

# **The decomposition of birth fluctuation in China since the COVID-19 pandemic**

**Cuiling Zhang<sup>1</sup>, Ting Feng<sup>2</sup> and Zhenzhen Zheng<sup>2</sup>**

1 China Population and Development Research Centre. Email: zcl\_cpdrc@hotmail.com

2 Institute of Population and Labor Economics, Chinese Academy of Social Sciences. Email: fengting@cass.org.cn

3 Institute of Population and Labor Economics, Chinese Academy of Social Sciences. Email: zhengzz@cass.org.cn

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## **Introduction**

The COVID-19 pandemic, which has lasted for three years, has had a marked impact on global population changes, including unconventional reductions in births, increases in deaths and delays in migration. Because the severity of the spread of the COVID-19 pandemic, the disease burden of the pandemic, the degree of socio-economic impact of its spread and control, and the public's perception of health risks differ, the duration of exposure to the epidemic has varied, and as a result, births in several countries have fluctuated in different patterns.

A stable social environment and predictable economic security are conditions that must be considered for getting married, forming a new family and having children. Social, economic and environmental emergencies have obvious negative effects on fertility behavior, such as long-term economic recession, global financial crisis, sudden malignant events, natural disasters and widespread infectious diseases. The extent and duration of fertility delay or reduction depend on the impact degree of the event and the impact period of its consequences. The epidemic situation in COVID-19 not only has the characteristics of epidemic diseases in human history, but also has a great impact on economic development under the background of globalization, so it also has the characteristics of economic recession and financial crisis. The impact of COVID-19 epidemic on fertility is complicated. Due to the different outbreak time and duration in different countries, people's risk awareness and government control measures are also different, and the differences in family policies and welfare security systems in different countries, the impact of the epidemic on fertility has different manifestations in different countries.

## **Data and methods:**

The Human Fertility Database (HFD), jointly operated and maintained by Max Planck Institute of Population Studies in Germany and Vienna Institute of Population Studies in Austria, has been publishing short-term fertility fluctuations (STFF) since March 2021, and has collected the monthly birth data of 45 countries/regions with reliable and timely birth statistics as of December 2022. ① . Firstly, this paper selects some developed countries with a monthly population of over 10,000 and typical models, including Japan, South Korea, the United States,

France, Italy, Spain, Germany, the Netherlands, Denmark, Norway and Sweden. By focusing on the changes of birth population in these countries since 2020, this paper introduces the influence of COVID-19 epidemic on the birth population in relevant countries and summarizes the general laws of birth population changes in relevant countries, to provide reference and comparison for judging the influence and mode of birth population changes in China. Then we shifted to use the birth registration data of China and explore its annual and monthly fluctuation.

In order to distinguish and compare the impact of the epidemic on marriage and childbearing more accurately, we further decomposes the decline in births into three factors, namely, 'changes in age structure of women in childbearing age', 'changes in the proportion of women with spouses' and 'changes in the marital fertility rate'. We use the sampling survey of population changes and census data to estimate the marital fertility rate of women of childbearing age. The age-specific marital fertility rate of women of childbearing age is calculated by dividing the number of age-specific births and the number of age-specific spouses in the Yearbook of Population and Labor Statistics of China in each year.

The decomposition method is as follows: (1) taking the actual number of births in the previous year as the starting point, use the age structure of women of childbearing age in the current year, multiply it by the proportion of women with spouses by age and the within-marriage fertility rate by age in the previous year and then add them up,, and the difference with the actual number of births in the previous year is the contribution of the change in the age structure of women; (2) continue to replace the proportion of women with spouses by age with the current year's value, then calculate the number of births, and the difference with the number of births of 1<sup>st</sup> step is the contribution of the change in the proportion of spouses; (3) Subtract the computed number of births of the 2<sup>nd</sup> step from the actual births in the current year, then get the contribution of the change in the marital fertility rate.

## Findings

### 1. The changing characteristics of the birth population in selected countries and China since the outbreak of the epidemic

Overall, affected by the epidemic situation, the birth scale of some developed countries observed in this paper has experienced a roller coaster phenomenon, that is, the number of births dropped sharply at the end of 2020 and the beginning of 2021, compensated for the rebound in 2021, and fell sharply again in 2022 (see Table 1). Compared with European and American countries, the birth fluctuation in Japan and South Korea has the characteristics of Asian countries, and the fluctuation affected by the epidemic is large and lasts for a long time. Compared with 2019, the monthly average number of births continues to decrease, and the birth fluctuation in South Korea is superimposed with the decline in the fertility level that has already appeared before, making it more difficult to estimate the impact of the epidemic.

The fluctuation of the birth population in China is similar to that in Japan and South Korea. In a society with low fertility rate, couples pay special attention to the health of newborns and try to avoid any health risks, while many Asian countries, including China, pay more attention to the risk of epidemic. The repeated impact of Covid-19 mutation on birth is no less than that in the early

stage of the epidemic. The first wave of COVID-19 epidemic, repeated wave and continuous overlapping of vaccine effects have affected the number of births.

**Table 1 Changes of monthly average number of births in some countries from 2019 to 2022**

Region	Country	Average monthly birth in 2019 (person)	Change in 2020 compared with the previous year (%)	Change in 2021 compared with the previous year (%)	Change in 2022 compared with the previous year (%)
East Asian	Japan	72116	-3.1	-3.3	-4.9
	South Korea	25201	-10.2	-4.2	-4.3
	China	1212509	-17.3	-11.8	-9.7
	US	312357	-3.8	+1.6	+0.2
	France	59513	-2.6	+0.9	-1.9
South Europe	Italy	35020	-3.9	-0.7	-2.0
	Spain	29923	-5.4	-0.9	-1.8
Western and northern Europe	Germany	64849	-0.8	+3.2	-7.2
	the Netherlands	14136	-0.8	+6.7	-6.6
	Danmark	19180	-1.6	+3.2	-8.2
	Norway Sweden				
Total (Exclude China)		632295	-3.5	+0.9	-2.2
Total (China include)		1844804	-12.6	-7.0	-6.6

*Note: the data are from the Human Fertility Database (<https://www.humanfertility.org/Data/STFF>, seasonal and calendar adjusted data, downloaded on October 22, 2023) and the birth registration data in National Health Commission of China.*

### **1.1 The monthly fluctuation characteristics of the birth population**

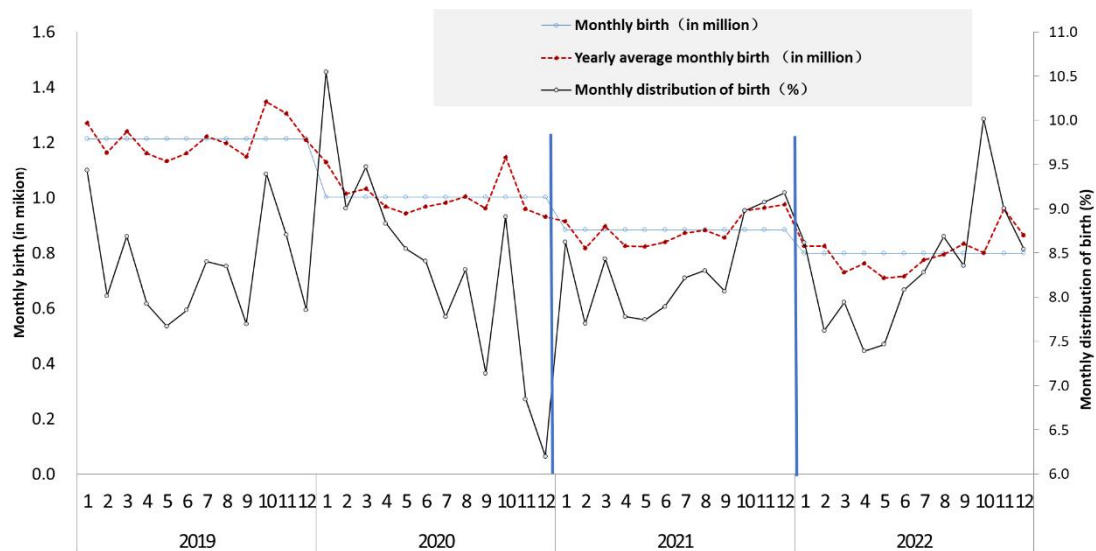
The annual birth population in China has fluctuated greatly since 2015. After the implementation of the universal two-child policy, it rose from 16.54 million in 2015 to 18.83 million in 2016, and then decreased from 17.65 million in 2017 to 15.23 million and 14.65 million in 2018 and 2019, and further declined year by year from 2020 to 2022, with 12 million and 14.65 million respectively.

From 2019 to 2022, the monthly number of births in China decreased step by step, reflecting the superposition of the decreasing trend of the number of births and the impact of the epidemic. In 2019, the monthly average number of births was 1.21 million, which has dropped to 1 million in 2020, and the monthly average number of births in 2021 and 2022 has further declined, reaching 885,000 and 799,000 respectively. Compared with the same period in 2015, the monthly birth population in 2018 and 2019 decreased by about 10% to 15% on average, but in 2020, the monthly birth population decreased by 20% to 30% on average from January to September, and the decline was accelerated in November and December, which was more than 45% lower than the same period in 2015, which was obviously affected by the epidemic that began in January of that year [2]. Although some countries have observed a rebound in the number of births in 2021,

the situation in China is different. The downward trend of the monthly birth population in 2021 has not been reversed, and the number of monthly births has decreased by an average of 35% compared with the same period in 2015, which is related to the large-scale vaccination at the end of 2020 and in 2021. Repeated epidemics and vaccine effects in 2022 contributed to a further decrease in the monthly birth population, with an average monthly decrease of 42% compared with the same period in 2015, a decrease of more than 51% in the same period in January, and a decrease of about 45% in February-May.

### ***1.2. The seasonal pattern changes of the birth population.***

The change of monthly birth pattern in China from 2020 to 2022 clearly shows the influence of COVID-19 epidemic on birth (Figure 1). For a long time, the monthly distribution of babies' birth in China is uneven, and the seasonal pattern of birth is relatively stable (as shown in Figure 1, 2019). The winter birth is the peak, and the proportion of the population born in October-December is high. March-June is the off-season of birth, and the proportion of the monthly birth population is relatively low. However, after the outbreak of the COVID-19 epidemic, the proportion of births in January and October in 2020 was relatively high, and the proportion of births in other regular peak months (such as November and December) was the lowest in recent years, while the proportion of births in regular low-lying months (March-June) was the highest in recent years. In 2021, with the normal development of the epidemic and the stabilization of people's attitude and cognition towards the epidemic, the seasonal pattern of birth gradually returned to the conventional pattern. However, in 2022, due to the repeated epidemic and relatively long duration, the vaccine effect continued, and the control of mobility and travel was strengthened in various places, social life and economic activities were obviously affected, which led to a change in the monthly distribution of births in that year. The monthly proportion of births from January to May reached the lowest level in recent years, and the proportion of births from July to September reached the highest level in recent years. The change of monthly pattern reflected that there was great uncertainty in the reproductive decision-making of childbearing age groups, and it was easy to passively postpone and cancel family planning under external shocks.



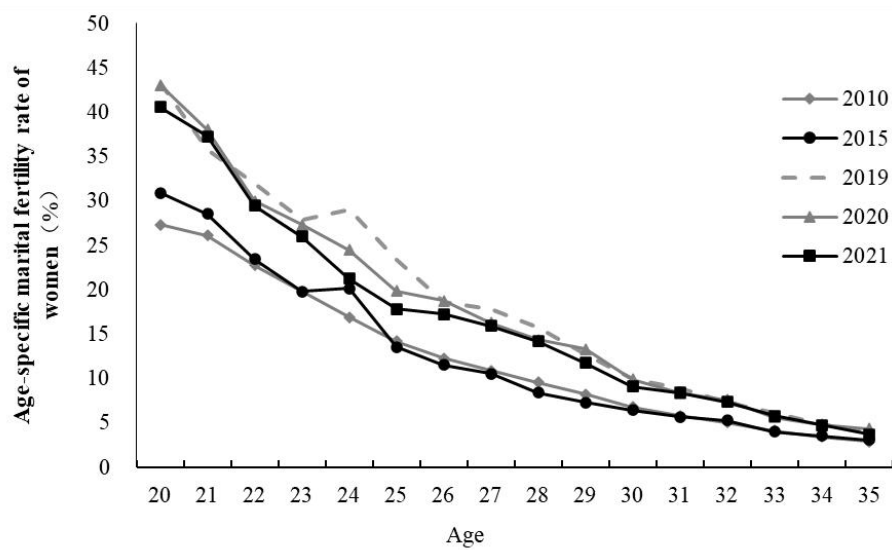
**Figure 1 Number of monthly births in China from 2019 to 2022 (10,000 people) and the distribution of monthly births in that year (%)**

*Note: The data comes from the monitoring data of the birth population in National Health Commission.*

## **2. Changes in marital fertility level and marriage since the COVID-19 epidemic**

The direct impact of the epidemic situation in COVID-19 on fertility behavior mainly comes from the spread and control restrictions of the epidemic situation, health considerations and insecurity about the uncertainty of the future, which leads couples of childbearing age to postpone or give up their family planning. The indirect influence comes from the delay of marriage. The fertility in China is mainly within marriage. For most people, marriage is a prerequisite for childbirth. The spread of epidemic situation and the influence of prevention and control measures on the formation of families and wedding ceremonies will lead to the delay of first marriage, which will indirectly affect the fertility rate. This section examines the direct and indirect effects of COVID-19 epidemic on fertility from two aspects: marital fertility and first marriage.

Using the sampling survey of population changes and census data to estimate the marital fertility rate of women of childbearing age, we find that the age pattern of marital fertility of women in the fertile period remains basically unchanged (see Figure 2). Overall, the marital fertility rate in 2019-2021 was higher than that in 2010 and 2015. However, compared with 2019, the marital fertility rate of women aged 22-30 decreased year by year in 2020 and 2021, with the biggest gap between 24 and 25 years old, reflecting the postponement of marital childbirth.



**Figure 2 Age-specific marital fertility rate of women in the fertile period from 2010 to 2021 (selected years)**

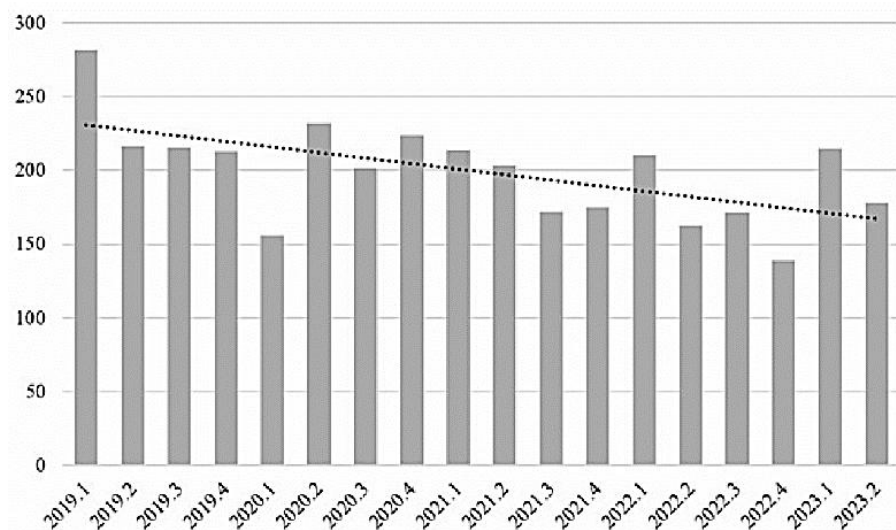
*Note: The age-specific marital fertility rate of women in childbearing age is calculated by dividing the number of age-specific births and the number of age-specific women with spouses in the Yearbook of Population and Labor Statistics of China in each year.*

Because the marital fertility rate in 2019 has increased compared with that in 2010 and 2015, and the age distribution pattern of women in the fertile period has remained stable from 2010 to 2021, it means that the decline of the marital fertility rate of women aged 22-30 in 2020 and 2021 is probably not a trend, but a temporary change affected by the epidemic. Therefore, if the cessation of childbearing by married women of childbearing age is postponed after the epidemic, the increase of compensatory childbearing will promote the rebound of fertility rate and the rebound of birth population.

## 2. The impact of the epidemic on marriage

In terms of marriage, due to the spread of the epidemic and the control of population mobility and gathering to stop the spread, the number of marriage registrations dropped sharply in the first quarter of 2020, and it has rebounded since then, but it still showed a downward trend until the end of 2021 (see Figure 3). In 2022, the closure measures, shortage of medical resources, youth unemployment and unstable employment, long-term separation between the two places and mobility restrictions caused by repeated epidemics still delayed marriage, that is, the trend of declining marriage number was further extended. Because women take on the unpaid work such as housework, childcare in the family, the COVID-19 epidemic has a more significant impact on women, such as the uncertainty and fragility of employment, working at home and taking care of children at home, which further intensifies the work-family conflict [10] and increases women's hesitation in marriage and childbirth. In addition, due to the large-scale crowd gathering in wedding ceremonies, the measures to control the epidemic directly or indirectly inhibit or delay the arrangement of young people getting married; Long-term epidemic control and home office measures have also changed the daily life rules of married small families.

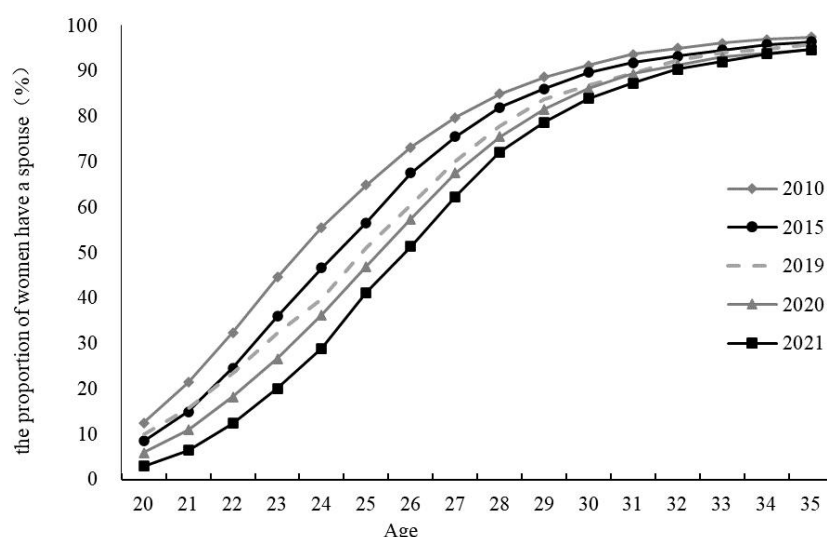
Long-term coexistence in closed space may highlight the fragility of marriage relations, leading to the dissolution of some small families [11], and disharmony in marriage relations will also lead to the postponement or cancellation of established family planning to a certain extent.



**Figure 3 The pairs of Marriage Registration by Quarter from 2019 to 2023, China**

*Note: The data are derived from civil affairs statistics and quarterly statistics of corresponding years (<https://www.mca.gov.cn/article/sj/>)*

Since 2010, the age of women's first marriage in China has been continuously delayed [12], and the proportion of women with spouses in the fertile period has been continuously decreasing (see Figure 4). In 2010, the proportion of 25-year-old women who had a spouse was 64.2%, which decreased to 55.9% in 2015, to 50.1%, 46.1% and 40.6% in 2019, 2020 and 2021, respectively. The decline rate was more than one third in 11 years, and the decline rate was obviously accelerated in the past two years. In 2021, it decreased by nearly 20% compared with 2019. Since China is still giving birth within marriage at this stage, the rapid decline in the proportion of women with spouses in the fertile period will directly lower the fertility level.



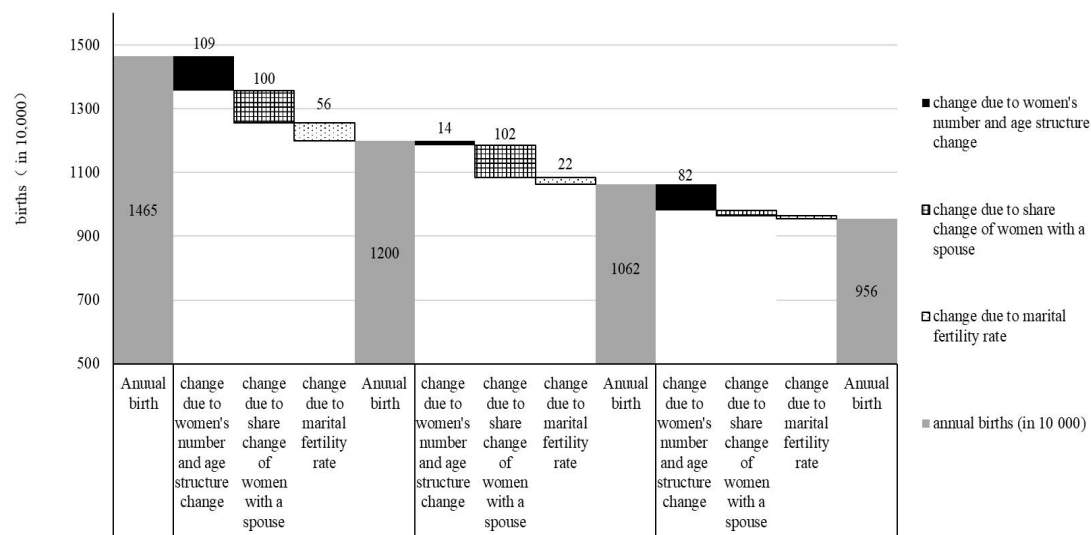
**Figure 4 Proportion of female with spouses by age in fertile period from 2010 to 2021 (selected years)**

The downward trend of the proportion of women with spouses in the fertile period was established before the epidemic, and the impact of the epidemic on the delay of first marriage and the increase of divorce will accelerate the decline. As a result, only part of the total change in the proportion of women with spouses is affected by the epidemic, and it is difficult to reverse the downward trend after the epidemic ends. In addition, the delay of first marriage and the increase of divorce affected by the epidemic situation, and the release of fertility potential involves both marriage and childbirth. Even if the epidemic situation ends and relevant policies create better conditions, it still needs to be gradually released.

#### **4. The decomposition results of the decline of the birth population during the epidemic**

The above analysis shows that the marital fertility rate and the proportion of spouses of women in the fertile period decreased during the epidemic period. However, from 2019 to 2022, the birth population in China continued to decline. Apart from the epidemic situation, the decline in the number of women of childbearing age and the aging age structure are also important reasons. With the baby-boomer gradually withdrawing from the fertile period 30 years ago, the decline in the birth population caused by the annual changes in the number and age distribution of women of childbearing age has nothing to do with the impact of the epidemic, and it is difficult to reverse it. It is called the "age structure change" factor below, which represents the role of population inertia.





**Figure5 The Decomposition Results of the Decline of Birth in China from 2019 to 2022**

*Note: The actual birth population data from 2019 to 2022 comes from the website of the National Bureau of Statistics (<https://www.stats.gov.cn>); The data of age structure of women of childbearing age in 2020 comes from the short table of China Census Yearbook 2020, and the data of age structure of women of childbearing age in 2021-2022 comes from the prediction of this study. The proportion of women of childbearing age who have different spouses is calculated from the Yearbook of Population and Labor Statistics of China in each year. The age-specific marital fertility rate is calculated by dividing the number of age-specific births and the number of age specific spouses in the Yearbook of Population and Labor Statistics of China.*

The "age structure change" factor reflects the influence of the change of the birth base population. The decline in the number of women of childbearing age and the aging of their age distribution in China will be a certain trend in a long period of time. From 2020 to 2022, the contribution of this factor to the annual decline of the birth population has always been positive, totaling more than 2 million in three years, accounting for about 40% of the decline in the birth population in three years. In 2020 and 2022, the contribution of age structure factors reached 1.09 million and 820,000 respectively, especially in 2022, which could explain about 80% of the decline in the birth population in that year. The low fertility level in China for decades has produced a strong population inertia, especially the large number of birth queues from 1986 to 1990 gradually moved out of the peak fertility period, which will continue to play an important role in the decline of birth population. This part of the impact is difficult to reverse, but it should be paid enough attention to in decision-making and policy evaluation.

In the society of giving birth within marriage, the factor of "the change of the proportion of spouses" reflects the influence of the change of the actual risk group of giving birth. With the improvement of women's education level and the change of family system, the trend of delaying first marriage and increasing divorce has been going on for many years, and the impact of the epidemic has accelerated the decline of the proportion of spouses. In 2020 and 2021, the decline in the proportion of spouses contributed 1 million and 1.02 million respectively to the decline in the birth population, both exceeding the contribution of the decline in the marital fertility rate,

and the contribution in 2021 exceeded 70%. As a prerequisite for childbearing, women's marriage has become a key link in the problem of marriage and childbearing. Because the release of this part of potential requires more conditions and it is difficult to put forward targeted countermeasures, the rebound space for the reduction of the birth population affected by this is relatively limited.

The "marital fertility rate change" factor reflects the influence of the fertility level of the actual risk groups. In 2020 and 2021, the contribution of the decline in marital fertility rate was 560,000 and 220,000 respectively, and the total contribution rate of the two years to the decline in birth population was less than 20%. Due to the aging trend of the age structure of women of childbearing age, the delay of first marriage and the increase of divorce have not changed significantly. Even considering the release of birth accumulation affected by the epidemic, it is difficult for the population born in 2023 to rebound substantially.

### **Conclusion:**

The COVID-19 epidemic, which has been prevalent for three years, has obviously affected the birth, death and migration of population in most parts of the world. From the fluctuation of monthly birth population with reliable records, we can see that the epidemic situation significantly interferes with the reproductive behavior of people of childbearing age, and China is no exception. However, unlike the fluctuation pattern of the birth population in Europe and the United States, the birth population in China continued to decline during the epidemic, and there was no compensatory birth rebound. Further analysis of the decline in the number of births shows that the changes in the age structure of women of childbearing age have contributed a lot to the decline in the number of births, which is difficult to change, while the fertility level within marriage is relatively stable and contributes little. Although the epidemic has affected the delay of first marriage, the delay of first marriage that occurred before the epidemic may continue in the future. The impact of the epidemic in China has superimposed the changes of marriage and childbearing behavior. This paper analyzes the fluctuation of birth population in China since the epidemic and its driving factors in many dimensions. The correlation mechanism and mode of action between macro external events and individual life events and important family decisions need to be supplemented by more micro-level data. The specific impact and duration of the epidemic on the income, employment, family relationship, intimate relationship and parenting pressure of different groups are still important topics to be further studied.

From the different survey results in recent years, the fertility will of the people of childbearing age in China is quite stable, and it has not been improved because of the implementation of the three-child policy; There are no obvious changes in various factors affecting the delay of first marriage among young people; The release of the two-child birth accumulated by the policy is coming to an end. Because the fertility in 2020-2022 is obviously restrained by the epidemic, it is estimated that there will be a certain number of compensatory births in 2023-2025, and the fertility rate and birth population may rebound slightly, but the general trend of first marriage and delayed childbirth will continue.

In recent years, the age of first marriage of China population has been continuously delayed.

Judging from the long-term trend of first marriage changes, the proportion of married women in the fertile period continues to decline in the 21st century. In addition to the increase in the age of first marriage, the proportion of unmarried women in the female population is also on the rise, especially in the "post- 80 s" and later birth queues, the proportion of unmarried women in urban and rural areas will rise rapidly. Voluntary infertility will also play an important role in the further decline of fertility rate. In recent years, non-fertility has become a voluntary choice of some families, and a few respondents began to choose the ideal number of children as childless in the survey of fertility willingness. The development of this trend is noteworthy.

China is in the process of the second demographic transition. Although the behavior of marriage and childbearing is different from the second demographic transition in Europe, which began at the end of the 20th century, the development trend of delaying the first marriage, having fewer children and having children later, and being unmarried and infertile has lasted for more than ten years or even decades before the epidemic. Without the intervention of foreseeable reversal factors, the rise of the age of first marriage and the delay of first childbearing will continue, the proportion of births with two children and above will gradually increase, and the level of unmarried and infertility may further rise. The three-year birth accumulation affected by the epidemic may be released in the next three years, but it is estimated that the total number of births that can be released will not exceed 2 million. If there is no strong fertility support policy, the delay of first marriage and childbearing and unmarried infertility will still have an important impact on the future fertility level.