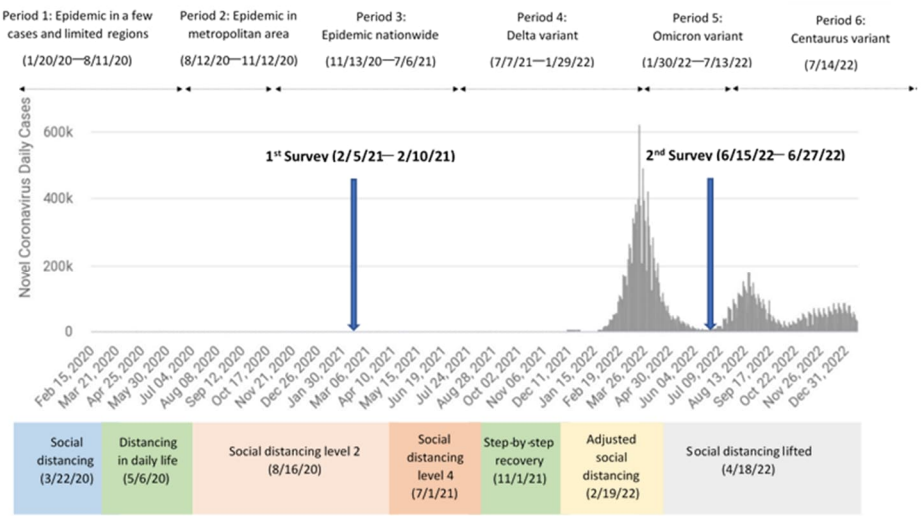
This study investigated the potential consequences of changes in marriage and childbearing intentions observed during the pandemic on fertility in South Korea (hereafter referred to as Korea). The study aimed to address two questions. First, how did marriage and childbearing intentions evolve during the COVID-19 pandemic in Korea? Second, what would the expected birth rate be if changes in marriage and childbearing intentions during the pandemic translated into corresponding behavioral changes? To address these questions, the study employed a simulation analysis based on the parity status life tables (PSLT) model (Schoen 2006), exploring hypothetical scenarios of intention changes by parity.

Korea provided an intriguing context for two main reasons. First, it is notable for its persistently low total fertility rate (TFR), despite the government's efforts to address the issue. In 2006 South Korea launched a comprehensive policy response with the First Basic Plan for Low Fertility and Aged Society (Lee 2009). Yet it failed to reverse the fertility decline. In 2021 the country's TFR reached an all-time low of 0.81, the lowest TFR in the world (OECD 2023). This continuous downward trend in fertility raises

concerns, underscoring the importance of understanding the potential influence of the COVID-19 pandemic (Kwan and Choi 2022; Sobotka 2022). Second, one distinctive aspect of Korean responses to the COVID-19 pandemic was the nation's exceptionally high compliance with government guidelines (Park, Im, and Cho 2020). This was not only driven by fear of infection but was also rooted in the country's culture. The Korean government's response to COVID-19 particularly stood out as it publicly disclosed information gathered from contact tracing of confirmed cases. This fostered an atmosphere of heightened alertness and alarm, significantly affecting various aspects of family life during the pandemic.

To investigate shifts in individual intentions for marriage and childbearing among Koreans, data were collected during two different phases of the pandemic. The first survey was conducted in February 2021, a time when the pandemic was prevalent nationwide and stringent social distancing measures were in force. The second survey was in June 2022, when social distancing measures were relaxed following the emergence of the less lethal Omicron variant (Figure 1).

Figure 1: Timeline of COVID-19 cases in Korea and data collections for this study



Note: Reconstructed by the authors based on Ahn et al. (2022), Kim (2022), and Worldometer (2023).

In this study we aim to provide a better understanding of changes in individuals' reproductive decisions during a crisis and the potential consequences for marriage and fertility patterns thereafter. We draw on a combination of population census, vital statistics, and online survey data to examine changes in marriage and fertility intentions among women of childbearing age during the COVID-19 pandemic. Based on the changes in intention, simulation analysis is employed to explore various scenarios, assuming that intention changes translate into corresponding behaviors. This provides valuable insights into the implications of COVID-19 for reproductive behaviors in Korea. This paper is structured as follows: Section 2 describes data and methods. Section 3 explains the analysis results. Section 4 discusses the implications of findings.

2. Data and methods

2.1 Data

Multiple datasets were utilized in this study. To estimate the distribution of marital status and parities among the population, 2% microdata from the 2015 census and data from population registers were used. From the population registers, mid-year population sizes for each age group were obtained, while the census microdata provided estimates for the proportions of individuals never married and the distribution of parities across different age groups.

The next step involved utilizing the data to estimate the number of transitions to first marriage and subsequent parities. Integrating the datasets enabled us to derive the age-specific rates of transition to first marriage and the progression to higher parities for the year 2015. Since 2019 was the last year before the COVID-19 outbreak, data from 2019 would ideally have been used as a baseline to assess the implications of the pandemic-driven changes in marriage and fertility intention. However, the census was not conducted in 2019; hence two assumptions were employed to approximate the 2019 marriage and fertility patterns. First, the ratios of age-parity-specific fertility rates in 2015 to those in 2019 were assumed to be identical to the ratios of age-specific fertility rates in 2015 to those in 2019. Second, the proportion of individuals who were never married by age in 2019 was extrapolated based on 2010 and 2015 census microdata. This method enabled us to align the marriage and parity-specific fertility schedules in 2019 with those in 2015 while maintaining the 2019 levels. Under these assumptions, we were able to create estimates of baseline fertility and marriage patterns in 2019 and assess pandemic-driven changes.

A survey of Koreans' attitudes regarding marriage and family during the COVID-19 era (the Korea Value Survey) was also employed to estimate changes in marriage and

fertility intention. This survey was conducted online by the Population Policy Lab at the Korea Development Institute (KDI) School of Public Policy and Management, and data were collected in two waves: the first from February 5 to February 10, 2021, and the second from June 15 to June 27, 2022. Each wave of the survey involved a sample of 2,000 Korean men and women aged 25 to 49, randomly drawn from one of the major internet panels in Korea, consisting of approximately 1.58 million individuals. The sampling was stratified based on age, sex, and region to ensure appropriate representation. Notwithstanding the large size of the panels and stratified sampling, there were concerns about how representative the samples were given the inherent nature of the opt-in internet panel survey (Groves et al. 2009). However, the online survey was a valuable alternative for gathering data given the difficulties of conducting in-person household surveys during the pandemic.

For the analysis, the final analytical sample was limited to a group of women, of whom 809 were never married and 994 were married. The sample was not sufficiently large for further subgroup analyses based on factors such as socioeconomic status, and potential heterogeneity in response to the pandemic across those subgroups was not taken into consideration.

To measure the changes in marriage intention during the pandemic among those who were never married, respondents were asked the following question: "Have your marriage plans changed after the COVID-19 pandemic?" They could choose from the following response options: (1) not changed/more or less the same; (2) plan to get married sooner than originally planned; (3) plan to get married later than originally planned.

To measure changes in childbearing plans during the pandemic, respondents were asked the following question: "Have your plans to have a child changed after the COVID-19 pandemic?" The response options were as follows: (1) not changed/more or less the same; (2) decided to have fewer children or give up having children altogether; (3) decided to have children or have more children; (4) decided to delay having a child; (5) decided to have a child sooner; (6) do not know. For the analysis, responses indicating "fewer children" and "delay in having a child" were recoded as negative changes in fertility intention, while responses indicating "more children" and "having a child sooner" were recoded as positive changes.

2.2 Simulations based on parity progressions

Simulations were conducted on the basis of parity progressions under several assumptions. Firstly, a synthetic cohort that followed age-specific rates of transition to first marriage and subsequent parities was assumed. Women's reproductive life course was assumed to follow a sequential order: never married and childless → married and

childless → married with one child → married with two children → married with three-plus children. Secondly, the simulations assumed that it was only married women who were at risk of a birth. The potential bias due to this assumption was deemed negligible, given the rarity of nonmarital fertility in Korea (Lee 2017). Thirdly, transitions to first marriage or higher parity were assumed to occur once a year. Fourthly, the female reproductive period was assumed to start at age 20 and end at age 49. Fifthly, childbearing intentions for women with two or more children (parity 2+) were assumed to be unchanged, as transitions to three or more children are rare in Korea (Yoo 2023). Basically, all women were assumed to go through their reproductive stages sequentially, moving from never married to married and higher parities, following age-specific transition rates of first marriage and higher parities in a given year. This was an extension of the PSLT, which estimates the TFR by using the ratio of the total number of parity transitions by the end of a reproductive period to the number of women in a synthetic cohort (Schoen 2006). TFR estimates from the PSLT in the United States were higher than period TFRs, but the differences were negligible (Schoen 2006). In this study, the PSLT method was extended to account for transitions to marriage as well. This method was useful for examining how the impact of the pandemic on fertility might vary, depending on the stage of a woman's reproductive life, encompassing transitions to marriage and higher parities. Furthermore, this method facilitated the integration of information on intention changes with data on marital status and parity transitions.

Not all individuals experience all transitions, and some remain in the never-married state or have fewer births. If transition rates are high, then the proportion of those with higher parity will increase at a faster pace, leading to an increase in the average number of children. The proportion of the never married was assumed to be 1 at the beginning of the reproductive period at age 20 and to decrease monotonically based on age-specific rates of transition to first marriage, which could be observed or simulated. The proportion of married childless women was consequently dependent on two transition rates. If the transition to first marriage was high, the rate of married childless women would increase, while it would decrease if the transition to parity 1 was high. The same logic applied to higher parities. By constructing a marital status and parity life table, the mean number of children born to women of a specific age could be estimated using the following formula:

$$\text{Mean number of children for women aged } x = P_{x1} + 2 \times P_{x2} + \text{Mean}_{3+} \times P_{x3+}$$

P_{xp}: *Proportion of parity p at age x*
Mean_{3+}: *Average number of children for women with three or more children*

This formula does not include the never married with a parity of 0 because these women's average number of children is zero. It estimates the TFR as the average number of children born at the end of the childbearing period at age 49 for a synthetic cohort that follows the age schedule of first marriage and parity-specific fertility. This can be considered a special case of multi-state models (Palloni 2001; Muniz 2020). Whereas multi-state models typically allow for two-way transitions, such as transition from the healthy to the unhealthy and vice versa, our model allows only one-way transitions – from never married to married and from lower to higher parities. Using this model, simulations of the following scenarios were performed:

1) All changes: Changes in marriage and fertility intention leading to behavioral changes
2) Marriage change: Only changes in marriage intention leading to behavioral changes
3) First birth change: Only changes in fertility intention among childless women leading to behavioral changes
4) Second birth change: Only changes in childbearing intention among women with one child leading to behavioral changes

The aim of the simulation analysis was not to forecast the post-pandemic TFR. The objective was instead to illustrate what the TFR would be if changes in marriage and fertility intention after COVID-19 translated into actual changes in marriage and fertility. This enabled us to explore the potential association between changes in family formation intentions and actual fertility outcomes.

We should note several features of analyses. Firstly, our simulations were period-based and did not distinguish quantum and tempo of fertility. As is well-known, the TFR is not free from the tempo effect (Bongaarts and Feeney 1998). Delaying childbearing can lead to a reduction in the TFR, even if the quantum remains unchanged. Nevertheless, since our primary focus was to understand expected fertility changes resulting from intention changes from a period perspective, tempo-adjusted fertility change was beyond the scope of our study. A similar concern pertains to fertility recovery. It remains uncertain whether intention changes during the pandemic will be permanent or temporary. This issue was not examined in detail in our study since we did not focus on analyzing quantum changes. Rather we aimed to explore the implications of intention changes on fertility outcomes from a period perspective.

Secondly, there is a concern about the potential overestimation of fertility decline in our study. We assumed that changes in marriage and childbearing intentions observed in the Korea Value Survey would fully translate into behavioral changes. For example, if a woman's intention to get married diminished during the COVID-19 pandemic by x percent, the actual transition to first marriage was assumed to decline by the same

magnitude. This assumption could be unrealistic if intention changes did not lead to corresponding behavioral changes. Nevertheless, given the absence of alternative estimates of the relationship between intention and events, our study was necessarily based on this simplifying assumption. Another related concern is failure to achieve intended family size in the context of extremely low fertility in Korea. However, this is not necessarily problematic because the focus of our study was not on family size but on changes in marriage and fertility intention. Since both pre- and post-pandemic fertility rates are lower than the intended fertility, the potential underestimation issue may not be critical.

Finally there is the issue of sampling error. Our analysis used census and registration data, which is not subject to sampling error. Nonetheless, it is challenging to analytically assess sampling error in a simulation analysis that combines survey data with census and registration data. To address sampling variability in our simulation analysis, a bootstrap method was employed. We resampled 1,000 times with replacement by age and region to obtain estimates for marriage and fertility intention changes. These estimates were combined with census and registration data to conduct our simulation in order to assess sampling errors. The results of the bootstrap sampling variability were presented using boxplots.

3. Results

3.1 Descriptive analysis

Table 1 shows marriage intention changes among never-married women. In 2021, 20.3% of never-married women were discouraged in their marriage intentions (negative change), while only 8.1% changed their marriage intentions in a positive direction. This difference of 12.2 percentage points indicates a prevalence of negative shift in marriage intention. In 2022, this difference was reduced to 7.5 percentage points, suggesting that attitudes toward marriage became less negative. On average, however, negative changes in marriage intention were 10.0 percentage points higher than positive ones.

Table 1: Changes in marriage intention among never-married women

	(Unit: percentage)		
Marriage intention changes	2021	2022	Total
No change	71.6	71.8	71.7
Negative	20.3	17.8	19.2
Positive	8.1	10.4	9.2
Difference (negative–positive)*	12.2	7.5	10.0
N	433	376	809

*Unit: percentage point.

Table 2 shows fertility intention changes among married women by parity. In all parity groups, negative fertility changes in childbearing plans were more pronounced in 2022 than in 2021. On average, negative change was 18.8 percentage points higher than positive change among childless women and was 16.4 percentage points higher among women with one child. Changes among women with higher parities were limited, however.

Table 2: Changes in fertility intention among currently married women

	(Unit: percentage)			
	2021			
	No child	1 child	2+ children	Total
No change	79.4	84.8	95.7	89.1
Negative	18.7	12.0	3.9	9.4
Positive	1.9	3.2	0.4	1.5
Difference (negative–positive)*	16.8	8.8	3.4	7.9
N	107	125	234	466
	2022			
	No child	1 child	2+ children	Total
No change	69.7	76.9	95.1	84.3
Negative	25.4	23.1	3.4	13.8
Positive	4.9	0.0	1.5	1.9
Difference (negative–positive)*	20.5	23.1	1.9	11.9
N	122	143	263	528
	Total			
	No child	1 child	2+ children	Total
No change	74.2	80.6	95.4	86.5
Negative	22.3	17.9	3.6	11.8
Positive	3.5	1.5	1.0	1.7
Difference (negative–positive)*	18.8	16.4	2.6	10.1
N	229	268	497	994

*Unit: percentage point.

As expected, fear of infection was high in 2021, and it certainly had a major impact on fertility intention. Nevertheless, in 2022 the situation was very different, as infection worries had reduced. Comparison of marriage and childbearing intention changes in 2021 and 2022 reveals the dynamics of intention changes according to the progress of the COVID-19 pandemic. Overall, the negative trend in changes in intention was observed to be higher than the positive trend throughout the pandemic.

3.2 Simulations

Figure 2 shows the baseline distribution of marital status and parity by age when we applied the age-specific rates of transition to first marriage and next parity in 2019. This distribution is different from the observed marital status and parity distribution in 2019 because this is an implied distribution based on the transition rates in 2019. The proportion of the never-married monotonically decreases because the transition to first marriage is irreversible. Transition to first marriage slows down considerably after the age of 35. The share of other states can increase or decrease as age increases. The proportion of childless married women increases by the early 30s and then decreases and stays constant after age 35. The proportions of parities 1 and 2 steadily increase until age 40 and stay constant afterward. Finally, the proportion of parity 3+ remains very low. Combined together, the mean number of children increases steadily at age 40 but remains below one. In this analysis, the TFR is estimated by the mean number of children at the end of the reproductive period. This equals 0.915, which is very close to the official TFR of 0.918 in 2019, indicating that the PSLT method is appropriate to estimate TFR.

Figure 2: Baseline marital status and parity distribution in 2019

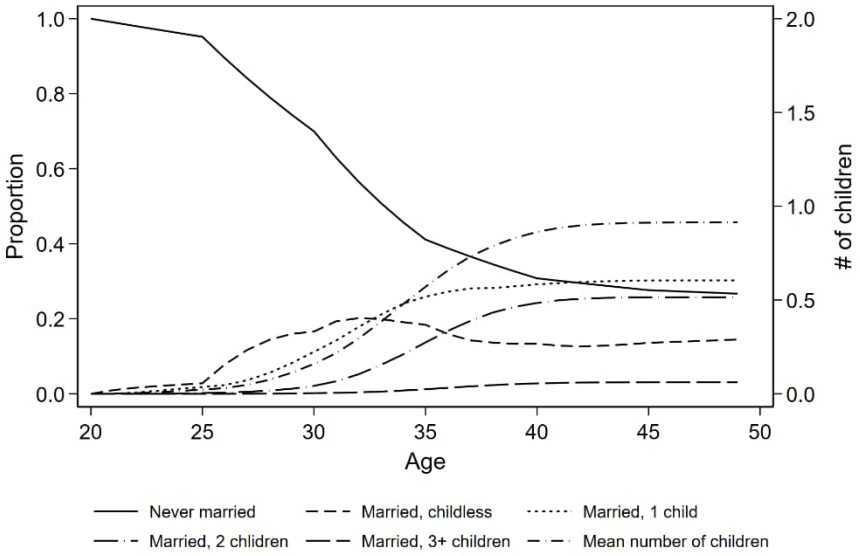
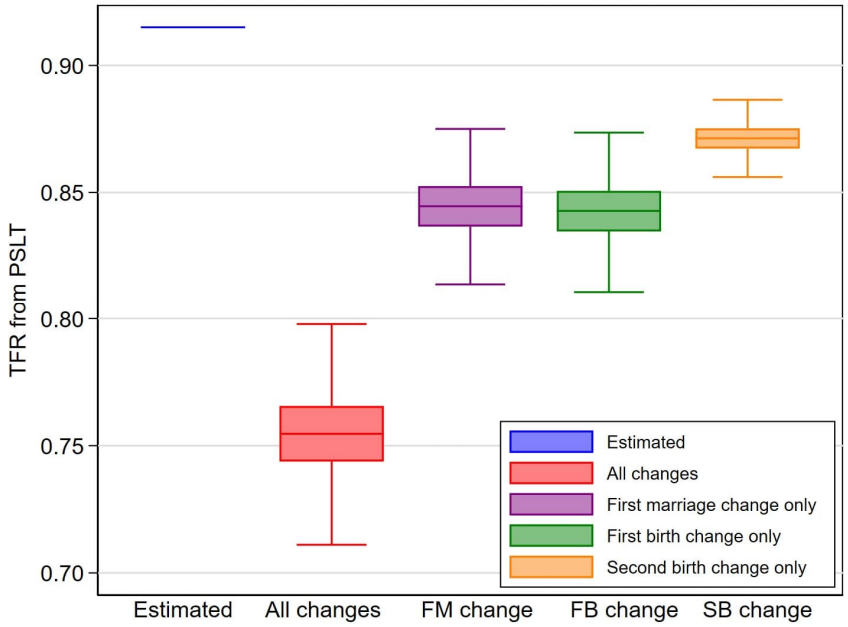


Figure 3 presents the TFRs estimated from the simulations using boxplots. All four scenarios yielded lower TFRs than the estimated ones. If changes in intention with regard to first marriage and first and second childbearing led to corresponding behavioral changes, then the TFR would decrease to 0.754. If only the changes in intention of first marriage and first childbearing led to behavioral changes, then TFR would drop to 0.843–0.845. The impacts of changes in intention with regard to the second child appear smaller than those of earlier transitions. The bootstrapped sampling distributions are widest in the "all changes" scenario. This is the case because sampling error was accumulated in each transition in the first scenario, while the other scenarios involved only one intention change.

Overall, fertility would decline by 0.044–0.161 if changes in marriage and fertility intention led to behavioral changes. Interestingly, the estimates reflecting changes in intention regarding first marriage and first birth happened to be very similar to the TFRs in 2020 and 2021, which were 0.837 and 0.808, respectively. This indicates that intention changes did not fully translate into changes in marriage and childbearing behavior because the model did not account for the general declining trend in fertility in Korea. If the baseline were set taking into account this general trend, we would have obtained lower TFRs than presented. Hence the fact that the simulated TFRs are similar to or lower than

the actual TFRs suggests that negative changes in marriage and childbearing intention may have led to partial changes in behavior.

Figure 3: TFR estimated from PSLT simulation



Note: FM: first marriage; FB: first birth; SB: second birth.

4. Discussion

The COVID-19 pandemic has brought Korea's persistently low fertility to the forefront of academic and public attention. This has highlighted the importance of understanding the pandemic's impact on individuals' intentions and their behavioral changes with regard to family formation. Against this backdrop, this study examined the potential consequences of changes in attitudes observed during the pandemic on fertility in Korea. To identify the pandemic-induced changes in intention and estimated TFRs in the case of intention changes leading to behavioral changes, we conducted a simulation analysis based on parity progression models, incorporating multiple datasets. By taking the parity

progression approach, our study considered the influence of intention changes on fertility outcomes at different stages of reproductive life.

Our findings indicated a negative shift in marriage and childbearing intentions that outweighed the positive shift among women of reproductive age in Korea. Our simulation results suggested that the TFR in Korea would decline to 0.754 if changes in intention regarding marriage and childbearing were to lead to corresponding behavioral changes. These findings are aligned with existing research reporting that the recent rapid fall in fertility in Korea has been driven not only by a fall in the marriage rate but also by a fall in marital fertility rates (Kye, Yoo, and Choi 2022).

Our study was subject to several limitations that should be noted. We discussed several of these in Section 2.2 but consider some additional drawbacks here. Firstly, our analysis did not explicitly account for the declining fertility trend in Korea. The baseline fertility is the pre-pandemic year 2019. To project the post-pandemic TFR as accurately as possible, specifying the appropriate baseline is essential. For example, Berrington et al. (2022) used different combinations of baseline fertility trends to forecast the post-pandemic fertility rate. Our study differed from this study in that its primary focus was to understand the implications of intention changes induced by COVID-19 rather than to forecast post-pandemic fertility.

Secondly, our study did not examine age-specific intention changes. The effects of the pandemic may differ across age groups (Berrington et al. 2022), and we would ideally have been able to examine these differences. Nevertheless, given the limited sample size, our study assumed that intention changes did not vary across age groups. However, the bias resulting from this constraint is not likely to be substantial because age-specific intention changes are associated with marital status and parity.

This study, despite these limitations, advances the existing literature by taking the life course approach and integrating survey results into a simulation to examine pandemic-related effects. The study also improves understanding of shifts in individuals' family planning decisions during the crisis and their potential consequences afterward. The findings of the study indicate that the TFR in Korea would continue to fall even further from its current all-time low if the observed intention changes actually do lead to behavioral changes. Furthermore, the implications of the study extend beyond Korea; the attention provoked by the reduction in fertility in Korea in the wake of the pandemic reflects broader concerns in other countries, including Chile, Lithuania, and Portugal, which have experienced sustained fertility declines (Sobotka 2022).

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