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ORIGINAL ARTICLE

# Implications of COVID-19 on mental health of pregnant women: Does timing of infection matter?

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**KEYWORDS**
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Woman

**Abstract**
*Background and Objectives:* This study aimed to examine sociodemographic and clinical characteristics between pregnant women infected (cases) and non-infected (controls) with COVID-19 and their offspring, focusing on the trimester in which the infection occurred
*Methods:* A total of 115 mother-infant dyads (64 cases and 51 controls), were analysed to evaluate maternal, delivery and new-borns' characteristics. In particular, anxiety and depressive symptoms, sleep satisfaction, perinatal stress, bonding, social support or fear of COVID-19, during pregnancy and 6-weeks after delivery were explored. Student's *t*-test, chi-square and repeated measure analysis of variance were used for comparisons when appropriate
*Results:* No significant differences were observed between the two groups in any of the variables analysed, except for the mothers' education, which was higher in the control group. Regarding the timing of infection, those who were infected during the first trimester reported lower levels of perceived social support and higher levels of anxiety
*Conclusions:* These findings suggest that the emotional impact of the pandemic may be similar throughout the population, regardless of infection status. However, the impact of the COVID-19 on mental health of future mothers appears to be more significant during the early stages of pregnancy. These results underscore the relevance of providing adequate support from the early stages of pregnancy, in order to enhance women well-being.


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## Introduction

During normal circumstances, pregnancy can become a daunting experience for women, as they undergo relevant mental and physical changes.[1-3] Approximately 10 % of pregnant women and 13 % of women that give birth experience some form of mental disorder.[4] However, it is noteworthy that exposure to diseases or natural disasters can worsen mental health problems.[3] Notably, the COVID-19 pandemic has had a profound emotional impact on pregnant women, causing increased anxiety due to the uncertainties surrounding its effects on maternal and fetal health, as well as confinement and isolation.[5,6] Several studies estimated that the prevalence of anxiety and depression symptoms during COVID-19 was 42 % and 25 % respectively,[7] with a more severe psychological impact observed in the early pregnancy [8] possibly due to uncertainty about fetal development, given the higher likelihood of miscarriage and the profound life changes it entails for the mother. Moreover, the COVID-19 impact extends beyond emotional health, affecting also aspects such as social support [9,10] or sleep problems.[11]

Both the increase in anxiety symptoms and sleep problems during pregnancy can lead to harmful outcomes for both mother and child, including delivery complications,[12-16] and long-term consequences on the child's health and development, affecting motor skills and behaviour.[17-22] Thus, the timing of COVID-19 infection during gestation is crucial, as infections during the first trimester may have a greater impact on neurological development,[23] and may suppose an added risk of developing several mental disorders in adulthood, including emotional disorders, schizophrenia or autism,[24-30] In this line, the results found in the pilot study of the present work with 42 infants, showed that those who were exposed to the virus had a poorer development in motor skills and interactive behaviour, particularly when exposure occurred in the third trimester of pregnancy.[31] Regarding women, anxiety or depressive symptoms, sleep problems and social support during pregnancy may also increase the risk of complications during pregnancy, delivery and child developmental outcomes.[32-35]

Considering the negative consequences triggered on both the new-born's neurodevelopment and the mother's emotional well-being, it is vital to examine the possible effects of COVID-19 on the psychological state of these women and the trimester in which infections occur. In this sense, the present study aimed to examine potential long term differences between pregnant women who have been infected with COVID-19 (cases) and those who have not (controls) and their offspring, as well as differences among cases, based on the trimester in which they were infected, both during pregnancy and 6-weeks after delivery. Given the great impact of COVID-19 on overall mental health in the general population, we hypothesized that women who experienced COVID-19 during pregnancy will present greater emotional symptoms, compared to those who did not contract the disease. In the same way, we expect that women infected during the first trimester of pregnancy will present a greater psychological impact and worse perception of social support compared to those who were infected at a later stage of pregnancy.

## Method

### Procedure

All the data in this study were obtained from a prospective study carried out in Spain—Cohort of COVID-19 pregnant women and new-borns (COGESTCOV-19). The study recruited a cohort of pregnant women and their new-borns, in order to explore epigenetic changes related to stress and inflammation during pregnancy and to examine the presence of infections and stressors during embryonic development with an increased risk of developing neurological and psychiatric disorders in their offspring. Participants were informed of the presence of the study through their midwives in charge of monitoring the pregnancy and social media platforms (Facebook, Instagram, and Twitter). They were classified as controls (if they had not passed COVID-19 during pregnancy and serological test confirm the absence of antibodies) and cases (if they tested positive for SARS-CoV-2 during pregnancy) and were matched. All participants completed a series of questionnaires during pregnancy and 6-weeks after delivery.

### Participants

The COGESTCOV-19 enrolled a total of 115 mother-infant dyads (64 cases and 51 controls) between December 2020 and February 2022, corresponding to six distinct waves of the COVID-19 pandemic in Spain. Among the total 64 cases comprising the sample, it is noteworthy that 13 individuals contracted COVID-19 during the first trimester of pregnancy, 28 during the second trimester, and 23 during the third trimester. Participants completed a series of questionnaires during pregnancy and 6-weeks after delivery. During pregnancy, the assessment was conducted a few days after the moment of infection. Upon confirmation of the virus's presence, the assessment was conducted as soon as possible after the risk of infection to others had passed. Subsequently, for the control group sample, a dyad not exposed to the infection was sought, located at a similar gestational week within a 4-week interval.

### Instruments

Data collection was carried out through semi-structured interviews, one of them during the prenatal period—which includes information on sociodemographic information and their medical and psychological status—, and another one in the 6-weeks after delivery—which would also include information about delivery and neonatal outcomes of their children.

Anxiety symptoms were assessed with The Spielberger State-Trait Anxiety Inventory (STAI),[36] a 40-item inventory that evaluates through two different subscales both state and trait anxiety. Total scores range from 0 to 60 points, with higher scores indicating greater anxiety-related symptomatology. Depressive symptoms were assessed with The Edinburgh Postnatal Depression Scale (EPDS),[37] a 10-item questionnaire that evaluates the most common depressive symptoms during the perinatal period. Total score ranges from 0 to 30 points, with higher scores indicating greater depressive-related symptomatology. The level of subjective sleep satisfaction was assessed with the Oviedo Sleep

Questionnaire (OSQ),[38] a 15-item scale that evaluates sleep disorders based on DSM-IV and ICD-10 criteria. The items are rated on a 5-point Likert scale ranging from 1 to 5, except for the first one which is from 1 to 7 points. Prenatal stress was assessed with the Prenatal Distress Questionnaire (PDQ),[39] a 12-item instrument that evaluates specific worries and concerns during pregnancy. Total score ranges from 0 to 48 points, with higher scores indicating greater stress-related symptomatology. Social support was assessed with The Duke-UNC Functional Social Support Questionnaire,[40] an 11-item multidimensional scale that evaluates four different areas: confidant support and affective support. In addition, the scale provides a global social support measure. Total score ranges from 11 to 55, with higher scores indicating greater perceived social support. Postnatal stress was assessed with the Stress Perceived Scale (PSS),[41] a 14-item questionnaire that evaluates individuals' appraisal of their life as stressful. Total score ranges from 0 to 70, with higher scores indicating higher perceived stress. Bonding between mothers and new-borns was assessed with The Postpartum Bonding Questionnaire (PBQ),[42] a 25-item scale that evaluates the mother's feelings or attitudes towards her baby. Total scores range from 0 to 125, with higher scores indicating worse bonding. Fear of COVID-19 was assessed with the Fear of COVID-19 scale (FCV-19S),[43] a 7-item scale that evaluates perceived psychological vulnerability to illness. Total score ranges from 7 to 35, with higher scores indicating greater fear of COVID-19.

In addition, we considered the following demographic variables: age of the mother; gestational age (in weeks); marital status; educational level, and employment status. We also collected data about weight, length, infection term, vaccination for COVID-19, type of hospitalization, type of birth, and new-borns' sex.

### Data analysis

Differences in pregnant women were analysed according to the trimester of COVID-19 infection (cases), as well as examined clinical and sociodemographic differences between women infected with COVID-19 and those who did not (controls), and their offspring, both during pregnancy and 6-weeks after delivery.

Student's *t*-test for independence samples and the chi-square test were used when appropriate to carry out comparisons between cases and controls. Analysis of variance was also performed for variables with only one assessment moment (PBQ, PDQ, T-STAI and PSS scales) to compare clinical information according to the trimester of pregnancy at the moment of the COVID-19 infection. To further evaluate the changes over time we used repeated measures analyses of variance (ANOVA), after controlling for potential confounders (existence of previous children and adjusted household conditions). Post hoc multiple comparisons (pairwise t-test) were corrected by Bonferroni. The power analysis was conducted using G*Power 3.1 software [44] with an ANOVA repeated measures between factors test. The analysis indicated that, considering two measurements, two or three groups, and a sample size of $N$ = 115, the study was adequately powered to detect medium effect sizes ($\alpha$= 0.05; $f$ = 0.25; so $\beta$= 0.87 or 0.79, respectively). For statistical analysis, we used the IBM-SPSS statistical software program, v. 23. All statistical tests were two-tailed, and significance was determined at the 0.05 level.

## Results

### Description of the sample

Mean age of the participants was 34.01 (SD, 3.63). Most participants were currently working (56.4 %), living with a partner (94 %) and, with high educational level (64 %). The average weight of mothers was 71.99 (SD, 12.01) and their height was 164.16 (SD, 6.49). Regarding pregnancy-related information, the sample had an average of 39.50 (SD, 1.35) weeks of gestational age, and the majority had an unscheduled type of delivery (75 %), presented a natural birth (89.7 %), and achieved full term (99.1 %). Likewise, the most frequent time of infection during pregnancy was during the 2nd trimester (43.75 %), and the number of women vaccinated was 93 (77.83 %). In relation to new-borns, the majority were boys (55.8 %), with a mean weight of 3.36 (SD, 0.45) and a length of 54.16 (SD, 41.69). The information divided by groups is shown in Table 1.

### Differences between cases and controls

Only significant differences were found in terms of the mother's level of education, with a higher proportion of women with higher education in the control group (*chi-square*= 7.923; *df*= 1; $p$ = 0.005) (Table 1).

No significant within-group, between-group and group-by-time effects were observed in any of the scores obtained on the different scales ($p > 0.05$) in either of the two evaluations administered (Table 2).

### Differences among cases based on the timing of infection

As depicted in Table 3, repeated measures ANOVAs exclusively identified significant differences between-group effects for perceived social support ($F$ = 3.953; $p$ = 0.010; $\eta^2$=0.022) and sleep satisfaction ($F$ = 3.084; $p$ = 0.031; $\eta^2$=0.004). Specifically, there is an observed higher perceived social support and sleep satisfaction among pregnant women infected during the second trimester compared to those infected during the first trimester. Similarly, for the cross-sectional measures collected during pregnancy (PDQ) and 6 weeks postpartum (PSS, PBQ, and T-STAI), we only observed significant differences in the case of trait anxiety ($F$ = 3.33; $p$ = 0.043), indicating higher symptoms of trait anxiety in women infected during the first trimester of pregnancy.

## Discussion

The study aimed to examine potential long-term differences between pregnant women infected with COVID-19 (cases) and those who have not (controls) and their offspring, as well differences among cases based on the trimester of infection, both during pregnancy and 6-weeks after delivery. On the one hand, contrary to our expectations, no

**Table 1** Sample description of participants cases and controls.

| | Cases *n* = 64 Mean (SD) | Controls *n* = 51 Mean (SD) | 95 % CI Difference[2] | Value[3] | p-value |
|---|---|---|---|---|---|
| Mother age | 33.69 (3.71) | 34.39 (3.59) | −2.064, 0.0.655 | −1.027 | .307 |
| Gestational age (weeks) | 39.67 (1.160) | 39.29 (1.540) | −0.136, 0.881 | 1.452 | .149 |
| Mother weight | 72.00 (12.21) | 71.97 (12.04) | −4.49, 4.56 | 0.015 | .988 |
| Mother length, cm | 164.03 (6.39) | 164.31 (6.68) | −19.75, 50.26 | 0.864 | .390 |
| New-born's sex (Boy)[1] | 37 (60.66 %) | 24 (39.34 %) | | 1.318 | .251 |
| Infection Term[1] | | | | | |
| 1st | 13 (20.31 %) | | | | |
| 2nd | 28 (43.75 %) | | | | |
| 3rd | 23 (35.94 %) | | | | |
| Vaccination for COVID-19 Vaccinated | 50 (78.13 %) | 43 (84.31 %) | | 1.287 | .461 |
| Delivery hospitalization (scheduled)[1] | 13 (20.3 %) | 13 (25.5 %) | | 0.197 | .657 |
| Birth[1] | | | | 4.730 | −193 |
| Natural | 37 (57.8 %) | 23 (45.1 %) | | | |
| Induction | 16 (25 %) | 15 (29.4 %) | | | |
| C-section | 6 (9.4 %) | 11 (21.6 %) | | | |
| Full term[1] | 58 (90.6 %) | 49 (96.1 %) | | 0.838 | .360 |
| Marital status[1] | | | | 0.007 | .625 |
| With partner | 60 (93.8 %) | 48 (94.1 %) | | | |
| Without partner | 4 (6.2 %) | 3 (5.9 %) | | | |
| Educational level[1] | | | | 7.923 | **.005** |
| Basic studies | 30 (46.9 %) | 11 (21.6 %) | | | |
| Higher studies | 34 (53.1 %) | 40 (78.4 %) | | | |
| Employment status[1] | | | | 0.054 | .816 |
| Working | 35 (54.7 %) | 29 (56.9 %) | | | |
| Not working | 29 (45.3 %) | 22 (43.1 %) | | | |
| New-borns' weight | 3.34 (4.65) | 3.38 (4.25) | −204.91, 134.64 | −0.410 | .682 |
| New-borns' length | 50.17 (1.85) | 58.87 (61.53) | −24.57, 7.17 | −1.087 | .280 |

[1] n (%).
[2] *CI*= Confidence Interval.
[3] Student *t*-test or Pearson's chi-squared test as appropriate.

statistically significant differences were found between cases and controls, in terms of maternal, delivery, and new-born characteristics; nor in any of the scales used in the study (i.e., symptoms of anxiety or depression, sleep satisfaction, prenatal and postnatal stress, bonding, social support or fear of COVID-19). Only significant differences were found between both groups in the educational level, where the control group had a higher proportion of mothers with higher education. On the other hand, and in line with one of our initial hypotheses, women infected with COVID-19 during the first trimester showed worse perceived social support, greater anxiety trait symptoms and poor sleep satisfaction, compared to those who were infected later in pregnancy.

Interestingly, COVID-19 infected pregnant women showed more anxiety and worse perceived social support during the first trimester compared to later stages of pregnancy. These findings align with previous studies that have reported similar results,[45,46] showing that COVID-19 had a greater psychological impact on women infected at early pregnancy.[8] Pregnancy itself entails a significant life transition involving numerous biological and psychological changes, as well as a shift in familial and social roles,[47] along with adjustments in lifestyle, relationships, body image and uncertainty about possible health problems that may arise related to the new-born throughout pregnancy,[47,48] especially in early pregnancy. Moreover, when considering the additional burden of a viral infection, with uncertain effects on fetal neurodevelopment, could further exacerbate symptoms during this critical period. It is important to consider that infections during the first trimester of pregnancy can have a significant impact on neurological development,[23] thereby increasing the risk of developing mental disorders in adulthood.[26,28] This may further explain the heightened anxiety symptoms observed in infected mothers during the first trimester, as the consequences of COVID-19 may be more harmful. Additionally, it is worth noting that approximately one in five pregnancies result in a miscarriage before 24 weeks,[49,50] leading most women to announce their pregnancies after this critical period has passed. Consequently, it is plausible that the social support received and perceived by women during the first trimester is lower compared to the subsequent months. Similarly, a diminished sleep satisfaction has been observed among pregnant women infected during the first trimester. This phenomenon may be attributed to the elevated prevalence of anxiety symptoms reported by women in this cohort, as previous studies have substantiated the association between sleep disturbances and anxiety or stress.[51,52]

Contrary to our initial hypotheses, COVID-19 infection during pregnancy did not correlate with delivery-related, maternal, or new-born characteristics, nor with symptoms

**Table 2** Repeated measures ANOVAs for clinical scales between cases and controls.

| | Cases $n = 60$ | | Controls $n = 50$ | | Effect size | Group | Time | Timex Group |
|---|---|---|---|---|---|---|---|---|
| | During pregnancy | 6-weeks after pregnancy | During pregnancy | 6-weeks after pregnancy | F values | | | |
| S-STAI | 3.9 (0.4) | 9.7 (8.4) | 3.7 (0.7) | 9.1 (6.6) | 0.017 | 0.329 | 1.840 | 0.119 |
| EPDS | 5.3 (3.1) | 4.1 (3) | 5.4 (3.5) | 3.7 (3.5) | 0.005 | 0.056 | 0.153 | 0.479 |
| OSQ | 32.2 (7.9) | 32 (7) | 33.7 (8.9) | 33.1 (7.9) | 0.000 | 0.947 | 0.119 | 0.048 |
| DUKE | 47 (5.6) | 47.80(6.6) | 46.6 (5.3) | 48.4 (6.6) | 0.007 | 0.006 | 0.031 | 0.758 |
| Fear of COVID | 13.4 (4.1) | 11.1 (4.5) | 14 (5.1) | 11 (3.8) | 0.010 | 0.063 | 2.725 | 1.069 |

*Notes*= *** $p < 0.001$. ** $p < 0.01$. *$p < 0.05$.

**Table 3** Repeated measures ANOVAs for clinical scales across different trimesters of pregnancy.

| | 1st Term ($n = 11$) | | 2nd Term ($n = 27$) | | 3rd Term ($n = 22$) | | Effect size | Group | Time | Timex Group |
|---|---|---|---|---|---|---|---|---|---|---|
| | During pregnancy | 6-weeks after pregnancy | During pregnancy | 6-weeks after pregnancy | During pregnancy | 6-weeks after pregnancy | F values | | | |
| S-STAI | 3.7 (0.6) | 14.2 (8.8) | 4 (0) | 7.5 (7.2) | 3.9 (0.5) | 10 (9) | 0.062 | 2.052 | 1.775 | 2.279 |
| EPDS | 5.8 (2.6) | 5.7 (3.3) | 5.2 (2.5) | 3.6 (2.2) | 5.2 (3.9) | 4 (3.4) | 0.018 | 0.773 | 0.187 | 0.628 |
| OSQ | 36.8 (8.8) | 35.7 (4.4) | 29.7 (5.7) | 30.3 (7.1) | 33.1 (8.8) | 32.2 (7.6) | 0.004 | 3.084* | 0.081 | 0.128 |
| DUKE | 43.3 (7) | 42.5 (8) | 48.3 (4.5) | 50.2 (4.4) | 47.2 (5.4) | 47.6 (6.6) | 0.022 | 3.953* | 0.031 | 0.786 |
| Fear of COVID | 14 (4.4) | 11.5 (4.5) | 13 (3.9) | 11.4 (3.9) | 13.3 (4.6) | 10.6 (5.4) | 0.018 | 0.266 | 2.247 | 0.638 |

*Notes*= *** $p < 0.001$. ** $p < 0.01$. *$p < 0.05$.

of anxiety, depression, stress, sleep quality, perceived social support, bonding or fear of COVID-19. In this sense, previous literature showed contradictory results. On the one hand, these results are in line with a previous study, which also found no differences in terms of affective symptoms between mothers' cases and controls.[53] Nevertheless, on the other hand, a previous systematic review and meta-analysis showed that the prevalence of symptoms of anxiety and depression was higher for COVID-19 infected pregnant women, compared to those who did not.[54] It is important to emphasize that all the aforementioned studies were conducted in the early stages of the pandemic, therefore, a possible cause explaining the absence of differences found in our study may be the timing of data collection, since most of the sample was assessed more than a year after the onset of the epidemic. One noteworthy factor that may account for the absence of differences between women in the case and control groups is the healthcare system in Spain. The health system in this country is public, making it freely accessible to all individuals, thereby providing an added sense of reassurance for this population. Moreover, Spain boasts an extensive welfare system with a more generous social safety net, contributing to the overall well-being and security of its residents.[55] This includes the provision of paid maternity and paternity leave, as well as the accessibility of postpartum healthcare services, further enhancing the support available to individuals and families. Moreover, similar levels of sleep quality or perceived social support between cases and controls might explain the absence of differences in anxiety and depressive symptoms, since these variables have been shown to play a protective role in the development and maintenance of these types of symptoms.[56-59] Mothers who did not pass the COVID-19 during pregnancy had higher educational levels, possibly due to their higher likelihood of participating in research projects and adhering to protective behaviours.[60] Furthermore, socioeconomic disadvantages among individuals with lower educational levels could expose them to higher risk of contagion.[61]

The present study has several limitations. First, most of the included cases had mild COVID-19 infection, which restricts the generalizability of these results to those cases in which the symptoms were more severe. This may also explain the absence of significant differences at the emotional level of the mothers, since the disease did not have a substantial impact on their health. Second, it was not possible to achieved perfect matching for all the dyads at the educational level between cases and controls. In the same way, all the variables analysed were collected in the short term. It would be interesting to see if in the long term, significant differences between cases and controls are appreciated. Finally, it is worth noting that data collection started in December 2020, several months after the start of the pandemic, so it is likely that the results will differ from studies that analysed the same variables months earlier. The timing of data collection may have reduced the psychological impact, since as described by Aknin et al. (2022), a significant decrease in emotional symptoms has been observed one year after the start of the epidemic.[62] At the same time, it is important to take into account that, the vaccine in pregnant women began to be administered in August 2021, which is a possible reason why part of the sample was not vaccinated at any time.

In this sense future research should compare the psychological state of pregnant women before and after the pandemic and consider the wave in which each mother was infected, considering that the severity and impact of the pandemic may have varied over time. At the same time, it would be necessary to analyse possible biological differences in pregnant women both during and after pregnancy. Similarly, although the pilot study of the present work [31] showed certain differences in the neurodevelopment of infants exposed to COVID-19 with respect to unexposed, it would be relevant to examine the long-term neurodevelopment of new-borns, especially focusing on whether COVID-19 infection can suppose an increased risk of developing mental disorders such as schizophrenia or autism. This could provide valuable insights on how the pandemic has affected the mental and physical health of pregnant women and their offspring and could inform future public health policies and interventions.

Despite the aforementioned limitations, our findings suggest that COVID-19 does not significantly impact maternal or newborn outcomes, neither during pregnancy, nor at 6-weeks after delivery. It is likely that, at the time the data was collected, the pandemic had affected all people equally, regardless of their exposure to the virus. However, it remains crucial to provide adequate social support from the early stages of pregnancy, in order to improve women's wellbeing and ensure positive long-term outcomes for both mothers and new-borns.

## Conflicts of interest

None.

## Ethics considerations

All participants were provided with an information sheet describing the study protocol and aims. Written informed consent was obtained from all the participants on the first visit (before blood test and interview). In addition, informed consent was obtained from both parents of the new-born. The Clinical Research Ethics Committee of Cantabria (CEIm —2020.190) approved the study protocol and all procedures contributing to this work comply with the Helsinki Declaration.

## Data availability

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

## Authors' contribution statements

All the authors have participated and have made substantial contributions to this paper. SBM: design, statistical analysis, interpretations of data and drafting the article; NMG: design, interpretations of data and revising the article; MMC, VOGF: design and statistical analysis. ASS:

interpretations of data and revising the article; RAA: conception, design, interpretations of data and revising the article.

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