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Human Nutrition & Metabolism 33 (2023) 200198

Contents lists available at ScienceDirect

Human Nutrition & Metabolism

journal homepage: www.sciencedirect.com/journal/human-nutrition-and-metabolism

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ARTICLE INFO

Keywords:
Coffee
Depression
Insomnia
Stress
Tea
Ilex paraguariensis

ABSTRACT

Purpose: This work aimed to study postpartum mental outcomes and determinants of the intake of caffeinated beverages during the pandemic in women from Argentina.
Methods: This cross-sectional study recruited 619 women who responded to online self-report questionnaires during the first and second waves of COVID-19, including validated instruments (Insomnia Severity Index, Perceived Stress Scale, Postpartum Depression Screening Scale, Memory Complaint Scale, and Breastfeeding Self-Efficacy Scale), and general data. Intake frequency and amount of caffeinated beverages were estimated. Multivariate regression and structural equation models identified associations and effects ($p < 0.05$).
Results: Women were under social restrictions for 60.39 days, with home and essential activities increasing caffeinated intake. They ingested (mL/d): *yerba mate* (1457.71), coffee (66.85), tea (67.61), and soft drinks (50.95), which provided 646.20 mg/d of caffeine. Intakes of coffee and *yerba mate* were higher than pre-pandemic ones. Coffee was positively associated with stress and insomnia, and indirectly linked to higher levels of depression and memory complaints, and lower breastfeeding self-efficacy. Tea showed a similar but weaker association. *Yerba mate* correlated inversely with depression (through direct pathways), insomnia, and memory complaints (through indirect pathways), promoting breastfeeding self-efficacy. Soft drinks and caffeine did not present significant associations.
Conclusion: Although findings do not imply causation, results suggest that beverages would exhibit caffeine-independent affective and cognitive roles, which might be anxiogenic in the case of coffee and tea (to a lesser extent). *Yerba mate* showed antidepressant potential. Given that breastfeeding might be compromised during the pandemic, *yerba mate* intake is promissory to protect postpartum mental health.

1. Introduction

The psychological well-being of women during puerperium is crucial for maternal and child health. In this sense, postpartum women are particularly vulnerable to COVID-19 pandemic-related stressors [1]. During the pandemic, there has been a reported increase in the prevalence of mental disorders like postpartum depression and anxiety [2]. Their well-being is impaired by infection-related uncertainties and fears, the effects of confinement measures that affect socialization, and other factors such as the detrimental financial impact of the pandemic, the increased demand for care tasks, and domestic dysfunction, among others [3].

Dietary behaviors have also changed during the pandemic because of time spent at home due to confinement measures, working/studying from home, and people's financial status [4]. Since early stages of the pandemic, different organizations have provided recommendations to help individuals adapt their nutritional behavior to the new situation [5,6]. Home confinement led to less healthy eating habits, such as increased consumption of sweets, refined flours, and caffeinated beverages [7,8].

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https://doi.org/10.1016/j.hnm.2023.200198
Received 27 March 2023; Received in revised form 2 May 2023; Accepted 31 May 2023
Available online 9 June 2023

Caffeine is an alkaloid belonging to the group of methylxanthines (1,3,7-trimethylxanthine) [9]. It is widely consumed in diet, especially in beverages such as coffee, tea, *yerba mate*, cola drinks, and energy drinks. Although moderate consumption does not pose health risks, excessive exposure can exert adverse effects such as anxiety, irritability, palpitations, tremors, depression, and insomnia [9]. Due to its stimulating properties on the nervous system, caffeinated beverages are commonly consumed in work and study environments to improve intellectual ability, concentration, attention, and wakefulness, as well as to reduce fatigue and improve psychomotor coordination [9]. In Argentina, *yerba mate* is the main source of caffeine, unlike other countries where coffee is the main one. *Yerba mate* consumers usually drink it daily and several times per day, regardless of socioeconomic status [10]. The consumption of *yerba mate* has a long cultural and historical tradition in Argentina and is an important form of socialization. In addition to caffeine, *yerba mate* also contains other bioactive compounds such as polyphenols, which are attributed with the beneficial effects of this drink [11].

Caffeinated beverage intake has attracted the attention of the scientific community during the pandemic, being associated with poor sleep quality, anxiety, and depression [12]. Furthermore, increased caffeine intake has been reported throughout the first three waves of COVID-19 in Croatia, and showed correlations with symptoms of anxiety and depression [13]. Coffee consumption has been described as one of the main factors responsible for the higher rates of anxiety and insomnia, which in turn correlates with increased sadness and depression [14,15]. According to Dongol et al., women and coffee drinkers show higher levels of stress, clinical insomnia, and poor sleep quality, promoting fear of COVID-19 [16]. Likewise, during the COVID-19 pandemic, *yerba mate* intake increased in Argentina during periods of lockdown, partly due to work and study activities being shifted to the home, but so far its association with health outcomes has not been investigated [17].

Multiple subpopulations, including college students and health professionals, have been the focus of the studies exploring the association between caffeinated beverages and mental health during the pandemic [14–16]. Although postpartum women have been especially vulnerable to mental health disorders during the pandemic, evidence in this group is still lacking. Moreover, caffeine intake during lactation should be limited as it may influence maternal and infant health [18]. Therefore, the present work aimed to study the mental outcomes and determinants of caffeinated beverage intake in postpartum women during the COVID-19 pandemic in Argentina. In particular, our hypothesis was that the consumption of caffeinated beverages conditioned by home-based activities is associated with the mental well-being of postpartum women, with coffee and *yerba mate* having opposing implications.

2. Methods

2.1. Sample and procedure

For this cross-sectional study, online questionnaires were self-administered to 619 postpartum women from Argentina recruited from health centers and social media during the first (2020) and second (2021) waves of COVID-19. Recruitment campaigns were carried out during high infection rates, and postpartum women were asked to take part in an online survey concerning the pandemic's effects on their health. Social media recruitment campaigns employed three tactics: (1) joining and sharing in existing Facebook groups focused on pregnancy and maternity, (2) reaching out to postpartum women through an Instagram campaign, and (3) distributing the survey's online link via WhatsApp. Furthermore, women who visited health clinics for newborn screening were invited to participate by providing them with the Facebook or Instagram account name, or by sending them the survey's link through WhatsApp. These approaches facilitated snowball sampling by allowing users to like, share, and disseminate the social media post with others. There was no paid advertising or compensation for research participation. Inclusion criteria were: adult (≥18 years old), living in Argentina, and being in the first twelve months postpartum.

Additionally, a sample of 284 postpartum women from the same location was used, collected between May 2013 and February 2020, to form an additional pre-pandemic sample with the aim to compare daily caffeine beverage intake before and during the pandemic. The women in the pre-pandemic sample were recruited from healthcare centers and through social media campaigns. Then, using a food frequency questionnaire, the number of times each beverage was consumed per day, week, or month, as well as the portion size (large, medium, or small), were recorded using a photographic atlas of foods. Moreover, sociodemographic information was collected.

All participants signed informed consent before being voluntarily included. A Research Ethics Committee (registration codes REPIS-3177/145/2654/5554) approved this study according to the Declaration of Helsinki and current country legislation. Results were reported according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies (Supplementary material).

2.2. Data collected and instruments used

Data collection took place during the Preventive and Mandatory Social Isolation/Distancing governmental restriction for the first (from May to July 2020) and second (from April to July 2021) COVID-19 waves. It was decided to use virtual questionnaires due to government restrictions on circulation and the implementation of social distancing measures. The data collection protocol consisted of a battery of validated self-report questionnaires for sociodemographic data, mental health status, breastfeeding practice, and food frequency (explained below). Non-response bias was tested using the selective extrapolation method, by comparing the demographic variables of the first 10% of responses against the final 10% of responses [19]. No significant differences were found, which indicated that there was no response bias (Supplementary material). Moreover, the likelihood of response bias was minimized by ensuring the confidentiality of the information.

2.3. Psychological assessment

Through online questionnaires, the following instruments were self-administered:

- Insomnia Severity Index (ISI), a reliable and valid 7-item questionnaire, with higher scores indicating more severe insomnia and impact on life quality [20]. Each item was rated on a 5-point Likert scale (0–4, where 0 indicates no problem and 4 corresponds to a very severe problem). Scores were transformed on a scale ranging from 0 to 28 points. A cut-off of ≥10 points identifies clinically significant symptomatology, with a sensitivity of 86% and a specificity of 88% [20].
- Pandemic-related Perceived Stress Scale (PSS-10), a 10-item scale to measure how different life situations are perceived as stressful, with higher scores corresponding to higher psychological stress. The items are rated on a 5-point Likert scale from 0 (never) to 4 (very often). The scores of items 4, 5, 7, and 8 are reversed [21]. A cut-off of ≥20 is used to identify stressed women (sensitivity of 83% and specificity of 61%) [22].
- Postpartum Depression Screening Scale-Short Form (PDSS-SF), a 7-item scale that assesses signs suggestive of depressive disorders during postpartum, with higher scores indicating a higher level of depression [23]. Each item was rated on a 5-point Likert scale (1–5, where 1 indicates "strongly disagree" and 5 corresponds to "strongly agree"). Scores were transformed on a scale ranging from 7 to 35. A cut-off score of 17 points or greater suggests a clinically significant level of depression (89% sensitivity and 77% specificity) [24].

- Memory Complaint Scale for Patients (MCS-P), a scale of 7 questions with graded responses of increasing intensity of subjective complaints concerning memory functioning in daily life situations. The items are graded responses of increasing intensity (0, 1, and 2), and scores were transformed on a scale ranging from 0 to 14 [25]. Scoring ≥3 points indicates the presence of probable memory impairment [2].
- Breastfeeding Self-Efficacy Scale-Short Form (BSES-SF), a 14-item scale valid to identify women with breastfeeding difficulties [26]. The responses were given on a 5-point Likert scale (1 for "not at all confident" to 5 for "always confident"), with scores ranging from 14 to 70 for low to high breastfeeding self-efficacy, respectively. A cut-off of >50 is used to define adequate breastfeeding confidence (sensitivity >70% and specificity >50%) [27].

2.4. Demographic characteristics

As previously done [2], a questionnaire was used to collect data about sociodemographic variables (e.g., maternal age, partnership status, years of education, employment status, health insurance, among others), characteristics of social isolation (e.g., teleworking, online learning, number of cohabitants during isolation) and breastfeeding (e.g., type -exclusive/partial/artificial-, previous breastfeeding experience).

2.5. Dietary intake assessment

Regular dietary intake of caffeinated beverages during the previous week (coffee, *yerba mate*, black tea, and soft drinks) was recorded using a validated food frequency questionnaire (FFQ). This instrument has shown adequate levels of validity and reproducibility for Latin American populations, with a moderate overestimation of 4% and no constant bias [28]. Women were asked about the frequency (never or times per week/day, as appropriate) and the usual portion size of each beverage (small, medium, or large) using a photographic atlas based on standard portion sizes in Argentina. Then, caffeine intake was estimated based on previous studies about its content in dietary products from Argentina: coffee = 0.41 mg/mL, *yerba mate* = 0.33 mg/mL, tea = 0.12 mg/mL, soft drinks = 0.11 mg/mL [29].

The questions about the consumption of caffeinated beverages were divided into four sections (one for each beverage), where each section contained three items about weekly frequency, daily quantity, and daily frequency. In the first item, participants had to indicate the number of days they had consumed the beverage in the last seven days, ranging from 0 (never) to 7 (every day). In the second item, women had to indicate the average size of the portions consumed of that beverage during the last week. In the case of coffee and tea, the possible responses were 80 ml (small portion), 150 ml (medium portion), 300 ml (large portion), or "I did not drink coffee/tea in the last week". In the case of *yerba mate*, the amount of *mate* was calculated based on 1-L vacuum flask or kettle, with the following response categories: <250 ml (a quarter of a vacuum flask), 250 ml (a quarter of a vacuum flask), 500 ml (half a vacuum flask), 1 L (one vacuum flask), 1.5 L (one and a half vacuum flask), 2 L or more (two or more vacuum flask), or "I did not drink *mate*". As for soft drinks, these were estimated based on glasses, with possible responses of 150 ml (small portion), 200 ml (medium portion), 300 ml (large portion), or "I did not drink soft drinks in the last week". In order to facilitate and standardize responses, a set of color photographs and common household utensils were used to represent different serving sizes that are representative of the Argentine population. Finally, the third item asked about the average number of times per day that the person consumed the beverage. Fig. 1 shows an example of the questions.

Table 1 shows reliability statistics of the instruments. All instruments showed high levels of internal consistency, with values of α and ω above 0.80.

2.6. Statistical analysis

All statistical analyses were performed using the Stata software (version 15, StataCorp). P values below 0.05 were considered significant. Internal consistency was measured using the Cronbach's alpha (α)

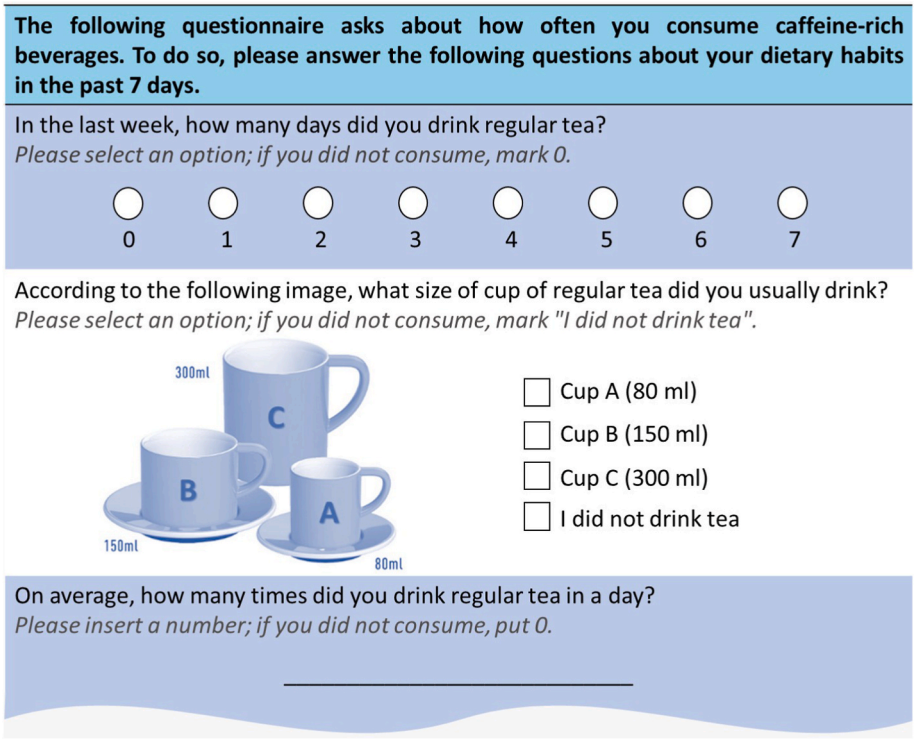

Fig. 1. Example of the questionnaire on caffeinated beverages consumption.

Table 1
Reliability of the measuring instruments.

Instrument	Items (n)	α	ω
Insomnia Severity Index (ISI)	7	0.811	0.818
Pandemic-related Perceived Stress Scale (PSS-10)	10	0.831	0.832
Postpartum Depression Screening Scale-Short Form (PDSS-SF)	7	0.826	0.832
Memory Complaint Scale for Patients (MCS-P)	7	0.817	0.831
Breastfeeding Self-Efficacy Scale-Short Form (BSES-SF)	14	0.879	0.891
Beverage intake questionnaire:			
Coffee	3	0.891	0.894
Yerba mate	3	0.852	0.855
Tea	3	0.907	0.908
Soft drinks	3	0.861	0.861

Note. α = Cronbach's alpha; ω = McDonald's omega.

and McDonald's omega (ω) coefficients. Descriptive statistics were calculated for numerical variables (mean, standard deviation, median, and interquartile range -IQR-) and categorical ones (percentages). Beverage intakes were compared with respect to pre-pandemic data by analysis of covariance (ANCOVA) with Bonferroni's *post hoc* correction. The ANCOVA models were controlled for demographic variables because both samples showed significant differences (Supplementary material). The relationship between the intake of caffeinated beverages and the psychological scores was assessed by multiple regression analysis adjusted by demographic and health variables to rule out potential confounders. Effect sizes were estimated using eta-squared (η^2) with 95% confidence intervals (95%CI).

Pearson's correlation coefficients (r) were calculated to test associations among the mental health scales. The structural equation modeling technique (SEM) provided a theoretical model of the effects of caffeinated beverage intake on the mental health of postpartum women. This construct was characterized by seven observed variables, according to recent evidence on the COVID-19 pandemic [2]. The following goodness-of-fit indices were estimated: The Chi-square value relative to the degrees of freedom (χ^2/df), Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), Tucker Lewis Index (TLI), and Standardized Root Mean Square Residual (SRMR) to assess standardized direct, indirect, and total effects (βs). The usage of the terms "total effect," "indirect effect," or "total effect" is employed in the present study as they are standard technical terms, and do not imply causality.

For multivariate regression models with ten predictors, power calculation indicated that a sample size of 497 participants was sufficient to detect a small effect size (f2 = 0.05) with a statistical power of 0.95. Therefore, this study's larger sample allowed the detection of minimal effects.

3. Results

On average, participants were 30.16 (5.71) years old with 5.30 (3.48) months of postpartum. Most women were in a couple (94%). The sample included primiparous and multiparous women who practiced breastfeeding (exclusive −51%- or partial −41%-) or artificial lactation (8%). They had been restricted from social activities for 60.39 (19.01) days per wave due to government measures against the COVID-19 pandemic.

Regarding their employment and education, 42% of participants were unemployed, 25% were teleworkers, 33% were essential workers, and 36% were e-students. Teleworkers and e-learning students had a mild increased frequency of coffee intake (β = 0.09, p = 0.040; β = 0.09; p = 0.054, respectively). Although β were relatively low, *yerba mate* intake was statistically significantly increased in both teleworking (β = 0.12; p = 0.010) and essential work (β = 0.10, p = 0.038).

The largest caffeine-intake contributor and most consumed beverage was *yerba mate* (69.17%) (Table 2). Other sources of caffeine were coffee (14.51%), tea (9.79%), and soft drinks (6.54%). The pre-pandemic sample reported the following daily intake: *yerba mate* = 907.76 (1030.17) mL/d, tea = 65.15 (120.41) mL/d, soft drinks = 46.47 (142.91) mL/d, and coffee = 32.20 (61.18) mL/d. When comparing the two samples, *yerba mate* (F = 18.51, p < 0.0001) and coffee (F = 11.62, p = 0.0003) were more ingested during the pandemic with respect to the previous period after controlling for demographics, whereas tea (F = 0.01, p = 0.9406) and soft drinks (F = 0.07, p = 0.7900) did not present significant differences.

The amount of coffee consumed during the pandemic was positively associated with insomnia (β = 0.14; p = 0.006, η^2 = 0.015 (95%CI = 0.001–0.045)), perceived stress (β = 0.14; p = 0.019, η^2 = 0.020 (95%CI = 0.001–0.062)), postpartum depression (β = 0.16; p = 0.001, η^2 = 0.023 (95%CI = 0.004–0.058)), and memory complaints (β = 0.11; p = 0.030, η^2 = 0.010 (95%CI = 0.000–0.034)). Likewise, the frequency of coffee intake correlated directly with insomnia (β = 0.12; p = 0.004, η^2 = 0.012 (95%CI = 0.001–0.034)), perceived stress (β = 0.15; p = 0.009, η^2 = 0.023 (95%CI = 0.001–0.068)), and memory complaints (β = 0.09; p = 0.032, η^2 = 0.010 (95%CI = 0.000–0.025)), but negatively with breastfeeding self-efficacy (β = −0.09; p = 0.013, η^2 = 0.011 (95%CI = 0.001–0.033)). Additionally, tea intake was associated with postpartum depression (β = 0.10; p = 0.034, η^2 = 0.009 (95%CI = 0.001–0.035)) and memory complaints (β = 0.17; p < 0.001, η^2 = 0.027 (95%CI = 0.005–0.064)). In contrast, the frequency of *yerba mate* intake showed inverse associations with levels of insomnia (β = −0.09; p = 0.030, η^2 = 0.010 (95%CI = 0.000–0.028)) and postpartum depression (β = −0.13; p = 0.002, η^2 = 0.015 (95%CI = 0.002–0.041)). In addition, soft drink intake correlated positively with breastfeeding self-efficacy (β = 0.09; p = 0.035, η^2 = 0.011 (95%CI = 0.000–0.038)). Despite the effects shown by these caffeinated beverages, no significant associations existed between caffeine intake and mental health scores (Table 3). The results of the overall F-test were significant for all models except for perceived stress and there was no problem of collinearity (Supplementary material).

The mean and median scores of the scales were: 9.97 (SD = 5.52) and 10 (IQR = 6–14) for ISI, 17.31 (SD = 6.52) and 18 (IQR = 13–24) for PSS, 15.77 (SD = 6.63) and 14 (IQR = 10–20) for PDSS-SF, 3.97 (3.24) and 3 (IQR = 1–6) for MCS-P, and 57.09 (SD = 8.83) and 59 (IQR = 52–64) for BSES. Violin plots containing boxplots highlighting the median scores are displayed in Fig. 2.

Fig. 3 shows correlations between the scales. Insomnia was positively correlated with perceived stress (r = 0.301, p < 0.0001), postpartum depression (r = 0.561, p < 0.0001), memory complaints (r = 0.339, p < 0.0001), and negatively correlated with breastfeeding self-efficacy (r =

Table 2
Intake of caffeinated beverages by postpartum women during the COVID-19 pandemic in Argentina (n = 619).

	Mean	SD	Median	Q1	Q3
Coffee					
Caffeine supplied (mg/d)	27.41	63.58	0	0	17.57
Intake frequency (d/week)	2.16	2.68	1	0	4
Intake amount (mL/d)	66.85	155.07	0	0	42.86
Yerba mate					
Caffeine supplied (mg/d)	513.83	762.31	165	0	660
Intake frequency (d/week)	5.12	2.73	7	3	7
Intake amount (mL/d)	1457.71	2053.91	500	0	2000
Tea					
Caffeine supplied (mg/d)	8.09	20.5	0	0	5.14
Intake frequency (d/week)	2.02	2.61	0	0	3
Intake amount (mL/d)	67.61	170.98	0	0	42.86
Soft drinks					
Caffeine supplied (mg/d)	5.59	16.66	0	0	3.14
Intake frequency (d/week)	1.07	1.59	0	0	2
Intake amount (mL/d)	50.95	151.55	0	0	28.57
Total caffeine (mg/d)	646.20	784.47	350.57	131.14	783

Note. SD = standard deviation; Q1 = first quartile; Q3 = third quartile.

Table 3
Multivariate regressions between caffeinated beverage intake and mental health status in postpartum women during the COVID-19 pandemic in Argentina (n = 619).

	Insomnia severity	Perceived stress	Postpartum depression	Memory complaints	Breastfeeding self-efficacy
Coffee					
Amount (mL/d)	0.14 p = 0.006	0.14 p = 0.019	0.16 p = 0.001	0.11 p = 0.030	−0.05 p = 0.263
Frequency (d/week)	0.12 p = 0.004	0.15 p = 0.009	0.06 p = 0.135	0.09 p = 0.032	−0.09 p = 0.013
Yerba mate					
Amount (mL/d)	−0.05 p = 0.388	−0.09 p = 0.142	−0.03 p = 0.642	−0.02 p = 0.687	0.09 p = 0.107
Frequency (d/week)	−0.09 p = 0.030	−0.03 p = 0.564	−0.13 p = 0.002	−0.07 p = 0.092	0.02 p = 0.610
Tea					
Amount (mL/d)	0.08 p = 0.098	0.10 p = 0.091	0.10 p = 0.034	0.17 p < 0.001	0.03 p = 0.473
Frequency (d/week)	0.07 p = 0.080	0.08 p = 0.183	0.03 p = 0.476	0.05 p = 0.199	0.01 p = 0.745
Soft drinks					
Amount (mL/d)	−0.01 p = 0.865	−0.02 p = 0.640	0.02 p = 0.615	0.00 p = 0.955	0.09 p = 0.035
Frequency (d/week)	0.03 p = 0.495	−0.01 p = 0.922	0.05 p = 0.263	0.04 p = 0.271	0.04 p = 0.254
Total caffeine (mg/d)	−0.04 p = 0.502	−0.07 p = 0.224	−0.01 p = 0.812	−0.01 p = 0.898	0.06 p = 0.297

Note. Results expressed as betas adjusted by parity (number of children), employment (not working, home working or essential worker), taking online classes (yes or no), duration of restrictive anti-COVID-19 measures (days), cohabitants (number), postpartum duration (months), type of breastfeeding (exclusive, partial or artificial lactation).

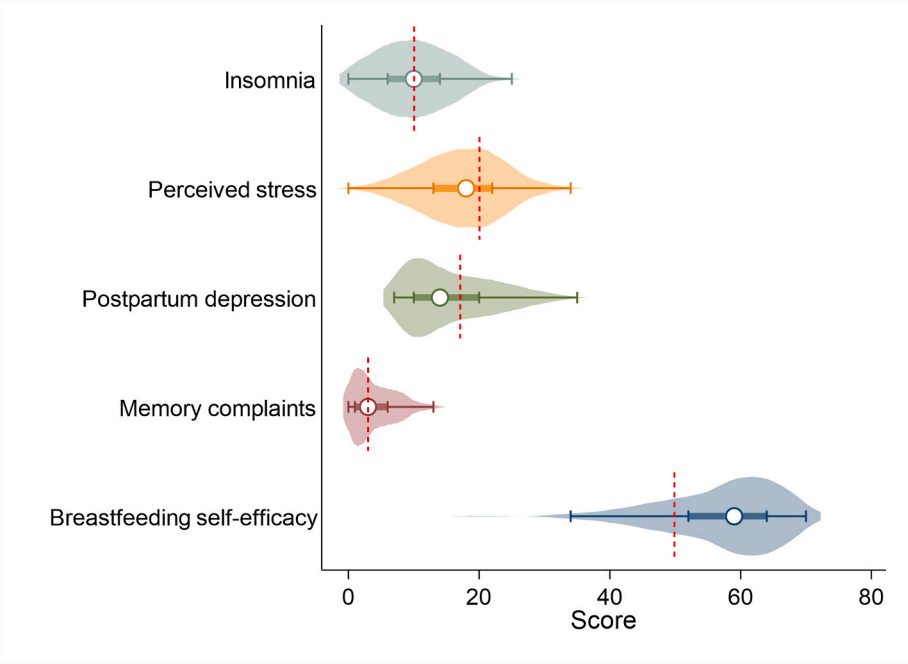

Fig. 2. Violin plots for mental health self-report instrument scores of puerperal women during the COVID-19 pandemic in Argentina. The circles denote medians and the red dotted lines represent the diagnostic cut-off point for each scale (Insomnia Severity Index = 10; Perceived Stress Scale = 20; Postpartum Depression Screening Scale-Short Form = 17; Memory Complaint Scale = 3; Breastfeeding Self-Efficacy Scale-Short Form = 50). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

−0.167, p = 0.0001). Regarding perceived stress, it was positively correlated with postpartum depression (r = 0.424, p < 0.0001) and memory complaints (r = 0.278, p < 0.0001) but inversely with breastfeeding self-efficacy (r = −0.226, p = 0.0003). Postpartum depression was directly associated with memory complaints (r = 0.363, p < 0.0001). In addition, inverse relationships between breastfeeding self-efficacy with postpartum depression (r = −0.271, p < 0.0001) and memory complaints (r = −0.096, p = 0.0211) were found.

Fig. 4 shows the designed SEM diagram with adequate goodness-of-fit indices (χ^2/df = 1.02, CFI = 0.99, TLI = 1.00, SRMR = 0.024, RMSEA = 0.025), while direct, indirect, and total effects are displayed in Table 4. Coffee intake showed positive direct effects on stress (βs = 0.18, p < 0.01) and insomnia (βs = 0.08, p < 0.05). This beverage also positively correlated with postpartum depression, insomnia, and memory complaints, but negatively with breastfeeding self-efficacy, through an indirect path. By contrast, *yerba mate* had an inverse direct effect on postpartum depression (βs = −0.12, p < 0.01) and indirect effects on insomnia and memory complaints, which was positively associated with breastfeeding self-efficacy.

4. Discussion

This study aimed to study mental outcomes and determinants of caffeinated beverage intake in postpartum women during the COVID-19 pandemic in Argentina. Briefly, results showed that women who worked or studied from home due to mobility restrictions consumed a greater amount of coffee and *yerba mate*. Combining data collected during the pandemic with pre-pandemic data, a higher intake of coffee (107.6%) and *yerba mate* (60.6%) was found during the pandemic. Moreover, the amount and frequency of the consumption of these caffeinated beverages were differentially related to mental health status. In this sense, it was found that coffee was associated with a worse mental health status, while *yerba mate* was correlated with a better one. These findings confirmed the stated hypotheses.

In the current work, the intake of caffeinated beverages varied widely, although *yerba mate* predominated over the other drinks, in accordance with data from Argentina and other South American countries [29]. Although the caffeine average exceeded daily recommendations for lactating women, most participants showed adequate intakes below 500 mg/day. Although this compound is stimulant, it was not

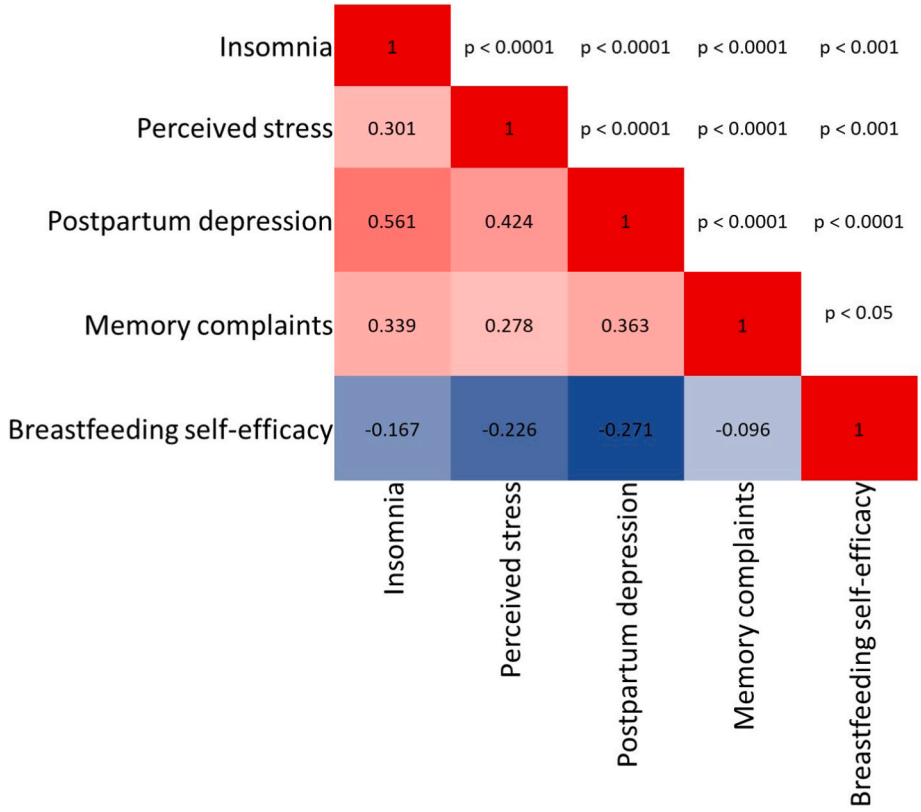

Fig. 3. Heat-map showing Pearson's correlation coefficients between mental health indicators of postpartum women from Argentina during COVID-19 pandemic.

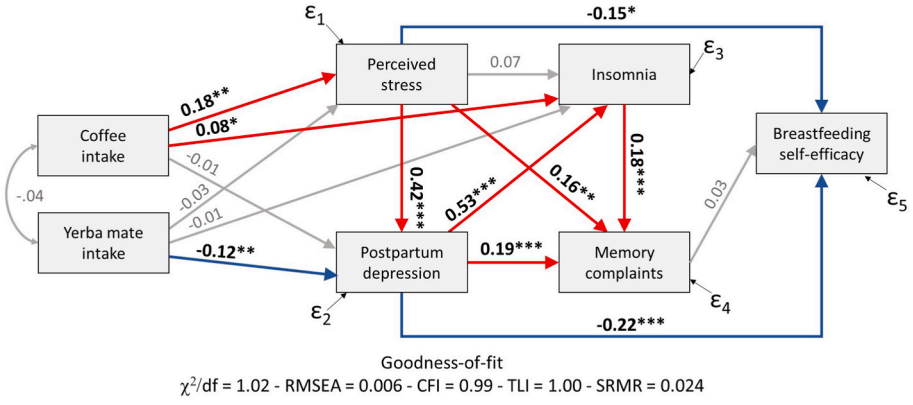

Fig. 4. Structural equation model with standardized direct effects of coffee and *yerba mate* intakes on postpartum mental health during COVID-19 pandemic restrictions in Argentina. Red arrows indicate positive direct effects, blue arrows indicate negative direct effects, and gray arrows indicate non-significant relationships. The usage of the word "effect" corresponds to terminology associated with SEM analysis, hence the arrows in the model do not imply causation. χ^2/df = chi-square value relative to the degrees of freedom; CFI = comparative fit index; TLI = Tucker Lewis index; SRMR = standardized root mean square residual; RMSEA = root mean square error of approximation. Statistically significant paths highlighted in black: *p < 0.05, **p < 0.01, ***p < 0.001. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

involved in the effects of the beverages; thus, other molecules were bioactive [30]. Moreover, several polyphenols counteract the effects of caffeine. In this sense, although the ergogenic activity of this xanthine is well-known [30,31], its psychotropic effects and the consequent well-being (at cognitive and affective levels, as assessed) involve different neurochemical pathways, which can be modulated by nutrients and phytochemicals present in the beverages [32–34]. Furthermore, adequate nutrition is essential for facing the increased physical and mental demands of the COVID-19 pandemic [35]. The effort and dedication required by working and studying at home or being an essential worker increase such demands during social isolation and distancing [36], which might enhance the intake of ergogenic beverages to compensate, mainly *yerba mate* for postpartum women. Despite the demand-related increase in energetic drink intake previously reported [8,37], the current study explains how beverages were consumed according to specific working conditions.

Mental energy includes affective, cognitive, and motivational dimensions, which can be approached by evaluating postpartum depression, memory, and self-efficacy impairments, respectively. Certain dietary compounds are proposed as mental energy promoters, such as caffeine, B-complex vitamins, polyphenols, and other phytochemicals [38]. In this regard, phytochemicals display antidepressant effects through the synaptic regulation, involving the levels of monoaminergic neurotransmitter and metabolizing enzymes in different parts of the brain. Also, phytochemicals prevent hyperactivity of the stress-related hypothalamic-pituitary-adrenal axis. They are a safe, cost-effective, and efficient alternative as part of women's nutrition, which may outperform caffeine [39,40]. Although this methylxanthine is a worldwide consumed psychostimulant [9], habituation after prolonged exposure is a plausible phenomenon in human beings [41], which

Table 4
Standardized effects of the coffee and *yerba mate* intakes on postpartum mental health during COVID-19 pandemic restrictions in Argentina by structural equation modeling (n = 619).

	Coffee intake			*Yerba mate* intake		
	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total Effect
Pandemic perceived stress	0.18 p = 0.001	–	0.18 p = 0.001	−0.03 p = 0.635	–	0.03 p = 0.635
Postpartum depression	−0.01 p = 0.820	0.08 p = 0.002	0.07 p = 0.098	−0.12 p = 0.003	−0.01 p = 0.635	−0.13 p = 0.002
Severity of insomnia	0.08 p = 0.022	0.05 p = 0.049	0.13 p = 0.002	−0.01 p = 0.828	−0.07 p = 0.003	−0.08 p = 0.059
Memory complaints	–	0.06 p = 0.001	0.06 p = 0.001	–	−0.04 p = 0.023	−0.04 p = 0.023
Breastfeeding self-efficacy	–	−0.04 p = 0.015	−0.04 p = 0.015	–	0.03 p = 0.033	0.03 p = 0.033

Note. The usage of the word "effect" corresponds to terminology associated with SEM analysis, hence the results do not imply causation.

explains the lack of significant associations between dietary caffeine intake and the mental variables assessed by the current study. Moreover, sensitivity to this compound is population-specific by depending on polymorphisms in the genes CYP1A2 and ADORA2A that regulate caffeine metabolism and bioactivity, respectively [42]. Thus, these genetic, gender-related, and behavioral factors should be evaluated in future. This evidence supports a caffeine-independent potential of the beverages of interest on habitual consumers. Furthermore, recent literature suggests relevant benefits to mental performance that exceed those associated with caffeine for multi-ingredient energy drinks and several low-caffeine extracts, including high-flavonoid formulations [43]. Coffee and tea may supply lower amounts of B-complex vitamins, minerals, other methylxanthines, and polyphenols than *yerba mate*, given their different nutritional composition and intake level [44–47]. Micronutrients are essential for healthy brain metabolism to present ergogenic effects [48], which are almost absent in soft drinks. In consequence, psychostimulant potential of *yerba mate* over other beverages on mental energy is promising.

Coffee intake showed positive correlation with perceived stress, being associated with insomnia as expected [49]. These effects were related with more postpartum depression and memory complaints in women, in accordance with previous data during the COVID-19 pandemic [2]. The association between tea consumption and poorer mental health status was weaker, in concordance with its lower intake. Although coffee and tea are reported as beneficial and antidepressant [50], differences found in this study seem to contradict this. A possible explanation is that women adhere to three different dietary patterns during the puerperium, rich in macronutrients, phytochemicals, or calories, respectively, with coffee and tea negatively contributing to the second one (i.e., women who highly consume them have a low intake of healthy vegetables and fruits) [28]. Thus, despite their potential benefits, they are associated with unhealthy dietary habits, which are detrimental to mental health [51].

Contrarily, *yerba mate* intake is independent of pattern adherence and provides greater amounts of bioactive compounds [28,52], which could explain its psychoactivity. Concerning this, experimental data from animal models support the antidepressant potential of this plant-based beverage [53]. This effect can in turn improve other mental health scores and maternal self-efficacy [2,54]. The influence of vegetable infusions on breastfeeding self-efficacy depended on their corresponding affective and cognitive effects, in concordance with the psychodynamic bases of self-efficacy [55].

Eating behaviors have been altered during the COVID-19 pandemic [4], prompting several researchers to warn about the increased intake of caffeinated beverages, unhealthy habits, and psychiatric morbidity (depression, anxiety, and insomnia) [12]. These disorders show great reciprocity by modulating complex neurological pathways [56,57]. Although pre-pandemic studies show that caffeine intake is a risk factor for insomnia and postpartum depression [57,58], its exact mechanisms and implications remain partially unknown. *Yerba mate* may exert benefits through its socializing role among Argentinian inhabitants and its numerous neuroactive compounds [59,60].

It is necessary to recognize some limitations that can affect the generalization of our results: causality is difficult to be assessed using cross-sectional designs, assessment of risk factors for mental compromise is complex, and consumption of alcohol or other substances was not considered. On the other hand, this study was based on nutritional estimations that tend to produce response biases (e.g., social desirability and inaccurate memory) [61]. To prevent this bias, participants were reminded of the confidential nature of the study and shown visual serving references, which are part of a validated and reproducible instrument with a 4% overestimation and no constant bias [28]. Furthermore, self-report measures of caffeine consumption are valid methods to predict actual caffeine levels [62]. Another limitation is that we did not collect data of prior mental health status before lockdown, so it was not possible to test whether the associations between caffeinated beverage consumption and mental health found in the pandemic sample were different in the pre-pandemic sample. Therefore, it would be interesting to assess this issue in the post-pandemic setting. Besides, future studies should collect information about specific aspects of daily life that have been impacted by the pandemic, such as physical activity or drug consumption. To assess the impact of postpartum women's illicit substance use during the pandemic, we recommend that future research implement a specific population-based design, given that the study population has a high level of substance use restriction (thus, a relative low prevalence) [63], and therefore the casuistry does not allow for a more comprehensive approach in the present study. Last, although it is not common practice to adjust alpha in the contexts of the multivariate statistical methods used in this study because of their lower risk, it is important to recognize that the estimation of numerous parameters could lead to alpha-inflation [64]. Nonetheless, our findings are highly relevant for addressing postpartum women's mental health and allow a better understanding of the nutritional factors that influence well-being during the COVID-19 pandemic. Future research is encouraged to deepen this issue.

In conclusion, the pandemic modified the nutritional behaviors of postpartum women in Argentina with a higher intake of caffeinated beverages. Coffee might exert anxiogenic effects as it was associated with affective and cognitive impairment, while tea shows a similar but much weaker relationship. On the other hand, *yerba mate* potentially enhanced mental energy, as it was associated with lower scores for postpartum depression and indirectly with improved mental well-being. Moreover, these results are relevant because they are associated with maternal self-efficacy, which is crucial to support breastfeeding. Because differentiated links were found with respect to dietary sources, it can be assumed that caffeinated beverages would exert effects independent of caffeine on mental health, which might depend on different compounds acting synergistically. Future studies are needed to replicate the current findings and also to further establish causal mechanisms.

Funding

This work was supported by Secretaría de Ciencia y Tecnología - Universidad Nacional de Córdoba (grant number SECYT-UNC 472/2018). Mariela V. Cortez is a postdoctoral fellow of Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET). Ana V. Scotta is a Ph. D. fellow of SECYT-UNC.

Data statement

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Author contributions

Agustín R. Miranda: Conceptualization; Project administration; Methodology; Software; Investigation; Formal analysis; Writing-Original Draft; Writing-Review & Editing. Mariela V. Cortez: Methodology; Investigation; Visualization; Writing-Original Draft; Writing-Review & Editing. Ana V. Scotta: Methodology; Investigation; Visualization; Writing-Original Draft; Writing-Review & Editing. Elio A. Soria: Project administration; Supervision; Methodology; Formal analysis; Funding acquisition; Writing-Original Draft; Writing-Review & Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

The authors gratefully acknowledge the participants of this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.hnm.2023.200198.

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