Midwifery 120 (2023) 103631

Contents lists available at ScienceDirect

Midwifery

journal homepage: www.elsevier.com/locate/midw

The impact of COVID-19 on breastfeeding rates: An international cross-sectional study

Ana Ganho-Ávila[a,*], Raquel Guiomar[a,*], Mónica Sobral[a], Francisca Pacheco[a], Rafael A. Caparros-Gonzalez[b,c,d], Carla Diaz-Louzao[e], Emma Motrico[f], Sara Domínguez-Salas[f], Ana Mesquita[g], Raquel Costa[h,i,j], Eleni Vousoura[k], Eleni Hadjigeorgiou[l], Rena Bina[m], Rachel Buhagiar[n], Vera Mateus[o], Yolanda Contreras-García[p], Claire A. Wilson[q], Erilda Ajaz[r], Camellia Hancheva[s], Pelin Dikmen-Yildiz[t], Alejandro de la Torre-Luque[u]

[a] *Center for Research in Neuropsychology and Cognitive Behavioral Intervention, Faculty of Psychology and Educational Sciences, University of Coimbra, 3000-115 Coimbra, Portugal*
[b] *Department of Nursing, Faculty of Health Sciences, University of Granada, 18071 Granada, Spain*
[c] *Instituto de Investigación Biosanitaria ibs. Granada, Spain*
[d] *Mind, Brain, and Behavior Research Center (CIMCYC), University of Granada, 18011 Granada, Spain*
[e] *Research Methodology Group, University Clinical Hospital of Santiago (CHUS), Health Research Institute of Santiago de Compostela (IDIS), Santiago de Compostela, 15706, Spain*
[f] *Psychology Department, Universidad Loyola Andalucia, Avenida de las Universidades s/n, Dos Hermanas (Sevilla), Spain*
[g] *School of Psychology, University of Minho, Campus Gualtar, 4710-057 Braga, Portugal*
[h] *EPIUnit - Instituto de Saúde Pública, Universidade do Porto, Rua das Taipas, n° 135, 4050-600 Porto, Portugal*
[i] *Laboratório para a Investigação Integrativa e Translacional em Saúde Populacional (ITR), Universidade do Porto, Rua das Taipas, n° 135, 4050-600 Porto, Portugal*
[j] *HEI-Lab: Digital Human-environment Interaction. Lusófona University, Lisbon, Portugal*
[k] *Department of Psychology, National and Kapodistrian University of Athens, Greece*
[l] *Nursing Department, School of Health Science, Cyprus University of Technology, Cyprus*
[m] *School of Social Work, Bar Ilan University, Ramat Gan, Israel*
[n] *Department of Psychiatry, University of Malta, Malta*
[o] *Graduate Program on Developmental Disorders and Mackenzie Center for Research in Childhood and Adolescence, Center for Biological and Health Sciences, Mackenzie Presbyterian University, São Paulo, Brazil*
[p] *Departamento de Obstetricia y Puericultura. Facultad de Medicina. Universidad de Concepción, Chile*
[q] *Section of Women's Mental Health, King's College London and South London and Maudsley NHS Foundation Trust, UK*
[r] *College University Beder, Tirana, Albania*
[s] *Sofia University St Kliment Ochridski, Bulgaria*
[t] *Department of Psychology, Kirklareli University, Kirklareli, Turkey*
[u] *Department of Legal Medicine, Psychiatry and Pathology, Universidad Complutense de Madrid. Centre for Biomedical Research in Mental Health (CIBERSAM), 28040 Madrid, Spain*

ARTICLE INFO

Article history:
Received 9 July 2022
Revised 17 January 2023
Accepted 6 February 2023

Keywords:
Breastfeeding
Perinatal health
Cross-countries
COVID-19
SARS-CoV-2

ABSTRACT

Background: Breastfeeding promotes children's health and is associated with positive effects to maternal physical and mental health. Uncertainties regarding SARS-CoV-2 transmission led to worries experienced by women and health professionals which impacted breastfeeding plans. We aimed to investigate the impact of self-reported and country-specific factors on breastfeeding rates during the COVID-19 pandemic.
Methods: This study is part of a broader international prospective cohort study about the impact of the COVID-19 pandemic on perinatal mental health (Riseup-PPD-COVID-19). We analysed data from 5612 women, across 12 countries. Potential covariates of breastfeeding (sociodemographic, perinatal, physical/mental health, professional perinatal care, changes in healthcare due to the pandemic, COVID-19 related, breastfeeding support, governmental containment measures and countries' inequality levels) were studied by Generalized Linear Mixed-Effects Models.

* Corresponding authors.
E-mail addresses: ganhoavila@fpce.uc.pt (A. Ganho-Ávila), raquel.guiomar@uc.pt (R. Guiomar).

https://doi.org/10.1016/j.midw.2023.103631
0266-6138/© 2023 Elsevier Ltd. All rights reserved.

Results: A model encompassing all covariates of interest explained 24% of the variance of breastfeeding rates across countries (first six months postpartum). Overall, first child (β = -0.27), age of the child (β = -0.29), preterm birth (β = -0.52), admission to the neonatal/pediatric care (β = -0.44), lack of breastfeeding support (β = -0.18), current psychiatric treatment (β = -0.69) and inequality (β = -0.71) were negatively associated with breastfeeding ($p < .001$). Access to postnatal support groups was positively associated with breastfeeding ($\beta = 0.59$; $p < .001$). In countries with low-inequality, governmental measures to contain virus transmission had a deleterious effect on breastfeeding (β = -0.16; $p < .05$) while access to maternity leave protected breastfeeding ($\beta = 0.50$; $p < .001$).
Discussion: This study shows that mother's COVID-19 diagnosis and changes in healthcare and birth/postnatal plans did not influence breastfeeding rates. Virtual support groups help women manage breastfeeding, particularly when their experiencing a first child and for those under psychiatric treatment. The complex associations between covariates and breastfeeding vary across countries, suggesting the need to define context-specific measures to support breastfeeding.
© 2023 Elsevier Ltd. All rights reserved.

Introduction

Breastfeeding improves children survival rates (Yapo, 2020), provides health and developmental advantages (Bartick et al., 2021; Koletzko et al., 2019), and boosts maternal physical and mental health (Victora et al., 2016; Yuen et al., 2022). However, uncertainties associated with the risk of transmission of the SARS-CoV-2 from infected mothers to their newborns and governmental containment measures to minimize virus spread have impacted breastfeeding plans, both negatively and positively (Caparros-Gonzalez et al., 2020; Peroni and Fanos, 2020; Vassilopoulou et al., 2021). Furthermore, the delay in testing the safety of SARS-CoV-2 vaccines for breastfeeding women and the frequent recommendation updates as evidence accumulated, increased vaccinated women's level of uncertainty, potentially disrupting their breastfeeding plans (Sutton et al., 2021). Conversely, governmental confinement mandates allowed breastfeeding women to stay at home beyond maternity leaves via teleworking, which for many was an opportunity to extend their breastfeeding.

Both prior to and during the COVID-19 pandemic, the World Health Organization (WHO) acknowledged breastfeeding as the preferred feeding method for newborns and infants, particularly during the first six months of life (World Health Organization, 2017, 2020). Indeed, WHO have declared their ambition that by 2025, 50% of the world's children be exclusively breastfed during the first six months of life, regardless the socioeconomic and cultural setting (World Health Organization, 2017, 2020).

The two largest systematic reviews and meta-analysis commissioned by the WHO (funded by Bill & Melinda Gates Foundation;(Rollins et al., 2016; Victora et al., 2016)) showed that breastfeeding initiation, type, and duration differ between women according to distinctive biopsychosocial factors. Biological factors that impact breastfeeding (such as prenatal maternal medication, prematurity and neonatal care) explain a small proportion of those who do not initiate early breastfeeding or stop it in the first months of life (Rollins et al., 2016). Individual factors such as women's smoking, overweight and mental health can potentially compromise breastfeeding as well (Rollins et al., 2016). Nevertheless, according to the literature, the strongest predictor of breastfeeding is the women's prenatal and postnatal intention, and this is particularly true when there is a favourable socioeconomic context (Celi et al., 2005).

Paradoxically, although low-income and lower-middle-income countries have fewer policies supporting new mothers, these countries report higher general breastfeeding rates (more than 90%) than high-income countries (HIC; less than 85%). Moreover, whereas breastfeeding rates at 6 months are above 80% in low and lower-middle income countries, it is below 80% in upper-middle income countries, and below 45% in high-income countries. The same direction of differences continues toward the 12 months of the child, when breastfeeding prevalence is lower than 20% in most high-income countries (exceptions go to the USA (27%) and Norway (35%)) (Victora et al., 2016).

The trend to substitute breastfeeding/breast milk in high-income countries or in wealthier groups in lower- and middle-income countries started in the 20th century with the public space gained by the formula market and breast milk substitutes industry along with women's increased participation in the economies as active workers (Rollins et al., 2016). Currently, however, this trend is reversing. Wealthier and more educated women in middle and high-income countries tend to present higher breastfeeding rates than those from lower income groups and with lower levels of education. Nevertheless, in lower income-countries breastmilk substitutes is still positively correlated with the household income (Victora et al., 2016).

In global health crises such as the COVID-19 pandemic, several factors affected breastfeeding rates. Across countries, new hospital practices aiming to mitigate the virus transmission between the mother and the child (e.g., mother-infant separation, pre-lacteal supplementation) contributed to delayed or non-initiation of breastfeeding. Similarly, community containment measures compromised health care visits and postnatal care follow-ups and limited social contacts and familial support, further reducing breastfeeding support to new mothers (Kotlar et al., 2021). Globally, the COVID-19 pandemic had a negative toll on economies, increasing unemployment rates (mostly for women), and leading to financial insecurity (Motrico et al., 2020). In addition, exposure to the disease, mortality, grief, and the perception of threats to life, along with over-exposure to social media information associated with SARS-CoV-2 transmission contributed to increased uncertainty and insecurity, exerting a mental health burden on pregnant and young mothers (Usmani et al., 2021). Nonetheless, the impact of the pandemic might not have been equal for all women within and across countries, as it depended on the local epidemiological context, the socioeconomic and cultural circumstances, and on the readiness of national or local governments to manage public health in face of the pandemic outbreaks (Hale et al., 2021).

Given the uncertainties and life-changes surrounding the COVID-19 context in the past two years, this study aims to gather a cross-cultural understanding about the influence of sociodemographic variables, perinatal outcomes, mothers physical and mental health, professional perinatal care, changes in healthcare and birth/postnatal plan due to the pandemic, breastfeeding support, COVID-19 diagnosis of the mother, governmental containment measures and countries' inequality levels concerning education, health on breastfeeding rates during the COVID-19 pandemic, through self-reports of women from 12 collaborating countries of the Riseup-PPD-COVID-19 observational prospective study (Motrico et al., 2021).

Methods

Study design, ethics and hypotheses

This study is part of a larger international prospective cohort study about the impact of the COVID-19 pandemic on perinatal mental health (Riseup-PPD-COVID-19). It was conducted across the 12 participant countries, namely in eight high-income countries (Chile, Cyprus, Greece, Israel, Malta, Portugal, Spain, and the United Kingdom) and four upper-middle income countries (Albania, Brazil, Bulgaria, Turkey), according to the World Bank (https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html).

The study complied with the regulatory documents for studies in humans (namely the Ethical Principles of the Chapter of Fundamental Rights of the EU, and the updated Declaration of Helsinki) and was approved by each local Ethical Committee prior to initiation. Data processing and management complied with the Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April and repealing Directive 95/46/EC (General Data Protection Regulation). Electronic informed consents were obtained from all participants, and procedures to secure privacy, confidentiality, and anonymization were strictly followed. Study procedures are described in detail elsewhere (Motrico et al., 2021).

We hypothesized that sociodemographic variables (e.g., unemployment), perinatal outcomes (e.g., preterm birth), variables related to mental (e.g. depression and anxiety symptoms) and physical health conditions (e.g., respiratory problems, diabetes, heart disease), COVID-19 diagnosis of the mother, and COVID-19-related variables (e.g., number of new infections per million at the time of response [Global Change Data Lab, online, available at https://ourworldindata.org/]) would reduce breastfeeding rates. Additionally, we expected that putatively protective breastfeeding factors such as those concerning maternity-related support (e.g., access to perinatal healthcare, or attending breastfeeding support groups), would contribute to increased breastfeeding rate. Finally, and in line with the breastfeeding trend between low-income and high-income countries, we hypothesised that women from upper-middle income countries would present increased breastfeeding rates compared with women from high-income countries.

As for governmental responses to the COVID-19 outbreak (e.g., school/work closures) our study was exploratory, as according to the literature, these can be both protective (e.g., extended maternity leave) and unprotective (e.g., reduced social support) towards breastfeeding plans. We modelled governmental response distributions according to the Containment and Health Index (CHI), a cross-temporal and real-time updated measure of governmental responses over the pandemic period, from the Oxford COVID-19 Government Response Tracker (OxCGRT) (Hale et al., 2021).

Hence, we anticipated country-specific variability in breastfeeding decisions and conducted a subgroup analysis rendering to the Inequality-adjusted Human Development Index (IHDI), to capture how the distribution of health, education, and income within each country would impact breastfeeding. The estimates used were those from 2019 (United Nations Development Program, available online, http://hdr.undp.org/en/countries). Finally, to better picture our data we conducted a subgroup analysis accounting for countries' economies contrasting middle-high with high-income countries.

Participants and data collection

Women in the perinatal period from 10 European countries (Albania, Bulgaria, Cyprus, Greece, Israel, Malta, Portugal, Spain, Turkey, and the United Kingdom), together with Brazil and Chile, participated in the larger study. Recruitment was conducted indirectly, through social media (Twitter, WhatsApp, Facebook and Instagram, Reddit, ResearchGate, LinkedIn), networks of involved organizations, such as universities, health centers and NGOs, policymakers, and other stakeholders involved in the field of perinatal mental health and participating in Riseup-PPD COST Action (CA18138); and directly, through personal messages or email to other networks where the research team is involved. A unique link was set per country, that provided information about the study in the local language (i.e., study purpose, voluntary nature of participation, risks and benefits, confidentiality), an informed consent, the local research coordinators' contacts, and the questionnaires. Participants completed the 20 min online survey about their "experiences and feelings associated with the COVID-19 pandemic". The survey took about 20 min to complete. Recruitment occurred between 7 June and 31 October 2020and during this period 15,611 women answered the survey.

For the current study, the original dataset was reviewed according to new eligibility criteria. That is, because we were interested in breastfeeding rates, only data entries from postpartum women (women within the first 6 months after birth by the time of survey completion) were included. Complete data entries from pregnant women or women beyond the first six months after birth by the time of survey completion were excluded (not eligible participant's entries (n = 260, 1.7%). Additionally, participants' data entries were excluded whenever eligibility criteria were unclear due to 1) uncomplete data about the newborn/infant age (n = 4976; 31.9%), uncomplete data concerning pregnancy or postpartum (n = 1798, 11.5%), incoherent data (e.g., incoherent dates of birth/expected date of birth; n = 300; 1.9%), duplicates (n = 112; 0.7%) and extremely incomplete questionnaires (n = 2553, 16.4%). The remaining eligible 5612 participants were included in the analysis.

Measures

To accomplish the study objectives, we selected a set of critical self-reported variables within the full scope of the Riseup-PPD-COVID-19 Survey, concerning sociodemographic variables, perinatal outcomes, physical and mental health status, professional perinatal care, changes in healthcare and birth/postnatal plan due to the pandemic context, COVID-19 diagnosis of the mother, breastfeeding support during COVID-19, and breastfeeding status (Table S2 depicts these set of selected variables and corresponding questions/answers).

Three other variables, concerning local context specificities, were extracted from online sources:

The **new covid cases per million** (at the date of survey completion), available at the COVID-19 Data Repository by the Center for Systems Science and Engineering (CSSE) of the Johns Hopkins University (Global Change Data Lab, online, available at https://ourworldindata.org/).

The **containment health index (CHI)**, a composite measure combining restrictions such as school/work closures, travel bans, testing policy, contact tracing, face coverings, and vaccine policy). CHI is updated in real-time by the Oxford COVID-19 Government Response Tracker (OxCGRT; online, available at https://www.bsg.ox.ac.uk/research/research-projects/covid-19-government-response-tracker) (Hale et al., 2021). Exposure to CHI was operationalized as the area under the curve (AUC) of the 30 days before the date of participation for each woman.

The **Inequality-adjusted Human Development Index (IHDI)**, a distribution-sensitive measure of the human development level within countries that was developed by the United Nations Organization. IHDI comprises three dimensions concerning countries' achievements: health, education, and income, and considers how these are distributed among the population. Lower values indicate

higher inequality. Estimates for 2019 were retrieved online (United Nations Development Program, online, hdr.undp.org/en/countries).

Data analysis

Missing data (13.52%) were imputed under the random forest algorithm, with 10 multiple imputations, and 50 maximum iterations to find the optimal solution of imputed data (see number of participants with missing data for each variable of interest prior to missing data imputation in Table S1). Density plots showed that imputed data followed the same distribution as the original data (Figure S1, in Supplementary Materials). The main and subgroup analyses were repeated in the complete cases sub-sample to see if results would change. As presented in the supplementary materials section (supplemental data analysis), results in the complete cases (N = 3337) broadly mirrored imputed analyses. Descriptive statistics for the influencing factors on breastfeeding rates were compared across countries using the Pearson's $\chi 2$ test for categorical and Mann-Whitney's U test for continuous independent variables (not normally distributed). To deal with type I error inflation due to the large sample size, only medium effect-size differences were considered meaningful (for categorical variables: Cramer's $V \geq 0.30$; for continuous variables: Cohen's $d \geq 0.50$; Lin et al., 2013). Generalized Linear Mixed-Effects Models were used to study the relationship between potential covariates (independent variables) and the breastfeeding rate (dependent variable), controlling for the country. We followed a forward approach for covariate entry, supported by previous reviews (Pacheco et al., 2021). Models with an increasing number of covariates were estimated: an unconstrained model (without covariates; Model 1), a model with sociodemographic covariates (Model 2), and the full model with all covariates of interest (Model 3; see Table 1). Model fit was compared with the Akaike Information Criterion (AIC), (Sakamoto et al., 1986) with lower values indicating a better fit. The conditional R^2 was used as an estimate of explained variance by the entire model (Nakagawa and Schielzeth, 2013). Variance inflation factor (VIF) values were used to assess multicollinearity between the variables (whether the estimated coefficients were inflated due to shared variance between the covariates; Shrestha, 2020). VIF values between 1 and 5 suggest moderate correlation between the variables, and values over 10 indicate high multicollinearity (Belsley, 1991). To further explore the results, subgroup analyses were conducted comparing model covariates of breastfeeding between high and low IHDI countries (divided according to percentiles) such that countries with higher inequality levels were below 40% of the IHDI percentile (Chile, Brazil, Turkey, Albania, Portugal, Bulgaria), and countries with lower inequality levels were above 60% of the IHDI percentile (Israel, Spain, Greece, UK, Cyprus, and Malta). The full generalized linear mixed-effects model with the covariates of interest previously tested was repeated for the two subgroups. The significant factors of each model, and the country-specific intercepts were qualitatively compared.

All analyses were conducted on R software, (R Core Team, 2021) with *mice, lmerTest, lme4, psych*, and *glmnet* packages.

Results

Descriptive statistics

The total sample comprised 5612, mothers (mean age = 32.2, SD = 5.13), the majority of whom were living in Portugal, Brazil, Turkey, and Spain (18.7%, 18.1%, 12.8% and 11.1%, respectively) and completed the survey in the postpartum period (mean newborn/infant age in days = 94.95; SD = 51.66). Significant differences between mothers currently breastfeeding (vs. not breastfeeding) in the variables of interest had a small effect size, and therefore were not considered meaningful. Detailed descriptive statistics are displayed in Table 1.

Generalized linear mixed-effects models

The full model with all covariates of interest (Model 3) was the one showing a better fit to the data (AIC = 4672.10), explaining 24% of the variation in the breastfeeding rate (for more details about Models 1, 2 and 3, and comparative estimations see Table 2). Model 3 suggests that the probability of women to breastfeed was significantly reduced when her child was older (OR = 0.75, SE = 0.04, $Z = -7.12$, $p < .001$) and when this child was her first (OR = 0.76, SE = 0.08, $Z = -3.32$, $p < .001$). The probability of breastfeeding was also reduced when the birth was preterm (< 37 or < 32 weeks' gestation; OR = 0. 59, SE = 0.13, $Z = -4.00$, $p < .001$), and when the baby was admitted to NICU/PICU (OR = 0.64, SE = 0.13, $Z = -3.42$, $p < .001$). Moreover, reduced probability to breastfeed was found when mothers were currently receiving psychiatric treatment (OR = 0.50, SE = 0.17, $Z = -4.06$, $p < .001$), when there was a lack of lactation or other postnatal support following discharge from the hospital as a result of the COVID-19 outbreak (OR = 0.84, SE = 0.09, $Z = -1.98$, $p < .05$), and when the mother perceived no/irrelevant changes to prenatal care due to COVID-19 pandemic context (OR = 0.78, SE = 0.10, $Z = -2.48$, $p < .05$). Finally, breastfeeding rate was lower in countries with higher IHDI (that is, in countries showing lower levels of inequality across education, health and income; OR = 0.49, SE = 0.19, $Z = -3.72$, $p < .001$).

On the contrary, the model supports that when the mother was on maternity leave (OR = 1.54, SE = 0.11,Z = 3.97, $p < .001$), or when she had access to virtual support groups (e.g., virtual mom group, virtual lactation support; OR = 1.80, SE = 0.09,Z = 6.91, $p < .001$) the probability of breastfeeding increased. No other covariates were significantly associated with breastfeeding rates. VIF values ranged from 1.02 to 2.37, meaning that no multicollinearity issues between model covariates were detected.

Regarding the random-effects component (i.e., country-specific effects; Fig. 1), data on intercept provide marginal predictions of breastfeeding probability, when the covariates have a zero (random-effects) effect. In this regard, Chile, Israel and Turkey showed higher random-effects intercept, supporting an increased probability of women to breastfeed in these countries. On the contrary, Brazil, Cyprus, Bulgaria, and Malta showed lower random-effects intercept, suggesting a decreased probability of breastfeeding.

As for subgroup analysis, in both high and low inequality level countries, breastfeeding rates decreased when the baby was older (OR = 0.70, SE = 0.06, $Z = -5.50$, $p < .001$; OR = 0.79, SE = 0.05, $Z = -4,45$, $p < .001$, respectively), when the woman was experiencing her first child (OR = 0.76, SE = 0.13, $Z = -2.23$, $p < .05$; OR = 0.77, SE = 0.11, $Z = -2,36$, $p < .05$, respectively), when the birth was preterm (OR = 0.54, SE = 0.19, $Z = -3.14$, $p < .01$; OR = 0.65, SE = 0.18, $Z = -2,43$, $p < .05$, respectively), and when the mother was currently under psychiatric treatment (OR = 0.56, SE = 0.26, $Z = -2.22$, $p < .05$; OR = 0.43, SE = 0.23, $Z = -3,62$, $p < .001$, respectively; see Table S3). For both groups, breastfeeding was more likely when the mother had access to virtual support groups (e.g., virtual lactation support or virtual mom groups; OR = 1.57, SE = 0.13,Z = 3.59, $p < .001$; OR = 2.08, SE = 0.12,Z = 6.14, $p < .001$, respectively).

For high inequality level countries, breastfeeding rates decreased when the baby was admitted to the NICU/PICU (OR = 0.61, SE = 0.18, $Z = -2.72$, $p < .01$), when mothers' perceived that they were not very well supported by prenatal care providers (OR = 0.60, SE = 0.23, $Z = -2.24$, $p < .05$), when mothers perceived absent changes in prenatal care due to COVID-19

Table 1
Descriptive statistics of participants for variables relevant for breastfeeding rates.

	Currently Breastfeeding group	Currently not Breastfeeding group	Contrast test	ES
n	4637	975		
Country			264.4***	0.217
Albania	0.5	0.4		
Brazil	20.1	8.4		
Bulgaria	1.0	1.2		
Chile	6.4	2.1		
Cyprus	4.2	10.5		
Greece	7.9	11.8		
Israel	8.3	7.3		
Malta	2.6	6.6		
Portugal	18.7	18.7		
Spain	10.4	14.3		
Turkey	13.8	7.8		
UK	6.1	11.1		
Mother's age (years)	32.2 (5.05)	32.51 (5.47)	−1.7	−0.024
Baby's age (days)	92.25 (51.54)	107.78(50.30)	−8.7***	−0.114
Employment status			42.9***	0.087
Employed	10.9	18.5		
On maternity leave	64.9	59.8		
Unemployed or student	24.2	21.7		
First pregnancy /first child			12**	0.047
Yes	55.3	61.4		
No	44.7	38.6		
Preterm birth			49.1***	0.094
Yes	7.2	14.1		
No	92.8	85.9		
Need for neonatal care			22.3***	0.064
Yes	9.2	14.3		
No	90.8	85.7		
Mother-baby separation at birth			1.8	0.019
Yes	7.9	9.2		
No	92.1	90.8		
Physical health (history)			4.8*	0.03
Yes	14.7	17.5		
No	82.3	82.5		
Physical health (during pregnancy)			3.9*	0.027
Yes	14.8	17.3		
No	85.2	82.7		
Mental health (history of mood or anxiety disorder diagnosis)			12.7***	0.048
Yes	11.6	15.8		
No	88.4	84.2		
Mental health (history of psychiatric treatment)			5.1*	0.031
Yes	15.2	18.2		
No	84.8	81.8		
Mental health (current psychiatric treatment)			23.1***	0.065
Yes	4.1	7.7		
No	95.4	90.8		
Formal perinatal care (prenatal support)			5.5	0.031
Very well supported	67.9	67.5		
Somewhat well supported	25.8	24.3		
Not very well supported	6.2	8.2		
Formal perinatal care (postnatal support)			11.6**	0.045
Very well supported	52.0	46.9		
Somewhat well supported	32.9	34.5		
Not very well supported	15.0	18.7		
Prenatal care changes due to COVID-19 pandemic			12.3**	0.047
Worsened	36.5	31.1		
No change, Not relevant	51.8	57.7		
Improved	11.8	11.2		
Postnatal care changes due to COVID-19 pandemic			2.6	0.021
Worsened	41.9	43.8		
No change, Not relevant	45.7	45.4		
Improved	12.4	10.8		
Level of stress experienced about changes in perinatal experiences due to COVID-19			8.2*	0.016
No distress	9.3	9.5		
Low distress	38.9	34.1		
High distress	51.8	56.4		
COVID-19 diagnosis			0.4	0.01
Yes	2.8	2.4		
No	97.2	97.6		

(*continued on next page*)

Table 1 (*continued*)

	Currently Breastfeeding group	Currently not Breastfeeding group	Contrast test	ES
Breastfeeding support during COVID-19 (virtual support groups)			64.7***	0.108
Yes	42.7	28.7		
No	57.3	71.3		
Lack of breastfeeding support following discharge from the hospital			12.5***	0.048
Yes	26.7	32.3		
No	73.3	67.7		
CHI	60.58 (7.5)	58.29 (6.89)	9.3***	0.116
IHDI	0.73 (0.09)	0.77 (0.07)	−15***	−0.172
New cases per million	107.47 (175.17)	109.29 (212.1)	−0.03	−0.004

Note. Percentage of cases are displayed for dichotomous and categorical variables. Mean and standard deviation (between brackets) are displayed for continuous variables. The Mann-Whitney's U test (continuous variables) and χ^2 tests (dichotomous/categorical variables) were used as contrast test statistics. Effect size (ES) estimates were the Cohen's *d* for continuous variables and Cramer's *V* for non-continuous ones. CHI = Containment Health Index; IHDI = Inequality-adjusted Human Development Index;.

* $p < .05$.

** $p < .01$.

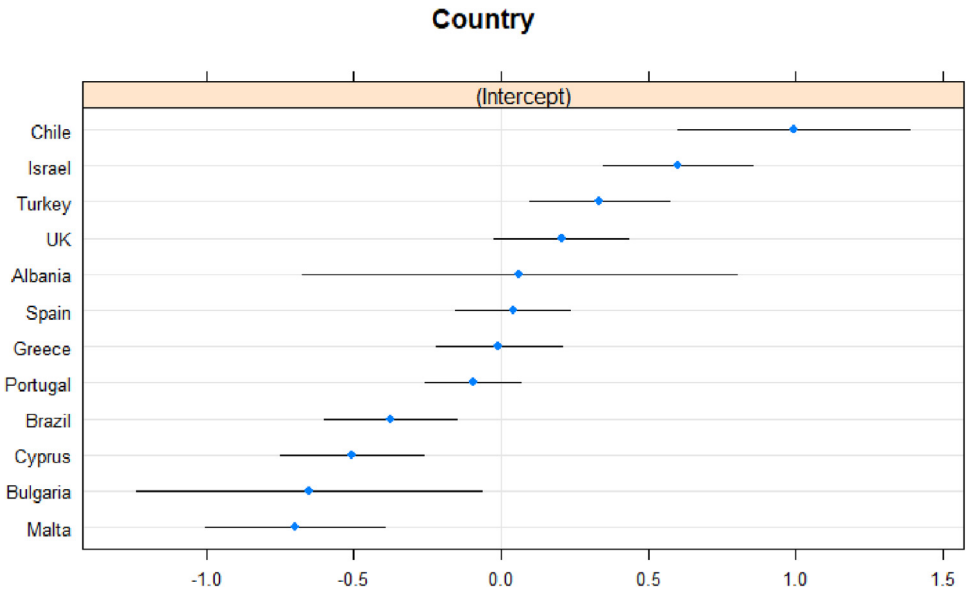

Fig. 1. Random-effects variability of breastfeeding rates across the participating countries. Dots refer to point estimates of deviations with 95% confidence interval (line).

(OR = 0.73, SE = 0.15, $Z = -2.04$, $p < .05$) and when mothers did not receive breastfeeding support following discharge from the hospital due to COVID-19 outbreak (OR = 0.56, SE = 0.14, $Z = -4.30$, $p < .001$). For low inequality level countries, breastfeeding rates were lower when the containment measures implemented were more restrictive (OR = 0.85, SE = 0.07, $Z = -2.18$, $p < .05$), when mothers perceived that the support received from prenatal care provider improved due to the COVID-19 outbreak (OR = 0.64, SE = 0.22, $Z = -2.05$, $p < .05$) and when they perceived to be somewhat not very well supported by postnatal care providers (OR = 0.64, SE = 0.18, $Z = -2.49$, $p < .05$). Maternity leave was positively associated with breastfeeding rate only for countries with low inequality levels (OR = 1.65, SE = 0.14, Z = 3.54, $p < .001$). Country-specific marginal predictions coming from intercepts for the subgroup analysis are presented on Fig. 2.

Discussion

To the best of our knowledge, this study is the first cross-cultural study observing an extensive set of mother-reported and context-specific covariates impacting breastfeeding rates amidst the pandemic context . Data from 5612, women, from high and upper-middle income countries, six of which with high inequality levels (Chile, Brazil, Turkey, Albania, Portugal, and Bulgaria) and six with low inequality levels (Israel, Spain, Greece, UK, Cyprus, and Malta) was analysed., this

As expected, breastfeeding rates were reduced with the newborn/infant age (that is, older child age was associated with lower chances of being breastfed), by lack of women's experience (first child), when the newborn was preterm or needed postnatal care. Moreover, breastfeeding rates were decreased when the mother was currently under psychiatric treatment. Mothers' perception of no or irrelevant changes in prenatal care due to COVID-19 and the lack of support following discharge from the hospital also negatively influenced breastfeeding rates. Finally, lower inequality levels were negatively associated with breastfeeding rates. On the other hand, being on maternity leave, and having access to virtual support groups (e.g., virtual mom groups or virtual lactation support groups) were associated with an increased probability of breastfeeding across countries during COVID-19, being one of the strongest covariates.

In general, breastfeeding support experiences have been found to be associated with better adherence to breastfeeding, with the availability of professional care being frequently critical for suc-

Table 2
Generalized linear mixed-effects models - predictors of breastfeeding rate, controlling for country of residence.

	Estimated coefficient	SE	z
(intercept)	1.87***	0.23	8.27
Mother's Age	−0.03	0.04	−0.74
Baby's Age	−0.29***	0.04	−7.12
Employment status (Ref. Employed)			
On maternity leave	0.44***	0.11	3.97
Unemployed or student	0.21	0.13	1.60
First pregnancy/First baby (Ref. No)			
Yes	−0.27***	0.08	−3.32
Preterm birth (Ref. No)			
Yes	−0.52***	0.13	−4.00
Need for neonatal care (Ref. No)			
Yes	−0.44***	0.13	−3.42
Mother-baby separation at birth (Ref. No)			
Yes	−0.12	0.14	−0.84
Physical health (history; Ref. No)			
Yes	−0.14	0.10	−1.313
Physical health (during pregnancy; Ref. No)			
Yes	−0.20	0.10	−1.91
Mental health (history of mood or anxiety disorder diagnosis; Ref. No)			
Yes	−0.18	0.13	−1.32
Mental health (history of psychiatric treatment; Ref. No)			
Yes	0.04	0.12	0.32
Mental health (current psychiatric treatment; Ref. No)			
Yes	−0.69***	0.17	−4.06
Formal perinatal care (prenatal support; Ref. Very well supported)			
Somewhat well supported	0.09	0.10	0.87
Not very well supported	−0.16	0.16	−1.02
Formal perinatal care (postnatal support; Ref. Very well supported)			
Somewhat well supported	−0.14	0.10	−1.43
Not very well supported	−0.17	0.13	−1.33
Prenatal care changes due to COVID-19 pandemic (ref. Worsened)			
No change. Not relevant	−0.25*	0.10	−2.48
Improved	−0.30	0.18	−1.71
Postnatal care changes due to COVID-19 pandemic (ref. Worsened)			
No change. Not relevant	−0.09	0.10	−0.90
Improved	0.05	0.18	0.28
COVID-19 diagnosis (Ref. No)			
Yes	0.09	0.25	0.36
Breastfeeding support during COVID-19 (virtual support groups; Ref. No)			
Yes	0.59***	0.09	6.91
Lack of breastfeeding support following discharge from the hospital (Ref. No)			
Yes	−0.18*	0.09	−1.98
Containment Health Index	−0.13	0.07	−1.81
Human Development Index inequality-adjusted	−0.71***	0.19	−3.72
New covid cases per million	−0.06	0.04	−1.55
Random-effects SD	0.52		
AIC			
Model 1 (no covariates)	5075.03		
Model 2 (with sociodemographic variables)	4960.44		
Model 3 (with all covariates of interest)	4672.1		
R^2			
Model 1 (no covariates)	0.101		
Model 2 (with sociodemographic variables)	0.154		
Model 3 (with all covariates of interest)	0. 244		

Note.
*** $p < .001$;** $p < .01$;.
* $p < .05$; Ref. = Category of reference; SE = Standard error; Estimates, SE, and z values of the full model.

cess (Beggs et al., 2021; Vazquez-Vazquez et al., 2021). The deleterious effect of the pandemic context on breastfeeding support was previously shown in a study about the quality of facility-based maternal and newborn care in COVID-19 across 12 countries of the European Union where the authors found that 34% of mothers perceived that their breastfeeding support was inadequate (Lazzerini et al., 2022). These results highlight the importance of virtual interventions during the pandemic of which one good example is the telehealth support program developed by Feinstein and colleagues (Feinstein et al., 2022) and where sessions were facilitated by lactation professionals. Upon promising results, the authors considered that the remote format was a critical element for the efficacy of the program, improving accessibility to breastfeeding support and decreasing travel restraints.

Contrary to our hypothesis, previous psychiatric treatment or diagnosis were not significant covariates of breastfeeding rates. In contrast and aligned with the literature on perinatal mood and anxiety symptoms, (Butler et al., 2021; Wouk et al., 2017) current psychiatric treatment was negatively correlated with breastfeeding rates. The distinctive impact between previous treatments or diagnosis and current psychiatric treatment might be explained by the fact that women with previous history of psychiatric treatment and diagnosis were already signaled as a population at heightened risk (Ceulemans et al., 2021; Kotlar et al., 2021) and efforts to protect

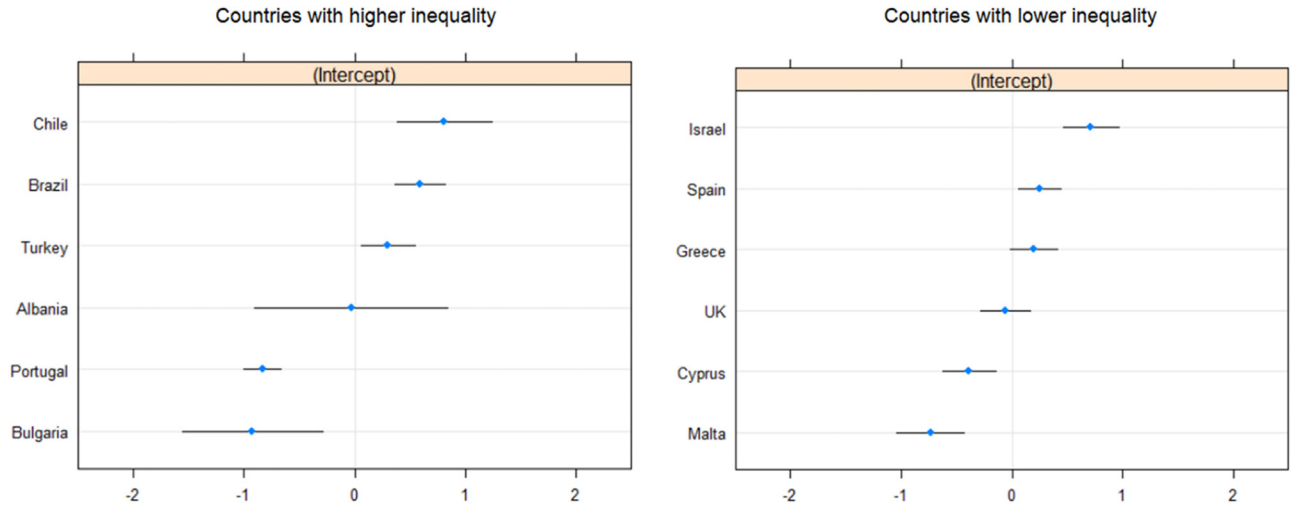

Fig. 2. Random-effects variability of breastfeeding rates across the participating countries divided into lower and higher inequality subgroups. Dots refer to point estimates of deviations with 95% confidence interval (line).

pregnancy and breastfeeding from potential deleterious effects of treatments were anticipated. On the other hand, current unforeseen perinatal mental health issues evidence the lack of preparedness of health systems to prevent, anticipate, detect and diagnose in due time common perinatal mental health issues which were even more common amidst the COVID-19 pandemic (Iyengar et al., 2021). Moreover, in face of a disrupted health system, women in current psychiatric treatment for the first time, might have been inconsistently advised about breastfeeding while on medication. Therefore, in face of unreliable health information by absent breastfeed-specialized healthcare support, medicated women might have decided not to breastfeed and safely feed their newborn with an accessible alternative – formula (Baker et al., 2021). In line with this rationale, our study showed that globally, another covariate negatively associated with breastfeeding was the lack of access to postnatal support following discharge.

In contrast with our study hypothesis, COVID-19 diagnosis did not impact breastfeeding rates. This result may be due to the large imbalance between the variable categories (with only 2.7% of women included in the study reporting COVID-19 diagnosis). Therefore, we conducted a sensitivity analysis with a random subsample of the COVID-19 negative group sized similarly to the COVID-19 positive group and without the random effect of countries. This model showed that COVID-19 diagnosis was still not a significant predictor of breastfeeding rates ($\beta = 0.15$; $p = .717$). . On the other hand, the fact that the COVID-19 diagnosis is not a predictor of breastfeeding might be explained by the time window of data collection (June and October 2020), which started almost six months after the onset of the pandemic in China and after three large-scale lockdowns in European countries were settled. In between, after a short suspension of existing evidence-based clinical guidelines for labor, delivery, and breastfeeding across the world, these were largely claimed back as evidence showed that the benefits of breastfeeding outweigh the risks of SARS-CoV-2 transmission (Spatz et al., 2021; Vassilopoulou et al., 2021). Indeed, several breastfeeding guidelines published shortly after the pandemic outbreak supported breastfeeding by COVID-19-positive mothers (contrasting procedures with more restrictive guidelines (Favre et al., 2020)) which might have influenced either mothers' knowledge and healthcare practices, promoting breastfeeding early on.

Furthermore, breastfeeding was negatively associated with newborn admission to the NICU/PICU. Indeed, newborns in neonatal care are significantly less likely to be exclusively breastfed during their first 3 months of life (Bartick et al., 2021), and more so amidst the COVID-19 pandemic. Additionally, the probability of women to breastfeed was significantly reduced when mothers were experiencing a first child. Other studies have reported that previous birth experience influences the probability to breastfeed. Ballesta-Castillejos and colleagues (Ballesta-Castillejos et al., 2020) have reported that mothers' decision to breastfeed increased when they had already two or three children and had previous positive breastfeeding experiences. Potentially, first-time mothers were more fearful considering the uncertainties experienced not only with the new journey through maternity but also with the uncertainties brought on by the unexpected pandemic. This idea is in line with another study (Snyder and Worlton, 2021), in which non-first-time breastfeeding mothers reported that their previous breastfeeding experience and knowledge helped overcome the lack of support that could have otherwise compromise their breastfeeding.

In our study, country-specific variability was also shown to model the multifactorial impact of the COVID-19 pandemic. Countries with lower levels of inequality (thus, increased distribution of resources regarding education, health, and income) presented overall reduced breastfeeding rates. This is a known trend since the seventies, that WHO exposed in their report in 1981 (WHO Collaborative Study on Breast-Feeding and World Health Organization, 1981), showing that women from upper and upper-middle income groups in urban areas were less likely to breastfeed than women in urban lower-income groups. Additionally, women from urban lower-income urban groups were less likely to breastfeed than women from rural areas and more traditional groups. This pattern was associated not only with wealthiness but also with education, as women with higher levels of education show lower rates of breastfeeding regardless their country's income classification (Rollins et al., 2016).

In our study, amongst the countries with high inequality levels, Chile (high income country) and Brazil (upper-middle income country) stand out as those where women reported the highest probability of breastfeeding. Similarly, Portugal (high-income country) and Bulgaria (upper-middle income country) stand as those where women reported the lowest probability to breastfeed. These results, show that it is not only the income but also education and health within countries that contribute to breastfeeding rates. Within-countries' inequalities concerning access to education and

adequate perinatal health care can also explain why changes in prenatal care due to COVID-19 and neonatal care needs were particularly detrimental in countries with higher inequality levels.

In countries with low inequality levels, Cyprus and Malta stand out as those where women reported the lowest probability to breastfeed, and Israel and Spain stand out as those with higher breastfeeding rates. The four countries are high-income countries. Furthermore, for countries with low inequality levels, maternity leave was strongly associated with breastfeeding.

On the other hand, the restrictive governmental measures to mitigate SARS-CoV-2 spread (e.g. lockdowns), and the perceived postnatal health care support as "somewhat not good" exerted a detrimental effect on breastfeeding. These findings are in line with previous literature. For example, Cheng et al., 2021) showed that amidst the pandemic, there was an unequal burden for women in the U.K. in what concerns time spent on childcare and home-schooling during lockdowns. However, Brown and Shenker's (Brown and Shenker, 2021) study, also in the U.K., showed that 41.8% of new mothers felt that lockdowns benefited their breastfeeding plans, while 27.0% experienced the opposite. Both studies point out that women who experience lockdowns as barriers to breastfeeding are typically from poorer households, have lower education, and are from minorities, confirming that adverse family and social contexts need to be considered as breastfeeding determinants.

Although our data does not show it, previous data from countries with higher inequality levels, shows the opposite trend. That is, periods of lockdown seem to be breastfeeding protective in countries such as Brazil (Holand et al., 2022) where stay-at-home mandates might have been experienced as an opportunity to extend the time spent with the child.

Strangely, in countries with low inequality levels, women's perception of improved prenatal care support due to COVID-19 outbreak was associated with lower breastfeeding rates. Also, in countries with high inequality levels the perception of absent/not-relevant changes in prenatal care support was associated with lower breastfeeding rates. These unexpected effects suggest the need to further explore the cross-cultural content validity of these questions to secure they are measuring the constructs of interest (the perception of prenatal care support and the perception of changes in the support received by the prenatal care providers due to COVID-19 outbreak).

Several other limitations should be considered in this study. First, while online data collection supported broader outreach it also led to a reduced number of completers (15,611 women answered the survey but only 5612 completed protocols were eligible). That is, due to the nature of the study (online data collection), stringent quality measures were implemented (e.g. removal of extremely incomplete cases, and incongruent data). After applying data quality strategies (namely, removing duplicates and incoherent/incomplete data), more than two-thirds (38.3%) of participants were excluded. This should lead to a throughout analysis about the extent to which results are compromised by recruitment/population biases. Moreover, such a high rate of uncompleted entries, should lead us to rethink methodological decisions concerning recruitment strategies and characteristics of the survey that could be improved for future studies.

Second, data collection was conducted late in the COVID-19 pandemic (between June and October 2020) when the most limiting breastfeeding practices were already being resolved across countries hindering the early impact that COVID-19 had on perinatal services delivery during the first months of the pandemic (Lazzerini et al., 2022).

Third, different rates of participation between countries might have led to biased results towards those with an increased number of responders (e.g., 0.45% for Albania, and 1.05% for Bulgaria; whilst 18.05% for Brazil and 18.73% for Portugal). Moreover, the survey lacks a measure of ethnicity, so it was not possible to access the possible impact of it on breastfeeding rates, which is a limitation of this study.

Forth, the number of women that have been diagnosed with COVID-19 participating in the survey was rather small (only 2.7%). Such a small sample of SARS-CoV-2 positive women completing the survey might have hindered the impact that changes in perinatal health care practices toward mothers diagnosed with COVID-19 (e.g., mother-newborn separation when testing positive for SARS-CoV-2) have on breastfeeding rates. Moreover, our survey might have not caught those women experiencing the most negative impact of such changes in perinatal care (most probably due to their unavailability to participate in research as they were already overwhelmed by the experience of motherhood).

Fifth, the cross-sectional design of the data presented here does not allow for extracting causality or for discarding reversal causality hypotheses. Upcoming, longitudinal studies are deemed necessary to ascertain the impact of the selected set of covariates and confirm its predictive value in breastfeeding dynamics across time.

Finally, because the survey did not include explicit measures of partner support, nor of women's breastfeeding intentions/expectations, the clear association between these two factors known to impact breastfeeding rates is compromised.

Conclusions

The cross-cultural nature of our study offers critical information to the study of the determinants of breastfeeding rates and to the field of implementation research. It suggests that implementing and providing access to virtual or blended perinatal health care (including virtual support groups) is globally the most decisive protective factor for breastfeeding initiation and maintenance. The importance of developing and implementing virtual interventions during the pandemic and beyond is something health practitioners and managers should consider improving breastfeeding rates, regardless of country specificities.

It also suggests that particular attention should be given to first-time mothers, supporting them to manage and overcome breastfeeding issues towards a positive experience with the current newborn and beyond. Furthermore, it shows the importance of supporting perinatal mental health with particular attention to preventive and early screening and diagnostic measures. Training health providers to detect and diagnose those women experiencing depressive/anxiety symptoms for the first time and helping them manage their symptoms, is of the utmost importance to increase treatment adherence while respecting their breastfeeding choices.

Future studies should explore in-depth the relationship between the timing of data collection and implementation of clinical guidelines during COVID-19 to better understand the association between both.

The study results warrant further research of the available data within the full set of the the Riseup-PPD-COVID-19 international prospective cohort study and distinctive data points, to effectively understand the complex associations between covariates and breastfeeding rate and the moderator role that these factors may represent in the pandemic context.

Declaration of Competing Interest

The authors state no conflict of interest.

CRediT authorship contribution statement

Ana Ganho-Ávila: Conceptualization, Methodology, Project administration, Funding acquisition, Supervision, Writing – origi-

nal draft, Writing – review & editing. **Raquel Guiomar:** Conceptualization, Data curation, Formal analysis, Methodology, Visualization, Writing – original draft. **Mónica Sobral:** Conceptualization, Methodology, Writing – review & editing. **Francisca Pacheco:** Conceptualization, Methodology, Writing – review & editing. **Rafael A. Caparros-Gonzalez:** Conceptualization, Methodology, Supervision, Writing – review & editing. **Carla Diaz-Louzao:** Data curation, Methodology, Software, Writing – review & editing. **Emma Motrico:** Data curation, Investigation, Resources, Writing – review & editing. **Sara Domínguez-Salas:** Data curation, Investigation, Resources, Writing – review & editing. **Ana Mesquita:** Data curation, Investigation, Resources, Writing – review & editing. **Raquel Costa:** Data curation, Investigation, Resources, Writing – review & editing. **Eleni Vousoura:** Data curation, Investigation, Resources, Writing – review & editing. **Eleni Hadjigeorgiou:** Data curation, Investigation, Resources, Writing – review & editing. **Rena Bina:** Data curation, Investigation, Resources, Writing – review & editing. **Rachel Buhagiar:** Data curation, Investigation, Resources, Writing – review & editing. **Vera Mateus:** Data curation, Investigation, Resources, Writing – review & editing. **Yolanda Contreras-García:** Data curation, Investigation, Resources, Writing – review & editing. **Claire A. Wilson:** Data curation, Investigation, Resources, Writing – review & editing. **Erilda Ajaz:** Data curation, Investigation, Resources, Writing – review & editing. **Camellia Hancheva:** Data curation, Investigation, Resources, Writing – review & editing. **Pelin Dikmen-Yildiz:** Data curation, Investigation, Resources, Writing – review & editing. **Alejandro de la Torre-Luque:** Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Software, Supervision, Visualization, Writing – review & editing.

Ethical approval

This study is part of a larger international prospective cohort study (Motrico et al., 2021) about the impact of the COVID-19 pandemic on perinatal mental health (Riseup-PPD-COVID-19). The study complied with the regulatory documents for studies in humans and was approved by each local Ethical Committee prior to initiation. Electronic informed consents were obtained from all participants, and procedures to secure privacy, confidentiality, and anonymization were strictly followed.

Funding

This study is supported by the Portuguese Foundation for Science and Technology (FCT) Grants to MS (2021.07006.BD), RG (2020.05099.BD), and AGA (2020.02059.CEECIND). Carla Díaz-Louzao was supported by the Primary Care Prevention and Health Promotion Research Network redIAPP (Instituto de Salud Carlos III-ISCIII/RD16/0007/0006/Co-funded by FEDER), and by the project ED431C 2020/20, co-financed by the "Consellería de Cultura Educación e Ordenación Universitaria da Xunta de Galicia". Rena Bina was supported by the Bar-Ilan Dangoor Centre for Personalized Medicine. Vera Mateus received financial support from CAPES/PrInt grant nº. 88887.583508/2020-00. EPI-Unit - UIDB/04750/2020, ITR - LA/P/0064/2020, and HEILab - UIDB/05380/2020 are supported by Portuguese fundings through FCT - Fundação para a Ciência e a Tecnologia, IP. Raquel Costa has a Postdoctoral grant supported by the European Social Fund (ESF) and FCT (SFRH/BPD/117597/2016; RC postdoctoral fellowship). Ana Mesquita was supported from the Portuguese Foundation for Science and Technology (FCT) and from EU through the European Social Fund and from the Human Potential Operational Program - IF/00750/2015. The Psychology Research Centre (PSI/01662), School of Psychology, University of Minho, is supported by FCT through the Portuguese State Budget (Ref.: UIDB/PSI/01662/2020). Claire A Wilson is funded by the UK's National Institute for Health and Care Research (NIHR) as an Academic Clinical Lecturer. The Center for Research in Neuropsychology and Cognitive and Behavioral Intervention (CINEICC) of the Faculty of Psychology and Educational Sciences of the University of Coimbra is supported by the Portuguese Foundation for Science and Technology and the Portuguese Ministry of Education and Science through national funds and co-financed by FEDER through COMPETE2020 under the PT2020 Partnership Agreement [UID/PSI/01662/2013].

Acknowledgements

This paper is part of the COST Action Riseup-PPD CA18138 and was supported by COST under COST Action Riseup-PPD CA18138.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.midw.2023.103631.

References

Baker, P., Santos, T., Neves, P.A., Machado, P., Smith, J., Piwoz, E., Barros, A.J.D., Victora, C.G., McCoy, D., 2021. First-food systems transformations and the ultra-processing of infant and young child diets: the determinants, dynamics and consequences of the global rise in commercial milk formula consumption. Matern Child. Nutr. 17 (2). doi:10.1111/mcn.13097.

Ballesta-Castillejos, A., Gómez-Salgado, J., Rodríguez-Almagro, J., Ortiz-Esquinas, I., Hernández-Martínez, A., 2020. Factors that influence mothers' prenatal decision to breastfeed in Spain. Int. Breastfeed. J. 15 (1), 97. doi:10.1186/s13006-020-00341-5.

Bartick, M.C., Valdés, V., Giusti, A., Chapin, E.M., Bhana, N.B., Hernández-Aguilar, M.-.T., Duarte, E.D., Jenkins, L., Gaughan, J., Feldman-Winter, L., 2021. Maternal and Infant Outcomes Associated with Maternity Practices Related to COVID-19: the COVID Mothers Study. Breastfeed. Med. 16 (3), 189–199. doi:10.1089/bfm.2020.0353.

Beggs, B., Koshy, L., Neiterman, E., 2021. Women's Perceptions and Experiences of Breastfeeding: a scoping review of the literature. BMC Public Health 21 (1), 2169. doi:10.1186/s12889-021-12216-3.

Belsley, D.A., 1991. Conditioning Diagnostics: Collinearity and Weak Data in Regression. John Wiley & Sons, Inc., New York.

Brown, A., Shenker, N., 2021. Experiences of breastfeeding during COVID-19: lessons for future practical and emotional support. Matern Child. Nutr. 17 (1). doi:10.1111/mcn.13088.

Butler, M.S., Young, S.L., Tuthill, E.L., 2021. Perinatal depressive symptoms and breastfeeding behaviors: a systematic literature review and biosocial research agenda. J. Affect. Disord. 283, 441–471. doi:10.1016/j.jad.2020.11.080.

Caparros-Gonzalez, R.A., Pérez-Morente, M.A., Hueso-Montoro, C., Álvarez-Serrano, M.A., de la Torre-Luque, A., 2020. Congenital, intrapartum and postnatal maternal-fetal-neonatal SARS-CoV-2 infections: a narrative review. Nutrients 12 (11), 3570. doi:10.3390/nu12113570.

Celi, A.C., Rich-Edwards, J.W., Richardson, M.K., Kleinman, K.P., Gillman, M.W., 2005. Immigration, race/ethnicity, and social and economic factors as predictors of breastfeeding initiation. Arch. Pediatr. Adolesc. Med. 159 (3), 255. doi:10.1001/archpedi.159.3.255.

Ceulemans, M., Foulon, V., Ngo, E., Panchaud, A., Winterfeld, U., Pomar, L., Lambelet, V., Cleary, B., O'Shaughnessy, F., Passier, A., Richardson, J.L., Hompes, T., Nordeng, H, 2021. Mental health status of pregnant and breastfeeding women during the COVID-19 pandemic—A multinational cross-sectional study. Acta Obstet. Gynecol. Scand. 100 (7), 1219–1229. doi:10.1111/aogs.14092.

Cheng, Z., Mendolia, S., Paloyo, A.R., Savage, D.A., Tani, M., 2021. Working parents, financial insecurity, and childcare: mental health in the time of COVID-19 in the UK. Rev. Econ. Househ. 19 (1), 123–144. doi:10.1007/s11150-020-09538-3.

Favre, G., Pomar, L., Qi, X., Nielsen-Saines, K., Musso, D., Baud, D., 2020. Guidelines for pregnant women with suspected SARS-CoV-2 infection. Lancet Infect. Dis. 20 (6), 652–653. doi:10.1016/S1473-3099(20)30157-2.

Feinstein, J., Slora, E.J., Bernstein, H.H., 2022. Telehealth can promote breastfeeding during the Covid-19 pandemic. NEJM Catal..

Hale, T., Angrist, N., Goldszmidt, R., Kira, B., Petherick, A., Phillips, T., Webster, S., Cameron-Blake, E., Hallas, L., Majumdar, S., Tatlow, H., 2021. A global panel database of pandemic policies (Oxford COVID-19 Government Response Tracker). Nat. Hum. Behav. 5 (4), 529–538. doi:10.1038/s41562-021-01079-8.

Holand, B.L., de Oliveira Agostini, C., Pacheco, M.C.M., de Leon, D.M.Z., Drehmer, M., Bosa, V.L., 2022. Association between breastfeeding and complementary feeding in pre-pandemic and pandemic COVID-19 times: maternar cohort study. J. Pediatr. (Rio. J) doi:10.1016/j.jped.2021.12.007.

Iyengar, U., Jaiprakash, B., Haitsuka, H., Kim, S., 2021. One year into the pandemic: a systematic review of perinatal mental health outcomes during COVID-19. Front. Psychiatry 12. doi:10.3389/fpsyt.2021.674194.

Koletzko, B., Godfrey, K.M., Poston, L., Szajewska, H., van Goudoever, J.B., de Waard, M., Brands, B., Grivell, R.M., Deussen, A.R., Dodd, J.M., Patro-Golab, B., Zalewski, B.M., 2019. Nutrition during pregnancy, lactation and early childhood and its implications for maternal and long-term child health: the early nutrition project recommendations. Ann. Nutr. Metab. 74 (2), 93–106. doi:10.1159/000496471.

Kotlar, B., Gerson, E., Petrillo, S., Langer, A., Tiemeier, H., 2021. The impact of the COVID-19 pandemic on maternal and perinatal health: a scoping review. Reprod. Health 18 (1), 10. doi:10.1186/s12978-021-01070-6.

Lazzerini, M., Covi, B., Mariani, I., Drglin, Z., Arendt, M., Nedberg, I.H., Elden, H., Costa, R., Drandić, D., Radetić, J., Otelea, M.R., Miani, C., Brigidi, S., Rozée, V., Ponikvar, B.M., Tasch, B., Kongslien, S., Linden, K., Barata, C., …., Valente, E.P., 2022. Quality of facility-based maternal and newborn care around the time of childbirth during the COVID-19 pandemic: online survey investigating maternal perspectives in 12 countries of the WHO European Region. Lancet Reg. Health - Eur. 13, 100268. doi:10.1016/j.lanepe.2021.100268.

Motrico, E., Bina, R., Domínguez-Salas, S., Mateus, V., Contreras-García, Y., Carrasco-Portiño, M., Ajaz, E., Apter, G., Christoforou, A., Dikmen-Yildiz, P., Felice, E., Hancheva, C., Vousoura, E., Wilson, C. A., Buhagiar, R., Cadarso-Suárez, C., Costa, R., Devouche, E., … Ganho-Ávila, A.Riseup-PPD-COVID-19 Group, 2021. Impact of the Covid-19 pandemic on perinatal mental health (Riseup-PPD-COVID-19): Protocol for an international prospective cohort study. BMC Public Health 21 (1), 368. doi:10.1186/s12889-021-10330-w.

Motrico, E., Mateus, V., Bina, R., Felice, E., Bramante, A., Kalcev, G., Mauri, M., Martins, S., Mesquita, A., 2020. Good Practices in Perinatal Mental Health during the COVID-19 Pandemic: a report from task-force RISEUP-PPD COVID-19. Clín. Salud 31 (3), 155–160. doi:10.5093/clysa2020a26.

Nakagawa, S., Schielzeth, H., 2013. A general and simple method for obtaining R^2 from generalized linear mixed-effects models. Methods Ecol. Evol. 4 (2), 133–142. doi:10.1111/j.2041-210x.2012.00261.x.

Pacheco, F., Sobral, M., Guiomar, R., de la Torre-Luque, A., Caparros-Gonzalez, R.A., Ganho-Ávila, A., 2021. Breastfeeding during COVID-19: a narrative review of the psychological impact on mothers. Behav. Sci. 11 (3), 34. doi:10.3390/bs11030034.

Peroni, D.G., Fanos, V., 2020. Lactoferrin is an important factor when breastfeeding and COVID-19 are considered. Acta Paediatr. 109 (10), 2139–2140. doi:10.1111/apa.15417.

R Core Team, 2021. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing.

Rollins, N.C., Bhandari, N., Hajeebhoy, N., Horton, S., Lutter, C.K., Martines, J.C., Piwoz, E.G., Richter, L.M., Victora, C.G., 2016. Why invest, and what it will take to improve breastfeeding practices? Lancet North Am. Ed. 387 (10017), 491–504. doi:10.1016/S0140-6736(15)01044-2.

Sakamoto, Y., Ishiguro, M., Kitagawa, G., 1986. Akaike Information Criterion Statistics, 1st ed. Springer, Dordrecht.

Shrestha, N., 2020. Detecting multicollinearity in regression analysis. Am. J. Appl. Math. Stat. 8 (2), 39–42. doi:10.12691/ajams-8-2-1.

Snyder, K., Worlton, G., 2021. Social support during COVID-19: perspectives of breastfeeding mothers. Breastfeed. Med. 16 (1), 39–45. doi:10.1089/bfm.2020.0200.

Spatz, D.L., Davanzo, R., Müller, J.A., Powell, R., Rigourd, V., Yates, A., Geddes, D.T., van Goudoever, J.B., Bode, L., 2021. Promoting and protecting human milk and breastfeeding in a COVID-19 world. Front. Pediatr. 8. doi:10.3389/fped.2020.633700.

Sutton, D., D'Alton, M., Zhang, Y., Kahe, K., Cepin, A., Goffman, D., Staniczenko, A., Yates, H., Burgansky, A., Coletta, J., Williams, Z., Gyamfi-Bannerman, C., 2021. COVID-19 vaccine acceptance among pregnant, breastfeeding, and nonpregnant reproductive-aged women. Am. J. Obstetr. Gynecol. MFM 3 (5), 100403. doi:10.1016/j.ajogmf.2021.100403.

Usmani, S., Greca, E., Javed, S., Sharath, M., Sarfraz, Z., Sarfraz, A., Salari, S.W., Hussaini, S.S., Mohammadi, A., Chellapuram, N., Cabrera, E., Ferrer, G., 2021. Risk factors for postpartum depression during COVID-19 pandemic: a systematic literature review. J. Prim. Care Commun. Health 12, 215013272110593. doi:10.1177/21501327211059348.

Vassilopoulou, E., Feketea, G., Koumbi, L., Mesiari, C., Berghea, E.C., Konstantinou, G.N., 2021. Breastfeeding and COVID-19: from nutrition to immunity. Front. Immunol. 12. doi:10.3389/fimmu.2021.661806.

Vazquez-Vazquez, A., Dib, S., Rougeaux, E., Wells, J.C., Fewtrell, M.S., 2021. The impact of the Covid-19 lockdown on the experiences and feeding practices of new mothers in the UK: preliminary data from the COVID-19 New Mum Study. Appetite 156, 104985. doi:10.1016/j.appet.2020.104985.

Victora, C.G., Bahl, R., Barros, A.J.D., França, G.V.A., Horton, S., Krasevec, J., Murch, S., Sankar, M.J., Walker, N., Rollins, N.C., 2016. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. Lancet North Am. Ed. 387 (10017), 475–490. doi:10.1016/S0140-6736(15)01024-7.

World Health Organization, 1981. Contemporary Patterns of breast-feeding : Report On the WHO Collaborative Study On Breast-feeding. World Health Organization.

World Health Organization. (2017). *Guideline: protecting, promoting and supporting breastfeeding in facilities providing maternity and newborn services.*

World Health Organization. (2020). *Breastfeeding and COVID-19: scientific brief.* .

Wouk, K., Stuebe, A.M., Meltzer-Brody, S., 2017. Postpartum mental health and breastfeeding practices: an analysis using the 2010–2011 pregnancy risk assessment monitoring system. Matern. Child Health J. 21 (3), 636–647. doi:10.1007/s10995-016-2150-6.

Yapo, Y.V., 2020. Breastfeeding and child survival from 0 to 5 years in Côte d'Ivoire. J. Health Population Nutrit. 39 (1), 5. doi:10.1186/s41043-020-0210-4.

Yuen, M., Hall, O.J., Masters, G.A., Nephew, B.C., Carr, C., Leung, K., Griffen, A., McIntyre, L., Byatt, N., Moore Simas, T.A., 2022. The effects of breastfeeding on maternal mental health: a systematic review. J. Women's Health 31 (6), 787–807. doi:10.1089/jwh.2021.0504.