



Impact of covid-19 pandemic over depressive symptoms among mothers from a population-based birth cohort in southern brazil

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Abstract

Purpose Our aim was to assess the impact of COVID-19 on depressive symptoms among mothers from a population-based birth cohort in Pelotas, Southern Brazil.

Methods A subgroup of mothers from the Pelotas 2004 Birth Cohort was assessed pre-pandemic (November, 2019 to March, 2020) and mid-pandemic (August–December, 2021). In both follow-ups, depressive symptoms were assessed using the Edinburgh Postnatal Depression Scale (EPDS). Pre-pandemic (T_1) and pandemic-related predictors (T_2) were analyzed. Prevalence of depression (EPDS score ≥ 13) at T_1 and T_2 were compared with chi-square test. Changes in EPDS from T_1 to T_2 were estimated by multivariate latent change score modelling.

Results 1,550 women were assessed. Prevalence of depression increased 38.1% (from 18.9% at T_1 to 26.1% at T_2) ($p < 0.001$). At T_1 , higher schooling, higher family income and being employed or working were related to lower EPDS, whereas being beneficiary of a cash transfer program and a larger number of people living in the household predicted higher EPDS. The deterioration of ones' own perception of quality of overall health ($\beta = 0.191$; $SE = 0.028$; $p < 0.001$) and worst family financial situation due to the pandemic ($\beta = 0.083$; $SE = 0.024$; $p = 0.001$) predicted the increase in EPDS from T_1 to T_2 .

Conclusion Almost two years after the beginning of the pandemic, the prevalence of depressive symptoms among the women was higher than before the pandemic. The deterioration of ones' own perception of quality of overall health and worst family financial situation due to the pandemic are proxies for the effect of COVID-19 pandemic (the true exposure of interest) in the women mental health.

Keywords COVID-19 · Pandemic · Depression · Women · Mental health · Impact

Introduction

Brazil had its first confirmed case of COVID-19 on February 26, 2020, and on March 20, 2020, the Brazilian Ministry of Health declared community transmission of SARS-CoV-2.

Together with the United States and India, Brazil soon turned one of the countries with the highest total number of confirmed cases in the world. (World Health Organisation 2021) In the absence of vaccine against the SAR-CoV-2 (which in Brazil became available in February 2021), social

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restriction was essential for slowing the virus transmission and thus flattening the curve of cases, reducing the demand on health services, and preventing the collapse of the health system. However, based on studies on the effect of social restrictions among individuals facing previous epidemics and disasters, concerns were raised on potential parallel and longstanding mental health crisis associated with social restrictions during the COVID-19 pandemic. (Holmes et al. 2020; Pfefferbaum and North 2020) Fear of contagion, fear to die and of the death of family members, anxiety, sadness, anger, and loneliness were negative emotional effects due to social distancing, travel restriction, and quarantine. (Brooks et al. 2020).

The responses to the pandemic consequences however can be heterogeneous, depending on socio-demographic characteristics and pre-existing psychopathological features. (Fiorillo and Gorwood 2020) which may modulate the vulnerability to the emotional consequences of any disaster-related trauma. (Brooks et al. 2020) A systematic review and meta-analysis of predominantly European and North American cohort studies with pre (March to April, 2020) *versus* during pandemic measurement of depression, general mental health and/or anxiety (May to July, 2020) found that overall, there has been considerable resilience in mental health. (Robinson et al. 2022) The increase in mental health symptoms was largest among studies that sampled participants in the early stages of the pandemic, and severity of symptoms decreased significantly over the following months, although worsening and duration of symptoms were largest in studies examining depression and mood disorders symptoms. (Robinson et al. 2022).

A systematic review aiming to quantify the impact of the COVID-19 pandemic on the prevalence and burden of major depressive disorder in 2020 estimated an additional 53.2 million (44.8 to 62.9) cases of major depressive disorder globally, corresponding to an increase of 27.6% (25.1 to 30.3%), with women being affected more than men: An increase of 29.8% (27.3–32.5%) compared to 24.0% (21.5–26.7%) in men. (COVID-19 Mental Disorders Collaborators 2021) In Latin America, a study conducted from April to December 2020 in four countries (Argentina, Brazil, Colombia, and Mexico) found that women reported higher anxiety, depression, and stress compared with men and that parents of adolescents fared worse than did families with younger children. (Ben Brik et al. 2022) A web-based study planned to investigate the potential predictors of depressive symptoms during the initial stage of the COVID-19 outbreak among Brazilian adults showed that quarantine length longer than 30 days, female sex, young age, and chronic diseases were associated with depressive symptoms. (Schmitt et al. 2021) Domestic violence, particularly intimate partner violence, and endemic systemic racism against Black women were also found to increase the risk of maternal depression during

the pandemic. (Njoroge et al. 2022; Sediri et al. 2020; She-wangzaw Engda et al. 2022).

Locations hit hardest by the pandemic in 2020, as measured with decreased human mobility and daily SARS-CoV-2 infection rate, had the greatest increases in prevalence of major depressive disorder. (COVID-19 Mental Disorders Collaborators 2021) Additionally, the long-term mental health impact of COVID-19 may take weeks or months to become fully apparent. (Maunder 2009) and is likely to be more severe among vulnerable populations, such as those who face barriers in accessing health care, those who belong to lower socio-economic strata, (Rajkumar 2020) and in countries where the offer of mental health assistance is limited. (Duan and Zhu 2020).

With a COVID-19 mortality rate five times higher than the global average, (Alves 2021) limited access to mental health services, (Munhoz et al. 2016) and socioeconomic inequalities in the prevalence of mental disorders, (Moraes et al. 2017) Brazil met all the conditions to raise concerns about the potential consequences of the pandemic on the mental health of the population. Thus, the purpose of this study was to examine the change in depressive symptoms before *versus* during the pandemic among mothers from a population-based birth cohort in Southern Brazil, and to explore whether changes differed based on pre-pandemic and pandemic-related factors.

Material and Methods

Pelotas is a Southern Brazilian city with a current population of about 344 000 inhabitants. All women who gave birth in 2004 and who lived in the urban area of the municipality were invited to participate in the Pelotas 2004 Birth Cohort. Births were identified by daily visits to all hospitals of the city, where 99% of births occur. Mothers were interviewed and their children were examined within 24 h postpartum. The sample included a total of 4,231 livebirths (non-response rate at recruitment < 1%). (Barros et al. 2006; Santos et al. 2011, 2014).

After birth, children were followed-up several times. Mothers were followed-up with questions at the same time points as the children. The current study used maternal variables collected at three moments: At birth, immediately before the pandemic (at the cohort 15-year follow-up, which started in November 2019 and was early interrupted on March 20, 2020, due to social distancing measures) and at mid-pandemic (carried out from August to December 2021). From now on the immediately before the pandemic follow-up will be called T₁ and the mid-pandemic follow-up will be called T₂. At T₁, data gathering from mothers and adolescents took place at the Center for Epidemiological

Research of the Federal University of Pelotas. At T₂ mothers were interviewed in person at their homes.

Depressive symptoms

Maternal depressive symptoms at T₁ and T₂ were assessed using the Edinburgh Postnatal Depression Scale. (Cox et al. 1987) The EPDS is a self-report questionnaire with ten items rated on a 4-point Likert scale, which measure the intensity of depressive symptoms over the previous seven days. The score range varies from 0 to 30 points, with higher scores indicating more severe depressive symptoms. Although the EPDS was developed for screening depression in women postnatally, it has been shown to be useful in the assessment of women outside the postnatal period. (Cox et al. 1996) The scale was validated in Brazil, (Santos et al. 2007) with sensitivity of 59.6% (49.5–69.1%) and specificity 88.3% (83.9–91.9%) at the cutoff ≥ 13 . Depressive symptoms were investigated both on a continuous scale (as symptoms) and in the binary (as depression).

Predictors of latent change scores

Selection of pre-pandemic and mid-pandemic predictors of latent change scores was based on the literature (Xiong et al. 2020) and on the availability of variables gathered at birth and at T₁ and T₂.

- Pre-pandemic predictors of latent change scores

Socio-demographic characteristics were assessed through interviews carried out with the women at the time of childbirth and included family income in the month prior to delivery (later grouped in quintiles); education (number of completed years of formal education); self-reported skin color (white or non-white), with non-white including brown, yellow, indigenous, and black skin color; living with a partner (yes/no); and age at childbirth. At T₁ the mothers were asked if they were currently working and/or employed; the number of people living in the household; and if the family was beneficiary of the government cash transfer program (*Programa Bolsa Família*). (Brasil and Ministério da Cidadania 2017).

- Pandemic-related predictors of latent change scores

During T₂ women were asked whether they lost their job during the pandemic (yes/no); if the family requested the pandemic-specific government cash transfer benefit (*Programa Auxílio Emergencial*) (yes/no); subjective perception of own overall health during the pandemic (“*Since the beginning of the pandemic, how do you classify your health?*”, with possible answers including “Excellent”, “Very Good”, “Good”,

“Regular”, and “Bad”), and analyzed as a score ranging from 0 (excellent) to 5 (bad); and family financial situation during the pandemic (“*Compared to February 2020, i.e., before the pandemic, how is your family’s financial situation?*”, with possible answers including “Better”, “Equal”, and “Worst”).

Statistical analysis

The analyses were restricted to women who had information in both T₁ and T₂ assessments. After the description of the sample, a paired t-test was employed to compare mean EPDS scores at T₁ and T₂. The chi-square test was used to compare the proportion of women with depression (EPDS ≥ 13) at T₁ and T₂. For a robust estimation of the changes in depressive symptoms between T₁ and T₂, a multivariate latent change score (LCS) modelling approach, as shown in Fig. 1A, was employed. (Kievit et al. 2018; Klopck and Wickrama 2020) In the next step, the T₁ (for the initial levels), and T₂ covariates (for the latent change scores) were included to investigate the predictors of the initial levels of depressive symptoms and of the latent change scores. Standardized coefficients for the predictors were calculated. The analyses were conducted in Mplus 8.4, (Muthén and Muthén, 2015) with maximum likelihood estimator (MLR) with robust standard errors. Missing data was handled using full information maximum likelihood estimation (FIML). (Enders 2010) As model fit indices for the multivariate latent change analysis, the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Root Mean Square Error of Approximation (RMSEA), and the Standardized Root Mean Square Residual (SRMR) were calculated. Specifically, CFI/TLI ≥ 0.90 , RMSEA < 0.08 and SRMR < 0.08 are considered a good fit. (Hu and Bentler 1998; Kline 2011).

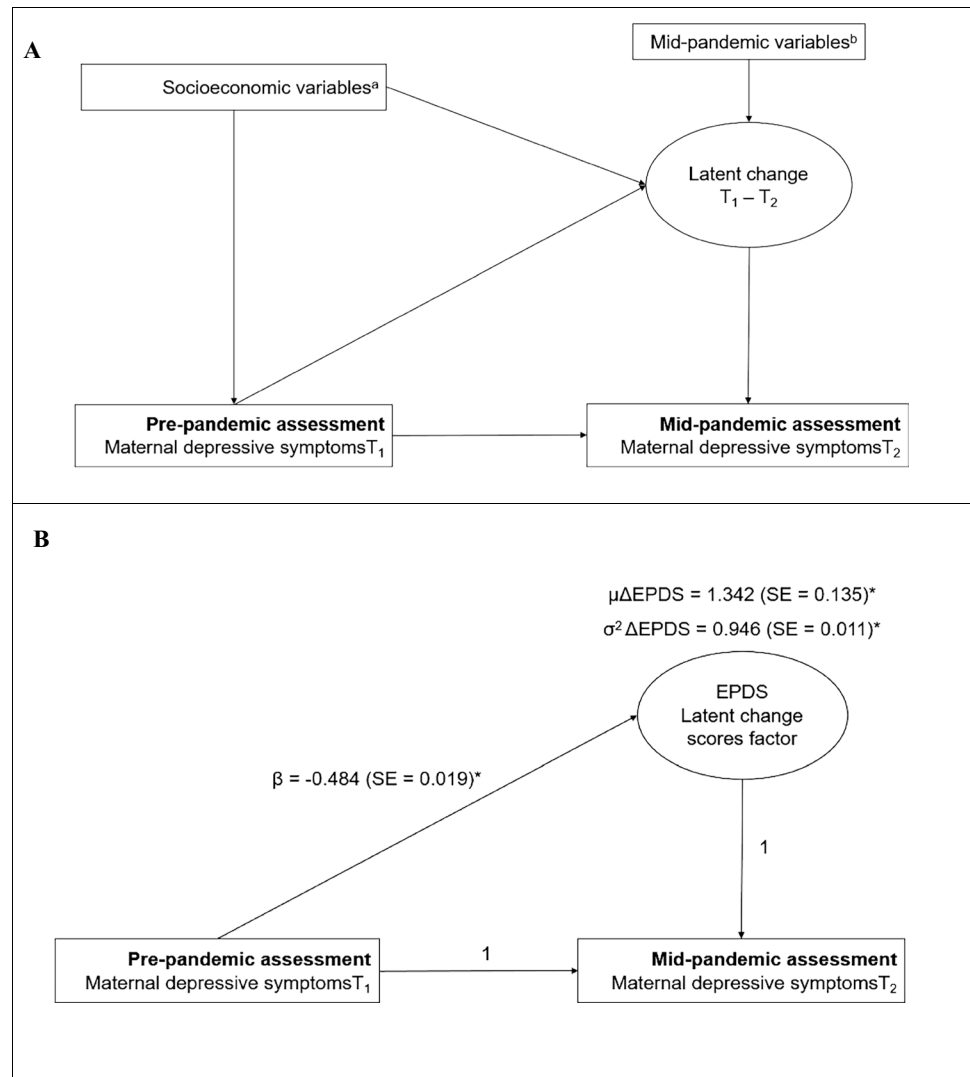
Ethics

All the Pelotas 2004 Birth Cohort follow-ups were approved by the Research Ethics Committee of the Faculty of Medicine, Federal University of Pelotas. All principal caregivers and adolescents signed an informed consent form before data collection. The present study was also approved by the Research Committee of the University of São Paulo School of Medicine. Women who were at risk of suicide or had severe symptoms of depression were home visited by mental health providers and/or were referred to mental health care services.

Results

Table 1 compares women characteristics at T₁ and T₂. A total of 1,949 women were interviewed at T₁, of whom 1,805 were reinterviewed at T₂. There was no difference between

Fig. 1 Latent change score (LCS) model for changes in maternal depressive symptoms between the pre- (T₁) and mid-pandemic (T₂) periods. (A) Theoretical model. ^aSocio-economic predictors included family income, schooling, skin colour, marital status, age at childbirth, employment status, and government cash transfer benefit (Programa Bolsa Familia) at T₁. ^bMid-pandemic predictors included job loss during pandemic, financial change during pandemic, perceived overall health, and pandemic-specific government cash transfer benefit (Programa Auxílio Emergencial). (B) Statistical model. $\mu\Delta EPDS$ refers to the mean latent change of the Edinburgh Postnatal Depression Scale (EPDS) between T₁ and T₂. $\sigma^2 \Delta EPDS$ represents the individual variability over time. Standardized estimates and coefficients are shown. SE = Standard error; * $p < 0.001$



the two samples in terms of socio-demographic characteristics. Among the 144 women lost between T₁ and T₂, the proportion of those with ≥ 9 years of schooling and living in households with four people or less was lower than in the samples assessed at T₁ and T₂.

Of the 1,949 women interviewed at T₁ 1,728 answered the EPDS questionnaire. Of the 1,805 women who were interviewed at T₁ and T₂, 1,661 answered the EPDS questionnaire at T₂. A total of 41 women missed EPDS information at T₁ and T₂. The analyzed sample comprised 1,550 women interviewed at T₁ and T₂, and with information on EPDS on both occasions.

Table 2 presents the characteristics of the women at childbirth (N = 4,231) and the proportion analyzed in the current study (N = 1,550). More than two thirds of the women (67.8%) were 20–34 years old at childbirth, 40.9% had nine or more completed years of school, more than one quarter (27.0%) self-reported non-white skin color, and 16.4% lived without a partner. The analyzed sample represented 36.6%

of the original cohort. The women's age and years of schooling, as well as the proportion of women who lived with a partner were higher in the analyzed sample than in the original cohort. The proportion of women from the first family income quintile was lower in the analyzed sample than in the entire cohort. There was no difference in the proportion of the women at the original cohort and the analyzed sample in regard to the skin color.

The mean time interval between T₁ and T₂ interview was 20.7 (standard deviation – SD = 1.5) months. The women were on average 43.2 (SD = 6.9) years old at T₁ and 44.9 (SD = 6.9) years old at T₂.

A paired t-test showed that there was a significant increase in the mean EPDS scores from T₁ (mean = 7.6; standard error—SE = 0.1) compared to T₂ (mean = 8.9; SE = 0.1) ($p < 0.001$). The proportion of women presenting EPDS score ≥ 13 at T₁ was 18.9% (95% confidence interval—95%CI 17.0–21.0%), in contrast to 26.1% (95%CI 23.9 – 28.3%) in T₂ ($p < 0.001$). Among the 294 women with

Table 1 Distribution of the women interviewed in the pre-pandemic wave (T₁), mid-pandemic wave (T₂) and of those lost to follow-up between T₁ and T₂

	Pre-pandemic sample (T ₁)	Mid-pandemic sample (T ₂)	Lost to follow-up between T ₁ and T ₂
	N = 1949	N = 1805	N = 144
	% (95% CI)	% (95% CI)	% (95% CI)
Schooling (years)			
0–4	14.3 (12.8 – 15.9)	14.2 (12.6 – 15.9)	15.9 (10.8 – 22.9)
5–8	40.8 (38.6 – 43.0)	40.0 (37.8 – 42.3)	50.7 (42.5 – 58.8)
≥ 9	44.8 (42.6 – 47.1)	45.8 (43.5 – 48.1)	33.3 (26.1 – 41.4)
Family income (quintiles)			
1 st quintile (poorest)	18.7 (17.0 – 20.5)	18.1 (16.3 – 19.9)	27.1 (20.4 – 34.9)
2 nd to 5 th quintile	81.3 (79.5 – 92.9)	81.9 (80.1 – 83.6)	72.9 (65.0 – 79.6)
Number of people living in the household at T ₁ ^a			
2–4	69.9 (67.7 – 72.0)	70.7 (68.5 – 72.9)	57.4 (48.2 – 66.1)
≥ 5	30.1 (28.0 – 32.2)	29.2 (27.1 – 31.5)	42.6 (33.9 – 51.8)
Skin color			
White	73.4 (71.4 – 75.3)	73.4 (71.3 – 75.4)	72.9 (65.0 – 79.6)
Non-white	26.6 (24.7 – 28.6)	26.6 (24.6 – 28.7)	27.1 (20.4 – 34.9)
Living with a partner at childbirth			
Yes	84.8 (83.1 – 86.3)	84.9 (83.2 – 86.5)	82.6 (75.5 – 88.0)
No	15.2 (13.7 – 16.9)	15.1 (13.5 – 16.8)	17.4 (12.0 – 24.5)
Age at birth (years)			
< 20	17.9 (16.3 – 19.7)	17.4 (15.8 – 19.3)	24.3 (18.0 – 32.0)
20–34	66.5 (64.4 – 68.5)	66.4 (64.1 – 68.5)	68.0 (60.0 – 75.2)
≥ 35	15.5 (14.0 – 17.2)	16.2 (14.5 – 17.9)	7.6 (4.3 – 17.9)
Beneficiary of government cash transfer program at T ₁ ^b			
Yes	13.7 (12.2 – 15.5)	13.6 (12.0 – 15.4)	15.2 (9.5 – 23.5)
No	86.2 (84.5 – 87.8)	86.3 (84.5 – 88.0)	84.8 (76.5 – 90.5)
Employed or working at T ₁			
Yes	63.3 (61.0 – 65.7)	68.2 (61.8 – 66.5)	51.4 (41.9 – 60.9)
No	36.6 (34.3 – 39.0)	35.8 (33.4 – 38.2)	48.6 (39.1 – 58.1)

95%CI: 95% confidence interval; ^a Number of people living in the household, including the cohort member (child born in 2004); ^b *Programa Bolsa Família*

EPDS ≥ 13 at T₁, 66.0% presented EPDS ≥ 13 at T₂, whereas among the 1,256 women with EPDS < 13 at T₁, 16.7% presented EPDS ≥ 13 at T₂ ($p < 0.001$).

Figure 1B shows the results for the multivariate latent change model. The model fit for the multivariate latent change model was excellent: $\chi^2 = 6.999$, $df = 3$, CFI/TLI = 0.997/0.972, RMSEA (90%CI) = 0.018 (0.000–0.035), and SRMR = 0.006. The mean of the latent change factor was positive and significant (mean slope = 1.342; SE = 0.135; $p < 0.001$), indicating a worsening in the women depressive symptoms during the pandemic. The variance for the latent change scores was significant ($\sigma^2 \Delta EPDS = 0.946$; SE = 0.011; $p < 0.001$), meaning that there were significant inter-individual differences in the amount of depressive symptom changes experienced by the women included in the study. The coefficient for the proportional change was negative and significant ($\beta = -0.484$; SE = 0.019; $p < 0.001$), indicating that the lower the level of depressive symptomatology

in T₁, the greater the increase in EPDS observed from T₁ to T₂.

Table 2 shows the predictors for depressive symptoms at T₁ and for the latent change scores. Better indicators of socioeconomic position were associated with lower levels of depressive symptoms at T₁. Higher schooling, higher family income and being employed or working were related to lower EPDS scores at T₁. On the other hand, being a beneficiary of the *Programa Bolsa Família* and a larger number of people living in the household predicted higher levels of depressive symptoms at T₁.

None of the socio-demographic and pre-pandemic characteristics was a predictor for change in depressive symptoms between T₁ and T₂, thus indicating that the size of increase (positive β coefficients) or decrease (negative β coefficients) related to these characteristics did not depend on EPDS values at T₁. Of the pandemic-related predictors, the deterioration of ones' own perception of quality of overall health

Table 2 Socio-demographic characteristics of study participants

Characteristics	Original cohort (at child birth) N = 4231	Analyzed sample (%) N = 1550	<i>p</i> -value*
Schooling (years)			0.005
0–4	655 (15.6)	30.7	
5–8	1731 (41.4)	35.3	
≥ 9	1802 (43.0)	40.9	
Family income (quintiles)			< 0.001
1 st quintile (poorest)	872 (20.6)	30.7	
2 nd to 5 th quintile	3359 (79.4)	38.2	
Skin color			0.746
White	3090 (73.0)	36.8	
Non-white	1141 (27.0)	36.2	
Living with a partner at childbirth			0.018
Yes	3539 (83.6)	37.4	
No	693 (16.4)	32.6	
Age at childbirth (years)			< 0.001
< 20	799 (18.9)	31.4	
20–34	2865 (67.8)	36.1	
≥ 35	563 (13.3)	46.9	

* *p*-value for the difference in the proportion of women at the analyzed sample in relation to the distribution of the women at the original cohort

($\beta = 0.191$; $SE = 0.028$; $p < 0.001$) and a worst family financial situation due to the pandemic ($\beta = 0.083$; $SE = 0.024$; $p = 0.001$) were positive, thus indicating that these variables predicted the increase in EPDS score counting observed from T_1 to T_2 .

Discussion

Using data from mothers of a Brazilian ongoing population-based birth cohort, this study found that about one in every five women interviewed at T_1 was depressed ($EPDS \geq 13$). At T_2 , one in every four women scored $EPDS \geq 13$, representing a 38.1% increase in depressive symptoms prevalence between the pre-pandemic and the mid-pandemic period. At T_1 , the predictors of lower EPDS score were higher family income, being employed or working, and higher schooling, whereas the predictors of higher EPDS was the greater number of people living in the household and being beneficiary of the government cash transfer program. The deterioration in mental health from T_1 to T_2 was mainly predicted by a worst perception of women's own health and a worsening in the family financial situation from before to during the pandemic.

The prevalence of depressive symptoms at T_1 (18.9%; 95%CI 17.0–21.0%) in our study is in agreement with the

results of a meta-analysis of population-based cross-sectional studies of Brazilian adults (18–65 years old), which found an overall prevalence of depressive symptoms in the female population of 22% (95%CI 20–24%).(Silva et al. 2014) On the contrary, the prevalence of depressive symptoms at T_1 in our study is higher than the observed in other countries (14.4%).(Lim et al. 2018) The higher prevalence among Brazilian women may in part be explained by heightened exposure to severe adversity, particularly violence against women and girls. A study planned to investigate the mediating effect of violence in the association between biological sex and depression or suicidal ideation in adult respondents to a nationwide Brazilian survey found that women were at higher risk of major depressive episode and suicidal ideation than men, and that this association was mediated by suffering violence from a family member or acquaintance in the last 12 months.(Carpena et al. 2020).

The prevalence of depressive symptoms at T_2 (26.1%) in our study is similar to that reported in a systematic review and meta-analysis of 173 studies conducted during the first six months of the COVID-19 pandemic (27%; 95%CI 24–31%).(Dragioti et al. 2022) That meta-analysis reported that the overall increase in mental health symptoms was most pronounced during the first two months after the World Health Organization declared a pandemic (March 2020), before decreasing and being comparable to pre-pandemic levels for most symptom types by mid 2020. Our data however were collected more than 20 months after the beginning of the SARS-CoV-2 domestic transmission in Brazil and around six months after the second and most severe peak of COVID-19 in the country, leading to several thousand deaths by the disease per day. Thus, our findings indicate not only that the pre-pandemic prevalence of depressive symptoms in our setting was higher than in European and North American countries (where most of the studies of the impact of COVID-19 over mental health came from), but also that depressive symptoms arising during the pandemic lasted longer among our population or that the negative feelings raised by the second wave of the pandemic triggered adverse effects on mental health (Table 3).

In the adjusted analyses, the deterioration in mental health from T_1 to T_2 was mainly predicted by a worst perception of women's own health and with a worsening in the family financial situation from before to during the pandemic. Self-evaluation of health state is subjective, combining physical and emotional issues, including sense of wellbeing and satisfaction with life and does not refer exclusively to feelings of physical pain and discomfort, but also to the psychological and social consequences of having a problem.(Fayers and Sprangers 2022) A population-based study in Brazil found that, after adjusting for age, material hardship was among the factors that contributed most to deterioration of health perception among the women.(Szwarcwald, Souza-Júnior,

Table 3 Demographic, pre-pandemic and mid-pandemic predictors of T₁ EPDS scores and latent change scores from T₁ to T₂

	Pre-pandemic (T ₁) EPDS scores	p-value	Latent change score	p-value
	β coefficient (SE ^a)		β coefficient (SE ^a)	
<i>Demographic and pre-pandemic predictors</i>				
Schooling (years)	-0.094 (0.030)	0.002	0.035 (0.031)	0.263
Family income (quintiles)	-0.065 (0.029)	0.025	0.020 (0.031)	0.520
Number of people living in the household	0.065 (0.028)	0.022	-0.036 (0.030)	0.240
Single	-0.033 (0.025)	0.193	-0.050 (0.028)	0.071
Non-white	0.009 (0.026)	0.734	-0.053 (0.027)	0.051
Age (years)	-0.012 (0.026)	0.649	-0.001 (0.026)	0.972
Beneficiary of government cash transfer program at T ₁ ^b	0.075 (0.029)	0.011	-0.025 (0.028)	0.375
Employed or working at T ₁	-0.065 (0.026)	0.012	0.028 (0.028)	0.317
<i>Pandemic-related predictors</i>				
Job loss during the pandemic	-	-	0.018 (0.023)	0.432
Beneficiary of pandemic-specific government cash transfer program ^c	-	-	-0.009 (0.024)	0.719
Worst perception of own overall health	-	-	0.191 (0.028)	<0.001
Worst financial situation due to the pandemic	-	-	0.083 (0.024)	0.001

Standardized β coefficients are shown. Maximum likelihood robust estimator was used, with full maximum information likelihood for handling missing data; ^aSE = standard error; ^bPrograma Bolsa Família; ^cAuxílio Emergencial

Esteves, Damacena, & Viacava, 2005) Thus, the association of worst perception of women's own health and the worsening in the family financial situation with increase in EPDS score found in our study reflects the interconnection between these two determinants of mental health.

Although depression results from a complex interaction between social, psychological, and biological factors, periods of major economic crises, which lead to unemployment, financial difficulties, and increased poverty have been associated with increase in prevalence of mental disorders, particularly in rates of depression and suicide. (Ibrahim et al. 2019; Konstantakopoulos et al. 2019; Stuckler et al. 2009) In Brazil, after a period of improved economic growth, (International Monetary Fund and World Economic Outlook 2012) from 2013 onwards the country is facing a scenario of economic recession, with increased unemployment, precarious work, and increased poverty, which may lead to feelings of disillusion and hopelessness in the population. This situation was aggravated by the arrival of COVID-19 pandemic in the country. Also, the care of children after the closing of schools and of family members who fall ill are generally the responsibility of women. (Wenham et al. 2020) Women are more likely to be financially disadvantaged during the pandemic because they perceive lower salaries and have less savings and less secure employment than men. (Burki 2020) Thus the consequences of economic hardships are more likely to affect the women than men. They are also more likely to be victims of domestic violence, the prevalence of which increased during periods of lockdown and stay-at-home orders. (Arenas-Arroyo, Fernandez-Kranz, &

Nollenberger, 2021; Piquero, Jennings, Jemison, Kaukinen, & Knaul, 2021) All these factors contribute to the incidence or the worsening of depressive symptoms among the women.

The perceived worsening in the overall health and in the financial situation are per se risk factors for mood depression. (Goodwin 2006; Guan, Guariglia, Moore, Xu, & Al-Janabi, 2022) In the current study, however, these two variables were investigated taking into account their relationship with the pandemic. Then, in our study, these two pandemic-related predictors should not be interpreted as risk factors for mood depression but as proxies for the effect of COVID-19 pandemic in the women mental health.

Strengths and limitations

Among the strengths, longitudinal studies are unique to characterize the time course of the mental health burden associated with the COVID-19 pandemic. More, a longitudinal study using an established cohort with pre-pandemic data for comparison meets the ideal conditions to provide more detailed and reliable evidence of this association.

Among the limitations, this study reports the impact of COVID-19 over depressive symptoms at the second half of 2021, when the vaccines against the SARS-Cov-2 were in place and the caseload of the infection was decreasing in Brazil. Although we can intuitively estimate that depression rates would be higher when the vaccines were not available and the rate of infection and mortality were very high, other aspects of social life in Brazil (federal government minimization of the severity of COVID-19, lack of political

coordination and lack of educational campaigns on the importance of non-pharmacological measures) could have affected the result in the opposite direction. Also, we have no information about the occurrence of COVID-19 in the women nor whether some of them became seriously ill from COVID-19. Additionally, the self-evaluation of health state is inclusive of emotional issues and the observed relationship between that factor and depressive symptoms may be almost entirely driven by that construct. Another limitation of the study is the lack of information on domestic and intimate partner violence, which is an important risk factor associated with an increase in the prevalence of mental disorders during times of major economic crisis. Women who suffered domestic violence during the pandemic showed more severe symptoms of depression, anxiety, stress, and suicidal ideation. (Sediri et al. 2020; Shewangzaw Engda et al. 2022) Also, the women's age and years of schooling, as well as the proportion who lived with a partner were higher in the analyzed sample than in the original cohort, and the proportion of women belonging to the poorest families was lower in the analyzed sample than in the entire cohort. But, as these characteristics were not associated with the outcome, these differences probably have not introduced selection bias in our results.

Conclusion

This cohort study examining the presence of depressive symptoms prior to (2019) and during the COVID-19 pandemic (2021) among mothers from a population-based cohort study in Brazil showed that there was a statistically significant increase in depressive symptomatology in the period. The increase was larger for women with a perceived worsening in their overall health and in their financial situation due to the pandemic. These two pandemic-related predictors should not be interpreted as risk factors for mood depression but as proxies for the effect of COVID-19 pandemic (the true exposure of interest) in the women mental health.

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Declarations

Conflict of interests The authors have no competing interests to disclose.

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