

Cortisol, maternal stress and breastfeeding rate at hospital discharge: a systematic review

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The author does not present any conflict of interest.

Abstract

Introduction: Breastfeeding is considered the best way to provide essential and necessary nutrients to the newborn, intervening in its growth and development. However, early abandonment of this method is quite common, due to various factors such as stress.

Objectives: To determine whether the level of postpartum cortisol can serve as an indicator of maternal stress and whether there is a relationship between the level of cortisol and the rate of exclusive breastfeeding at hospital discharge.

Methodology: Systematic review of the literature under the PRISMA guidelines. PubMed, Web of Science, CINAHL and Scopus databases were used. Original articles published from 2017 to 2022 in English, French, Portuguese and Spanish were included. All study designs were eligible. Of the 3712 records initially identified, 15 studies were included in this review.

Results: Elevated cortisol levels, due to immediate postpartum stressors, have direct effects on the performance of the essential hormones in breast milk production. Exclusive breastfeeding rates are negatively influenced by perceived maternal stress.

Conclusion: Cortisol levels may be a good indicator of the level of stress to which the mother is subjected during the immediate postpartum period.

Keywords: Breastfeeding, cortisol, stress, immediate postpartum, breastfeeding difficulties, breastfeeding rates.

1. Introduction

Exclusive breastfeeding (EBF) is a distinctive process of biological inheritance and one of the primary early postnatal exposures for the newborn (NB).^{1,2} Breastmilk contains multiple bioactive compounds such as lipids, proteins, hormones and immune factors, These compounds provide the first line of defence against various forms of malnutrition, safeguarding the infant from a multitude of diseases such as diabetes and obesity and also women who breastfeed receive a host of benefits such as reduced future risk of cardiovascular disease, and some forms of cancer, especially breast and ovarian cancer.³⁻⁵

Due to the many benefits of EBF, the World Health Organization (WHO) advises that at least the first 6 months should be on EBF, and that thereafter, other complementary foods should be continued until approximately two years old.⁶ However, despite the fact that this natural and innate feeding process is one of the most efficient ways to ensure the survival and health of the NB and the mother, only 44% of NBs receive EBF in the first 6 months worldwide, a percentage that has been decreasing over the last decades in the European region.⁷⁻⁹

In order to understand this situation, one must first ascertain the existence of inter-individual and intrinsic variability that exists from one mother to another, even to the extent of intervening breastmilk components.¹⁰ Similarly, breastfeeding is not only an instinctive and acquired behaviour, but a myriad of factors, which includes demographic, socio-cultural, biological and economic factors, which will differentiate one breastfeeding from another.¹¹ Among these factors is the variant of stress, a negative tributary with physiological and hormonal triggers, which will be counterproductive to the success of EBF.¹²

Stress is a premonitory and universal response to any dangerous situation. This term has negative and life-limiting connotations that triggers a physiological and hormonal cascade in a person.¹³⁻¹⁵ The physiology of stress is produced by the activation of the hypothalamic-pituitary-adrenal (HPA) axis, a system whose primary function is to maintain homeostasis when the surrounding environment becomes threatening. Its end product, among other substances, is the secretion of cortisol.^{16,17}

The cohesion of breastfeeding and stress is mediated by a disparity of agents, which can be divided into two strands, one of which are those factors found internally in the mother; for instance, her level of vulnerability to stress, which being internalised can be more difficult to modify, and even the weakness to develop mental conditions such as depression and anxiety.^{18,19}

On the other hand, there are those stressors external to the mother that can be linked to biological difficulties in the breastfeeding method, such as breast engorgement, nipple latch-on, cracks, mastitis, pain when breastfeeding, breast engorgement, not finding a suitable position and difficulty in knowing the amount of milk the baby is drinking.^{12,20,21}

Furthermore, included in this variant other factors can be found, such as medical interventions during childbirth, the mother's incorporation into the labour market and her consequent conciliation, idealised postpartum expectations, prematurity of the baby, the baby's crying, frequent colic, health problems of the newborn, level of education,

aesthetic reasons, partner problems, instrumentation during childbirth, economic difficulties, feeling isolated and unsupported, etc.²²⁻²⁴.

Chronic stress can lead to hormonal dysregulation, notably in cortisol levels.²⁵ Both oxytocin and prolactin, hormones responsible for milk production and ejection respectively, are inversely proportional to cortisol concentrations. This means that when one is elevated in the blood the other will be suppressed and vice versa.^{26,27} Consequently, milk production will be negatively affected by this phenomenon, provoking another new source of stress in the mother. Therefore, it makes the implementation of this method even more difficult, due to the positive feedback of cortisol, which will suppress optimal levels of the essential hormones for lactation.²⁸

Consequently, due to the proliferation of early cessation of EBG, it is useful to describe the influence of cortisol as a biomarker of stress and its possible influence on the rate of EBG at hospital discharge.

2. Methodology

This systematic review is based on an observational and retrospective research, based on a qualitative and quantitative synthesis of the scientific literature, and not on a meta-analysis. The various guidelines of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement were followed for its development.²⁹ Its elaboration process in its different stages is detailed in a PRISMA flow chart. Table 1 (see annexes) shows the PICOS criteria (participants, intervention, comparison, outcomes, design) used for the inclusion of studies.

2.1 Search strategy and study selection

The search was conducted between January and March 2022 by combining the terms 'cortisol', 'breastfeeding' and 'stress' in the Web of Science, PubMed, Scopus and CINAHL databases. The selected articles were analysed for titles, abstracts and full text. Subsequently, a manual search was carried out in the journal Breastfeeding Medicine, and a snowball sampling was performed to examine the various citations of the selected publications in order to find relevant studies. On the other hand, "suggested publications" from the different databases included were also taken into account.

2.2 Inclusion and exclusion criteria

This review incorporated original studies issued from 2017 to 2022, inclusive; in English, French, Portuguese or Spanish, thus minimising language bias. In addition, the following eligibility criteria were applied: (1) participants comprised women older than 18 years in the postpartum at hospital discharge who had initiated EBG; (2) studies examined how cortisol, as an indicator of stress, influenced the rate of EBG at hospital discharge; (3) quantitative measurement of cortisol in different biological samples (saliva and blood/plasma). All study designs were eligible for inclusion. Publications that did not focus on cortisol-related factors as an indicator of stress on breastfeeding rate, as well as deviating from the mother's perspective, were excluded.

2.3 Data extraction

An initial selection of the identified records was made based on the title and abstract of the articles, and for those where the abstract did not appear or uncertainty remained about the suitability for inclusion in the review because they provided little information, the full texts were extracted.

2.4 Quality assessment

All studies included in this systematic review complied with the requirements for assessing both risk of bias and study quality set out by the PRISMA guidelines.²⁹ On the one hand, study quality and risk of bias were analysed by the web application, FLC 3.0 designed to support the development of systematic reviews of scientific evidence by providing support for the assessment of the quality of scientific studies and the synthesis of evidence.³⁰ On the other hand, the revised tools for assessing risk of bias in randomised trials (RoB 2)³¹ and bias in non-randomised studies of interventions (ROBINS-I) were also used.³²

2.5 Study selection and data analysis

The PRISMA flowchart (Figure 1) (see appendices) below shows the development of the literature search and the methodical selection of studies for inclusion in the review. This systematic search yielded a total of 3712 records in 4 different databases (Web of Science, n = 143; PubMed, n = 199; CINAHL, n = 60; Scopus, n = 3310). Before screening the records, a total of 3182 of ineligible studies were flagged by automation tools in each database, and 86 studies of these were flagged ineligible by a human. All duplicate studies (n = 110) were removed for appropriate filtering, and the remaining records (n = 215) were analysed according to title and abstract, discarding those that did not meet the inclusion and exclusion criteria (n = 112), did not meet the objectives of the review (n = 78) and focused more on other substances (n = 25). The end result was the inclusion of 15 studies.

3. Results

Table 2 (see annexes) presents and summarises the most relevant characteristics of the 15 studies included in this systematic review. The reviewed studies were published over a six-year period, from 2017 to the present. Demographically, the studies were conducted in Asia (6), Europe (5) and North America (4). The design of the vast majority of the studies included were observational cohort studies and 3 case-control studies. Specifically, 8 longitudinal and 4 cross-sectional cohorts; 2 longitudinal and 1 cross-sectional case-control studies were included. It was not possible to determine how the sample size was calculated in all articles, which simply reported the number of participants, for a total of 2264 participants in the 15 studies. In addition to measuring cortisol levels in postpartum women, the vast majority of the studies included cortisol levels during the gestational period, i.e. cortisol values were obtained at the different stages of reproduction that the woman went through from gestation (first 10-14 weeks of pregnancy) to late postpartum (more than 12 months postpartum). Cortisol concentrations were mostly measured in saliva, but on two occasions blood/plasma cortisol values were required.

4. Discussion

It is of great importance to study how stress affects the high rates of premature relinquishment of EBF. In this systematic review, we observed that cortisol is a biomarker of stress in breastfeeding women who have entered immediate postpartum. Early cessation of breastfeeding is influenced by a myriad of external factors that correlate with the interindividuality of each mother. Not only do psychological factors influence breastfeeding failure, but there are also various hormonal processes that when dysregulated by negative influences of these factors, sponsor a positive feedback cascade of both cortisol levels and other hormones that interfere with the HPA axis, resulting in the cessation of physiological breast milk production.

4.1 Relationship between cortisol levels and postpartum stress

In the 15 studies included in this review, cortisol is used as the biomarker chosen for stress, due to its dominance in its physiology. For this reason, it is of great importance to understand the pathways of cortisol production in response to stress stimuli.

The study by Van den Heuvel et al, a longitudinal cohort that was excluded because it did not fit the criteria for this review, examines hair capillary cortisol (HCC) as a biomarker of stress resilience rather than perceived stress in a mixed-ancestry sample.³³ It explains that the pathophysiology of stress begins with the activation of the hypothalamic-pituitary-adrenal (HPA) axis leading to the release of corticotropin-releasing hormone (CRH) in the hypothalamus to the hypothalamic-pituitary portal system, and that once it reaches the pituitary, especially the anterior or adenohypophysis CRH receptors, it triggers the release of adrenocorticotrophic hormone (ACTH).^{27,33} This hormone travels through the blood to the adrenal cortex, especially in the fascicular zone, which is responsible for secreting from cholesterol the primary product of this HPA axis, cortisol.

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Likewise, the review Kim et al, also discusses HCC as a biological marker of prenatal stress, which is why it was excluded from this analysis. Generally, these two studies agree on the retrospective nature of the extended detection of cortisol sampling in hair, which results in HCC not being influenced by immediate situational characteristics.²⁸ However, although HCC is a useful measure of stress, the considerable number of confounding factors such as sun exposure or chemicals in hair means that its validity is not as high as cortisol in saliva and blood.³³ This is one of the reasons why most of the studies included in this review measure cortisol in these two biological forms, especially salivary cortisol as it is a non-invasive and non-painful measure.

Cortisol secretion and concentration have a tendency to decrease after breastfeeding, due to the inhibitory effect of oxytocin.³⁵ However, the rise in cortisol levels reflects a direct relationship with perceived stress, so that the sum of the above factors generates distress and pathological stress in the mother, instigating a greater sense of self-efficacy to breastfeed.^{3,28}

The prospective cohort Shiraishi et al, a study in which a multiple logistic regression analysis was performed to study the factors affecting self-efficacy in EBF at 3 months postpartum, exposes some of the factors with the highest percentage of influencing early breastfeeding cessation.³⁶ One of the most relevant factors was breastfeeding self-efficacy, because perceived breast milk insufficiency has a 37% dominance rate in

breastfeeding cessation.^{37,38} Gillespie et al. also showed that primiparas were more likely to have more breast complications than multiparous women, showing that primiparas have elevations in both serum cortisol and pregnancy- and postpartum-specific distress.^{10,12} In the study by Uvnäs Moberg et al, which was reviewed and ultimately excluded for not meeting the inclusion criteria, the purported study is cited as showing that multiparous women had higher levels of oxytocin than primiparous women, and in turn reduced levels of ACTH and cortisol.³⁹ On the other hand, Shiraishi et al and Mizuhata et al state that women with high levels of education followed by feasible access to information have high levels of education, have prosperous attitudes towards breastfeeding in the immediate postpartum period, as they are more prepared and confident to face the difficulties that may arise.^{36,40} Another substantial factor in the maintenance of EBF during the months after hospital discharge is the return to work and its consequent reconciliation with breastfeeding. The lack of private spaces, inter-individual consideration and inclusion of breastfeeding mothers in the workplace is a favourable reason for formula feeding.^{19,23}

On the other hand, maternal inter-individuality plays a crucial role in breastfeeding, especially from a genetic point of view, as some mothers may have higher oxytocin levels than others. These higher levels might have repercussions on the development of breastfeeding and its relationship with stress.³⁸ Genetic variations in oxytocin physiology and the capacity to be affected by cortisol is explained in the Krol et al. study. In this, it is stated that the maternal response to cortisol is affected by the CD38 genotype, indicating that mothers with this gene had higher levels of oxytocin and higher oxytocin levels, and consequently greater reductions in cortisol, and were less susceptible to stress.

From a maternal-infant point of view, both stress and cortisol have influence on the maintenance of EBF. The studies Jonas et al and Neu et al, offer the positive correlation between maternal-infant cortisol levels and the clinical relevance of infant suckling to the production of milk and maternal self-efficacy. This is because suckling is the main basis for the release of PRL and oxytocin for prolonged breastfeeding, so that the longer the suckling time, the lower the cortisol levels will be.^{25,41,42}

It is worth noting that those NBs showing low suckling arousal, such as a disinterest in latching on to the nipple, will evoke negative feelings towards the EBF in the mother.²⁷ The Neu et al. pilot study, which analysis hormonal and neuromuscular responses to breastfeeding, measures both cortisol and saliva α -amylase levels, the latter being a biomarker of the sympathetic nervous system.²⁵ This study shows how large amounts of maternal cortisol suggest that mothers were less sensitive to the responses of their infants, who did exhibit more irritation and feeding cues.^{25,43} Thayer et al, state that those NBs who are breastfed have 40% more cortisol than those who are not breastfed by choice. This suggests the hypothesis that cortisol transfer through the breastfeeding transfer of cortisol through the medium of milk, and thus making infants susceptible to the concentration of cortisol of their mothers.⁴⁴

4.2 Correlation of cortisol to hormones involved in lactation

To understand the role of cortisol in postpartum and lactation, it is useful to know its dominance during pregnancy. The longitudinal study Syam et al analyses cortisol and

prolactin levels, milk volume and weaning time in lactating mothers with depressive symptoms. It explains that cortisol has a physiological upward trend in pregnancy, in order to suppress the maternal inflammatory system from attacking the foetus, as well as contributing to placental irrigation and foetal organ maturation.⁴⁵

On the other hand, the Simons et al cohort suggests that prenatal distress may predict negative postnatal care practices, indicating that elevated evening cortisol levels in the last weeks of pregnancy are positively associated with the onset of EBG.⁴⁶ However, it was shown that mothers who planned during gestation to breastfeed as a method of feeding their newborns may have experienced elevated stress, leading to unfavourable breastfeeding behaviours.⁴⁷ The study by Thayer et al also looked at cortisol profiles in late pregnancy and postpartum, affirming what the Syam et al study pointed out of the eminent concentration of cortisol to cooperate in fetal maturation in late gestation.^{44,45} Thus, we can assert the importance of having physiological cortisol levels during pregnancy, since an abnormal tendency due to stress induced at this delicate stage could induce dysregulation in the immediate postpartum period, and in breastfeeding at the same time.

As in pregnancy, childbirth is a crucial process in the mother that has a direct impact on the implantation of the type of feeding that will be given to the newborn, so it is appropriate to mention the influence of childbirth on EBG and how cortisol intervenes in this period.

According to Karakoyunlu et al, childbirth is an extremely stressful event for the mother, with practices such as emergency caesarean sections and instrumental delivery causing a reduction in oxytocin and prolactin flow in response to HPA axis activation.⁴⁸ This stress in the active phase of labour increased the time to initiation of breastfeeding for reasons such as lack of skin-to-skin exposure or lack of nipple attachment, leading to decreased breastfeeding self-efficacy in the immediate postpartum period.⁴⁹ Bigelow & Power, a case-control study, concluded that mothers who were in the skin-to-skin exposure group at birth had a significant reduction in stress, favouring breastfeeding implementation during the first 3 months, because this exposure raises oxytocin and lowers cortisol concentration.^{50,51}

The dominance of cortisol in preterm weaning is explained by the intervention of the disparate hormonal processes involved in milk production.²⁶ Studies Bibi et al and Syam et al describe that milk secretion in mammary epithelial cells is elicited by prolactin (PRL). This same case-control study Bibi et al relate cortisol to PRL and triiodothyronine (T3) levels, speculatively expressing that when there is a stressful stimulus in the mother, cortisol concentration rises suppressing T3, leading to successive decrease in PRL, and consequently emptying of milk supplies.^{45,52}

This event may be due to the effect of reversing the antagonistic effect of ACTH on suppressive functioning to release glucocorticoids.^{45,53} Similarly, decreased cortisol condensation originates during lactation, so they have bidirectional pathways, since a distortion of the HPA axis, could lead to lactation failure.⁵⁴ Bibi et al also point to the negative correlation of maternal employability with breastfeeding rates, with working mothers having higher stress levels than non-employed mothers, and the unfavourable cohesion of household income with mothers' LRP levels. This latter dismissal of the

socio-economic status of breastfeeding women may be interpreted in such a way that higher paid jobs are more demanding, producing a positive correlation between cortisol levels and maintenance of high socio-economic status.^{52,55}

However, Bublitz et al, a secondary data analysis with a sample of 197 women, found that those mothers with psychosocial stress signalled by low socioeconomic status during gestation were less likely to breastfeed. This association is given by lower cortisol concentrations upon awakening.⁵⁶

Another essential component of lactation is oxytocin, which has the primary function of contracting the muscle fibres surrounding the alveolus of the lactiferous ducts for milk ejection to occur.⁵⁷ It not only plays a role in facilitating milk let-down, but also promotes physiological adaptations to motherhood.⁴² Cox et al, a study showing that oxytocin inhibits cortisol secretion in the HPA axis in postpartum women, so that decreased levels of oxytocin may lead to increased cortisol, in turn inhibiting PRL secretion and hindering breast milk production and storage.^{26,39}

In fact, the study by Uvnäs Moberg et al, not included for studying oxytocin as the key hormone in exerting its effects by means of active fragments without directly relating to cortisol and breastfeeding, states that according to different experimental findings in rats, the biphasic effect of oxytocin, which at first with the perception of a threat both cortisol and blood pressure increase and subsequently revert to a decrease, together with a rise in plasma levels of oxytocin.⁵⁸

According to Syam et al, dysregulation of physiological concentrations of prolactin, oxytocin and cortisol influence reactivity to the onset of mental conditions such as postpartum depression and anxiety that share a unidirectional relationship with breastfeeding, because the onset of these two conditions would determine the duration of breastfeeding and the switch to formula feeding. This study found that mothers with depressive symptoms experienced 13% faster weaning compared to healthy mothers.⁵⁹

Despite discounting a large number of studies that focused solely on cortisol as a biological component of breastmilk, there were two studies that looked at cortisol as a biomarker of stress, and studied its influence on both breastfeeding and milk components. One study by Moirasgenti et al. confirmed that an increase in cortisol caused by negative mood due to exposure to stressors in the puerperium had an influence on the reduction of immune function in breast milk, particularly with secretory immunoglobulin A (sIgA).⁶⁰

In the case of the study by Ziomkiewicz et al, it focuses on the metabolic consequences of mothers' stress, due to the significant energy required to cope with prolonged and chronic stressors, revealing the positive reactivity shared by stress and breastmilk fat. In this study, there is evidence that psychosocial stress has a considerable influence on affecting the biological components of breastmilk through two pathways, one of which is short-term stress that leads to elevated cortisol concentrations and elevated lactose and milk fat.¹⁸

However, long-term stress was associated with mobilisation and accumulation of unsaturated fatty acids in milk lactose. The importance of understanding the changes in milk composition due to exposure to stressors lies in the fact that this alteration may have

a negative impact on the mechanism of breast milk formation and maintenance, and at the same time lead to undesirable behaviours in EBF such as withdrawal.^{18,60,61}

4.3 Influence of cortisol on EBF success at hospital discharge

One of the aims of this review was to explore whether maternal cortisol levels had an influence on immediate postpartum EBF rates. It should be noted that, in general, most of the included studies discuss which feeding methods were eventually implemented across the different studies, with decreased rates of EBF, and elevation of mixed or formula feeding. However, none directly established cortisol as the main marker of early EBF cessation rates in the immediate postpartum period, but correlated these rates with stress levels.

In the case of the study by Shiraishi et al, which looked at factors affecting breastfeeding self-efficacy in a sample of 104 women, only 58.7% of women reported maintaining EBF after delivery without cessation during at least 3 months postpartum, 31.7% reported partial breastfeeding and 9.6% reported formula feeding. Of the 61 breastfeeding women who reported EBF, five switched to mixed breastfeeding after 3 months postpartum. In addition, it is noteworthy to mention that some of the factors with the highest percentage of significantly influencing breastfeeding cessation were planning to return to work, multiparity and breast complications.^{23,36}

Mizuhata et al report that of the 79 mothers who participated in their study, 38 faced difficulties in breastfeeding, with higher percentages of perceived stress levels than those who did not face difficulties. This resulted in only 44.5% of mothers eventually practising EBF. In fact, this same cross-sectional cohort suggested that maintaining exclusive breastfeeding suppressed cortisol secretion even in those mothers who established mixed breastfeeding, thus contributing to the decrease in stress.⁴⁰

On the other hand, the parity mentioned in the previous point has repercussions on breastfeeding rates, since the longitudinal study Gillespie et al shows that primiparas experienced 63% of difficulties and inconveniences in breastfeeding compared to 37% for multiparous mothers, thus leading to a high rate of breastfeeding abandonment in the first 3 months by a large proportion of the primiparas in the study (24.1%). It is also relevant to note that in planning the method of feeding the NB, especially those planning to breastfeed may experience high stress in late pregnancy because of concerns about their self-efficacy, leading to an increase in cortisol in response, and the eventual implementation of formula feeding without even attempting exclusive breastfeeding.⁴⁶

Childbirth is a delicate process for the mother that plays a critical role in the establishment of EBF. Karakoyunlu et al state that of the 51 postpartum women included in their study, 68.6% considered having a difficult birth and although 100% thought about breastfeeding, only 39.2% breastfed immediately after delivery. Hence, events in the active phase of labour were significant predictors of EBF.⁴⁹ Similarly, skin-to-skin contact is an effective method of establishing EBF; the Bigelow & Power study found that mothers who had skin-to-skin contact initially used exclusive breastfeeding as their method of choice for more than three months postpartum compared to those who did not make skin-to-skin contact who overwhelmingly chose mixed and formula feeding at visits.⁵⁰

The relationship between cortisol levels, stress and postpartum depression also influences EBF cessation rates, as shown by Syam et al who report that of the 92 mothers in their longitudinal study, those with depressive symptoms had a 13.4% potential to wean more quickly than those without these symptoms, with 54.3% of mothers remaining exclusively breastfeeding for the first two months postpartum and 45% experiencing early cessation of EBF.⁴⁵

In addition, it is crucial to mention some factors included in the studies that influence breastfeeding success. On the one hand, Bublitz et al. report that 34% of the mothers who participated in the study reported lower socio-economic status during pregnancy and only 13.7% of them established exclusive breastfeeding.⁵⁶ Similarly, 18% of those who formula fed their babies in the first weeks postpartum were relatively younger with a mean age of 24 years. On the other hand, Bibi et al state that employment status is a strong predictor of long-term breastfeeding, as in their study the 41 participants who were employed had only 19.51% of EBF and 39.03% of weaning compared to 42.85% of non-employed mothers who had established exclusive breastfeeding. This may have been due to the stress load they were exposed to with consequent elevated cortisol levels.⁵²

Due to the large amount of heterogeneity found in the studies in this review, we can affirm that the vast majority essentially analyse the influence of stress variables on breastfeeding from a psychological point of view but not from a physiological one, with particular mention of cortisol. This is due to the plurality of anxiety and stress scales, such as the Perceived Stress Scale (PSS) used in the disparity of studies, making it difficult to discern the hormonal link between stress, cortisol and breastfeeding. However, it is important to note that stress scales are necessary when studies establish a relationship between cortisol levels and cortisol scores. Continuous updates of research on breastfeeding, stress and cortisol conclude that increased cortisol levels in the body, due to exposure to stressors in the immediate postpartum period, have direct effects on the performance of hormones essential for breast milk production, namely oxytocin and prolactin, the latter less studied as a covariate in stress. In addition, it has been found that postpartum EBF rates at hospital discharge are not directly influenced by elevated cortisol levels, but by exposure to postpartum stressors.

5. Conclusion

This study was a systematic review of the literature that examined cortisol level as a biological biomarker of postpartum maternal stress and the influence on exclusive breastfeeding rates at hospital discharge. The presence of elevated cortisol in postpartum women in response to postpartum stress was negatively correlated with the biological components responsible for the physiological functioning of breast milk production and secretion. Similarly, exclusive breastfeeding rates at hospital discharge were influenced by mothers' perceived stress without a direct relationship to cortisol levels. Further studies analysing stress approaches from a more physiological point of view are needed to accurately validate the role of cortisol on breastfeeding rates in the immediate postpartum period and to prevent the negative consequences of premature cessation of breastfeeding due to the current high prevalence of cessation.

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Figure 1. PRISMA flow diagram (2020)

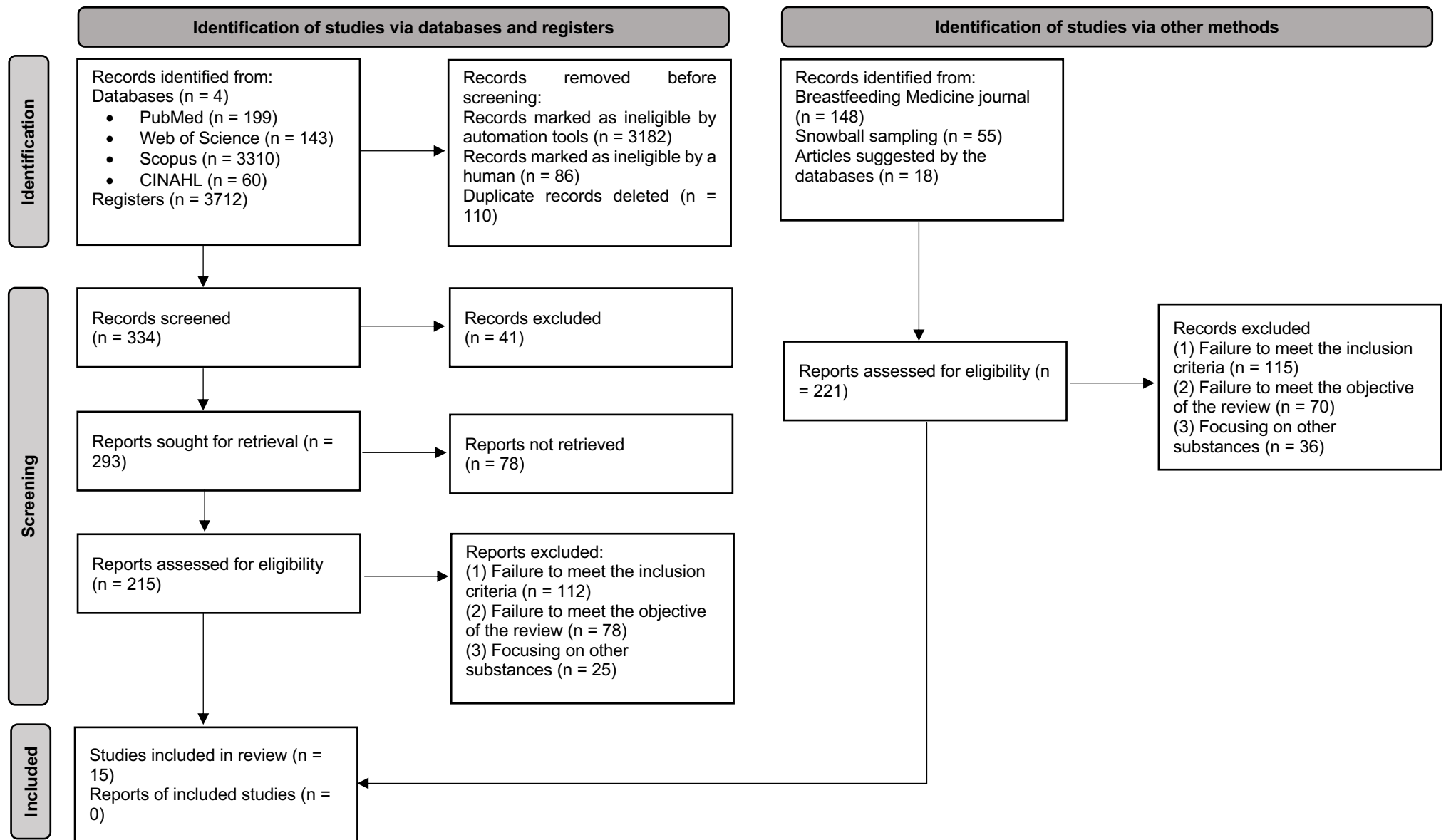


Table 1. PICOS criteria for study inclusion

Parameter	Criterion
Participants	Postpartum women at discharge from hospital who breastfeed
Intervention	Not applicable
Comparison	Cortisol levels of women with EBF at hospital discharge versus cortisol levels of women without EBF at hospital discharge
Outcomes	Elevated cortisol levels produce effects on breast milk production and maintenance. EBF rates are negatively influenced by maternal perceived stress
Study design	All study types

EBF (exclusive breastfeeding).

Table 2. Characteristics of the 15 studies included in this systematic review

References	Country	Study design	Sample size	Reproductive stage	Cortisol biological sample	Key results	Study quality	Risk of bias
Gillespie et al. (2018) ¹⁰	United States	Longitudinal cohort	137	From 10 weeks gestation to 11 weeks postpartum	Cortisol levels ($\mu\text{g/dL}$) in blood	Elevations associated with primiparity with specific distress in pregnancy precede cortisol elevations in the face of multiparity in the postpartum period.	High	Low
Ziomkiewicz et al. (2021) ¹⁸	Poland	Longitudinal case-control study	146	From 5 months postpartum	Saliva cortisol levels (ng/dL)	Short-term stress was positively associated with elevated breast milk lipids, reversed under chronic stress, and negatively associated with milk lactose.	High	Low
Neu et al. (2017) ²⁵	United States	Longitudinal cohort	20	From the first 24 hours postpartum to 3 months postpartum	Saliva cortisol levels ($\mu\text{g/dl}$)	Elevated cortisol levels with low NCAFS1 scores suggest that mothers were less sensitive to cues from their infants, who had clearer feeding cues.	High	Low
Shiraishi et al. (2020) ³⁶	Japan	Prospective longitudinal cohort	104	From the third trimester to three months postpartum	Saliva cortisol levels ($\mu\text{g/dl}$)	High cortisol levels after breastfeeding are considered a possible modifiable predictor of EBF at 3 months postpartum, reflecting physiological and psychological stress.	High	Low
Krol et al. (2018) ³⁸	Germany	Transversal cohort	84	From 120 and 196 days post partum	Saliva cortisol levels ($\mu\text{g/dl}$)	Mothers with genetically high oxytocin levels had reduced cortisol in response to breastfeeding compared to those with genetically lower oxytocin levels.	High	Low
Mizuhata et al. (2020) ⁴⁰	Japan	Transversal cohort	79	From the first 14 days postpartum to 16 weeks postpartum	Saliva cortisol levels ($\mu\text{g/ml}$)	Breastfeeding reduces cortisol levels and maternal stress received, higher perceived stress was associated with postpartum depression.	High	Low

Tabla 2. Continued

References	Country	Study design	Sample size	Reproductive stage	Cortisol biological sample	Key results	Study quality	Risk of bias
Jonas et al. (2018) ⁴¹	Canada	Prospective longitudinal cohort	93	From 3 months postpartum until 12 months postpartum	Saliva cortisol levels (nmol/L)	Positive correlations in maternal-infant cortisol levels in pregnancy, at 3, 6 and 12 months postpartum among breastfeeding mothers.	High	Low
Simons et al. (2022) ⁴³	Netherland	Longitudinal cohort	174	From 37 weeks to 6 months postpartum	Saliva cortisol levels (nmol/L)	Prenatal evening cortisol predicts the onset of EBF and room sharing as an underlying mechanism between maternal physiological stress and infant outcomes.	Medium	Some concerns
Thayer et al. (2020) ⁴⁴	Philippines	Transversal cohort	741	From 1st trimester to 12 months postpartum	Saliva cortisol levels (nmol/L)	Basal cortisol levels increase throughout the day in pregnancy, but are suppressed during lactation, due to the HPA system.	High	Low
Syam et al. (2021) ⁴⁵	Indonesia	Longitudinal cohort	92	From third trimester to 6 months of breastfeeding	Cortisol levels (µg/dL) in blood	Dysregulation of physiological cortisol and prolactin levels play a role in stress reactivity. Mothers with depressive symptoms experienced weaning 13% faster than healthy breastfeeding mothers.	High	Low
Karakoyunlu et al. (2019) ⁴⁹	Turkey	Longitudinal cohort	51	From the active stage of labour until 4 hours postpartum	Saliva cortisol levels (nmol/L)	Negative correlation between breastfeeding success and cortisol levels in relation to perceived stress in the active phase of labour and immediate postpartum.	High	Low
Bigelow & Power (2020) ⁵⁰	Canada	Longitudinal case-control study	90	From 1 week postpartum to follow-up 9 years later	Saliva cortisol levels (nmol/L)	Mothers in the SSC group had a greater reduction in salivary cortisol and SSC helped maintain the decision to breastfeed.	Medium	Some concerns

Bibi et al. (2021) ⁵²	Pakistan	Transversal case-control study	88	From 2 months postpartum to 12 months postpartum	Cortisol levels ($\mu\text{g/dL}$) in blood and saliva	Job stress activates HPA, in turn inhibiting T3 synthesis, contributing to PRL depletion and impaired inhibition of the HPA axis.	High	Low
Bublitz et al. (2019) ⁵⁶	Netherland	Longitudinal cohort	197	From 24 weeks of gestation to 1 month postpartum	Saliva cortisol levels (nmol/L)	Women with high psychosocial stress due to low socio-economic status during pregnancy were less likely to breastfeed, due to HPA dysregulation.	High	Low
Moirasgenti et al. (2019) ⁶⁰	Greece	Transversal cohort	89	From 4 to 6 weeks postpartum	Saliva cortisol levels (mg/dl)	Elevated cortisol levels due to specific stress in the postpartum period were associated with a reduced concentration of sIgA, so that mothers would not offer sufficient immune protection.	Medium	Some concerns

¹ NCAFS: infant assessment feeding scale to assess mother-infant interaction during breastfeeding, with higher scores indicating optimal mother-infant behaviours; sIgA, secretory immunoglobulin A; HPA, hypothalamic-pituitary-adrenal; PRL, prolactin; SSC, skin-to-skin contact; T3, triiodothyronine.