


RESEARCH ARTICLE

# Impact of the COVID-19 pandemic on pregnancy postponement – evidence from Japan

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## Abstract

Japan has faced a decline in fertility since the coronavirus disease 2019 (COVID-19) pandemic. This study aimed to investigate the rate of pregnancy postponement and its contributing factors, with a particular focus on economic- and COVID-19 infection-related indicators. This study used data from 768 observations of married women aged 18 to 50 years with pregnancy intentions. The data were obtained from two rounds of a large web-based survey conducted by the Japan COVID-19 and Society Internet Survey (JACSIS) in 2020 and 2021. A generalised estimating equation (GEE) model was employed, as well as Poisson regression models for sub-sample analysis divided by year to estimate the year differential magnitude of the contributing factors' impacts. Approximately 20% of married women with childbearing intentions postponed their childbearing. The analyses revealed that declining income and anxiety about future household finances were significantly related to delayed childbearing, while fear of COVID-19 and infection rate were not. Additionally, the adverse effects of unfavourable economic conditions were stronger in 2021. Notably, age did not influence the decision of pregnancy postponement. Older women postponed pregnancy just as much as younger women. In conclusion, this study confirmed that the COVID-19 pandemic, particularly its related adverse economic conditions, contributed to Japan's current baby bust. Considering that advanced maternal age is already common in Japan, this decreased fertility may result in the long-term negative consequence of further population decline.

**Keywords:** pregnancy postponement; COVID-19 pandemic; economic uncertainty

## Introduction

In Japan, a baby bust was recently indicated during the coronavirus disease 2019 (COVID-19) pandemic. Vital statistics revealed that in a year, the total births decreased by 4.7% (Nakamura 2021). Similar trends have been reported in the United States and Europe (Demomy and Jones 2021; Hamilton 2021). Regarding micro-level evidence, Luppi et al. (2020) showed that, from survey data collected between March 27 and April 7, 2020, fertility plans for adults aged 18 to 34 years were negatively affected by COVID-19 in Italy, Germany, France, Spain, and the U.K. Among those who planned to have a child in January 2020, 37.9% (Italy), 55.1% (Germany), 50.7% (France), 49.6% (Spain), and 57.8% (the U.K) postponed their pregnancy, and 36.5%, 14.2%, 17.3%, 29.2%, and 19.2%, respectively, decided to abandon their fertility plans. Zhu et al.'s (2020) study in China revealed that 33.8% of couples who had pregnancy intentions before the pandemic decided to cancel their pregnancy plans during the pandemic. A similar percentage was found in the U.S., as 34% of women wanted to delay childbearing or have fewer

children because of the pandemic (Lindberg et al. 2020). Lower percentages were reported by Malicka et al. (2021) in Poland, where 16.3% decided to postpone pregnancy due to the pandemic. Hence, although the magnitudes varied, fertility behaviour has been affected by the pandemic worldwide.

Both common and individual reasons for avoiding pregnancy have been reported. Luppi et al. (2020) revealed that economic uncertainty, as measured by insecure future income due to the pandemic, affected the population in the U.K., but not in Italy, Germany, France, or Spain. U.S. and Polish citizens were reportedly affected by economic uncertainty (Lindberg et al., 2020; Malicka et al. 2021), while Chinese citizens were not. A higher regional prevalence of COVID-19 cases was associated with a higher prevalence of abandoners and those who postponed, called postponers in their papers, in Germany, France, and the U.K., but not in Italy and Spain. Zhu et al. (2020) reported that Chinese couples cancelled their pregnancy plans due to concerns about personal and foetal health, government prevention and control policies, and hospital prevention and control measures; however, no such findings were reported in the U.S. or Poland (Lindberg et al. 2020; Malicka et al. 2021).

In Japan, although there are concerns about fertility decline during the COVID-19 pandemic, detailed information regarding how many people have truly decided to delay childbearing, and the particular characteristics of these individuals, is lacking. Considering that various impacts and contributing factors were found across different countries, it is worth exploring the case of Japan, which had a relatively low prevalence of infection yet showed a noticeable fertility decline in the vital statistics. Thus, through a web-based, self-reported questionnaire survey conducted in 2020 and 2021 with a married female sample, this study provides the first evidence for whether an increase in decisions to delay childbearing occurred in Japan during the pandemic. Moreover, this study explores for whom and why this happened, with a particular focus on changes in socio-economic conditions caused by the pandemic.

### **Fertility behaviours in past pandemics**

To understand the mechanism of the impact of COVID-19 on fertility decisions, it is worth exploring past pandemics and the indications for fertility decisions, as well as the differences between past and current pandemics. Although limited, there have been studies on fertility responses to past pandemics. The findings of these studies suggest that there is an immediate negative response, followed by a positive response. Immediate responses observed after the Spanish flu in the U.S., Japan, Taiwan, and Brazil were caused by the deaths of people during their reproductive years, increased maternal mortality, miscarriages, and stillbirths or preterm births, which led to high mortality and low birth success rates (Bloom-Feshbach et al. 2011; Chandra and Yan 2015a, 2015b; Chandra et al. 2018; Guimbeau et al. 2020). Mamelund (2004) explored the situation in Norway during and after the Spanish flu and revealed the occurrence of replacement fertility, followed by a negative response.

It could be hoped that a baby boom may occur after the COVID-19 pandemic, as was observed in past pandemics. However, as Mamelund (2004) suggested, there are several notable differences between the two situations. First, there are dissimilarities between the Spanish flu and the COVID-19 pandemic in terms of mortality and fertility levels. The former's victims were infants/young children; hence, the fact that there was a decrease in the fertility rate followed by an increased birth rate could indicate that parents wished to replace their lost child (ren), even as they lowered their expectations for their offspring's survival chances. COVID-19 has not increased the mortality rate of infants/young children. Thus, the current birth rate decline has not transpired because of the increase in mortality in the parent-to-be population. In addition, replacement fertility is unlikely to occur because infants/young children are not the primary victims of COVID-19. Second, the fertility rate has been low for a long time. One of the reasons for this is the increasingly advanced age of pregnancy (Ogawa, 2003). Thus, postponing pregnancy for a year or two is not the same

issue as it was in the past. Moreover, the current childbearing delay might result in an abandonment of conception. For example, as mentioned earlier, Luppi *et al.* (2020) reported that in Europe abandonment of conception had been observed with a prevalence ranging from 14.2% (Germany) to 36.5% (Italy).

Another important COVID-19-related issue is the resulting economic crisis. The Easterlin hypothesis (Easterlin, 1969) explains the importance of relative income in determining the number of children born. There is an expectation that the second generation will strive to maintain the same or better living standards as were experienced by the first generation. Hence, when the shadow price and opportunity cost for childbearing and child-rearing are higher and the maintenance of their living standards is expected to be difficult, the parent generation desires fewer children. Although low economic growth can decrease both living standards and shadow prices, COVID-19's economic influence is unlikely to lower the latter, as in the case of unchanged education costs. In addition, in the present situation, people are experiencing an income drop in the face of rampant recession anxiety, thus making it difficult to improve their future living standards. Uncertainty is a major issue that must be explored in relation to fertility decisions based on both qualitative and quantitative perspectives (Comolli *et al.* 2021; Comolli and Vignoli 2021; Matysiak *et al.* 2021; Sobotka *et al.* 2011; Vignoli *et al.* 2020a, 2020b). Sobotka *et al.* (2011) reported that fertility behaviours are influenced by the surrounding financial climate, especially perceived long-term economic insecurity. For example, Ogawa (2003) reported a large drop in fertility corresponding to Japan's prolonged economic recession beginning in 1990. In their survey, over 30% of the respondents stated that their fertility behaviours were affected by increased economic uncertainty. Kravdal (2002) found that, in Norway, unemployment had a negligible impact on fertility through individual-level effects, despite the significant negative influence of aggregate-level unemployment on fertility decisions, possibly because the aggregated unemployment rate is a proxy for people's anxiety and uncertainty in financial situations.

In a more recent study, Caltabiano *et al.* (2017), Matysiak *et al.* (2021), Comolli *et al.* (2021), and Comolli and Vignoli (2021) further emphasised the critical role of uncertainty in fertility decisions by examining economic crises such as the ones occurring in Italy in 2008–2009, 2011, and mid-2013 (Caltabiano *et al.* 2017), and in 2011–2012 (Comolli and Vignoli 2021), as well as the ones impacting 28 European Union member states during 2002 and 2014 (Matysiak *et al.* 2021). The findings of these studies imply that economic recessions have differential effects in different countries. These effects reflect the overall countries' welfare systems and economic stability, because they influence people's anxiety and uncertainty in the face of fluctuating economic conditions. The COVID-19 pandemic has restricted economic activities in various ways, including travel restrictions and gatherings for events and/or dining out, and economic uncertainty has become a key issue in fertility decisions (Lindberg *et al.* 2020; Luppi *et al.* 2020; Malicka *et al.* 2021; Sobotka *et al.* 2021).

## Methods

### *Study design and participants*

This study used data from two rounds of the Japan COVID-19 and Society Internet Survey (JACSIS), complying with the ethical standards of the relevant national and institutional committees on human experimentation and with the 1975 Declaration of Helsinki and its 2008 revision. Ethical approval was obtained from the Research Ethics Committee of the Osaka International Cancer Institute (approved 19 June 2020; approval no. 20084). The Internet survey administration followed the Act on the Protection of Personal Information in Japan. The participants received credit points called 'Epoints,' which could be used for online shopping and cash conversion. These datasets were not deposited in a public repository because of confidentiality issues and the restrictions imposed by the ethical committee.

The JACSIS was conducted as a population-based online questionnaire survey using the Internet survey agency, Rakuten Insight, Inc., which has approximately 2.2 million panellists (see Miyawaki et al., 2021, for a detailed study design). Between 25 August and 30 September 2020, the first survey was conducted with a target sample size of 28,000 individuals. Of all Rakuten's panellists, 224,389 men and women aged 15-79 years, were invited to participate. A random sampling technique with stratification by sex, age, and prefecture, based on the 2019 population distribution, was used to cover Japan. When the target number of 28,000 was attained, the survey was terminated. As a follow-up, a second-round survey was carried out from February 8 to 26, 2021. Among the first-round survey respondents, 24,059 answered the second-round survey. Thus, we recruited 1,941 new participants using the same sampling technique as in the first-round survey. A total of 26,000 observations were obtained.

The following exclusion criteria were used to ensure data quality. First, those responses with discrepancies and/or artificial/unnatural answers were excluded. These were: (1) An invalid response to 'Please choose the second alternative from the bottom' (i.e., when panellists failed to select the second-last alternative from the five options available. This question was included to identify systematic respondent inattention); (2) Positive responses to all questions related to drug use (e.g., marijuana, cocaine, or heroin); and (3) Positive answers to all questions regarding 16 underlying chronic diseases. There were 2,518 and 2,858 respondents with discrepancies and/or artificial/unnatural responses in 2020 and 2021, respectively. From the remaining 25,482 (2020 data) and 23,142 (2021 data), the following were excluded: males ( $n = 12,673$  and  $11,766$  in 2020 and 2021, respectively), those aged  $< 18$  years or over 50 years ( $n = 6,134$  and  $5,736$  in 2020 and 2021, respectively), and those who were not married, including widows ( $n = 3,323$  and  $2,828$  in 2020 and 2021, respectively). Among the remaining participants ( $n = 3,353$  and  $2,812$  for the 2020 and 2021 data, respectively),  $n = 2,851$  and  $2,391$  from the 2020 and 2021 data, respectively, were excluded because they were not planning pregnancy. Furthermore, 82 (2020 data) and 73 (2021 data) responses were excluded due to incompleteness in relation to the responses for the variables examined in this study. Finally, 768 observations, with 420 and 348 observations in 2020 and 2021, respectively, were used in the analysis.

## Measures

### *Decision to delay childbearing*

Individuals who had decided to postpone their pregnancy were identified with the following question: 'In the past two months, have you avoided a planned pregnancy (using contraception) due to COVID-19?' The following three options were provided: 1 (yes), 2 (no), and 3 (not applicable; no plans for pregnancy). As mentioned above, data from respondents who answered '3 (not applicable; no plans for pregnancy)' were excluded.

### *Independent variables*

The variables included in the model were determined according to the discussion above in relation to two key aspects: economics and COVID-19 infection prevalence. The focused variables were employment status, income decline, and anxiety regarding the household financial outlook. Employment status was categorised as follows: 1, permanent full-time worker; 2, contract/temporary full-time worker; 3, part-time worker; and 4, not working. Although unemployment is an important indicator, its rate in Japan is low; therefore, the data did not contain sufficient relevant responses. Moreover, during the COVID-19 pandemic, people may not have searched for jobs. Thus, unemployed people, homemakers, and students were combined into the category of '4'.

The incidence of income decline due to COVID-19 was captured as a binary variable: 1, decreased; or 0, otherwise. In the first round of the survey, conducted in August 2020, the question was designed to examine changes from the pre-COVID-19 period. In its second round,

conducted in February 2021, the question was modified to ask more specifically about the respondent's situation in the most recent month in comparison to one year prior to assess experiences during COVID-19.

To assess economic anxiety, the following question was asked, 'Have you felt anxious about the household financial outlook?' The possible answers to this question were: 1 (Yes, I have felt it for the first time), 2 (Yes, I experienced it even before the COVID-19 pandemic), or 3 (No, I have never felt it). A dummy variable of 1: 'Have been feeling anxious' was created if the respondent made either of the former two selections, and the variable was scored 0 otherwise.

To examine the direct effects of COVID-19, fear of COVID-19 and the number of COVID-19 positive cases in the residential province were used. The Fear of Coronavirus-19 Scale (FCV-19S) was used to measure the former. The scale developed by Ahorsu *et al.* (2022) has been validated in Japan (Midorikawa *et al.* 2021). The score ranges from 7 to 35, with higher scores indicating stronger anxiety and fear (cutoff values have not been determined thus far). As for the number of COVID-19 positive cases in the residential province, information provided by the Kyushu Economic Research Center (2021) was used. The number of new cases for two months was assessed to correspond to the definition of pregnancy postponement; that is, postponement during the past two months.

In addition to the above-mentioned focus variables, sociodemographic and economic information, such as income, owning a house, age, whether the respondent had a child, and educational attainment, were chosen as controls. Moreover, responses from patients who had undergone fertility treatment were included.

### *Analytical model*

To estimate cumulative effects, a generalised estimating equation (GEE) model was first used with the 2020 and 2021 data, assuming a Poisson distribution and estimated prevalence ratios with robust standard errors. This quasi-likelihood method, based on generalised linear models, is suitable for partial panel data with binary outcomes (Liang and Zeger 1986; Zeger and Liang 1986). Goodness-of-fit chi-square tests were conducted for each analysis, and the results were not statistically significant.

Subsequently, data separately for 2020 and 2021 were analysed separately using the Poisson regression model with robust standard errors to observe any changes in the associated factors. The Poisson regression model was used, instead of logistic regressions, because the interpretation of the odds ratio as relative risk leads to potential exaggeration (Zocchetti, Consonni and Bertazzi 1995). In addition, by using robust error variance, overestimation of relative risk can be avoided when Poisson regression is applied to binominal data (Zou 2004). Furthermore, Poisson regression has an advantage over log-binomial regression, given its vulnerability when there is model misspecification. Because there is a lack of rigorous diagnostic tools to detect model misspecification, Poisson regression is preferred in this analysis (Chen *et al.* 2018).

Sampling weights were applied, and the statistical significance was determined at 10%, 5%, and 1% levels.

$$\begin{aligned} \text{Pregnancy\_postpone}_i = & \beta + \beta_1 \text{EMPLOYMENT}_i + \beta_2 \text{INCOME\_DECLINE}_i + \beta_3 \text{ANXIETY}_i \\ & + \beta_4 \text{COVID19}_i + \beta_5 X_i + \varepsilon_i \end{aligned} \quad (1)$$

*Pregnancy\_postpone<sub>i</sub>* was a binary variable identifying whether an individual *i* was 1: postponing pregnancy due to COVID-19 (over the past two months), or 0: not postponing pregnancy. *EMPLOYMENT<sub>i</sub>* denotes the current employment status of *i*. A dummy variable was used in reference to *full-time workers (permanent)* to assess the prevalence of *full-time workers (contract/temporary)*, *part-time workers*, and *not working*. *INCOME\_DECLINE<sub>i</sub>* is a dummy variable equal

to 1: experiencing income decline and 0: not experiencing income decline.  $ANXIETY_i$  signified a variable that captured the uncertainty effect. It was constructed as follows: 1 = having been anxious about the household financial outlook and 0 = not anxious. Furthermore, COVID-19-related variables, FCV-19S, and the log of the number of COVID-19 cases in the residential province were included.  $X_i$  is a vector of  $i$ 's socioeconomic characteristics, including income, owning a house, age, educational attainment, and whether  $i$  has a child. The estimated regression coefficients and standard errors for the sampling distributions were asymptotically normal. Statistical analyses were conducted using STATA/MP 17.0.

## Results

As shown in Table 1, nearly 20% of married women delayed childbearing, with slight changes from 2020 (20.95%) to 2021 (18.68%). As for the variables of interest, the percentage of permanent full-time workers increased, whereas the percentage of other types of employment status decreased. The percentage of people who experienced income decline and who felt anxious about the financial outlook of the household decreased. COVID-19-related variables showed similar average scores for fear of COVID-19, and the number of COVID-19 positive cases in their residential province increased.

Table 2 shows the results of the GEE and Poisson regressions for 2020 and 2021 to provide an understanding of the factors associated with childbearing delays. Statistical significance was reported at the 1%, 5%, and 10% levels. According to the GEE estimation, the factors related to postponing pregnancy were experience of income decline (prevalence ratio [PR]:1.53, 95% confidence interval [CI] [1.16-2.03]), feeling anxious about household financial outlook (PR:1.73, 95% CI [1.31-2.28]), currently having no child (PR:1.56, 95% CI [1.16-2.08]), and university education or higher (PR:1.62, 95% CI [1.04-2.52]). Factors related to not delaying childbearing included older age and fertility treatment.

The results of Poisson regressions demonstrated that the associated factors were more strongly and significantly related in 2021 than in 2020. For instance, the PR of those feeling anxious about their household financial outlook increased to 3.07 (95% CI [1.82-5.19]). In addition, regarding employment status, compared to permanent full-time employees, contract full-time and part-time workers, as well as those not working, had a higher prevalence of postponing pregnancy, with PRs of 2.22 [95% CI (1.10-4.49)], 2.03 [95% CI (0.915-4.50)], and 2.26 [95% CI (1.13-4.49)], respectively. Income and educational levels indicated that those who were not in the lowest quartile were more likely to delay their pregnancy. The second poorest and the highest quartile had PRs of 2.01 [95% CI (1.10-3.65)] and 2.11 [95% CI (0.99-4.49)], respectively, with reference to the former. It should also be noted that owning houses, which was negatively correlated with pregnancy delay in 2020, became statistically nonsignificant in 2021. In 2021, those with no children had higher PRs of pregnancy delay (PR 1.78, 95% CI [1.04-3.05]). Regarding education, those who had studied at a vocational training school/two-year college [PR 2.34, 95% CI (1.25-4.39)] and those who had a university degree or higher [PR 3.16, 95% CI (1.64-6.10)] reported higher PRs than those who had a high school education or lower, with reference to the latter.

## Discussion

This study examined whether childbearing delay occurred due to the COVID-19 pandemic. Further, if it did occur, this study asked who the individuals making such decisions were and why. To answer these questions, changes in socioeconomic conditions caused by the pandemic were focused on. Due to the data characteristics, our observation sample was limited to married women who had been planning to be pregnant, at least until the time of the survey. Thus, our analyses did not cover those who had planned to become pregnant but fully abandoned their childbearing plans due to COVID-19.

Table 1. Descriptive statistics

	Total (n = 768)				2020 (n = 420)				2021 (n = 348)			
	Percentage/ Mean	Standard deviation	Minimum	Maximum	Percentage/ Mean	Standard deviation	Minimum	Maximum	Percentage/ Mean	Standard deviation	Minimum	Maximum
<b>Pregnancy postpone</b>	19.92%	0.40	0	1	20.95%	0.41	0	1	18.68%	0.39	0	1
<i>Employment status: Permanent full-time worker (Reference)</i>	36.85%	0.48	0	1	35.48%	0.48	0	1	38.51%	0.49	0	1
<i>Employment status: Contract full-time worker</i>	4.95%	0.22	0	1	5.00%	0.22	0	1	4.89%	0.22	0	1
<i>Employment status: Part-time worker</i>	23.31%	0.42	0	1	23.57%	0.42	0	1	22.99%	0.42	0	1
<i>Employment status: Not working</i>	34.90%	0.48	0	1	35.95%	0.48	0	1	33.62%	0.47	0	1
<i>Income decline</i>	35.81%	0.48	0	1	40.48%	0.49	0	1	30.17%	0.46	0	1
<i>Feeling anxious about household financial outlook</i>	36.20%	0.48	0	1	38.33%	0.49	0	1	33.62%	0.47	0	1
<i>Fear of COVID-19</i>	19.07	5.83	7	35	18.96	5.89	7	35	19.21	5.76	7	35
<i>Log of number of COVID-19 positive cases in the residential province</i>	7.74	1.93	0.69	10.83	6.91	1.83	0.69	9.48	8.74	1.54	4.34	10.83
<i>Income: The poorest quartile (Reference)</i>	23.31%	0.42	0	1	22.62%	0.42	0	1	24.14%	0.43	0	1
<i>Income: 2nd poorest</i>	25.91%	0.44	0	1	30.71%	0.46	0	1	20.11%	0.40	0	1
<i>Income: 2nd richest</i>	25.39%	0.44	0	1	23.10%	0.42	0	1	28.16%	0.45	0	1
<i>Income: Richest</i>	25.39%	0.44	0	1	23.57%	0.42	0	1	27.59%	0.45	0	1
<i>Owning a house</i>	47.53%	0.50	0	1	47.86%	0.50	0	1	47.13%	0.50	0	1
<i>Age</i>	35.75	7.26	18	50	35.50	7.24	18	50	36.05	7.28	19	50
<i>Education: High school or lower (Reference)</i>	19.40%	0.40	0	1	20.48%	0.40	0	1	18.10%	0.39	0	1

(Continued)

**Table 1.** (Continued)

	Total (n = 768)				2020 (n = 420)				2021 (n = 348)			
	Percentage/ Mean	Standard deviation	Minimum	Maximum	Percentage/ Mean	Standard deviation	Minimum	Maximum	Percentage/ Mean	Standard deviation	Minimum	Maximum
<i>Education: Vocational training school/2-years college</i>	32.29%	0.47	0	1	31.67%	0.47	0	1	33.05%	0.47	0	1
<i>Education: University or higher</i>	48.31%	0.50	0	1	47.86%	0.50	0	1	48.85%	0.50	0	1
<i>Currently having no child</i>	39.71%	0.49	0	1	40.95%	0.49	0	1	38.22%	0.49	0	1
<i>Fertility treatment</i>	64.71%	0.48	0	1	64.05%	0.48	0	1	65.52%	0.48	0	1

**NOTE:**

- 1) The income variable was created by using the whole JACSIS data sample for each year excluding the ones with discrepancies and/or artificial/unnatural responses (see page 6). Equivalent income was first calculated, and then divided into quartiles.
- 2) Regional dummies were included in the analysis, but they are not shown here for the sake of brevity. Regions were divided into 8: Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, and Kyushu/Okinawa.



**Table 2.** Regression results

	<i>Pregnancy postponement</i>					
	GEE(2020&2021)		2020		2021	
	PRs	95% CI	PRs	95% CI	PRs	95% CI
<i>Employment status: Permanent full-time worker (Reference)</i>						
<i>Employment status: Contract full-time worker</i>	1.189	[0.706,2.002]	0.845	[0.325,2.194]	2.222**	[1.100,4.489]
<i>Employment status: Part-time worker</i>	0.942	[0.602,1.476]	0.66	[0.295,1.481]	2.030*	[0.915,4.502]
<i>Employment status: Not working</i>	0.979	[0.677,1.416]	0.895	[0.549,1.458]	2.256**	[1.134,4.489]
<i>Income decline</i>	1.533***	[1.159,2.029]	1.485	[0.926,2.384]	1.541*	[0.944,2.515]
<i>Feeling anxious about household financial outlook</i>	1.729***	[1.313,2.278]	1.865**	[1.091,3.188]	3.072***	[1.818,5.190]
<i>Fear of COVID-19</i>	1.01	[0.985,1.036]	1.008	[0.963,1.056]	0.998	[0.955,1.043]
<i>Log of number of COVID-19 positive cases in the residential province</i>	0.99	[0.896,1.094]	0.935	[0.791,1.105]	1.159	[0.909,1.479]
<i>Currently having no child</i>	1.557***	[1.163,2.084]	1.366	[0.803,2.325]	1.778**	[1.038,3.044]
<i>Income: The poorest quartile (Reference)</i>						
<i>Income: 2nd poorest</i>	1.038	[0.721,1.494]	1.123	[0.580,2.175]	2.007**	[1.104,3.648]
<i>Income: 2nd richest</i>	0.956	[0.607,1.506]	0.964	[0.455,2.045]	2.108*	[0.989,4.494]
<i>Income: Richest</i>	0.928	[0.574,1.501]	1.115	[0.505,2.463]	1.523	[0.484,4.789]
<i>Owning a house</i>	0.795	[0.576,1.097]	0.522**	[0.285,0.957]	0.677	[0.404,1.132]
<i>Age</i>	0.967***	[0.943,0.991]	0.973	[0.934,1.014]	0.969	[0.932,1.009]
<i>Education: High school or lower (Reference)</i>						
<i>Education: Vocational training school/2-year college</i>	1.424	[0.892,2.274]	1.077	[0.495,2.347]	2.341***	[1.248,4.389]
<i>Education: University or higher</i>	1.617**	[1.038,2.520]	1.349	[0.650,2.800]	3.160***	[1.637,6.102]
<i>Fertility treatment</i>	0.313***	[0.224,0.437]	0.431***	[0.256,0.728]	0.211***	[0.119,0.375]

NOTE:

1. Robust standard errors were used for all analyses. 95% confidence intervals (95% CI) are reported in square brackets
2. Prevalence ratios (PRs) are reported, and \*p < 0.10, \*\*p < 0.05, and \*\*\*p < 0.01.
3. Regions and survey year (for GEE analysis) are adjusted. They are not reported for the sake of brevity.

First, it was revealed that approximately 20% of married women postponed their pregnancy due to the COVID-19 pandemic. Although this percentage is lower than those reported by Luppi *et al.* (2020), Zhu *et al.* (2020), and Lindberg *et al.* (2020), considering the very low fertility rate in Japan, this percentage raises serious concerns. It could be the case that the decline in Japan was lower than that in other countries due to the low fertility rate in the pre-pandemic era, leaving little space for a further decline.

In exploring what factors, in relation to the COVID-19 pandemic, were associated with child-bearing delay, it was found that economic uncertainty (anxiety about household financial outlook) was statistically significantly associated with pregnancy delay throughout the two rounds of surveys. However, fear of COVID-19 and the number of COVID-19 positive cases in the residential province did not indicate any association. This finding is consistent with the findings of Luppi *et al.* (2020) for the U.K., Lindberg *et al.* (2020) for the U.S., and Malicka *et al.* (2021) for Poland. Our subsample analyses further suggest the elevated effects of economic conditions. In 2021,

married women with more unstable working status and those who were not working were more likely to delay childbearing compared to those who were permanent full-time workers. Moreover, income decline significantly increased the probability of postponing pregnancy. The negative effect of economic uncertainty was also higher in 2021. During the COVID-19 pandemic, female workers were reported to have a higher risk of dismissal and contract termination. The impact was particularly severe for contract workers, as one in three experienced either dismissal or termination of contracts during April and November 2020 (Shu 2021).

Shu (2021) further revealed that over 30% experienced a large reduction in working hours or were given unrequested leaves of absence, while less than 20% were entitled to leave compensation. Thus, in the second round, the JACSIS survey conducted in February 2021 may have reflected these unfavourable conditions for female contract and part-time workers more strongly than in the first round conducted in September 2020. In addition, those who were not working in 2021 may have included those who lost their jobs during the pandemic and were unable to find another one, as Shu (2021) reported slow recovery in the female labour market. In addition, the discussion of Luppi et al. (2020) implies that the Japanese people are affected by economic uncertainty, partly because of the welfare system of the country. In Luppi et al.'s (2020) study, economic uncertainty only had significant effects on pregnancy postponement for British people among the surveyed nationalities. Interestingly, the U.K. is the only liberal welfare state. In Japan, there has been discussion that public assistance does not play a sufficient role as a safety net. It was estimated that public assistance only covered approximately 10% of the people classified as living below the poverty line, and this is even lower than that of the U.K., which was estimated to be approximately 62% (Yoshinaga 2019). Furthermore, it is a well-known fact that social stigma towards recipients contributes to a low public assistance take-up rate (Sekine 2008). Hence, this lack of public assistance and/or people's stigma towards it may have led to the decision to delay childbearing as a result of elevated financial anxiety and uncertainty.

The educational variables showed a positive association with childbearing delay. Higher education correlated with higher PRs of pregnancy postponement. This finding is consistent with the theory proposed by Friedman et al. (1994) and empirical evidence from the Organization for Economic Cooperation and Development (2009). For women with less education and limited earning ability, childbearing could become a strategy for life security, as more financial support from the welfare system is provided to those with children. Similarly, Catabiano et al. (2017) found that in Italy, very low-educated women accelerated their entrance to motherhood during the Great Recession. Kikuchi et al. (2021) reported that in the Japanese labour market during the pandemic, the most severely hit groups have been females and a contingent of low-skilled workers who are likely to be less educated. To ease the burden placed on these groups, there was a subsidy provided particularly to low-income child-rearing households. This situation may support the decision of women with less education to have children. On the other hand, those with higher education might have felt anxious about the possibility of losing their jobs, thus leading to a decision to delay childbearing.

Another possible path that should be explored is the relationship between education and risk aversion. Outreville (2015) found mixed results by reviewing the literature that explored the relationship between education and risk preferences, and no study has yet explored this relationship in Japan. It could be the case that highly educated Japanese women are more risk averse, leading to delayed childbearing. We also need to pay attention that, among married women aged 18–50 years, 24.6% had a high school or lower education level, 35.2% had vocational training school/two years of college, and 40.1% had a university degree or higher. Thus, there may be a self-selection towards marriage.

The significance and PRs of income variables in the analysis of the 2021 survey can also be explained by the same reasoning, as the second-poorest and second-richest quartile groups had higher PRs for childbearing delay than did the poorest quartile. Interestingly, in 2020, those who owned a house had a lower PR to postpone pregnancy; however, the significance of the effect disappeared and its magnitude decreased by 2021.

Based on these results, it is clear that attention should be paid to the pandemic's negative economic consequences. This further implies that the currently observed baby bust phenomenon could continue even after the COVID-19 infection has stabilised if economic uncertainty does not improve.

Additional concerns include the fact that there were no significant age-related discrepancies. Although small differences in the PRs for age were observed in the GEE analysis, the significance disappeared in the sub-sample analyses. Biologically, an increase in age lowers fertility. Hence, those who postponed pregnancy may have faced difficulty in childbearing after the pandemic due to their advanced age. In relation to this point, it is also worth noting that married women without children are more likely to postpone pregnancy. Having the first child at a more advanced age is likely to lead to a lower total number of children (Ministry of Health, Labour and Welfare 2015).

Despite these novel findings, there are limitations to this study that require caution when interpreting the results. First, it was conducted based on an online survey, meaning there may be sampling bias, such as including only those with access to the Internet and a certain level of digital literacy. Second, changes in socioeconomic conditions caused by the pandemic were the focus of this investigation, and this study examined how those changes relate to childbearing behaviour in general. However, due to data limitations, several factors that may significantly affect childbearing behaviours were not investigated in this study, namely: (1) couples' relationships pre- and during the pandemic; (2) their living arrangements, and (3) their combined level of childbearing desire. These factors may be particularly influential at the individual emotional and practical levels. In addition, the available resources for formal and informal parental support were not considered. There might be cases in which people are more willing to become pregnant where parental support is sufficiently provided, which should be studied in future research. Third, people who renounced their childbearing could not be studied. This indicates that, when interpreting these results, it should be understood that there may have been significantly more individuals who would have potentially had a child(ren) if they had not faced the economic uncertainty caused by the pandemic.

## Conclusion

This study confirmed that the COVID-19 pandemic has contributed to the current baby bust in Japan, and there is no plausible reason to expect a baby boom after its end unless economic prospects recover. People are not delaying childbearing due to the fear of COVID-19; however, they are avoiding pregnancy due to pandemic-related economic uncertainty and deteriorated labour market conditions.

Although financial anxiety may gradually disappear when the COVID-19 pandemic has ended, considering this prolonged crisis, there is an urgent need for public policy discussion. In addition, as Comolli *et al.* (2021) suggested, the way a crisis is handled and its aftermath affect perceptions of uncertainty, including not only economic insecurity but also perceived welfare uncertainty leading to reduced willingness to have a child.

As our sociodemographic characteristics showed, age was not a predictive factor for the postponement of pregnancy. Additionally, those wishing to have their first child postponed pregnancy. From a biological perspective, delaying childbearing by one–two years can pose further challenges to conception for those who are already advanced in age. Furthermore, having the first child at an older age indicates fewer opportunities to have a subsequent child. Considering these results, economic uncertainty is the largest barrier to pregnancy, rather than the fear of COVID-19 infection. Thus, economic recovery, job safety, and social support are crucial.

Another critical consideration is that this study only focused on those who were wishing and practically planning pregnancy. About 20% of married women delayed childbearing. Japan has long faced challenges with its decreasing total fertility rate. The current research suggests a further decline among those who desire children. This is a serious public-policy concern. In addition, as

mentioned earlier, this study did not investigate people who abandoned or became incapable of conception because of COVID-19, and this should be examined in future research.

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## References

- Aassve A, Nicolo C, Letizia M, Samuel P and Bacci M (2020) The COVID-19 pandemic and human fertility. *Science* **369**(6502), 370–371.
- Ahorsu DK, Lin CY, Imani V, Saffari M, Griffiths MD and Pakpour AH (2022) The fear of COVID-19 scale: Development and initial validation. *International Journal of Mental Health and Addiction* **20**(3), 1537–1545.
- Bloom-Feshbach K, Lone S, Cécile V, Kåre M, Mark AM, Magnus G and Viggo A (2011) Natality decline and miscarriages associated with the 1918 influenza pandemic: The Scandinavian and United States experiences. *Journal of Infectious Diseases* **204**(8), 1157–1164.
- Caltabiano M, Comolli CL, and Rosina A (2017) The effect of the great recession on permanent childlessness in Italy. *Demographic Research* **37**(1), 635–668. <https://doi.org/10.4054/DemRes.2017.37.20>
- Chandra S, Christensen J, Mamelund SV and Paneth N (2018) Short-term birth sequelae of the 1918–1920 influenza pandemic in the United States: State-level analysis. *American Journal of Epidemiology* **187**(12), 2585–2595.
- Chandra S and Yan LY (2015a) The 1918 influenza pandemic and subsequent birth deficit in Japan. *Demographic Research* **33**, 313–326.
- Chandra S and Yan LY (2015b) Fertility decline and the 1918 influenza pandemic in Taiwan. *Biodemography and Social Biology* **61**(3), 266–272.
- Chen W, Qian L, Shi J, and Franklin M (2018). Comparing performance between log-binomial and robust Poisson regression models for estimating risk ratios under model misspecification. *BMC Medical Research Methodology* **18**(1), 1–12.
- Comolli CL, Neyer G, Andersson G, Dommermuth L, Fallesen P, Jalovaara M, Jónsson AK, Kolk M and Lappgård T (2021) Beyond the economic gaze: Childbearing during and after recessions in the Nordic countries. *European Journal of Population* **37**(2), 473–520. <https://doi.org/10.1007/s10680-020-09570-0>
- Comolli CL and Vignoli D (2021) Spreading uncertainty, shrinking birth rates: A natural experiment for Italy. *European Sociological Review*, 2019, 1–16. <https://doi.org/10.1093/esr/jcab001>
- Demony C and Jones G (2021) *Analysis: COVID-19 Worsens Europe's Inequalities in Yet Another Way - The Fertility Gap*. Lisbon/Rome: Reuters. Available <https://www.reuters.com/article/us-health-coronavirus-eu-births-analysis-idUSKBN28B3XA> (accessed: 22 October 2021).
- Easterlin RA (1969) Towards a socioeconomic theory of fertility, in SJ Behrman, L Corsa and R Freedman (eds.) *Fertility and Family Planning: A World View*. Michigan: University of Michigan Press, pp. 127–156.
- Friedman D, Hechter M and Kanazawa S (1994) A theory of the value of children. *Demography* **31**(3), 375–401.
- Guimbeau, A, Menon N and Musacchio A (2020) *The Brazilian Bombshell? The Long-term Impact of the 1918 Influenza Pandemic the South American Way*. Massachusetts, National Bureau of Economic Research. No. w26929.
- Hamilton E., Martin JA and Osterman MJK (2021) *Births: Provisional Data for 2020*, Maryland: National Center for Health Statistics. Vital Statistics Rapid Release. no 12. <https://doi.org/10.15620/cdc:104993>.
- Kearney M and Levine P (2020) *The Coming COVID-19 Baby Bust: Update*. Washington: BROOKINGS Middle Class. Available <https://www.brookings.edu/blog/up-front/2020/12/17/the-coming-covid-19-baby-bust-update/> (accessed: 22 October 2021).
- Kikuchi S, Kitao S and Mikoshiba M (2021) Who suffers from the COVID-19 shocks? Labor market heterogeneity and welfare consequences in Japan. *Journal of the Japanese and International Economies* **59**, 101117.
- Kraval Ø (2002) The impact of individual and aggregate unemployment on fertility in Norway. *Demographic Research* **6**(10), 263–294.
- Kyushu Economic Research Center (2021) *Shingata Coronavirus Kokunai Kansen Data [COVID-19 Infection National Data]*. Kyushu: Kyushu Economic Research Center. Available [https://datasalad.jp/report/covid-19\\_patients/](https://datasalad.jp/report/covid-19_patients/) (accessed: 22 October 2021).
- Liang KY and Zeger LS (1986) Longitudinal data analysis using generalized linear models. *Biometrika* **73**(1), 13–22.

- Lindberg LD, VandeVusse A, Mueller J and Kirstein M** (2020) Early Impacts of the COVID-19 Pandemic: Findings from the 2020 Guttmacher Survey of Reproductive Health Experiences, New York: Guttmacher Institute, 2020, <https://www.guttmacher.org/report/early-impacts-covid-19-pandemic-findings-2020-guttmacher-survey-reproductive-health>
- Luppi F, Arpino B and Rosina A** (2020) The impact of COVID-19 on fertility plans in Italy, Germany, France, Spain, and the United Kingdom. *Demographic Research* **43**, 1399–1412.
- Malicka I, Mynarska M and Świdarska J** (2021) Perceived consequences of the COVID-19 pandemic and childbearing intentions in Poland. *Journal of Family Research* **33**(3), 674–702. <https://doi.org/10.20377/jfr-666>
- Mamelund SE** (2004) Can the Spanish influenza pandemic of 1918 explain the baby boom of 1920 in neutral Norway? *Population* **59**(2), 229–260.
- Matysiak A, Sobotka T, and Vignoli D** (2021) The great recession and fertility in Europe: A subnational analysis. *European Journal of Population* **37**(1), 29–64. <https://doi.org/10.1007/s10680-020-09556-y>
- Midorikawa H, Aiba M, Lebowitz A, Taguchi T, Shiratori Y, Ogawa T, Takahashi A, Takahashi S, Nemoto K, Arai T and Tachikawa H** (2021) Confirming validity of the Fear of COVID-19 Scale in Japanese with a nationwide large-scale sample. *PLOS One* **16**(2), e0246840.
- Ministry of Health, Labour and Welfare** (2015) White paper of Health, Labour and Welfare 2015 (*H25 Nendoban Kousei Roudo Hakusho - Wakamono no ishiki wo saguru- in Japanese*) <https://www.mhlw.go.jp/wp/hakusyo/kousei/13/> (accessed: 22 October 2021).
- Miyawaki A, Tabuchi T, Tomata Y and Tsugawa Y** (2021) Association between participation in the government subsidy programme for domestic travel and symptoms indicative of COVID-19 infection in Japan: Cross-sectional study. *BMJ Open* **11**: e049069.
- Nakamura Y** (2021) *Japan Births fall 4.7% on COVID Baby Bust*. Tokyo: NIKKEI Asia. Available <https://asia.nikkei.com/Spotlight/Coronavirus/Japan-births-fall-4.7-on-COVID-baby-bust> (accessed: 22 October 2021).
- Ogawa N** (2003) Japan's changing fertility mechanisms and its policy responses. *Journal of Population Research* **20**(1), 89–106.
- Organisation for Economic Co-operation and Development.** (2009) *Jobs for Immigrants: Labour Market Integration in Norway—The Labour Market Integration of Immigrants and Their Children in Norway, Paris*. Paris: Organisation for Economic Co-operation and Development. Available at: <http://www.oecd.org/dataoecd/35/17/4324752> (accessed: 22 October 2021).
- Outreville JF** (2015) The relationship between relative risk aversion and the level of education: A survey and implications for the demand for life insurance. *Journal of Economic Surveys* **29**(1), 97–111.
- Sekine Y** (2008) The rise of poverty in Japan: The emergence of the working poor. *Japan Labor Review* **5**(4), 49–66.
- Shu, E** (2021) Corona Shock to Jyosei no Koyo Kiki [COVID-19 Shock and Crisis of Female Employment Conditions] *JILPT Discussion Paper* 21-09. (<https://www.jil.go.jp/institute/discussion/2021/documents/DP21-09.pdf>) (accessed: 22 October 2021).
- Sobotka T, Jasilioniene A, Galarza AA, Zeman K, Nemeth L and Jdanov D** (2021) “Baby Bust in the Wake of the COVID-19 Pandemic? First Results from the New STFF Data Series.” SocArXiv. March 24. <https://doi.org/10.31235/osf.io/mvy62>.
- Sobotka T, Vegard S and Dimiter P** (2011) Economic recession and fertility in the developed world. *Population and Development Review* **37**(2), 267–306.
- Vignoli D, Bazzani G, Guetto R, Minello A and Pirani E.** (2020a). Uncertainty and narratives of the future: A theoretical framework for contemporary fertility. In R. Schoen (Ed.), *Analyzing Contemporary Fertility*, 25–47. [https://doi.org/10.1007/978-3-030-48519-1\\_3](https://doi.org/10.1007/978-3-030-48519-1_3)
- Vignoli D, Guetto R, Bazzani G, Pirani E and Minello A** (2020b) A reflection on economic uncertainty and fertility in Europe: The narrative framework. *Genus* **76**, 1. <https://doi.org/10.1186/s41118-020-00094-3>
- Yoshinaga J** (2019) ‘Han-fukushi/han-shuro’ to seikatsu-hosho, seikatsu-hogo [From part-welfare/working to social protection, life protection]. *Shakai-seisaku* [Social Policy and Labor Studies], **11**(1), 11–25.
- Zeger SL and Liang Y** (1986) Longitudinal data analysis for discrete and continuous outcomes. *Biometrics*, 121–130.
- Zhu C, Wu J, Liang Y, Yan L, He C, Chen L and Zhang J** (2020) Fertility intentions among couples in Shanghai under COVID-19: A cross-sectional study. *International Journal of Gynaecology & Obstetrics* **151**(3), 399–406.
- Zocchetti C, Consonni D, Bertazzi PA** (1995) Estimation of prevalence rate ratios from cross-sectional data. *International Journal of Epidemiology* **24**, 1064–1065.
- Zou G** (2004) A modified Poisson regression approach to prospective studies with binary data. *American Journal of Epidemiology* **159**(7), 702–706.

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