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BIRTH AND FERTILITY RATES BEFORE AND AFTER THE LOCKDOWN IN THE FEDERAL DISTRICT OF BRAZIL DUE TO THE COVID-19 PANDEMIC

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ABSTRACT

Background: The study aims to contribute to the understanding of birth and fertility trends in the Federal District (DF) of Brazil and whether the context of the COVID-19 pandemic and local lockdown have expressively affected its demographic behavior, as an initial hypothesis.

Methods: A historical review of the governmental decrees that determined the restrictive measures throughout the pandemic in the DF was carried out, to establish the critical period of quarantine and lockdown actions. Local birth and fertility rates were calculated from official records since the pre-pandemic period and data tabulation with the help of TabWin and R softwares.

Results: A monthly drop in birth rates in the DF of an average of 14% was observed in the months following lockdown measures as of March 2020, which coincides with the trend observed in European countries. The fertility rate of 1.59 in the year before the pandemic in the DF dropped to 1.32 children per woman in 2022.

Conclusions: Despite declines in local birth rates, it was not possible to establish a significant impact of the pandemic or local lockdown on the downward trend in birth and fertility rates in DF, already observed since the pre-pandemic years.

Keywords: Birth Rate. Fertility Rate. Pandemic Impact.

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INTRODUCTION

Fertility and birth rates are influenced by several factors and throughout the COVID-19 pandemic new elements have focused on the issue. Besides the already known demographic and behavioral aspects, biological and organic conditions such as the causality of infertility and also the conditions of accessibility to the health services responsible for managing these conditions, the pandemic has introduced new concerns, a scenario of uncertainties regarding the repercussions of COVID -19 on people's reproductive capacity in a first moment and in a second moment on eventual governmental and health response strategies face the pandemic, such as blockades/lockdowns, vaccines and therapeutic guidelines.

History points to medium-term increases in fertility after epidemics and catastrophes, even as a population-based way of compensating for the loss of offspring caused by such crisis, but the demographic pattern observed in the COVID-19 pandemic seems to provide a dim view of the possibility of a baby boom resulting from behavioral changes during the pandemic, such as confinement and increased contact between fertile couples (Aassve et al., 2020).

A study(Sobotka et al., 2023) assessing fertility trends in 38 higher-income countries showed that birth rate decline trends over the course of the pandemic are broadly similar to pre-pandemic demographic trends in most countries analyzed and that a sustained baby boom has not yet been observed during the first two years of the pandemic.

There are still uncertainties whether behavioral changes of couples of childbearing age throughout the pandemic have contributed to demographic outcomes that can be observed seasonally throughout the "waves" of the pandemic, as well as bringing possible long-term demographic impacts. Although a systematic review with meta-analysis that analyzed 1406 studies found no impact of COVID vaccination on fertility (Zaçe et al., 2022), another study found the couples' perception of the possible COVID vaccines impacts on fertility contributed to postpone reproductive plans (Chu et al., 2022).

Another analytical concern is the reflection on the hypothetical influence of events that would impact on demographic balance, such as increases in maternal mortality, perinatal mortality or mortality of women of childbearing age, could have occurred in the scope of the COVID-19 pandemic, or whether behavioral changes of couples of childbearing age - in their lifestyles or in the postponement of childbearing, of a previous trend or even exacerbated by the pandemic - would be more decisive for such a scenario.

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Even changes in menstrual cycle length patterns have been reported (Bruinvels et al., 2022), tending towards longer cycles, associated with greater consumption of processed meat throughout the pandemic, as well as a lack of motivation for eumenorrheic women to observe the characteristics and possible symptoms of their menstrual cycles, combined with the psychological stress experienced by them in the pandemic, appear to challenge health professionals to promote strategies to minimize possible long-term effects on fertility.

In Brazil, despite the heterogeneity of the response to the pandemic in the different subnational governments, there has been a downward trend in the birth rate, especially in the Federal District, possibly because it was the state of the federation that was the first to trigger blockade and lockdown actions and receives special attention in terms of analyzing the possible influence of the pandemic on Brazilian vital statistics. This perception is echoed in Australia, where a study showed that fertility intentions fell between 2.8 to 4.3% from intentions before the pandemic and this decrease in the desire to have more children was consistently greater in places where the lockdown was prolonged(Mooi-Reci et al., 2023).

This study intends to analyze the fertility and birth rates in DF in order to observe possible changes in population behavior on the occasion of the COVID-19 pandemic and as an initial hypothesis whether the pandemic period contributed to local birth rate reduction. Furthermore, to identify if local findings would find echo in contemporary international literature.

MATERIALS & METHODS

This is a descriptive longitudinal ecological study with analysis of the total fertility rate of the DF over the historical series since 2010, with emphasis from March 2020, the period when the lockdown began in the DF, to analyze the reflexes of the post quarantine period due to the COVID-19 pandemic on birth rates and fertility in the local population. Data were collected up to March 2023.

The crude birth rate was calculated by dividing the number of live births by the population residing in the DF during the period evaluated, obtained through the Information System on Live Births - SINASC, based on data extraction up to March21, 2023. This official governmental system computes live births in Brazilian territory since 1990 from the issuance of the Declaration of Live Births, an official document that is filled out by health

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professionals who provided obstetric or neonatal care, and which is necessary for the issuance of a Birth Certificate by the Civil Registry Office.

The consolidation of the Live Birth Certificates is carried out by the managerial instances of the Brazilian public health system, with respective aggregations at municipal, state and federal levels. Federal District Information System on Live Births – SINASC DF - can be visited at: http://tabnet.datasus.gov.br/cgi/deftohtm.exe?sinasc/cnv/nvDF.def and http://sinasc.saude.gov.br/default.asp and https://info.saude.df.gov.br/sala-de-situacao/.

The total fertility rate was obtained by summing the specific fertility rates for female residents in available groups from 15 to 49 years old, multiplied by the interval of years (five-year age groups),with tabulations performed using TabWin – free access software made available by DATASUS/Brazilian Ministry of Health and Microsoft Excel, with the support of the official technical instance professional of the state government (GIASS - DIVEP -SVS-SES-GDF).

The population data used were from the Brazilian Institute of Geography and Statistics (IBGE), considering the update of the official population projections for the respective years. Demographics were measured according to the IBGE databases: https://cidades.ibge.gov.br/brasil/df/panorama and maternal age range for fertility calculation at: https://info.saude.df.gov.br/sala-de-situacao/painel-infosaude-projecao-da-populacao-no-df/.

To try to shed light on whether the pandemic was a factor in the decrease in birth rates in the Federal District, the Interrupted Time Series (ITS) methodology was applied, with the Autoregressive Integrated Moving Average (ARIMA) approach, considering 2020 as the pandemic milestone. The data were tabulated with the aid of R Software, version 4.3.0.

The search for official legislation on the lockdown timeframes was based on the website of the Court of Justice of the Federal District and Territories –TJDFT, publicly available at: https://www.tjdft.jus.br/institucional/relacoes-institucionais/legislacao-covid-19-2013-coronavirus/legislacao-distrital-covid-19-coronavirus.

The research on “Analysis of the fertility rate of the Federal District in the context of the COVID-19 pandemic” was submitted to Plataforma Brasil, a Brazilian governmental instance that analyzes research projects, via the Research Ethics Committee of the University Center of Brasília (UniCEUB) on 08/09/2020, and its execution was approved by means of Opinion No. 002/2020 – CEP/ UniCEUB.

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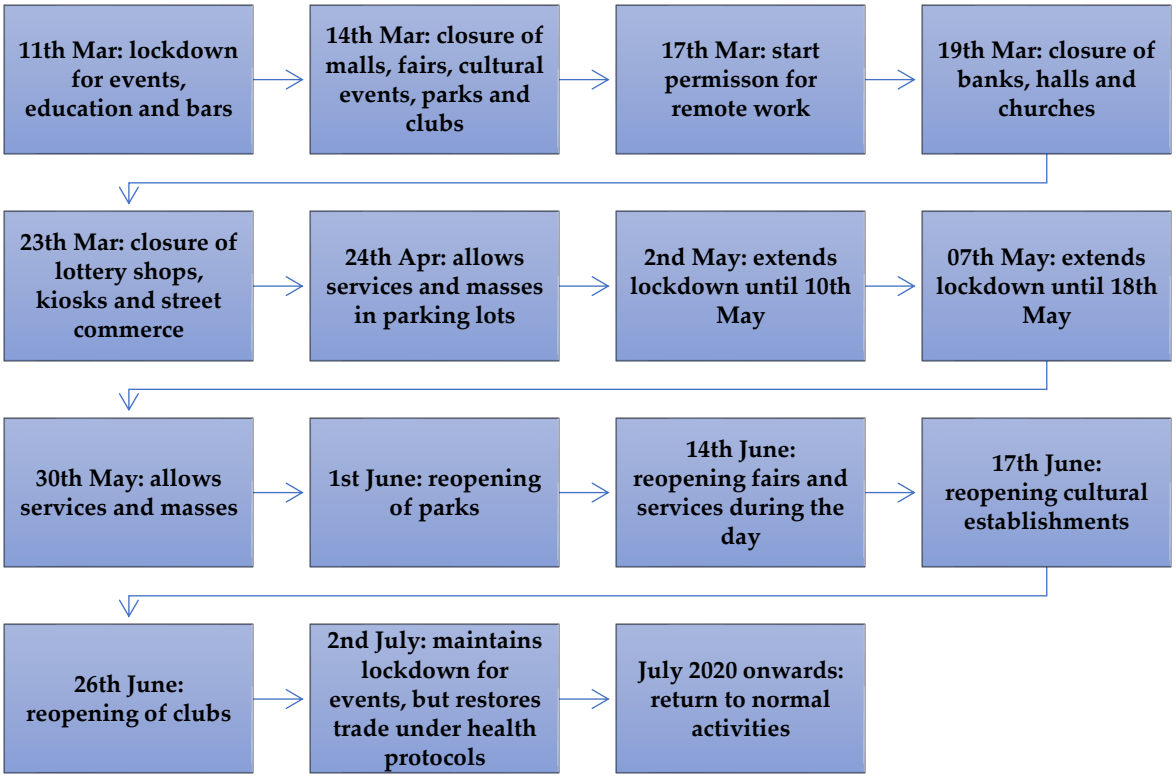
RESULTS

The DF was the first Brazilian state to decree a lockdown due to the COVID-19 pandemic(Da Silva et al., 2020)Legal and administrative measures were taken by the Federal District Government to limit the scope of various activities in the civilian sphere, with levels of responsibilities for different socio-economic sectors. The set of legal restrictions (decrees and ordinary laws) on the displacement of people and economic activities in the DF can be chronologically summarized in the *Fig. 1*.

Figure 1. Timeline of activity restrictions in the DF/Brazil 2020.



Source: Court of Justice of the Federal District and Territories.

Regarding lockdown timeframes, it is initially important to note that on 28/02/2020 a State of Health Emergency was decreed, which was followed by various limitations. The most incisive period of lockdown was concentrated between March and May 2020, with a first stage between 11th and 23th March, 2020, followed by a second stage, which extended the lockdown from 23rd March to May 18th, 2020.

Religious activities were partially restricted and gradually resumed, since in the meantime there was a state law that classified them as essential activities. The sectors hardest hit by the initial restrictive measures were the educational system, services and commerce in general, represented by shopping malls and other urban commerce and fairs,

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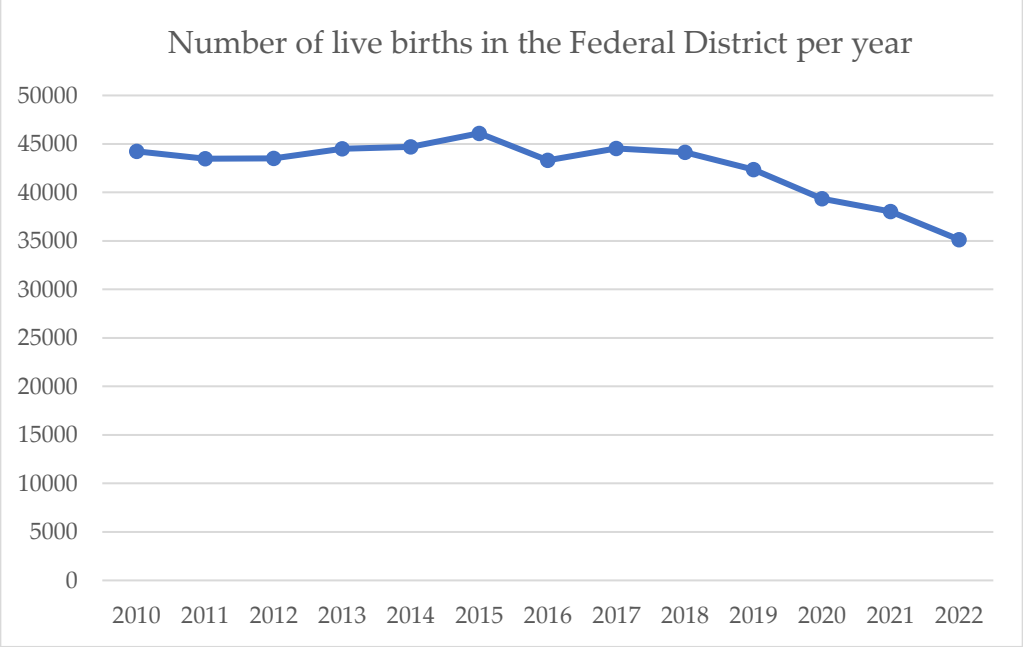
as well as the food trade branch. Parks, clubs and outdoor commercial activities were initially restricted, but gradually reopened from June 2020. From July 2020 there was a progressive resumption of the various sectors, but with the commitment to adopt specific health protocols. Thus, it can be noted that the DF showed lockdown apex between March and May 2020, with progressive regulatory relaxations from then on.

In relation to births and fertility, variables of interest to know possible correlations with the current lockdown period, it is important to highlight the behavior of the historical series of the number of live births in the DF over the years that preceded the pandemic. Although there are seasonal fluctuations in the number of live births in the last decade, the pre -pandemic average of 44,088 live births per year, whose median was 44,202 cases, is noteworthy. The median number of live births on the post-pandemic data available (2020-2022) was 38,022 live births, which shows a sharp decrease in birth rates in the DF after the pandemic, on the order of 14%. Birth and fertility data in the DF are represented in *Fig. 2* and *3* and *Table 1*.

Figure 2: Number of live births in the Federal District, 2010-2022.



Source: Birth Information System - SINASC. Extraction date: 21st March 2023.

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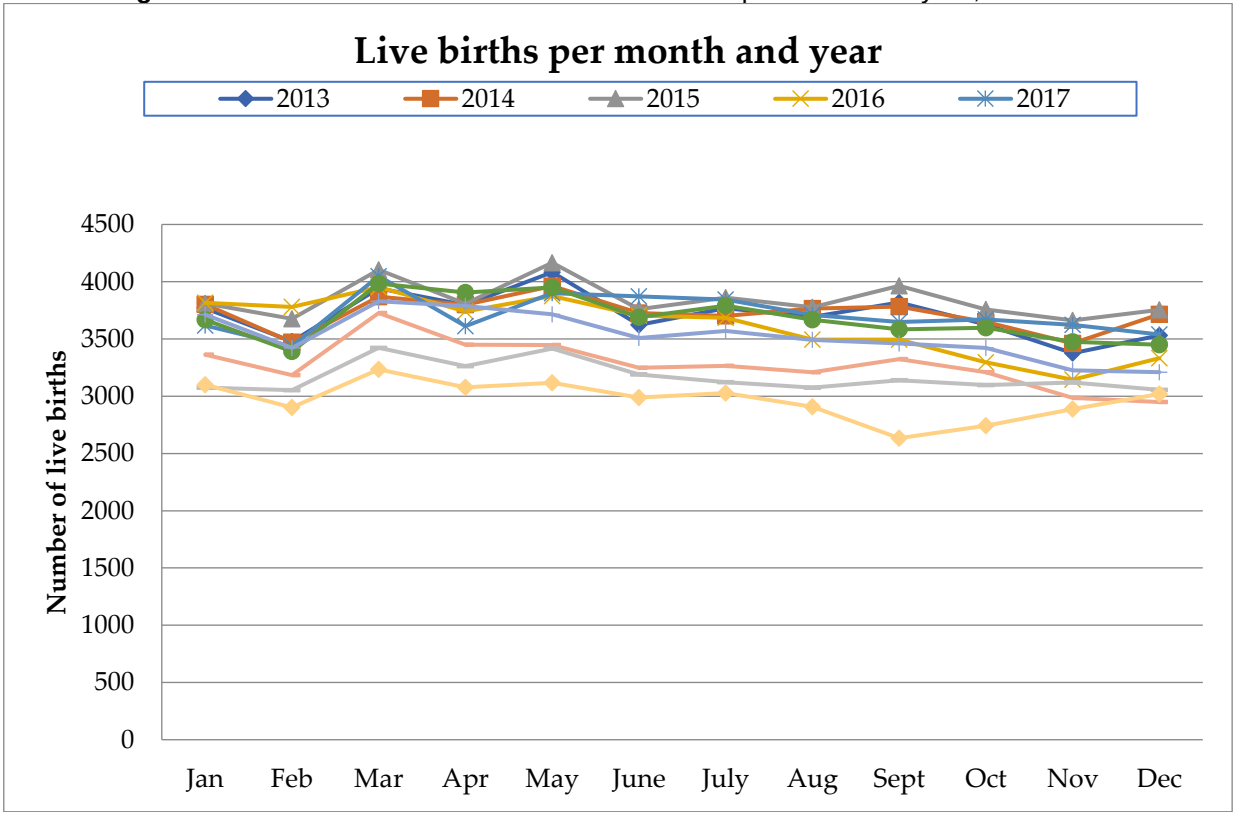
Figure 3. Number of live births in the Federal District per month and year, 2013-2022.



Source: Birth Information System - SINASC. Extraction date: 21st March 2023.

Table 1. Total number of live births in the Federal District per month and year, 2013-2022.

Month	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Jan	3769	3802	3810	3816	3618	3668	3712	3363	3075	3100
Feb	3478	3473	3677	3780	3435	3391	3422	3183	3053	2901
Mar	3941	3869	4104	3953	4049	3984	3829	3727	3423	3234
Apr	3797	3798	3808	3740	3613	3905	3789	3449	3262	3079
May	4083	3962	4166	3876	3900	3951	3715	3448	3416	3117
June	3623	3727	3759	3705	3873	3689	3509	3248	3189	2988
July	3768	3701	3862	3684	3843	3791	3569	3266	3124	3027
Aug	3693	3766	3776	3494	3709	3669	3491	3210	3075	2908
Sept	3820	3783	3964	3494	3649	3585	3462	3324	3140	2634
Oct	3627	3647	3758	3296	3671	3599	3421	3209	3098	2743
Nov	3376	3462	3662	3144	3624	3475	3227	2986	3121	2887
Dec	3530	3716	3754	3331	3540	3449	3210	2949	3055	3019

Source: Birth Information System - SINASC. Extraction date: 21st March 2023.

In relation to the number of births per year it is possible to note a historical series above 40000 live births per year until 2019 and from 2020 to 2022, the pandemic period, less than 40000 live births per year were observed and on a declining trend.

There is little variation of live births in relation to month of birth in the pre-pandemic years, but from 2020 onwards the number of live births per month was always below the

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respective months in the pre-pandemic years, and with peaks of births in the months during the first semester.

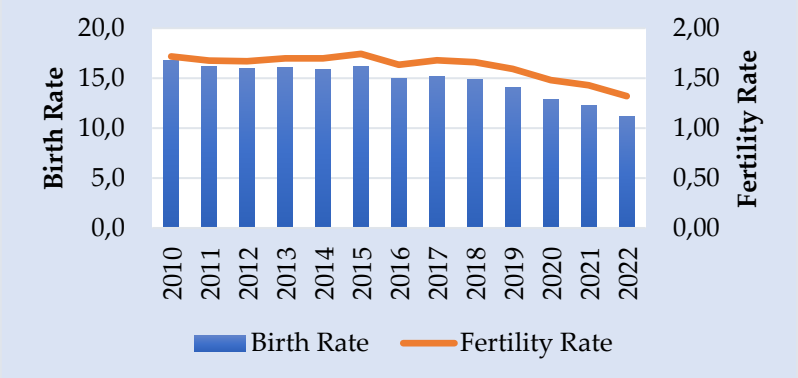
The birth rate in the DF presented stabilization above 16 from 2010 to 2015, from which there was a plateau of reduction between 2016 and 2019 and an even more drastic reduction between 2020 and 2022, coinciding with the period of the COVID-19 pandemic, where the birth rate for the first time was below 13. The fertility rate has been decreasing linearly, with a rate of 1.72 being observed in 2010, until it reaches 1.32 children per woman of childbearing age in 2022, a trend that implies a worsening of the demographic scenario, with all rates in the last decade below the desired population replacement rate of 2.1 children per woman, for an adequate demographic balance. The evolution and comparison of birth rates and fertility can be seen from *Table 2* and *Fig. 4*.

Table 2. Birth and fertility rates in the Federal District, 2010-2022.

Year	Live Births	Birth Rate	Fertility Rate
2010	44253	16,8	1,72
2011	43469	16,2	1,68
2012	43511	16,0	1,67
2013	44503	16,1	1,70
2014	44706	15,9	1,70
2015	46099	16,2	1,74
2016	43313	15,0	1,63
2017	44520	15,2	1,68
2018	44152	14,9	1,66
2019	42355	14,1	1,59
2020	39362	12,9	1,48
2021	38022	12,3	1,43
2022	35138	11,2	1,32

Source: GIASS /DIVEP/SVS and IBGE databases. Based on extraction date: 21st March 2023.

Figure 4. Birth x fertility rates in the Federal District, 2010-2022.



Source: GIASS /DIVEP/SVS and IBGE databases. Based on extraction date: 21st March 2023.

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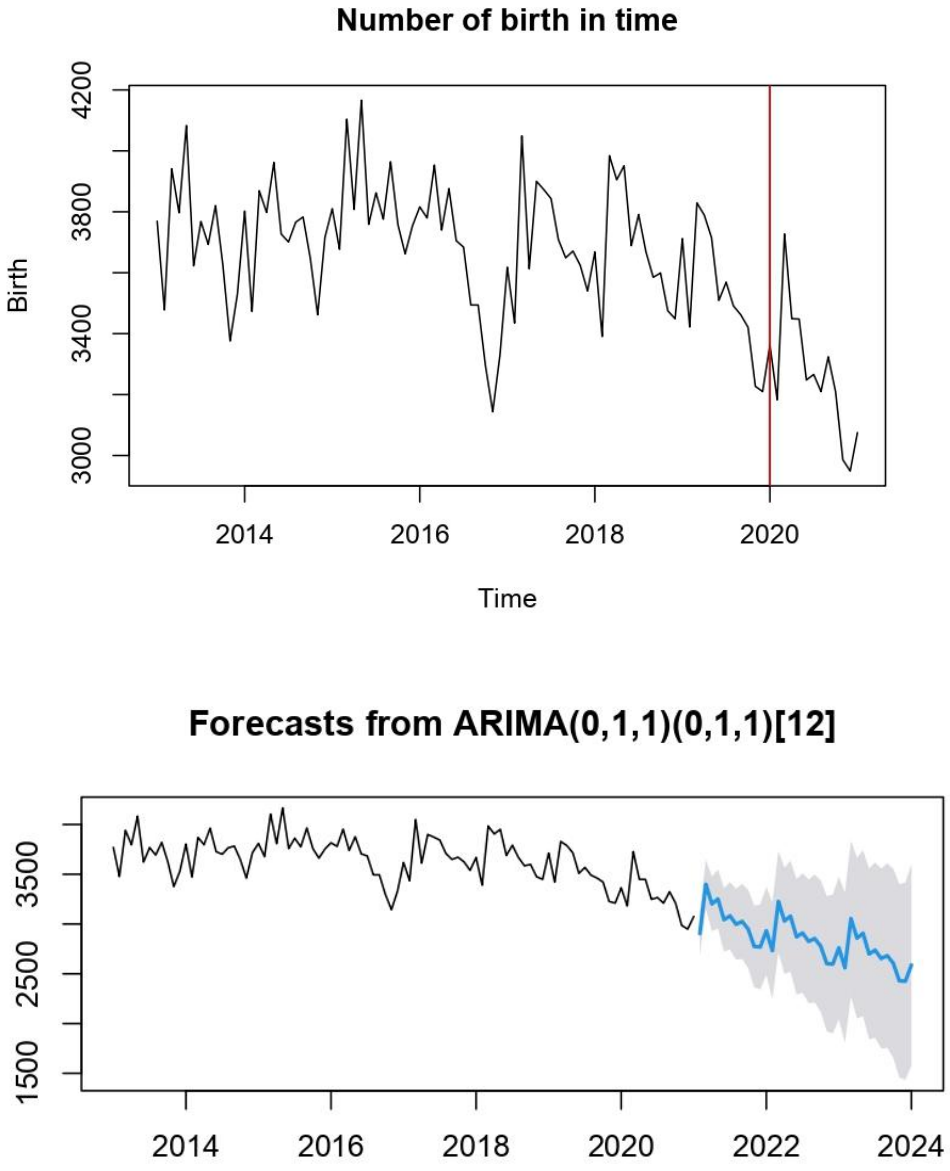
After reviewing the data to elucidate the declining trend in birth rates, a preliminary analysis based on interrupted time series (ITS) in Autoregressive Integrated Moving Average (ARIMA) methodology was included, considering 2020 as the milestone of the COVID-19 pandemic, whose preliminary results ((in the group without and with intervention the average was respectively 42269 and 43504 births per year, *p*=0.3 by Student's t-test)did not show a statistically significant drop in birth rates due to the pandemic or a significant change in the declining trend in forecasts up to 2024. These are summarized in *Fig. 5*.

Figure 5. Number of birth in time and forecasts from ARIMA up to 2024.



Source: Based on tabulations via R Software.

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DISCUSSION

A study conducted in 2011 on the birth profile in the DF based on the information system on live births (SINASC)(Motta, Lopes & Pereira, 2011) evidenced a crude birth rate in 2008 and the main characteristics captured were a reduction in birth rates, despite an increase in the local population in the period, a decrease in the proportion of adolescent mothers, reflected in the decrease in the specific fertility rate among adolescent mothers between 2000 and 2008 in the order of 38%.

It is noteworthy that the study considered birth data four years before the publication of the article. There is no mention of the reason for the delay in collection, but one hypothesis to be considered is the delay in consolidation of primary data in SINASC at the time, which delays the analytical power of population trends. Another data cited in the study is that 20% of births in the DF in 2008 were of women residing in other Brazilian states and who sought obstetric care in the federal capital, which leads to suspicion that the trend of birth reduction of autochthonous women is even more expressive.

Regarding the evaluation of the quality of the epidemiological and demographic variables of the Information System on Live Births, a former study already pointed out methodological limitations in capturing the results of births, especially in variables of completeness of filling out, situations that were pointed out in some Brazilian states, among them the DF(Romero & Cunha, 2007).

A recent government Report(Martins, 2022) whose specific chapter was dedicated to analyzing the impact of the COVID-19 pandemic on maternal deaths revealed that between 2010 and 2021 there were 216 maternal deaths in DF. A relevant point is that until 2020 the maternal mortality ratio had varied between 18.9% and 48.5%, but in 2021 the maternal mortality ratio increased to 94.8% (there were 36 maternal deaths per 100,000 live births).

The author identified that COVID-19 was responsible for 22 maternal deaths, with the occurrence of three deaths in 2020 and 19 in 2021, corresponding to 10.2% of all deaths in the period, being the most frequent specific cause and surpassing maternal deaths from obstetric causes. Such findings also accompanied the increase in mortality in women of childbearing age in the period, according to the study.

Although the maternal mortality in Brazil had always been in high levels, the maternal mortality in DF in 2021 exceeded the Brazilian goal of the Millennium Development Goals, whose maternal deaths should not exceed 35 for each 100,000 live births until 2015, that is, in the year 2021 there was failure to meet the UN goal, which had already been achieved

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until 2019 (8 maternal deaths) and 2020 (13 maternal deaths). However, despite the undeniable impact of the pandemic as a cause of increase in maternal deaths and women of childbearing age, such variables were not in themselves responsible for the birth rate reduction trend already underway in the Federal District, according to the data shown in *Fig. 5*.

From a demographic perspective, a study (Ullah et al., 2020) analyzed the trends in birth rates as a function of the recent epidemics of SARS in Hong Kong (2002), Zika virus in Brazil (2015) and Ebola in West Africa (2016) and observed that eight to 12 months after the respective epidemics there was a decline in the respective birth rates, which was followed by a noticeable upward trend in birth rates that lasted up to 20 months after the beginning of each of these epidemics. Finally, its authors narrate that the recovery of fertility would occur about a year and a half after the epidemic, either by the "replacement effect", usually to "replace" a stillborn child or a miscarriage experienced, or by the "accumulation effect", where the couple aims to expand their offspring. According to the results in DF birth rates expressed in *Tables 1* and *2*, this hypothesis seems to be refuted, at least in the reality of Brazilian Federal Capital, or maybe this demographic resumption needs more time of analysis to be noticed.

It is important to highlight that in demographic behavior of DF in the period of Zika virus epidemic, considering local birth rate, it is possible to observe that although Brazil has been more affected by Zika virus in Northeastern states of the country, the DF - located in center-western region of the country - did not present a considerable decrease in birth rate in 2015, but from 2016 on, followed by resumption of the historical series in the years 2017 and 2018, and subsequent new important decline in fertility between 2019 and 2020, period in which starts to prevail the pandemic scenario by COVID-19 and its hypothetical coassociation with decrease in fertility.

Such findings have echo in another study(Marteleto et al., 2022) that assessed birth trends covering the periods of the Zika epidemic and the COVID-19 pandemic in Brazil revealed a trend of stability in the general fertility rate in the pre-Zika period and no signs of a baby boom after the national Zika epidemic. Although the study analyzed the time series only until 2021, the authors comment that the impact of the COVID-19 pandemic was statistically insignificant on birth behavior in 13 Brazilian states studied, but unfortunately the Federal District was not among the states analyzed by the study.

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Report(Rocha et al., 2019)highlights that the local fertility rate has been falling and is currently insufficient to replace the local population and there will be a demographic decline in the coming decades if there are no migrations or birth incentives. In summary, even if the increase in birth rate in the post Zika virus epidemic period can be understood as a baby boom phenomenon, such phenomenon seems to be more expressive than the recent trend of insufficient demographic replacement in the context of the COVID-19 pandemic, at least regarding the federal capital.

In analyses on the impact of the pandemic on Brazilian demography, a decline in the life expectancy of Brazilians in 2019 and 2020 was observed, compared to levels 20 years ago in some states of the federation (*Table 2* and *Fig. 4*); however, the DF did not present a significant decline (Castro et al., 2021)Another relevant fact is that the monthly fall in birth rates in Brasília, around 10% in some months, follows the trend observed in high-income countries, which varied between 5.2% (Austria) and 11.2% (Spain and Portugal)(Aassve et al., 2021)

Few approaches have linked the outcome of lockdown in Brazil with vital statistics, and they have mostly done so with data aggregated at the federal level. Nevertheless, a multicentre study(Calvert et al., 2023) found consistent evidence of an increase in stillbirths in the months following lockdown in Brazil. For the calculation of stillbirths after lockdown, the study considered estimates from the Oxford Stringency Index and not the specific time frame of lockdown according to the respective decrees of the specific Brazilian city or state, as we have announced in the case of the DF in *Fig. 1*.

On the other hand, a scoping review on causes and surveillance of stillbirths in Brazil since 2010 did not capture the influence of the pandemic on the incidence of stillbirths, despite having analyzed up to the period 2020(Souza et al., 2023).

There are also Brazilian studies that analyzed some population behaviors throughout the pandemic and confinement measures, but they were carried out in other Brazilian cities, such as Araraquara(Aragão et al., 2023), Nova Friburgo(Faiões et al., 2022)and São Paulo (de Almeida et al., 2023).

Study (López-Gil, Tremblay & Brazo-Sayavera, 2021) reveals that adherence to healthy behaviors, especially physical activity during the pandemic was below the recommendations made for Spanish and Brazilian schoolchildren under confinement, if compared to the pre-pandemic scenario. Although the study did not analyze variables such as architectural conditions of the house of the research subjects, such as whether they had

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access to a backyard or lived in restricted flats, it is important to note that architectural dynamics may influence human behaviors during confinement, notably when this represents encouragement or discouragement to marital intimacy during the pandemic, despite its influence on reproductive decisions of the couple.

Another study (Micelli et al., 2020)analyzed 1482 Italian participants (944 men and 583 women) and found that 18% of the participants intended to have a child before the pandemic, a figure that dropped to 6.7% after the pandemic, basically motivated by fear of the consequences of pregnancy and by economic difficulties. In contrast, of the 1214 participants who did not intend to have children before the pandemic, 11.5% reconsidered their family planning, considering having children after the pandemic, basically motivated by more free time, greater interaction between the couple and the need for positivity in conjugal life.

By surveying women who correctly used “Tommy 's Planning for Pregnancy " tool, an application used by women who plan their pregnancies, the authors (Flynn et al., 2021)obtained 504 completed online questionnaires, which showed that 72% of them reported postponing a pregnancy due to the COVID-19 pandemic and 27% anticipated their pregnancy plans.

During the quarantine in Brazil changes in lifestyle habits were described in Brazilian adults, including a significant increase in the frequency of alcohol consumption, smoking, consumption of processed foods and fast food, increased sleep, and screen time. Conversely, reduced physical activity and fiber intake were observed (Souza et al., 2022).While the variables cited may influence fertility to some extent, a more rigorous analysis of whether such factors could have contributed to birth rates in the pandemic period would be required.

A study carried out in the DF in which the expectation of women waiting for assisted reproduction in a local public hospital was analyzed revealed that since the beginning of the implementation of the only public service for IVF in the DF it already presented difficulties in attending women with infertility, that 75% of the patients did not know how many people were waiting for the same treatment in that health unit and that there was no standard of information on the waiting time to start infertility treatment(Samrsla et al., 2007).

There is also an information gap on assisted reproduction in the Brazilian public system, pointed out in a recent Brazilian study that reviewed data from 2011 to 2021, where only three reports of approaches to assisted reproduction in Brazilian public hospitals were

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found. Among the reviewed articles, one descriptive article and another cross-sectional article were found that analyzed the profile of assisted people, and one report on the construction of a psychological protocol for care of people with infertility. The review echoes the various limitations of access to Brazilian public reproductive support services(Conceição et al., 2022).

Despite difficulties in providing infertility support services, affected in the context of the pandemic due to government recommendations, service restrictions or even discouragement of infertile couples from continuing treatment, it is advocated that the post-COVID-19 recovery scenario should include efforts to reform health systems in order to reduce underfunding of infertility services, as well as to reduce legal barriers to access(Affun-Adegbulu et al., 2020). However, and considering the incipient local data on infertility management services in the DF, it is early to establish that the postponement of fertility treatments has contributed to the reduction of birth rates in the DF in the conjuncture of the pandemic.

In an analysis (Trinchant et al., 2020)of the demographic conjuncture in the post-pandemic scenario, a great concern falls on Europe, the block that has the greatest challenge of increasing fertility in its countries, whose 66% of the countries already adopt governmental and social incentives to increase the birth rate, such as bonuses for babies, extended family leave, tax incentives and various labor flexibilities. Although the authors consider that there is no link between SARS CoV-2 infection and impediments to reproductive potential, they draw attention to short- and medium-term increases in global infertility.

Lockdowns may be associated with increased fertility as couples decide to increase sexual activity during confinement. On the other hand, fertility may decrease basically if there are economic uncertainties that lead couples to prevent pregnancies or decide to delay cohabitation or marriage. Prosperity and greater planning capacity in positive scenarios, on the other hand, tend to increase fertility(Berger et al., 2021)

Until March 2021, nine months after confinement, 11 out of 14 European countries experienced a decline in birth rates, ranging from -0.5% to -11.4%, with the sharpest decline occurring in eight European countries with the highest degree of excess mortality(De Geyter, Masciocchi & Gobrecht-Keller, 2022).

Another study (Pomar et al., 2022)that assessed impacts of the first wave of the pandemic in 24 European countries observed a 14.1% drop in birth rates usually occurring

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9-10 months after the critical moment of the pandemic, compared to the periods of 2018 and 2019. The findings of this study based on a block of European countries are very close to the results observed in the DF, including in the order of a 14% birth rate reduction, based on the results in *Table 2*.

The preliminary analysis to elucidate the trend of falling birth rate in DF according to Interrupted Time Series (ITS) applied in the Autoregressive Integrated Moving Average (ARIMA) methodology (*Fig. 5*), was that the perception of a pre-existing trend of falling birth rate in DF prevailed, as observed in other international realities.

CONCLUSIONS

It is notorious the trend of reduction of birth and fertility in the DF, already well established in the pre-pandemic period, which refutes the hypothesis of a local baby boom, at least for the first three years of the pandemic. The own scenario caused by Zika virus epidemic in the recent past in Brazil, seems not to have contributed in a significant way to modify the trend of birth and fertility reduction especially in the DF, particularly because the state has not been affected as much as the Brazilian Northeastern states, and also because of the sustained trend of local birth and fertility decrease along the last decade and that seems to continue in the post pandemic COVID-19 period.

Although the effects of birth and fertility impact the first two years of the pandemic, which may represent an analytical limitation for population-based inferences, the finding of the present study based on Interrupted Time Series applied in the ARIMA methodology was that the perception of a pre-existing trend of falling birth rate in DF prevailed, as observed in other international realities.

It is important to emphasize that the limitations of this study in inferring birth and fertility trends are related to a delay in registration in the information systems of live births in Brazil, especially in the notifications of birth records by subnational entities, as is the case of the Federal District. Late consolidations of birth records in government systems, depending on the magnitude of the data, may constitute analytical limitations.

Outcomes observed in the COVID-19 pandemic such as increased maternal mortality and mortality of women of childbearing age, although worrying, do not seem to be explanatory variables for the falling birth rate in DF. It may also be precipitate to state that the declining birth rate trend in the DF is explained by the impact of infertility, especially given the lack of knowledge on local incidence of infertility among women and couples and

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success rates in respective treatments. The literature has been pointing out that reproductive concerns experienced by couples in relation to the uncertainties caused by the pandemic, especially in decisions to postpone pregnancies, seem to be the most relevant elements for the analysis of post-pandemic scenarios.

The main findings of the study, with fertility rates sustainably below the population replacement rate, including a fertility rate of 1.32 in 2022, and with no clear connection with the lockdown that occurred in DF, indicate an inevitable scenario of population aging in the coming decades and stimulate new longitudinal analyses to observe the demographic behavior in DF after the most forceful years of the COVID-19 pandemic.

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