



Crisis sanitaria, política y socioeconómica en América Latina y el Caribe: contribución de los estudios de población

Valparaíso (Chile), entre el 06 y el 09 de diciembre de 2022



MEDIATION EFFECT OF THE COVID-19 PANDEMIC ON ¹THE SUBNATIONAL FERTILITY IN COLOMBIA

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1. Introduction

Whitin the literature on the COVID-19 pandemic and its relationship to fertility, some researchers point at the economic contraction, isolations, limited access to health services, an increase on COVID-19 cases, and the uncertainty produced by all these elements, as the causing factors of the change in fertility rates (Emery & Koops, 2022; Berrington and others, 2021; Ullah and others, 2020). In Colombia, the births rate of the first bimester of 2021 averaged 10.7% less than the same period of 2020. Nevertheless, the causing factors remain unknown. Consequently, the purpose of this study is to analyze the effects of the Covid-19 pandemic on the reduction of fertility rates in the short term at subnational or Department level (departments are the Colombian states or provinces) during the first bimester of 2021 for two groups of women: with and without a partner. Women with partner are those who were cohabitating with their partner or that were married, while women without a partner are those who were single, divorced or widowed. For simplicity, we call the first group '*married women*' and the second group '*single women*'. Internationally, we have observed a change in fertility plans of couples in Europe, where many opted for postponing or canceling all chances of bearing children (Luppi, Arpino, & Rossina, 2020). The USA also reported a significant drop in fertility rates which was possible to foresee in different ways; some authors even employed Google's data to observe keywords related to pregnancy and predicted a drop in fertility rates by 15.2% on February 2021, which extended until August (Wilde, Chen, & Lohmann, 2020). Other studies show the reduction in pregnancy rates is produced by the reduction of social mobility (Cohen, 2021). Besides, it is possible to infere that social isolation interrupted the normal process of social interaction for people to find a partner and stablish new relationships.

Studies in the Asia-Pacific region anticipate that the impacts of the pandemic on fertility will be inconsistent among countries and inside of each country. In low and middle-income settings where the restrictions in offer and demand hamper the access to family planning services, it is expected a rise in unwanted pregnancies between 2020 and 2021. However, COVID-19 might have an impact on the reduction of fertility rates (RFR), at least in the short term in places where women have more effective control on their fertility as a response to economic uncertainty and recession, as well as an increase in the number of unpaid work at home. At the country level, such impact lies in the cultural and political-institutional dominating environment; meanwhile, inside each country, probably, vulnerable groups like the poor, the marginalized, informal workers, and migrants will be the ones who will deal with stronger limitations to exercise control on their fertility (UNFPA, 2020).

Other authors believe that low birth rates are a temporal effect, and that it differentially affects countries depending on the levels of income, education, and economic conditions; however, they affirm that birth rates will turn back to their normal trends (Ullah, y otros, 2020; Aassve, Cavalli, Mencarini, Plach & Livi-Bacci, 2020).

As we have seen, the world health crisis caused by the pandemic obliged governments to implement containment measures to stop the spread of the virus. In Colombia, such measures included restrictions of mobility and massive closure of business establishments, among others. The first obligatory isolation took place on March 24th, 2020. The mandatory isolation measures ordered people to remain permanently on their dwellings and restrained them to go outside only when strictly necessary and for specific activities such as acquiring essential goods, receiving medical attention, or working in person at essential industries or services. This measure was implemented with those conditions until August 25st, 2020. On this date, economic activities that did not required massive social gathering reopened to the public.

Specifically on the healthcare sector, medical appointments classified as non-vital were suspended, which means that health services were provided with some constraints, including prenatal care for pregnant women. This was decided in order to avoid overcrowding and consequently avoid the spread of the virus. In addition, the level of occupation in Intensive Care Units (ICU) varied between 90% and 100% during the virus infection peaks. The collapse of the healthcare system produced additional consequences to the sexual and reproductive health of women and in access to contraceptive methods, UNFPA (2022) found a percentual decrease of 28% in reported care for women for all available contraceptive services between 2019 and 2020. Mobility restrictions also included the closure of business establishments, restaurants, hotels, and places of social gathering.

Among the consequences of such measures there's the reduction of social interaction between already existing couples that don't cohabit and a decrease in the probability of single people meeting a new partner. A similar outcome reported was the *feeling of loneliness* that is inquired for in the Social Pulse Survey of the National Statistical Office of Colombia -DANE-, with a peak of 13.6% of people who expressed to experience such feeling during July 2020 (DANE, 2020). Moreover, the economic contraction also translated in job losses and involuntary unemployment. For the 23 main cities in Colombia, unemployment ranged from 2% to 9.4% for men, and from 13% to 28.6% for women (DANE, 2022). All the above conditions also echoed in the mental health of the Colombian population, as 38% of households reported symptoms related to impaired mental health, and this situation aggravated in households headed by single mothers and in one-person homes (DNP, 2021). Women in Colombia presented high levels of worry and

nervousness when considering the future and weariness due to the increment of charges and responsibilities at home (DANE 2021). Such uncertainty, worryness and sadness may have affected future decisions regarding reproduction.

From the above, we identified four mediating factors in which COVID-19 may have impacted subnational fertility rates during the first 2021 bimester:

- i. A direct effect caused by the mandatory isolation restriction.
- ii. Constraints to access healthcare and contraceptive services.
- iii. Reduction in mobility and social interaction through the closure of business establishments, restaurants, hotels, etc.
- iv. Economic downturn and unemployment.

After controlling by the restriction in healthcare services, establishments that allow social interaction, and unemployment, we identify the direct effect as the mandatory isolation, which made cohabitating couples spend more time together and avoided single people interact with each other. For the first group, we expected an increase in GFR, and for the last, a decrease. We could not control by the access to contraceptive methods, which probably was reduced during the pandemic, reinforcing the increase of the subnational GFR for married or cohabitating women, who were permanently with their partners during the isolation.

A mediating analysis was carried out aiming at unbundling the total effect of the pandemic on fertility rates with the factors mentioned previously, employing panel data at subnational (department) level from 2014 to 2021. This strategy was selected since it allows the comparison of the years 2020 and 2021 with previous years.

The core conclusions are: 1) the reduction in the the number of births for the first bimester between 2020 and 2021 was 26.3% for single women and 7.3% for married or cohabitating women. 2) The circumstances lived in 2020 affected the first bimester subnational (departmental) GFR of married women via two mediators: the closure of commercial establishments, that allowed social interactions, and unemployment. 3) Finally, for single women's first bimester subnational GFR, no mediation effect is statistically significant, which suggests that it was affected by the mandatory isolation exclusively.

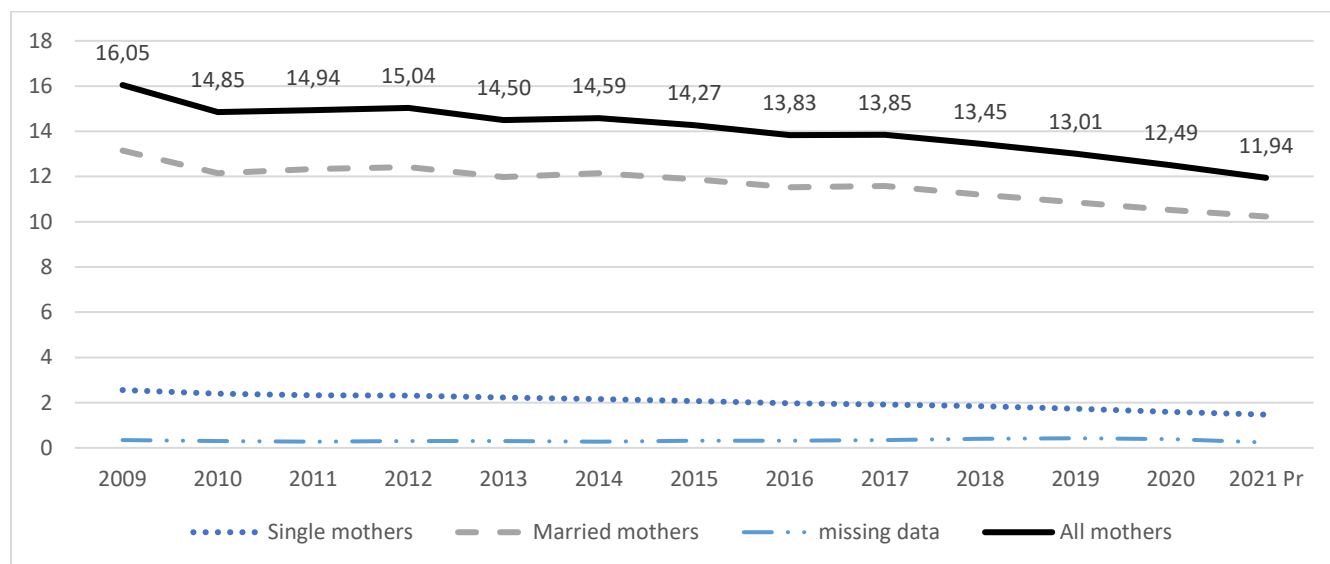
The document is divided into six sections: the first section is the introduction; the second section describes in detail the Colombian context of the year 2020, considering pandemic associated factors that affected the reduction of subnational fertility rates according to literature. The third section displays the information and data employed in the model proposed; then, the fourth section explains the mediation

analysis and its implementation. Later, the fifth section shows the results of the mediation analysis, and finally, the sixth section presents the conclusions of the study.

2. CONTEXT OF COLOMBIA IN TIMES OF COVID-19 IN 2020 AND ITS EFFECTS ON CHILDBIRTHS IN 2021

Colombia has experienced a sustained reduction on fertility in the last decades. The Gross Birth Rate (GBR), calculated from vital statistics and the 2020 backward population projections, shows a decrease in the number of births from 14.3 for every 1000 habitants in 2015 to 12.5 births for every 1000 habitants by 2020, and the beginning of 2021. Figure 1 shows that the contribution on the GBR of the year 2020 for married women or cohabitating with a partner is 84.15% and for single women (who live without a partner) is 12.8%, on the non-informed it contributes 3.1%.

FIGURE 1. Gross Birth Rate (GBR) 2009-2021 pr²



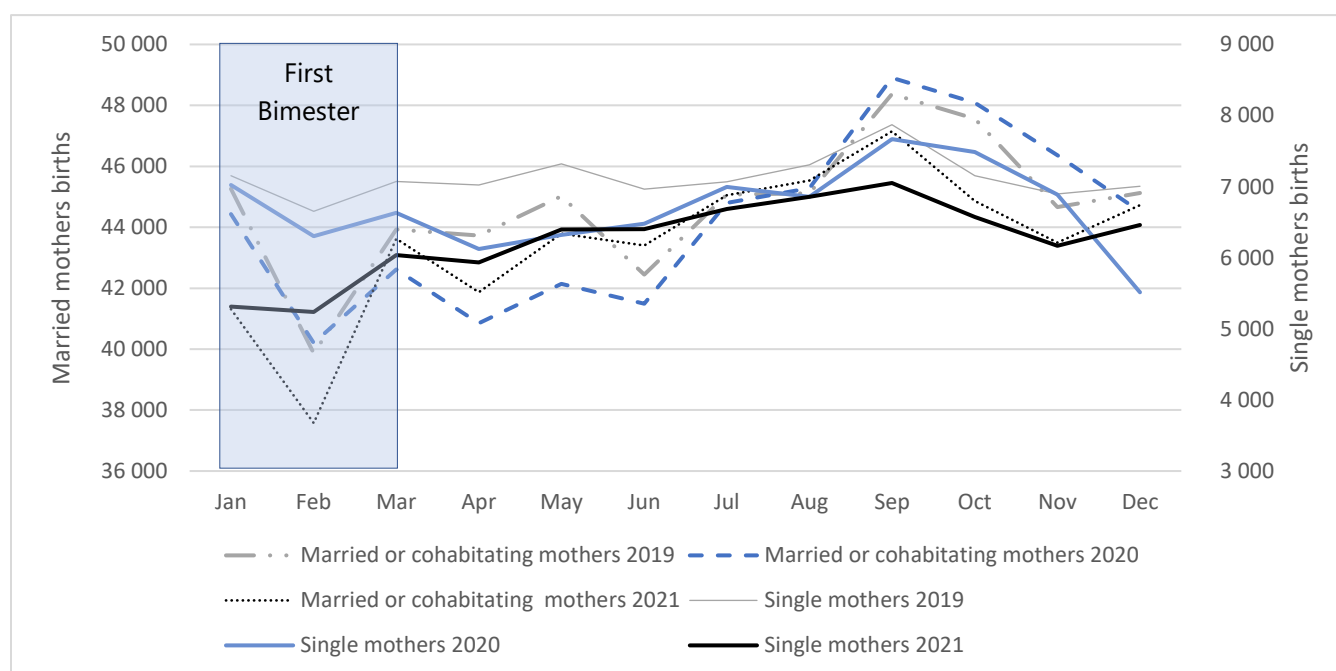
Source: Authors' estimation using Vital Statistics 2009-2021 and 2020 backward population projections.
 Note: GBR= total births over the total population multiplied by 1000.

Figure 2 shows the effect of the year 2020 on the births of 2021, in Colombia. Considering that the pandemic outbreak takes place in March 2020, such effects are seen approximately nine months after the event. Even though childbirths show a seasonal behavior, the pattern in the series of December 2020 showed a contraction of 6.54% compared to November 2020. This variation is unusual when comparing the same months with the previous two years, which shows a variation from 0.50% for 2019 and 2021.

² The figures for 2021 are preliminary (pr), that is, a percentage of data is recovered throughout the year 2022 from remote regions of the country.

The number of births of the first bimester of 2021 is 10.7% lower than the number of births reported on the same period of 2020, see Figure 2. In particular, the decrease for the same bimester of 2020 compared to 2019 was 1.6%, while the variation between 2019 and 2018 was 1.4%. For single women (not cohabitating with a partner) the reduction in the number of births in the first bimester of 2021 in comparison to 2020 was 26.3%, and for women that were married or cohabitating with a partner it was 7.3% between 2020 and 2021.

FIGURE 2. Monthly births in Colombia from 2019 to 2021



Source: Authors' estimation using Vital Statistics 2019-2021.

a) Effects of the number of positive cases of COVID 19 and deaths in women of childbearing age

In 2020, there were 1,642,802 positive cases of COVID-19 in Colombia, while in 2021 there were 3,514,639. From the cases of 2020, 33,35% corresponded to women of childbearing age, between 15 and 49 years (Women of Childbearing Age - WCA). In 2021 the same proportion was of 34,77%. In 2020, 4 out of 100 WCA registered a positive COVID-19 test; by 2021, the prevalence rate increased to 9 out of 100 WCA having a positive COVID-19 test. The mortality classified under this cause was estimated at 9,85 out of 100,000 WCA in 2020 and 30.12 out of 100,000 WCA in 2021. Regarding pregnant women,

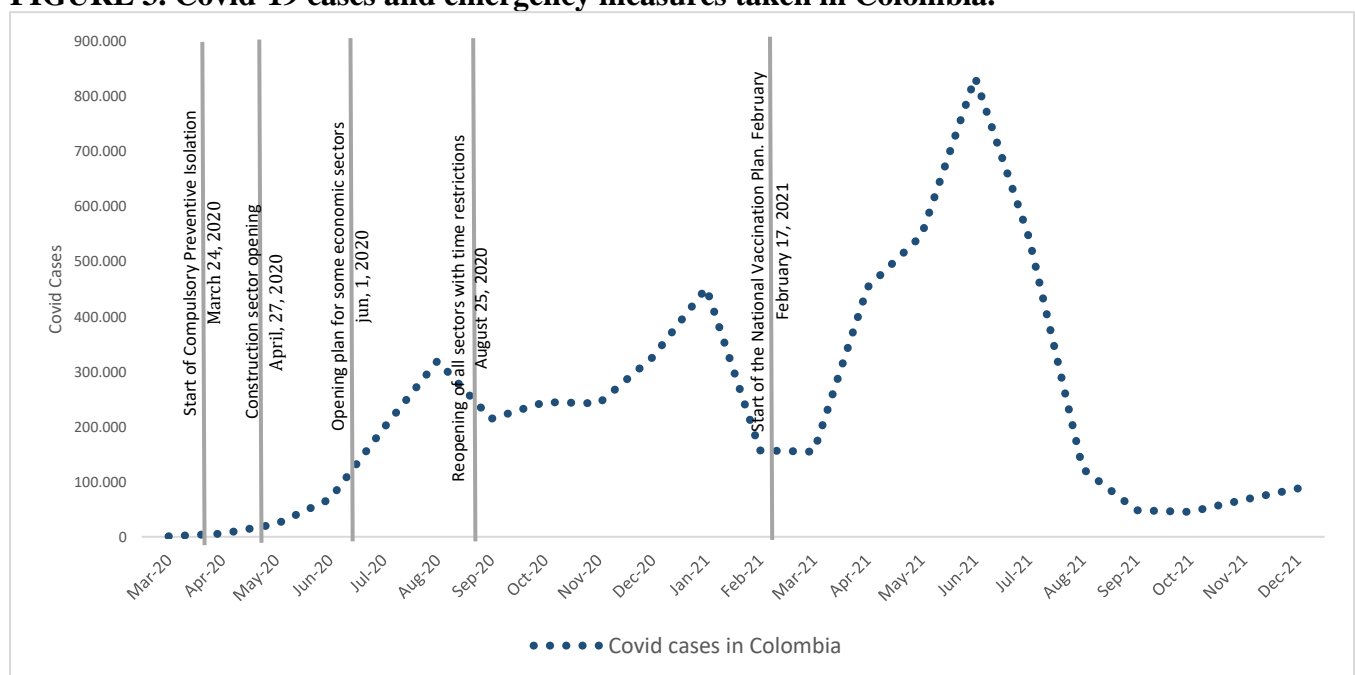
the Institute for National Health identified 20,902 cases with positive COVID-19 tests in pregnant women at the national level until February 2022, resulting in 232 deaths.

a) Compulsory isolation

In Colombia, mandatory isolation was a preventive measure against the spread of the Sars-Cov-2 virus. On March 24, 2020, through the National Decree 456, the mobility of the population was restricted throughout the country with some exceptions in care services such as health. People were confined and only one person from each household was authorized to go out in order purchase consumer goods or carry out essential activities. This measure was the strictest in the entire quarantine period and was extended until April 27, 2020. As of April 27, a first opening is made for certain economic sectors such as construction and public transportation with a maximum capacity occupancy limit of 35%.

Figure 3 shows the timeline of the isolation measures adopted in Colombia and the evolution of the number of COVID 19 cases. It is observed that the most restrictive measures were not imposed at the peaks of the pandemic. The restrictions were mainly associated with the measures adopted in other countries and that were replicated in Colombia. However, factors such as uncertainty, overinformation and isolation, might have generated changes in births. Our hypothesis is that the most restrictive measures at the end of March, April and May 2020 changed the birth trends for the months of December 2020, January 2021, and February 2021 for both married and single women, as seen in Figure 2.

FIGURE 3. Covid-19 cases and emergency measures taken in Colombia.



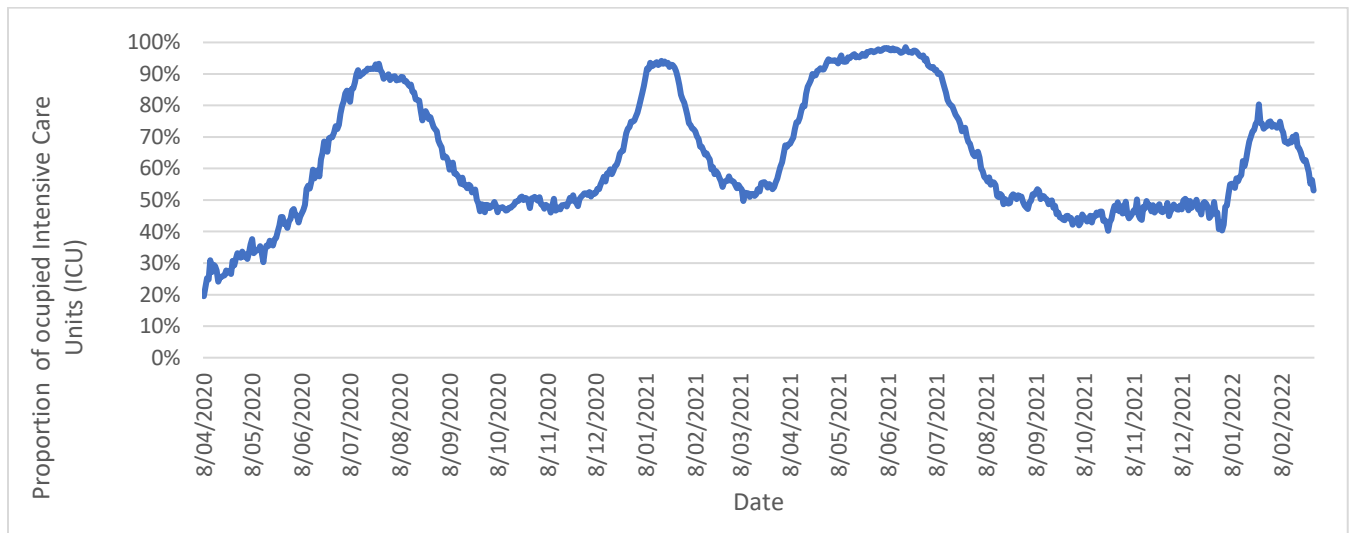
Source: Authors' estimation using covid cases report of Institute for National Health

The opening of the different economic sectors gradually took place. On June 1, 2020, economic activities began reopening, however, social activities (restaurants, bars, cinemas, theaters, sports practice, religious services, among others) remained totally restricted. Social interactions continued to be restricted and only same household members could interact freely. Subsequently, on August 25th, 2020 selective isolation took place instead of mandatory isolation, and only people with symptoms were isolated. This allowed people returning to some leisure activities that didn't require or risked crowds, with time and occupancy capacity limits. In 2021, the National Vaccination Plan began and the attendance to massive events started to be allowed on the condition of having a vaccination certificate, relaxing the restrictive measures for the entire population.

b) Effects of the access to public health services

In most countries healthcare services collapsed during the pandemic. According to the Ministry of Health of Colombia (2021), there were 5,346 Intensive Care Units (ICUs) in the country before the pandemic. This figure increased during the pandemic, and there were 11.349 ICUs by January of 2022. Nevertheless, Bogotá reached 95% of ICU occupancy by July 2020, as well as on January, May, June, and July of 2021, as seen in Figure 4 (Secretariat of Health of Bogota, 2022).

FIGURE 4. ICU Occupancy in Bogota from 2020 to 2022.

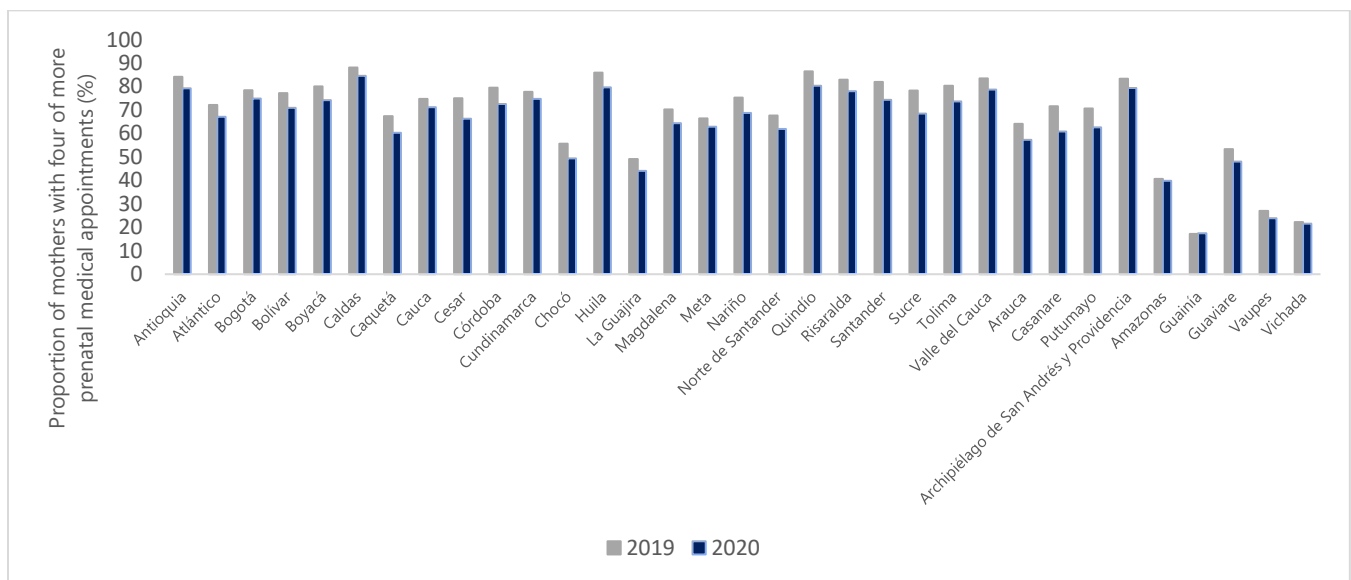


Source: Author's estimation using information from the Secretariat of Health of Bogota 2022

c) Effects of prenatal appointments constrictions

Prenatal appointments are fundamental to opportunistically diagnose and treat disorders like hypertension and sepsis during pregnancy, which are the leading causes of maternal mortality (Pasmíño de Osorio and Guzmán-Gómez 2009; Gálvez-Vengoechea and others 2009; Flores Ceccon and others 2020). As indicated before, during 2020 healthcare services were focused on caring for patients infected by COVID-19, and those medical appointments tagged as non-vital were postponed or attended remotely. In addition, the fear of infection when attending public health facilities, like hospitals and clinics, reduced the number of mothers attending four or more prenatal consultations. Figure 5 shows that for all the departments in 2020, excepting Guanía, this percentage was lower than in 2019, such reduction varied between 3 and 11 p.p.

FIGURE 5. Comparison of percentage of mothers with four or more prenatal consultations between 2019 and 2020.



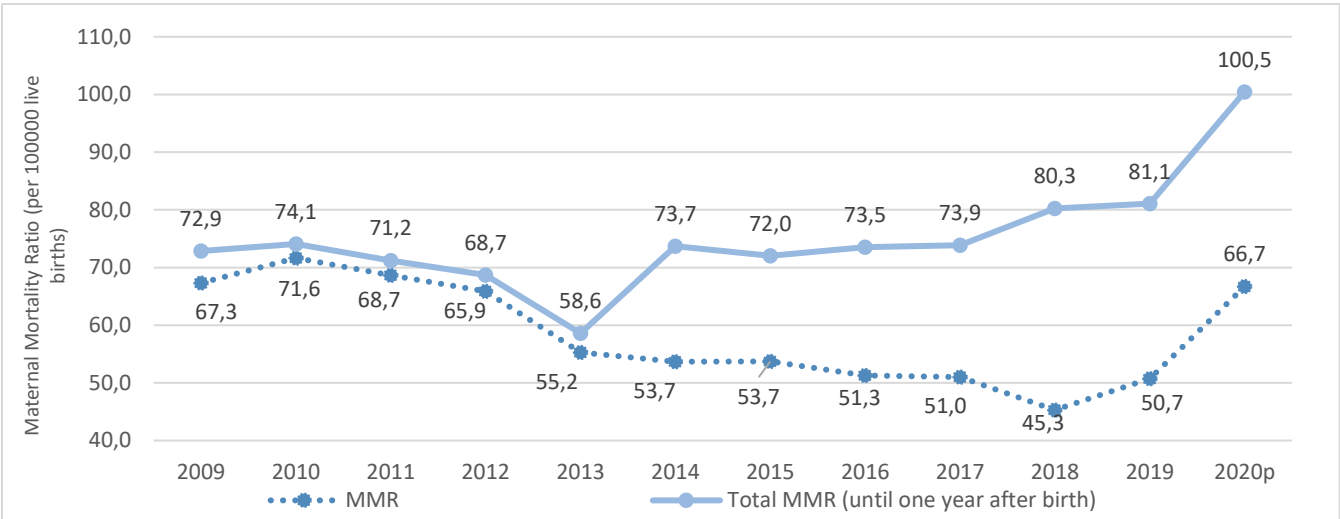
Source: Authors' estimation using Vital Statistics 2019 and 2020.

d) Effects of maternal mortality

The Maternal Mortality Ratio (MMR) measures the number of maternal deaths per 100,000 live births that took place during pregnancy, childbirth, or puerperium (during the first 42 days after childbirth), whose causes are associated with or aggravated by the pregnancy conditions or its care. According to Figure 5, between 2009 and 2020, the MMR in Colombia oscillated between 45.3 and 67.3 maternal deaths per 100,000 live births. Its behavior seems stable between 2013 and 2019, reaching 50,7 maternal deaths per 100,000 births alive in 2019.

The Total MMR also includes maternal deaths that occurred up to one year after childbirth. This indicator also displays a sustained growth from 2015 to 2019, moving from 72 to 81.1 in that period. This is the result of active research performed by DANE to improve coverage and avoid masking this phenomenon. A noticeable increase in the maternal mortality indicators is observed during 2020. The pandemic of COVID-19 worsens the situation of maternal mortality worldwide, and Colombia was not an exception. The boost of MMR compared to the previous year is close to 31%, and 24% for the Total MMR. As indicated, the healthcare system collapse produced by the pandemic reduced the attention of prenatal care, which could be one of the central causes of the increase in MMR.

FIGURE 6. Maternal Mortality Rate in Colombia, 2009-2020



Note: total MD = number of maternal deaths occurred during pregnancy, childbirth, or a year after the childbirth. MD pregnancy, childbirth and puerperium = number of maternal deaths during pregnancy, childbirth, or 42 days after the childbirth.

Source: Authors' estimation using Vital Statistics from 2009 to 2020p* (*preliminar estimates).

e) Effects of the closure of business establishments, tourism, and transportation

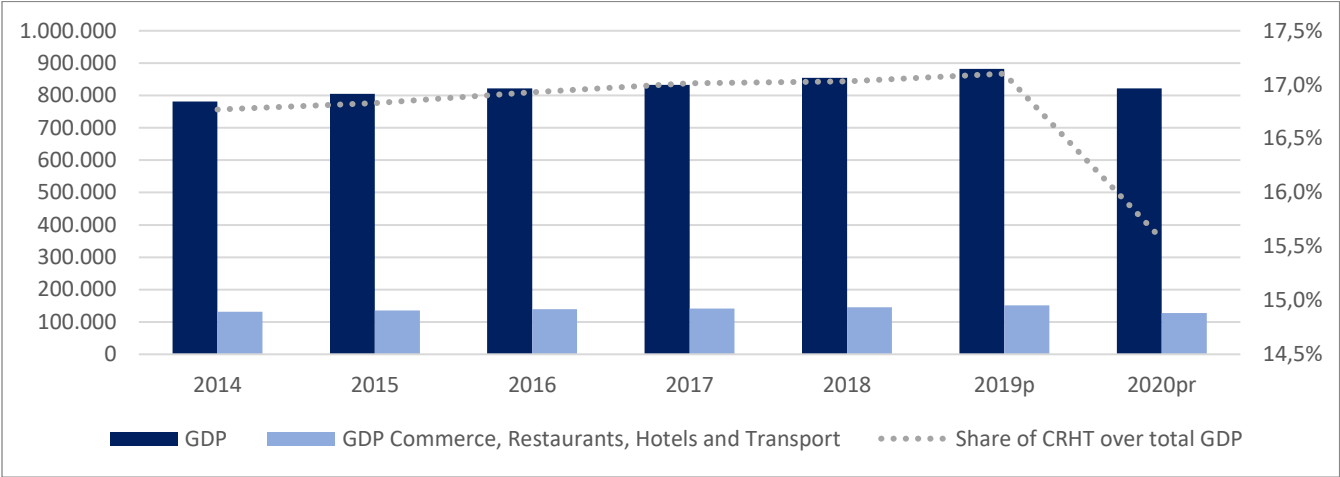
The compulsory isolation and the closure of business establishments and recreation spaces reduced the chances for social interaction. Therefore, processes of conformation of new couples and the interactions of those in existing relationships were interrupted, which affected the number of births.

The closure of commerce and businesses establishments started in the middle of March 2020. By September of the same year, some establishments like restaurants, bars, nightclubs, and activities involving the gathering of people were allowed to open with maximum capacity occupancy limits. Figure 6 shows the GDP associated with commerce (including restaurants, bars, and discotheques),

transportation, and tourism as proportion of the general GDP, as well as the values in billions of 2015 Colombian Pesos (COP).

A relevant drop is also observed in the GDP and the activity. Between 2019 and 2020, the GDP dropped 6.79%, while for commerce, restaurants, hotels, and transportation was the drop was of 15.16%. Meanwhile, the participation of this economic activity in the GDP moved from 17.1% to 15.6%, which is a reduction of 1.5 p.p.

FIGURE 7. Proportion of the activity of commerce, restaurants, hotels and transport over the total GDP. 2014-2020 pr



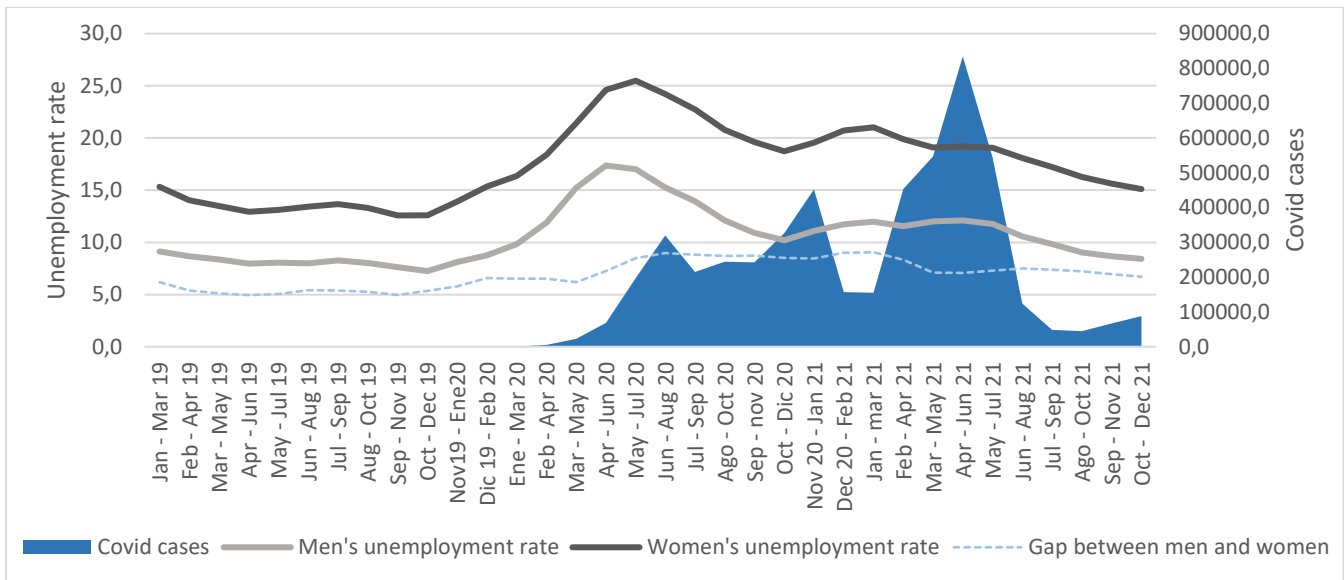
Source: Authors’ estimation using GDP estimations by department, DANE 2021. Retropolated series – Base 2015

f) Unemployment

As noted in the previous section, the GDP in Colombia dropped by 6.79% between 2019 and 2020. This affected households, especially through job stability. Unemployment rates in the trimester of May – July of the 23 main cities in Colombia went from 10.6% in 2019 to 22% in 2020 for men, and from 11.8% to 28.7% for women (DANE, 2022).

In Colombia, women’s unemployment rate went up by 4.3 p.p. on the February - April trimester of 2020 compared to the same period in 2019. National unemployment rate of women peaks reached 25.5% during May – July 2020 (see Figure 8). Although unemployment rates affected both men and women, the gender gap increased from 5.4 p.p. from October to December 2019 to 6.7 p.p. on the same period of 2021. In the most critical moments of the economic crisis, between June and August of 2020 and December 2020 to February 2021, the gender gap of unemployment peaked at 9.0 p.p.

FIGURE 8. National unemployment rates by sex, moving quarters 2019, 2020 and 2021



Source: Authors' estimation using labor market reports – DANE 2022

The labor component may be linked in two ways to the changes in the number of births. On the one hand, economic constraints at home may influence the decisions to postpone fertility to times of better economic climate. On the other hand, the availability of time, according to some authors, generates better conditions for childcare, which is an activity that is taken care of primarily by women (Baizán, Bruno, & Carlos, 2016). Job loss was found mainly in vulnerable households where informal employment prevails. The differentiated effects of closures by sectors of the economy made workers with higher education have an advantaged position to face the negative impact of the economic crisis caused by the pandemic (DNP, 2021).

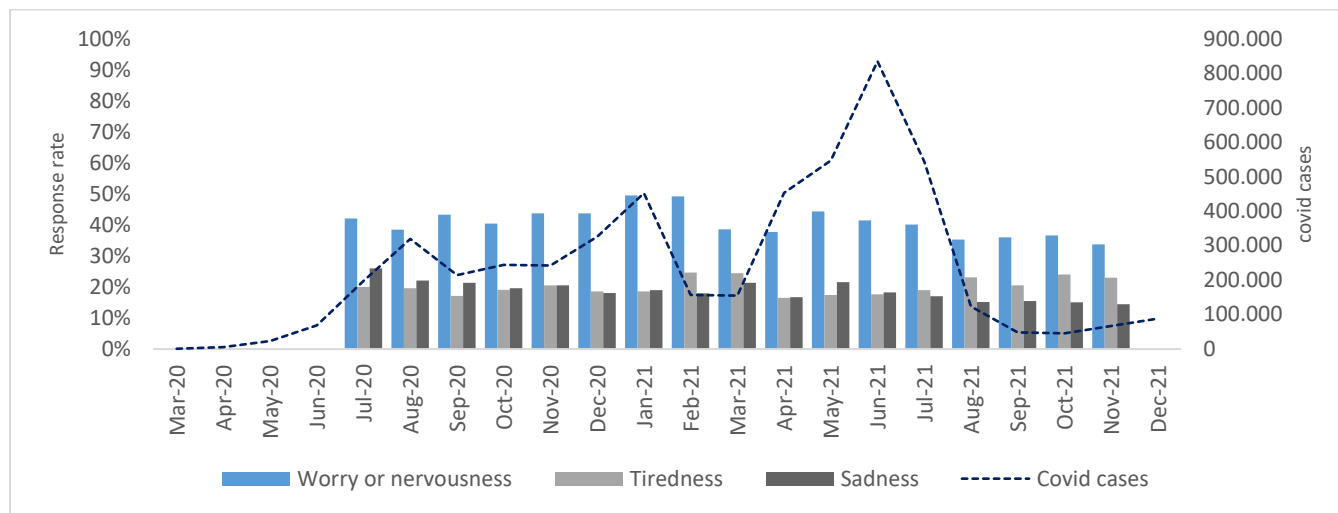
The isolations and unemployment also increased the number of hours women dedicated to unpaid labor, given that women would spend 7 hours and 22 minutes daily on unpaid labor between May and December of 2020, which drastically decreased to 3 hours daily on the same period of 2021. This demonstrates that domestic workload and non remunerated care at home fell on women in times of the pandemic.

g) Effects on levels of concern and uncertainty

Uncertainty about the future is one factors that generates increases negative emotions in the population, mainly in women. According to Thibaut and Wingarden (2020), COVID-19 has a deeper effect on the mental health of women than on men. According to the Survey of Social Pulse (EPS) by 2020 and 2021, women in Colombia experienced worry and nervousness (See Figure 9). On average, 40.8% of women went through situations like these caused by the pandemic, showing peaks in January (49.52%) and February (49.15%) 2021.

Emotional changes in the population were related to the temporary distribution of reports of cases of COVID-19 in three relevant peaks of the pandemic, between 2020 and 2021, with the respective relaxation valleys (Figure 10). Different measures of public policy were administered during these periods, including selective and generalized preventive isolations, restrictions, and the establishment of protocols for social and economic activities that involved gathering groups of people.

FIGURE 9. Main emotions experienced by women during the pandemic



Source: own elaboration from the database on INS and the result of the Monthly Survey of Social Pulse (EPS)-DANE Jul 2020 – Nov 2021

Other pandemic-related emotions were fatigue and sadness. For women in Colombia, fatigue oscillated 16.1% in April 2021 to a peak of 24.7% in February of the same year. As for sadness, women reported high levels of this feeling with a peak of 26% at the beginning of the pandemic in July 2020 and a minimum of 14.5% in November 2021.

3. Data

The leading input of the study was the series of births of Vital Statistics reported by DANE in the period between 2014 to 2021 at the departamental level. Births of the first bimester on year t , and women of reproductive age (between 15 and 49 years old) in t are used to estimate first bimester General Fertility Rate (GFR). The information of the first bimester is used since the births of January and February 2021 are the most affected by the pandemic.

Some independent variables are also estimated with Vital Statistics from 2014 to 2020, like early maternal deaths and the number of prenatal appointments (DANE, 2022). On the other hand, the following economic variables are used by department and year: women unemployment rate, total GDP, and GDP from commerce, restaurants, hotels, and transport for the same period (DANE, 2022). DANE only

estimates unemployment rates in the 23 main cities of Colombia (large department capitals). Thus, this indicator was used as a proxy variable for departmental unemployment rates (DANE 2022). Consequently, the estimations including this rate only have 23 observations per year.

4. Method

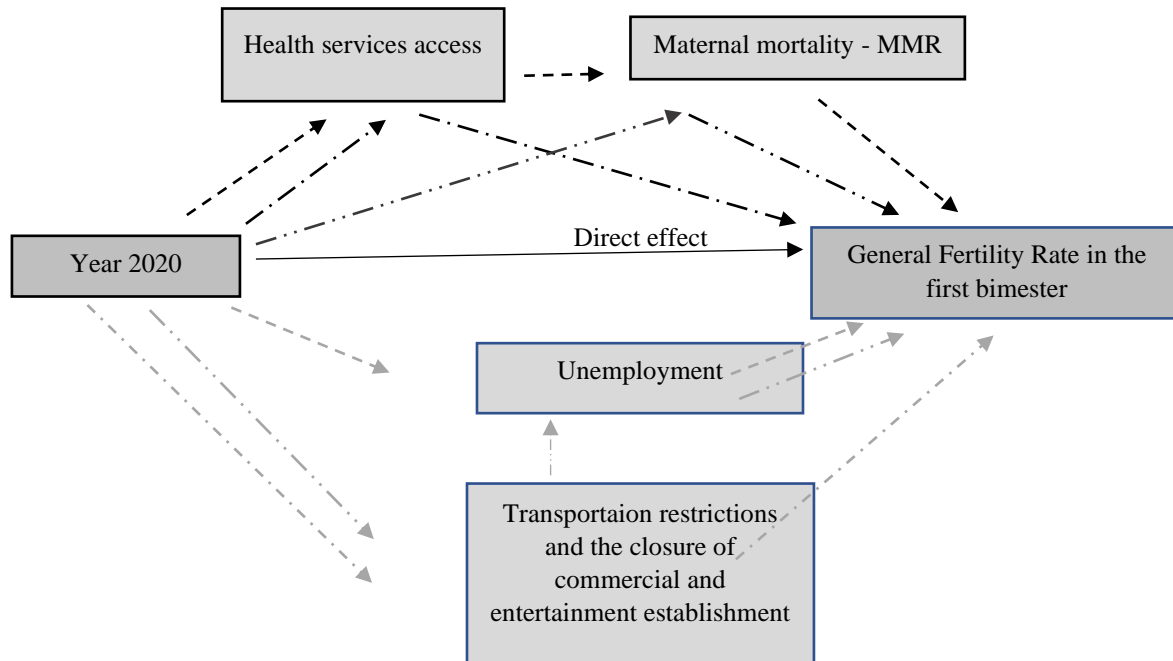
We are interested in knowing the extent to which the COVID-19 pandemic that occurred in 2020 affected department fertility rates through its impact on: 1. Transport restrictions and closure of commercial and entertainment establishments, 2. Healthcare access, and 3. Unemployment. To identify these causal mechanisms, we apply mediation models on a department-year panel data from 2014 to 2021, that contains characteristics of married and single women at department level.³ We use panel data because it allows us to compare 2020 to other years that did not have the particularities experienced in this year. Figure 10 presents the mediation model and the different trajectories that 2020 could use to affect first bimester department GFR.

Therefore, the year 2020 is the “treatment” (T), there are several “mediators” (M), which were mentioned before, and GFR in January and February of the next year (GFR) is the “final outcome” (Y). This means that T and M are measured in $t-1$ and Y in t . For instance, if Y is observed in 2021, T and M are measured in 2020. The reason for T and M being measured in $t-1$ is that the effects of an event, like the 2020 Coronavirus Pandemic, is observed in the number of births 9 months after.

After controlling by the restriction in healthcare services, spaces for social interaction and unemployment, we identify the direct effect as the compulsory isolation, which made couples spend more time together and avoided single people interact with each other. Therefore, compulsory isolation could affect the department GFRs of married and single women in opposite directions. For the first group, we expected an increase in GFR, and for the last, a decrease. We could not control by the access to contraceptive methods since there is not yearly data available about this topic, in consequence the effect could not be isolated. In this sense, the restriction of access contraceptive methods could have reinforced the increase of the departmental GFR particularly for married women, who were spending more time with their partners. The model described before is illustrated in Figure 10.

FIGURE 10. Mediation model: year 2020 – General Fertility Rate in the first semester

³ We use the series of births from 2014, because from that year there was an important improvement in the quality of the Vital Statistics due to the implementation of the Single Registry of Affiliates -RUAF



- Direct effect of compulsory isolation
- Indirect effect of 2020 via Health Services and MMR
- · · · → Indirect effect of 2020 via Health Services
- - - - → Indirect effect of 2020 via Maternal Mortality
- · · · → Indirect effect of 2020 via Mobility restrictions and the closure of commercial and entertainment establishments
- - - - → Indirect effect of 2020 via Unemployment
- · · · → Indirect effect of 2020 via Mobility restrictions and the closure of commercial and entertainment establishments and Unemployment

As every mediation model the total effect of T on Y could be expressed as the sum of an indirect outcomes, that considers the chain $T \rightarrow M \rightarrow Y$, or mediated effect of M, and a direct effect between T and Y, that is not mediated by M:

$$\underbrace{\frac{dE(Y(t))}{dt}}_{\text{Total Effect}} = \underbrace{\frac{\partial E(Y(t, m))}{\partial t}}_{\text{Direct Effect}} + \underbrace{\frac{\partial E(Y(t, m))}{\partial m} \frac{\partial E(M(t))}{dt}}_{\text{Indirect Effect}} \quad (1)$$

Where $M(t)$, $Y(t)$, and $Y(t, m)$ are the potential outcomes of M and Y when T is fixed at value t and M at value m. Next section analyzes each mediating effect of $T \rightarrow M \rightarrow Y$ presented in Figure 10, and at the

end, we estimate a final model that includes the mediators that were statistically significant. Since we use a department-year panel data to measure the impact of the events occurred in 2020, we chose to do Fixed Effect estimations following the recommendations of Wooldridge, J. (2012, pg. 496): “Nevertheless, in some applications of panel data methods, we cannot treat our sample as a random sample from a large population, especially when the unit of observation is a large geographical unit (say, states or provinces). Then, it often makes sense to think of each a_i as a separate intercept to estimate for each cross-sectional unit FE is almost always much more convincing than RE for policy analysis using aggregated data.”

The independent variables are estimated separately by married and single women, as well as the for the sum of both. Regarding the variables used to measure each mediator, the access to healthcare services is measured through the percentage of mothers with four or more prenatal consultations (%Prenatal) and is complemented with Maternal Mortality Rate (MMR).⁴ Transportation restrictions and closure of commercial and entertainment establishments are approximated with the participation of the following activities in GDP: commerce, restaurants, hotels, and transport (%CRHT-GDP). Finally, unemployment is measured with the unemployment rate for women (UnEmploy). All the estimates control by the percentage of mothers that have achieved any grade of secondary or more (%SecEdu). We control by this variable because social aspects, such as education achievement are determining factors of fertility (Baizán, Bruno, & Carlos, 2016) and affect the volume of births by department.⁵ **¡Error! No se encuentra el origen de la referencia.**

Table 1 shows the descriptive statistics of the variables included in the models for all departments, 33, and the ones with unemployment information, 23. In this table, we observe that the average department GFR of the first bimester for single women is less than one fifth of that for married women.

Table 1 Descriptive Statistics of the Variables for the Mediation Models

Variable	Obs	Total		Married Women		Single Women	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
33 departments							
First bimester GFR	231	8.96	2.53	13.38	3.23	2.54	1.09

⁴ ICU beds occupancy was not included in the mediation model because there is no record at the departmental level and over time; however, we think that this variable is highly related to MMR.

⁵ The education of women has contributed to improving their position within their households. Education allows women to assume more autonomy and greater control of their own lives, as well as, participate in decisions concerning their reproductive behavior. In addition, education inculcates attitudes that favor contraception and restrict the family size, which helps women have interests that go beyond domestic life (Kritz and Gurak, 1989; Levine, 1991, Mason, 1984).

%SecEdu	231	79.87	11.05	79.42	11.59	80.71	8.73
%Prenatal	231	69.73	18.28	70.44	18.62	61.94	18.19
MMR	231	79.61	101.26	86.72	103.40	168.45	296.87
23 departments							
First bimester GFR	161	8.67	1.98	13.40	2.86	2.23	0.67
%SecEdu	161	82.74	7.14	82.49	7.63	82.77	5.96
%Prenatal	161	77.00	9.34	77.81	9.77	69.46	10.11
MMR	161	59.52	44.23	68.90	40.73	146.38	112.91
%CRHT-GDP	161	16.41	2.85	16.41	2.85	16.41	2.85
UnEmploy	161	16.63	6.48	16.11	6.67	16.11	6.67

Source: Vital Statistics 2014-2021 and DANE 2021. Notes: GFR: General Fertility Rate in the first semester of the next year (births per 1000 women aged 15 to 49). %Prenatal: percentage of mothers with four or more prenatal consultations. MMR: Maternal Mortality Rate (deaths per 100.000 births). %SecEdu: percentage of mothers that have achieved any grade of secondary or more. %CRHT-GDP participation of commerce, restaurants, hotels and transport in GDP. UnEmploy: unemployment rate for women.

5. RESULTS

This section is divided into four parts. In the first, we explore the effect of 2020 on first bimester department GFR through health access. In the second and third, we analyze the mediation effect of the participation of commerce, restaurants, hotels, and transport in GDP and unemployment. The last part presents the final model, which considers the results of the three previous sections. In each section, we present the results for the three studied population: total, single and married women.

5.1. Mediation models: year 2020 → Health access → General Fertility Rate in the first bimester

¡Error! No se encuentra el origen de la referencia. This section presents the direct and indirect effects of 2020 via health services and MMR on first bimester GFR. Table 2 shows the results for the model Year 2020 → Prenatal consultations → MMR and the right for the model Prenatal consultations → MMR → first bimester GFR. The upper part reports the results considering 33 departments and the bottom 23, which are the ones with unemployment and GDP information. **Table 2** shows the results for the total population of women. According to this table, MMR was decreasing between 2.5 and 2.8 points yearly; however, the effect of 2020 was an increase in 31.8 for the 33 departments and 25.1 points for the 23. The direct effect of %Prenatal is not statistically significant for both groups and this occurs after controlling by the education variable. The correlation between these two variables is 0.57. Nevertheless, it is important to highlight that the percentage of mothers with more than four prenatal consultations was negatively affected in 2020, $\frac{\partial E(M(t))}{dt}$ is equal to -5.47 for the 33 departments.

**Table 2 The Direct and Indirect Effects of 2020 via Health Services and MMR
Year 2020 → Prenatal consultations → MMR
All women**

Total effect	Direct effect	Mediator
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	$\frac{dE(Y(t))}{dt}$		$\frac{\partial E(Y(t.m))}{\partial t}$		$\frac{\partial E(Y(t.m))}{\partial m}$		$\frac{\partial E(M(t))}{dt}$	Indirect Effect
33 departments or states								
Year 2020	31.814 *		31.308 *				-5.465 ***	0.506
	(16.072)		(19.039)				(0.622)	(10.143)
Year	-2.522		-2.621				-1.067 ***	0.099
	(3.440)		(3.977)				(0.133)	(1.981)
%SecEdu	-5.034 **		-4.967 *				0.722 ***	-0.067
	(2.556)		(2.891)				(0.099)	(1.340)
%Prenatal					-0.093			
					(1.856)			
MMR								
Year 2020	25.190 ***		26.316 ***				-5.706 ***	-1.126
	(6.368)		(8.469)				(0.565)	(5.559)
Year	-2.771 *		-2.532				-1.215 ***	-0.240
	(1.451)		(1.876)				(0.129)	(1.184)
%SecEdu	-0.563		-0.716				0.772 ***	0.152
	(1.160)		(1.386)				(0.103)	(0.753)
%Prenatal					0.197			
					(0.974)			
MMR								

Source: Vital Statistics 2014-2021. Notes: GFR: General Fertility Rate in the first semester of the next year (births per 1000 women aged 15 to 49). %Prenatal: percentage of mothers with four or more prenatal consultations. MMR: Maternal Mortality Rate (deaths per 100.000 births). %SecEdu: percentage of mothers that have achieved any grade of secondary education or more. The Sobel test is used to estimate the standard error of the Indirect Effect.

¡Error! No se encuentra el origen de la referencia.

Table 3 presents the results for the model Year 2020 → Prenatal consultations → First bimester GFR. This table shows that the reduction of GFR in the first semester of 2021, because of what occurred in 2020, was in average 0.49 for the 33 departments and 0.59 for the 23. The sign of %Prenatal is contradictory, the higher %Prenatal the lower GFR, besides it is not statistically significant at 90%; this occurs when we add the variable Year 2020. However, the departments with the highest GFR exhibit also the lowest %Prenatal because both variables are associated with departmental development.

Table 3 The Direct and Indirect Effects of 2020 via Health Services and MMR

Year 2020 → Prenatal consultations → First bimester GFR								
All women								
	Total effect		Direct effect		Mediator		Indirect Effect	
	$\frac{dE(Y(t))}{dt}$		$\frac{\partial E(Y(t.m))}{\partial t}$		$\frac{\partial E(Y(t.m))}{\partial m}$		$\frac{\partial E(M(t))}{dt}$	
33 departments or states								
Year 2020	-0.490 **		-0.543 **				-5.465 ***	0.053
	(0.211)		(0.250)				(0.622)	(0.131)
Year	-0.061		-0.071				-1.067 ***	0.010
	(0.045)		(0.052)				(0.133)	(0.026)
%SecEdu	-0.134 ***		-0.127 ***				0.722 ***	-0.007
	(0.034)		(0.038)				(0.099)	(0.018)
%Prenatal					-0.010			

(0.024)

23 departments or states							
Year 2020	-0.586	***	-0.759	***	-5.706	***	0.172
	(0.142)		(0.187)		(0.565)		(0.121)
Year	-0.068	**	-0.105	**	-1.215	***	0.037
	(0.032)		(0.041)		(0.129)		(0.026)
%SecEdu	-0.106	***	-0.082	***	0.772	***	-0.023
	(0.026)		(0.031)		(0.103)		(0.017)
%Prenatal					-0.030		
					(0.021)		

Source: Vital Statistics 2014-2021. Notes: GFR: General Fertility Rate in the first semester of the next year (births per 1000 women aged 15 to 49). %Prenatal: percentage of mothers with four or more prenatal consultations. MMR: Maternal Mortality Rate (deaths per 100.000 births). %SecEdu: percentage of mothers that have achieved any grade of secondary or more. The Sobel test is used to estimate the standard error of the Indirect Effect

Likewise, the mediating effect of MMR, in Table 4, is not statistically different from zero. Similar results are found for married and single women. In short, at least at departmental level, health access is not a determinant of the decrease in fertility rates. Hence, the trajectories of Figure 10 related to health services and MMR are discarded for the final models.

Table 4 The Direct and Indirect Effects of 2020 via Health Services and MMR

Year 2020 → MMR → GFR

	Total effect		Direct effect		Mediator		Indirect Effect
	$\frac{dE(Y(t))}{dt}$		$\frac{\partial E(Y(t.m))}{\partial t}$		$\frac{\partial E(M(t))}{dt}$		
33 departments or states							
Year 2020	-0.49	**	-0.411	*	31.814	**	-0.064
	(0.211)		-0.21		(16.072)		(0.045)
Year	-0.061		-0.067		-2.522		0.005
	(0.045)		-0.045		(3.44)		(0.008)
%SecEdu	-0.134	***	-0.146	***	-5.034	**	0.010
	(0.034)		-0.033		(2.556)		(0.007)
MMR					-0.002	***	
					(0.001)		
23 departments or states							
Year 2020	-0.586	***	-0.539	***	25.19	***	-0.050
	(0.142)		(0.15)		(6.368)		(0.052)
Year	-0.068	**	-0.074	***	-2.771		0.006
	(0.032)		(0.033)		(1.451)		(0.007)
%SecEdu	-0.106	***	-0.107	***	-0.563		0.001
	(0.026)		(0.026)		(1.16)		(0.003)
MMR					-0.002		
					(0.002)		

Source: Vital Statistics 2014-2021. Notes: GFR: General Fertility Rate in the first semester of the next year (births per 1000 women aged 15 to 49). %Prenatal: percentage of mothers with four or more prenatal consultations. MMR: Maternal Mortality Rate (deaths per 100.000 births). %SecEdu: percentage of mothers that have achieved any grade of secondary education or more. The Sobel test is used to estimate the standard error of the Indirect Effect.

5.2. Mediation model: Year 2020 → Transportation restrictions and the closure of commercial and

entertainment establishments (%CRHT-GDP) → General Fertility Rate in the first bimester

¡Error! No se encuentra el origen de la referencia. Table 5 shows the results for the model Year 2020 → %CRHT-GDP → GFR. According to this table, the direct effect of %CRHT-GDP on GFR for all women, $\frac{\partial E(Y(t,m))}{\partial m}$, is 0.30, which means that a one-percentage-point increase in the %CRHT-GDP might increase GFR in 0.3 births per 1000 women aged 15 to 49. However, the direct effect of 2020 is statistically not different from zero, suggests that %CRHT-GDP may completely mediate the relationship between the events of the year 2020 and GDP. The effect of 2020 on %CRHT-GDP, $\frac{\partial E(M(t))}{dt}$, is what we expected; in this year there was a decrease in this percentage of about 2 p.p. When we multiply $\frac{\partial E(Y(t,m))}{\partial m}$ by $\frac{\partial E(M(t))}{dt}$, the result is an indirect effect equals -0.62 births per 1000 women aged 15 to 49. Therefore, the proportion of the total effect that passes through %CRHT-GDP is 1.04 (-0.62/-0.59).

At department level for married women, the proportion of the indirect effect over the total effect is 0.68 (-0.54/-0.78). For single women there is not indirect effect of %CRHT-GDP on 2021 first bimester GFR, only direct effect, which corresponds to -0.54. Therefore, the events occurred in 2020 decreased department GFR for married women through the closure of commercial and entertainment establishments, but the single women’s rate seems to not have been affected by the diminish of these activities.

Table 5. The Direct and Indirect Effects of 2020 via Mobility restrictions and closure of commercial and entertainment establishments

Year 2020 → %CRHT-GDP → GFR

	Total effect		Direct effect		Indirect Effect
	$\frac{dE(Y(t))}{dt}$	$\frac{\partial E(Y(t,m))}{\partial t}$	$\frac{\partial E(Y(t,m))}{\partial m}$	$\frac{\partial E(M(t))}{dt}$	
All women					
Year 2020	-0.586 *** (0.142)	0.030 (0.211)		-2.040 *** (0.146)	-0.616 *** (0.169)
Year	-0.068 ** (0.032)	-0.113 *** (0.033)		0.148 *** (0.033)	0.045 *** (0.016)
%SecEdu	-0.106 *** (0.026)	-0.096 *** (0.025)		-0.032 (0.027)	-0.010 (0.009)
%CRHT-GDP			0.302 *** (0.080)		
Married women					
Year 2020	-0.779 *** (0.266)	-0.241 (0.413)		-2.057 *** (0.147)	-0.538 * (0.319)
Year	-0.066 (0.062)	-0.106 (0.066)		0.154 *** (0.034)	0.040 (0.025)
%SecEdu	-0.158 *** (0.046)	-0.148 *** (0.046)		-0.036 (0.026)	-0.009 (0.009)
%CRHT-GDP			0.262 * (0.154)		
Single women					

Year 2020	-0.399 *** (0.083)	-0.540 *** (0.127)		-2.002 *** (0.148)	0.141 (0.097)
Year	-0.056 *** (0.016)	-0.048 *** (0.017)		0.115 *** (0.029)	-0.008 (0.006)
%SecEdu	-0.039 *** (0.013)	-0.038 *** (0.013)		0.011 (0.024)	-0.001 (0.002)
%CRHT-GDP			-0.071 (0.048)		

Source: Vital Statistics 2014-2021. Notes: 23 departments are considered. The abbreviations mean: GFR: General Fertility Rate in the first semester of the next year (births per 1000 women aged 15 to 49). %CRHT-GDP participation of commerce, restaurants, hotels and transport in GDP. %SecEdu: percentage of mothers that have achieved any grade of secondary or more. The Sobel test is used to estimate the standard error of the Indirect Effect.

5.3. Mediation model: Year 2020 → Unemployment → General Fertility Rate in the first bimester

Table 6; **Error! No se encuentra el origen de la referencia.** presents the results when the mediator is the women unemployment rate, UnEmploy. According to this table, the circumstances experienced in 2020 highly increased the unemployment rate for women, almost 15 p.p in average at department level. However, the direct and indirect effects of unemployment, $\frac{\partial E(Y(t,m))}{\partial m}$, on department GFR are not statistically significant for the entire population of women. In contrast, the indirect effect of unemployment on married women's department GFR is negative and statistically significant at 90%. This suggests that the reduction of department GFR for married women is associated with unemployment rates and maybe with uncertainty about the future. For the case of the department GFR of single women, this is not affected directly or indirectly by unemployment, implying that the differences of the single women's GFR at department level in January and February 2021 is not related to unemployment levels.

**Table 6 The Direct and Indirect Effects of 2020 via Unemployment
Year 2020 → Unemployment → GFR**

	Total effect $\frac{dE(Y(t))}{dt}$	Direct effect $\frac{\partial E(Y(t,m))}{\partial t}$	Mediator $\frac{\partial E(Y(t,m))}{\partial m}$	Indirect Effect $\frac{\partial E(M(t))}{dt}$
All women				
Year 2020	-0.586 *** (0.142)	-0.778 *** (0.287)		14.918 *** (0.728)
Year	-0.068 ** (0.032)	-0.073 ** (0.033)		0.326 ** (0.166)
%SecEdu	-0.106 *** (0.026)	-0.106 *** (0.026)		-0.015 (0.133)
UnEmploy			0.013 (0.017)	
Married women				
Year 2020	-0.779 *** (0.266)	-0.035 (0.534)		14.998 *** (0.736)
Year	-0.066 (0.062)	-0.053 (0.062)		0.259 (0.171)
%SecEdu	-0.158 *** (0.046)	-0.155 *** (0.046)		0.060 (0.128)
UnEmploy			-0.050	-0.744 * (0.452)

(0.030)

Single women					
Year 2020	-0.399 *** (0.083)	-0.322 * (0.169)		15.070 *** (0.732)	-0.076 (0.150)
Year	-0.056 *** (0.016)	-0.055 *** (0.016)		0.244 * (0.143)	-0.001 (0.003)
%SecEdu	-0.039 *** (0.013)	-0.038 *** (0.013)		0.117 (0.116)	-0.001 (0.001)
UnEmploy			-0.005 (0.010)		

Source: Vital Statistics 2014-2021. Notes: 23 departments are considered. The abbreviations mean: GFR: General Fertility Rate in the first semester of the next year (births per 1000 women aged 15 to 49). UnEmploy: unemployment rate for women. %SecEdu: percentage of mothers that have achieved any grade of secondary or more. The Sobel test is used to estimate the standard error of the Indirect Effect.

5.4. Mediation model: Year 2020 → %CRHT-GDP → Unemployment

According to **Table 7**, the indirect effect of 2020 via %CRHT on women unemployment rate is not statistically different from zero for all women, and when use the information for both married and single women. Hence, the path Year 2020 → %CRHT-GDP → Unemployment → General Fertility Rate in the first bimester is discarded for the final model.

Table 7 The Direct and Indirect Effects of 2020 via %CRHT-GDP on Unemployment
Year 2020 → %CRHT-GDP → Unemployment

	Total effect		Direct effect			Indirect Effect
	$\frac{dE(Y(t))}{dt}$		$\frac{\partial E(Y(t,m))}{\partial t}$	$\frac{\partial E(Y(t,m))}{\partial m}$	$\frac{\partial E(M(t))}{dt}$	
All women						
Year 2020	14.918 *** 0.728		15.501 *** 1.142		-2.040 *** 0.146	-0.583 0.880
Year	0.326 ** 0.166		0.283 0.178		0.148 *** 0.033	0.042 0.065
%SecEdu	-0.015 0.133		-0.006 0.134		-0.032 0.027	-0.009 0.016
%CRHT-GDP				0.286 0.431		
Married women						
Year 2020	14.998 *** 0.736		15.649 *** 1.153		-2.057 *** 0.147	0.000 0.887
Year	0.259 0.171		0.210 0.184		0.154 *** 0.034	0.000 0.067
%SecEdu	0.060 0.128		0.071 0.129		-0.036 0.026	0.000 0.017
%CRHT-GDP				0.317 0.431		
Single women						
Year 2020	15.070 *** 0.732		15.611 *** 1.127		-2.002 *** 0.148	0.000 0.885
Year	0.244 * 0.143		0.213 0.152		0.115 *** 0.029	0.000 0.049
%SecEdu	0.117 0.116		0.114 0.117		0.011 0.024	0.000 0.009
%CRHT-GDP				0.270 0.427		

Source: Vital Statistics 2014-2021. Notes: 23 departments are considered. The abbreviations mean: GFR: General Fertility Rate in the first semester of the next year (births per 1000 women aged 15 to 49). UnEmploy: unemployment rate for women. %CRHT-GDP participation of commerce, restaurants, hotels and transport in GDP. %SecEdu: percentage of mothers that have achieved any grade of secondary or more. The Sobel test is used to estimate the standard error of the Indirect Effect.

5.5.Final mediation model

Considering the results of sections 5.1, 5.2, 5.3, and 5.4, the final model takes into account only two mediators for married women, %CRHT-GDP and unemployment, one for all women, %CRHT-GDP, and none for single women. The final model for the GFR of all women is the same of Section 5.2, Year 2020 → Transportation restrictions and the closure of commercial and entertainment establishments → General Fertility Rate in the first bimester. However, when we analyze the department GFR for married and single women separately, we find that the trajectories that 2020 used to affect the 2021 first bimester GFR were different.

The variables %CRHT-GDP and unemployment are the mediators between 2020 and 2021 married women’s first bimester GFR. According to Table 8, the ratios between their mediation effects and the total effect are 0.73 (-0.57/-0.78) for %CRHT-GDP and 1.03 (-0.80/-0.78) for unemployment, while the ratio of the direct effect is -0.76 (0.59/-0.78). As Figure 3 shows, April and May were the months with the strongest restrictions on places for social gathering, which could affect people interactions. Therefore, the higher the restriction at department level, the lower the married women’s GFR. The direct effect, which we relate to strict quarantine, even though it is positive, is not statistically different from zero. Regarding unemployment, the estimation suggests that an increase in department unemployment rate is associated with a reduction in the married women’s first bimester GFR. As the estimates show, department women unemployment rate increased 15 p.p in average, during May and July of 2020. Since we could not control by the limited access to contraceptive methods, which could have positively affected departmental GFR for married women, it is likely that the negative indirect effects of unemployment and the restrictions in commerce, transportation and entertainment establishments are higher. This would counter the positive effect of the limited access to contraceptive methods; thus, the total effect would still be negative

Table 8 The Direct and Indirect Effects of 2020 – Final model for married women

Total effect	Direct effect	%CRHT: participation of commerce, restaurants, hotels and transport in GDP			Unemployment		
		Direct effect	Mediator	Indirect Effect	Direct effect	Mediator	Indirect Effect
$\frac{dE(Y(t))}{dt}$	$\frac{\partial E(Y(t,m))}{\partial t}$	$\frac{\partial E(Y(t,m))}{\partial m}$	$\frac{\partial E(M(t))}{dt}$		$\frac{\partial E(Y(t,m))}{\partial m}$	$\frac{\partial E(M(t))}{dt}$	

Year 2020	-0.779 ***	0.591	-	2.057 ***	-0.573 *	14.99	8 ***	-0.797 *
	(0.266)	(0.632)		(0.147)	(0.388)	(0.736)		(0.466)
Year	-0.066	0.095	-	0.154 ***	0.043 *	0.259		-0.014
	(0.062)	(0.066)		(0.034)	(0.025)	(0.171)		(0.013)
%SecEdu	-0.158 ***	0.145 ***	-	0.036	-0.010	0.060		-0.003
	(0.046)	(0.046)		(0.026)	(0.009)	(0.128)		(0.007)
%CRHT-GDP			0.279 *					
			(0.154)					
UnEmploy						-0.053 *		
						(0.031)		

Source: Vital Statistics 2014-2021. Notes: 23 departments are considered. The abbreviations mean: GFR: General Fertility Rate in the first semester of the next year (births per 1000 women aged 15 to 49). UnEmploy: unemployment rate for women. %CRHT-GDP participation of commerce, restaurants, hotels and transport in GDP. %SecEdu: percentage of mothers that have achieved any grade of secondary or more. The Sobel test is used to estimate the standard error of the Indirect Effect.

Concerning the trajectories that 2020 used to affect the 2021 first bimester GFR of single women, the results show that there were not mediators, only direct effect, Table 9. This means that the strict social isolation that occurred in April and May 2020 seriously affected single women' 2021 first bimester GFR. Social interaction plays a key role to establish new couples. Meeting new people and establishing possible romantic relationships became more difficult for single people given the social distancing (Candel & Jitaru, 2021). Even though, virtual relationships increased due to the use of social networks like WhatsApp, Facebook, Tinder, Hinge, and Instagram, among others (Eleuteri & Terzitta, 2021), sexual encounters foundational for human procreation were reduced for single people, which decreased the number of pregnancies.

Table 9. The Direct and Indirect Effects of 2020 – Final model for single women

	Total effect		Direct effect	
	$\frac{dE(Y(t))}{dt}$		$\frac{\partial E(Y(t,m))}{\partial t}$	
Year 2020	-0.399	***	-0.399	***
	(0.083)		(0.083)	
Year	-0.056	***	-0.056	***
	(0.016)		(0.016)	
%SecEdu	-0.039	***	-0.039	***
	(0.013)		(0.013)	

6. Conclusions

When observing the excess mortality rates caused by COVID-19 in pregnant women, it is evident that this disease is not relevant to explain the reduction of fertility rates. Literature indicates other influencing

factors that indirectly affected reproductive decisions and consequently the number of births, including access to health services, reduction of social interactions emanated from mobility restrictions and compulsory isolation, increase of unemployment rates, and concerns about the future.

According to the analysis carried out in Colombia, we have seen a reduction of 7.2% in childbirths during the first trimester of 2021 compared to the same trimester of 2020. The mediation analysis demonstrates that the total effect of 2020 on department GFR is approximately -0.58 points in the first bimester 2021. When decomposing this effect among the factors stated in the literature, we obtain an indirect effect of -0.62 through transportation restrictions and closure of commercial and entertainment establishments. Thus, the effect of 2020 on GFR via this factor is higher than 100% ($-0.62/-0.58$). However, we found that the trajectories that 2020 used to affect the 2021 first bimester department GFR of married and single women were different. For the first group, this effect was via unemployment and commerce establishment closure and transportation restrictions; in contrast, the results for single women show no mediators, only direct effect, suggesting that, at least at department level, the main reason for the reduction of first bimester GFR was the compulsory isolation.

The mediating factors identified occurred within the framework of multiple health constraints implemented by the government as measures to contain the spread of the virus. The social impact of such restrictions is being unveiled from this type of research that displays how isolation and mobility restrictions echo in the intrinsic conditions of the human population, namely the need for social interaction. Human procreation necessarily requires the conformation of couples. Finally, it is suggested to carry out a study where women or households are the units to observe aiming at revealing new mediating effects; besides, other relevant results and effects may be observed that are not possible to verify at department level.

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