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**ΣΧΟΛΗ ΕΠΙΣΤΗΜΩΝ ΥΓΕΙΑΣ ΚΑΙ**  
**ΠΡΟΝΟΙΑΣ**  
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**ΠΜΣ ΠΡΟΗΓΜΕΝΗ ΚΑΙ ΤΕΚΜΗΡΙΩΜΕΝΗ ΜΑΙΕΥΤΙΚΗ**  
**ΦΡΟΝΤΙΔΑ**

**Μεταπτυχιακή Διπλωματική Εργασία**

**Πρακτικές Θηλασμού μητέρων νοσούντων από Covid-19.**  
**Συστηματική Ανασκόπηση και Μετανάλυση της πρόσφατης**  
**βιβλιογραφίας**

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**UNIVERSITY OF WEST ATTICA  
SCHOOL OF HEALTH AND  
CARE SCIENCES  
DEPARTMENT OF MIDWIFERY  
MSc in Advanced and Evidence-based Midwifery Practice**

## **Diploma Thesis**

**Breastfeeding Practices for COVID-19 Infected Mothers. A Systematic Review and Meta-analysis of the Current Literature.**

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**Athens, July 2023**



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**Μέλη Εξεταστικής Επιτροπής συμπεριλαμβανομένου και του Εισηγητή**

Η μεταπτυχιακή διπλωματική εργασία εξετάστηκε επιτυχώς από την κάτωθι Εξεταστική Επιτροπή:

| <b>A/a</b> | <b>ΟΝΟΜΑ ΕΠΩΝΥΜΟ</b> | <b>ΒΑΘΜΙΔΑ/ΙΔΙΟΤΗΤΑ</b>                 | <b>ΨΗΦΙΑΚΗ ΥΠΟΓΡΑΦΗ</b> |
|------------|----------------------|-----------------------------------------|-------------------------|
| 1.         | Λυκερίδου Αικατερίνη | Καθηγήτρια/μέλος                        |                         |
| 2.         | Δάγλα Μαρία          | Αναπληρώτρια<br>Καθηγήτρια/ μέλος       |                         |
| 3.         | Σαραντάκη Αντιγόνη   | Αναπληρώτρια<br>Καθηγήτρια/ επιβλέπουσα |                         |

## ΔΗΛΩΣΗ ΣΥΓΓΡΑΦΕΑ ΜΕΤΑΠΤΥΧΙΑΚΗΣ ΕΡΓΑΣΙΑΣ

Η κάτωθι υπογεγραμμένη Μπούκουρα Μαρία-Ελένη του Παναγιώτη, με αριθμό μητρώου 19025 φοιτήτρια του Προγράμματος Μεταπτυχιακών Σπουδών Προηγμένη και Τεκμηριωμένη Μαιευτική Φροντίδα του Τμήματος Μαιευτικής της Σχολής Επιστημών Υγείας και Πρόνοιας του Πανεπιστημίου Δυτικής Αττικής, δηλώνω ότι:

«Είμαι συγγραφέας αυτής της μεταπτυχιακής εργασίας και ότι κάθε βοήθεια την οποία είχα για την προετοιμασία της, είναι πλήρως αναγνωρισμένη και αναφέρεται στην εργασία. Επίσης, οι όποιες πηγές από τις οποίες έκανα χρήση δεδομένων, ιδεών ή λέξεων, είτε ακριβώς είτε παραφρασμένες, αναφέρονται στο σύνολό τους, με πλήρη αναφορά στους συγγραφείς, τον εκδοτικό οίκο ή το περιοδικό, συμπεριλαμβανομένων και των πηγών που ενδεχομένως χρησιμοποιήθηκαν από το διαδίκτυο. Επίσης, βεβαιώνω ότι αυτή η εργασία έχει συγγραφεί από μένα αποκλειστικά και αποτελεί προϊόν πνευματικής ιδιοκτησίας τόσο δικής μου, όσο και του Ιδρύματος.

Παράβαση της ανωτέρω ακαδημαϊκής μου ευθύνης αποτελεί ουσιώδη λόγο για την ανάκληση του πτυχίου μου».

Η Δηλούσα  
  
Μπούκουρα Μαρία-Ελένη, Μαία.

**Ψηφιακή Υπογραφή Επιβλέποντα**

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## **ΠΕΡΙΛΗΨΗ**

**Εισαγωγή:** Καθώς η πανδημία συνεχίζεται, όλο και περισσότερες γυναίκες γεννούν ενώ δίνουν μάχη με τον κορονοϊό.

**Σκοπός:** Ο στόχος αυτής της συστηματικής ανασκόπησης είναι η διερεύνηση του κινδύνου μετάδοσης του κορονοϊού από μητέρα που νοσεί, στο νεογνό της κατά τη διάρκεια του θηλασμού, της επαφής δέρμα με δέρμα και της συν διαμονής μητέρας νεογνού (Rooming-in).

**Μέθοδος- Υλικό:** Πραγματοποιήθηκε συστηματική αναζήτηση της βιβλιογραφίας σε διάφορες βάσεις δεδομένων και συγκεκριμένα στην Cochrane Library, στο PubMed Central και στο Scopus. Επίσης πραγματοποιήθηκε μετανάλυση της εκτίμησης της μόλυνσης των νεογνών από μητέρες με SARS-CoV-2 που θήλαζαν, έρχονταν σε επαφή δέρμα με δέρμα και έκαναν Rooming-in.

**Αποτελέσματα:** Συμπεριελήφθησαν συνολικά 18 μελέτες στην ανασκόπηση. Το ποσοστό των νεογνών που ήταν θετικό για τον ιό ήταν 2,8%. Οι πρακτικές που χρησιμοποιούνταν στις μελέτες διέφεραν από την απευθείας αποχωρισμό των μητέρων μέχρι την άμεση επαφή δέρμα με δέρμα, τη συνδιαμονή (rooming in) και τον αποκλειστικό θηλασμό. Μόνο μία μελέτη εξέτασε τους παράγοντες που σχετίζονται με τα θετικά τεστ των νεογνών. Αυτή η μελέτη έδειξε ότι ο μόνος παράγοντας που σχετίζεται με θετικό sars-cov-2 ήταν ο μητρικός δείκτης κοινωνικής ευπάθειας >90. Ο τύπος τοκετού, το Rooming-in, και το αν η μητέρα είναι συμπτωματική ή όχι δεν συσχετίστηκαν με θετικά αποτελέσματα στα νεογνά.

**Συμπεράσματα:** Το ποσοστό περιγεννητικής λοίμωξης είναι χαμηλό. Ο θηλασμός, η επαφή δέρμα με δέρμα και το Rooming-in συνίσταται τηρώντας προστατευτικά μέτρα όπως η αυστηρή υγιεινή των χεριών, η χρήση μάσκας και ο καθαρισμός του στήθους όταν χρειάζεται και όχι μετά από κάθε θηλασμό.

**Λέξεις κλειδιά:** covid-19, SARS-CoV-2, κορονοϊός, θηλασμός, πρακτικές, δέρμα με δέρμα επαφή, συνδιαμονή.

## **Abstract:**

**Introduction:** As the COVID-19 pandemic continues, more and more women are giving birth while battling SARS-CoV-2.

**Aim:** The aim of this review is to investigate the risk of transmission of the coronavirus from mother to infant during breastfeeding, skin-to-skin contact, and Rooming-in and to explore ways of managing covid-19 positive maternal-infant dyads. Maternity care practices such as skin-to-skin care, rooming-in, and direct breastfeeding are recommended, but it is unclear if these practices increase the risk of clinically significant COVID-19 in newborns, and if disruption of these practices adversely affects breastfeeding.

**Methods:** searches were accomplished in various databases and specifically in Cochrane Library, PubMed Central and Scopus up to 30th November 2021, using the Matrix Method and guided by the PRISMA, to identify studies involving mothers infected with COVID-19 and their infants in the early postpartum period. Criteria included English Language, broad search terms, full-text reviews and articles published from December of 2019 as well as the first case that appeared then. A meta-analysis was also performed to estimate the infection of infants from infected mothers who breastfed, had Skin to skin contact and did Rooming-in.

**Findings:** A total of 18 studies were included in this review. The rate of infected infants was 2,8%. The maternal practices were used in these studies varied from the direct separation of the dyad to direct skin-to-skin contact, Rooming-in and exclusive breastfeeding. One study examined the factors associated with positive tests in newborns. This study showed that the only factor was the maternal social vulnerability index >90. The type of delivery, Rooming-in, and if the mother had symptoms or not were associated with positive neonatal outcomes.

**Conclusion:** The rate of perinatal infection is low. Breastfeeding, skin-to-skin contact, and Rooming-in are recommended to follow all protective measures such as strict hand hygiene, the use of masks and breast cleaning when it is necessary and not after each breastfeeding.

**Keywords:** covid-19, coronavirus, SARS-CoV-2, breastfeeding, maternal practices, skin-to-skin contact, rooming in.

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## **ΚΑΤΑΛΟΓΟΣ ΣΥΝΤΟΜΟΓΡΑΦΙΩΝ**

CI: Confidence Interval

NR: No Reply

OR: Odds Ratio

PICOST: Population Intervention Comparison Outcome Study Timely

PRISMA: Preferred Re-reporting Items for Systematic Reviews and Meta-analysis

SARS-Cov2: Severe Acute Respiratory Syndrome Coronavirus 2

RCOG: Royal College of Obstetricians and Gynecologists

WHO: World Health Organization

## **ΕΥΧΑΡΙΣΤΙΕΣ**

Η συγγραφή της διπλωματικής μου εργασίας παρόλη τη δυσκολία που είχε ήταν επιτυχής λόγω της διαρκούς καθοδήγησης που είχα από τους καθηγητές μου.

Αρχικά, θα ήθελα να ευχαριστήσω την επιβλέπουσα μου αναπληρώτρια καθηγήτρια του Τμήματος Μαιευτικής του Πανεπιστημίου Δυτικής Αττικής, κα Αντιγόνη Σαραντάκη, για την πολύτιμη βοήθεια της και τη συνεχή καθοδήγησή της κατά τη διάρκεια της συγγραφής της παρούσας διπλωματικής εργασίας. Μέσω της διαρκούς στήριξής, της πολλής υπομονής, ενθάρρυνσης και πίστης σε έμμενα όλα αυτά τα χρόνια έπαιρνα δύναμη για να συνεχίσω και να καταφέρω να ολοκληρώσω τις μεταπτυχιακές μου σπουδές παρά τις πολλές δυσκολίες που υπήρξαν. Αν δεν ήταν εκείνη δεν θα τα κατάφερνα για αυτό το ευχαριστώ είναι πολύ λίγο.

Θα ήθελα να εκφράσω ειλικρινείς ευχαριστίες επίσης, στα μέλη της τριμελούς εξεταστικής επιτροπής, την Καθηγήτρια & Πρόεδρο του Τμήματος Μαιευτικής του Πανεπιστημίου Δυτικής Αττικής, κα Αικατερίνη Λυκερίδου, και την Αναπληρώτρια καθηγήτρια του Τμήματος Μαιευτικής του ΠαΔΑ, κα Δάγλα Μαρία για την ουσιαστική συμμετοχή τους στην ολοκλήρωση και επιτυχή διεκπεραίωση αυτής της προσπάθειας.

Τέλος, θα ήθελα να ευχαριστήσω τον σύντροφό μου και την οικογένεια μου και ιδιαίτερα την αδελφή μου, που όλο αυτό το χρονικό διάστημα στάθηκαν στο πλευρό μου με αγάπη και πολύ κατανόηση. Η υποστήριξη της αδελφής μου ήταν άκρως απαραίτητη για να φέρω εις πέρας την παρούσα διπλωματική εργασία.

# **1.INTRODUCTION**

Coronavirus disease 2019 (COVID-19) is caused by SARS-Cov2 and first appeared in December 2019 in China, specifically in Wuhan. This disease can occur from without symptoms or very mild to a life-threatening respiratory infection or a severe cardiac disorder [1]. The infection can appear at any age and anyone may become severe ill or die from this disease [2]. The virus can be transmitted from person to person when an infected person speaks, sneezes or coughs and a healthy person may inhale these droplets. Furthermore, if anyone comes in contact with surfaces or things of an infected person and then touches his eyes, nose or mouth can be infected with COVID-19 [3].

Pregnant women and young children are susceptible to COVID-19 [4]. The newborns are more vulnerable to SARS-CoV-2 infection due to do not have antibodies against coronaviruses [5]. The mode of transmission and potential effects of COVID-19 on pregnant mothers and their newborns are uncertainty. Data is still insufficient regarding if women with COVID-19 can transmit the virus to her newborn during labour or through breast-feeding [6]. The guidelines for taking care of maternal-newborn dyads have changed significantly during the pandemic [7].

The concern of possible transmission of the virus from an infected mother to her infant led to the disruption of some practices recognized as crucial for maternal bonding and breastfeeding initiation, such as skin-to-skin and rooming-in [8]. Breastmilk is rich in nutrients, bioactive molecules, antibodies, and microorganisms, which contribute to infants for their growth and development, maturation of immune, development of organs, and microbial colonization [9]. The active and passive immunity provided by breastmilk plays an important role in strengthening the infant's response to infectious diseases [10]. More-over, breastfed babies are less likely to be overweight as children or teenagers and have better tests IQ [11]. Breastfeeding has many positives for mothers. In particular, a me-ta-analysis showed that women who breastfeed for more than twelve months have a reduced risk of breast and ovarian cancer. Furthermore, breastfeeding was related with low-er risk of type 2 diabetes. In contrast, less breastfeeding time was related with a higher danger of postpartum depression [12]. Also, Skin to skin contact and Rooming in have multiple benefits for the dyad mother-infant. Skin to skin contact

helps the initiate of breastfeeding, stabilizes the levels of infant glucose and maintains newborn temperature [13].

RNA of virus has found in breastmilk, but this does not mean to infectivity from viable virus. Breast milk contains antibodies with a neutralizing capacity in the case of a mother infected with the virus [14]. Due to the heterogeneity of studies concerning the possibility of mother-to-child transmission, many scientific societies have recommended that SARS-CoV-2 positive mothers adopt practices of distancing themselves from their babies and use personal protective equipment, such as masks and gloves during rooming-in or breastfeeding [15]. So, it is urgent to examine all possible effects which can be caused in the newborn not only by breastfeeding but also by other practices related to the care of newborn as well as the contact and development of the mother's bond with the infant such as skin to skin contact.

## **2. MATERIAL AND METHODS**

### **2.1 Aim**

We aimed to examine the risk of transmission of SARS-CoV-2 from infected mother to neonate during the breastfeeding, the skin-to-skin contact, and the rooming-in.

### **2.2 Design**

The systematic review and meta-analysis were conducted following Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) 2020 standards [16].

### **2.3 Search Strategies**

PubMed, Scopus, and Cochrane Library were searched on 30th November 2021, and we removed duplicates. We used the following keywords: "COVID-19", "SARS-CoV-2", "Breastfeeding", "skin to skin contact", "rooming in", "transmission". These were used both separately and in combination with the help of the Boolean administrators (OR, AND, NOT). Since Covid-19 is a contemporary issue, records published since 2019 were identified in the primary search stage.

### **2.4 Inclusion and exclusion criteria of studies**

We used the acronym PICOST to determine the eligibility criteria of the articles. More specifically:

1. Population: We included studies which the sample consisted of mothers infected from SARS-CoV-2, as well as, and their newborns. SARS-CoV-2 infection had to be ascertained by a nasopharyngeal swab through a molecular test. We excluded studies which including < 20 infected mothers.
2. Intervention: We included studies that applied maternal practices such as breastfeeding, or skin to skin contact, or rooming in. Rooming-in was defined as allowing the mother and infant to remain together 24 hours per day during the birth hospitalization. We defined the skin-to-skin care as the practice of placing the infant directly on the mother to maximize surface-to-surface contact. Exclusive breastfeeding was defined as giving no other food or drink – not even water – except breast milk.
3. Comparison: The studies assessed mother-to-infant transmission of the SARS-CoV-2 during maternal practices.
4. Outcome: The prevalence of SARS-CoV-2 infection in infants, which had to be ascertained by a nasopharyngeal swab through a molecular test during the first 30 days after birth.
5. Study: We included only primary quantitative studies, such as prospective observational studies, retrospective observational studies, intervention studies, and descriptive studies. We excluded secondary studies (systematic review, meta-analysis), qualitative studies, letter – to – editor, editorial, protocols, and opinion articles. We excluded studies where the full text was not available.
6. Timely: We included studies that had been published up to 30th November 2021. The studies were published in the English language. We excluded studies where they were not written in the English language, or where the full text was not available.

### **2.5 Search outcomes and data extraction**

Two independent researchers separately identified and screened the titles and abstracts of the retrieved articles. Next, individual papers were subjected to full-text review. Conflicts in opinion between the two authors were resolved by the third.

Data on the following variables were extracted from the eligible studies: authors, publication year, country, number of mothers with SARS-CoV-2 infection, mother age, type of delivery, gestational age, number of infants with and without SARS-COV-2 infection, and frequency of maternal practices (breastfeeding, rooming in, skin-to-skin). Also, we recorded the measures that hospitals were taking to limit the spread of the virus from mothers to children.

### **2.6 Data synthesis and analysis**

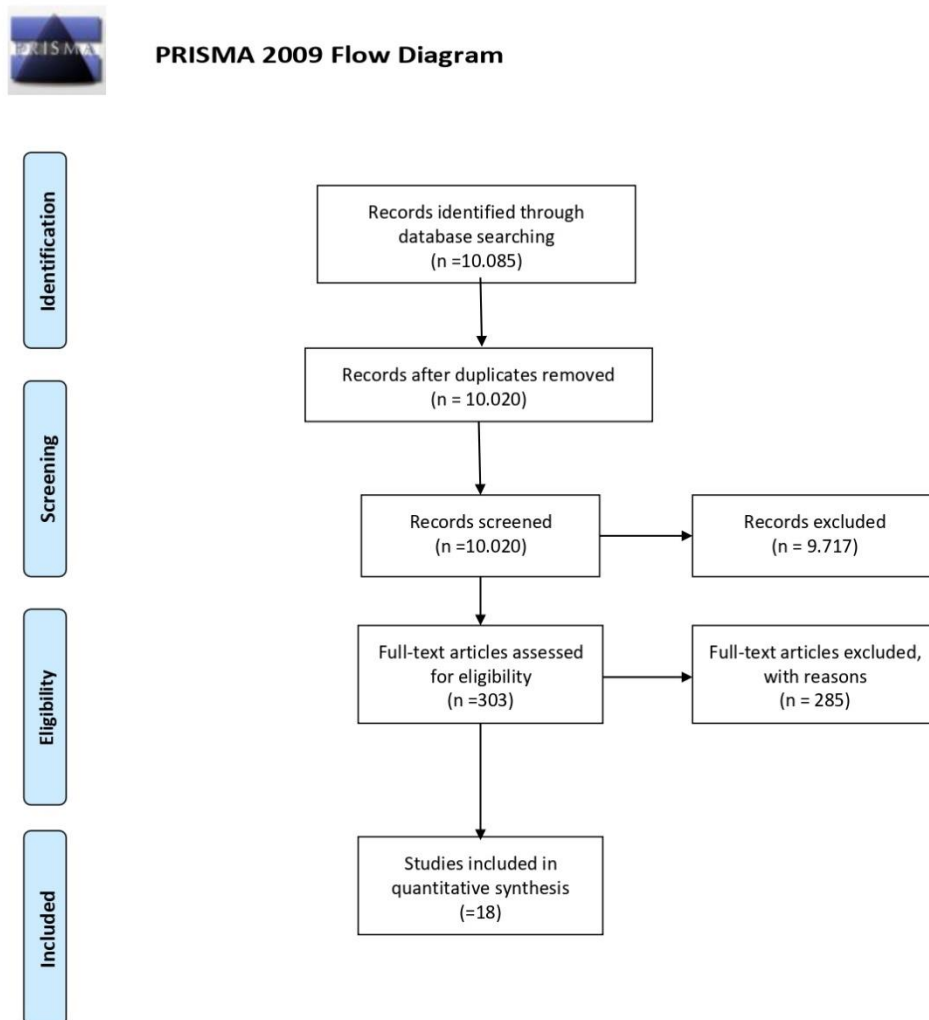
The main outcome measure was the estimate of infected infants born to mothers with SARS-CoV-2 infection. Random-effects models were used. Pooled data were given with 95% confidence interval values (95% CI) and showed by forest plots. We used I<sup>2</sup>-index to assess between-studies heterogeneity and values > 50% were considered as significant. We used a funnel plot and the Egger's test to assess the publication bias with a p-value <0.05 indicating publication bias. We performed subgroup meta-analyses for rooming-in, breastfeeding, and skin-to-skin contact as the independent variable. Statistical analysis was performed with STATA.

## **3. RESULTS**

### Results

After the search in three databases a total of 10.085 records was identified, specifically 9.746 in PubMed Central, 154 In Scopus and 185 In Cochrane Library. 65 records were removed because they were duplicates. Thus, 10.020 records were examined about their eligibility for inclusion. Finally, it was proved that 9.717 records were excluded because after reading their titles and abstracts were not relevant. Both authors read the full text of 303 records and only 18 met the criteria and were comprised in this study (Figure 1: Flow Diagram).

Figure 1: Flowchart of the literature search according to the Preferred Reporting Items for Systematic Reviews and Meta- Analysis.



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit [www.prisma-statement.org](http://www.prisma-statement.org).

From 18 studies, 6 studies were conducted in Spain [17-22], 4 in USA [23-26], 4 in Italy [27-30], and from 1 study in France [31], India [32], Israel [33], Portugal [34]. Four studies were retrospective [25,29,31,34]. Table 1 represents the main characteristics of included studies.



**Table 1: Main characteristics of the studies included in this systematic review.**

| First Author (publication year) | Type design                     | Study period                     | Country  | Number of mothers with SARS-CoV-2 infection | Age of mothers (years) Mean ( $\pm$ SD) | Asymptomatic COVID-19 illness, N (%) | Gestational age (weeks) Mean ( $\pm$ SD) | Route delivery, N (%) | Number of infants |
|---------------------------------|---------------------------------|----------------------------------|----------|---------------------------------------------|-----------------------------------------|--------------------------------------|------------------------------------------|-----------------------|-------------------|
| Angelidou et al (2021)          | Multicenter cohort study        | March 1, to July 31, 2020        | USA      | 250                                         | 30.4 ( $\pm$ 6.3)                       | 170 (68,0%)                          | 37.9 ( $\pm$ 2.6)                        | 113 (45,2%)           | 255               |
| Congdon et al (2021)            | Case-series study               | March to May, 2020               | USA      | 70                                          | NR                                      | NR                                   | 39.0 (36.3-41.6)**                       | 25 (35,7%)            | 70                |
| Conti et al (2021)              | Observational study             | April 1, 2020, to March 18, 2021 | Italy    | 37                                          | 31 (17 - 45)*                           | 10 (27,0%)                           | 39 (32-42)*                              | 18 (48.5%)            | 37                |
| Dumitriu et al (2021)           | Retrospective cohort study      | March 13 to April 24, 2020       | USA      | 100                                         | 28.5 (24.0 - 34.0)**                    | NR                                   | 39.0 (37.0 - 40.0)**                     | 46 (45.5%)            | 101               |
| Donati et al (2021)             | Prospective cohort study        | February 25, to July 31, 2020    | Italy    | 525                                         | 31.8 ( $\pm$ 5.69)                      | 235 (44,8%)                          | NR                                       | 177 (33.7%)           | 538               |
| Ferazzi et al (2020)            | Retrospective study             | March 1 to March 20, 2020        | Italy    | 42                                          | 32.9 (21-44)*                           | NR                                   | NR                                       | 18 (42.8%)            | 42                |
| Jiménez et al (2020)            | Prospective observational study | March 1 to May 31, 2020          | Spain    | 403                                         | NR                                      | 291 (72,2%)                          | NR                                       | 136 (26.0%)           | 403               |
| Marin Gabriel et al (2020)      | Descriptive study               | March 13 to May 31, 2020         | Spain    | 242                                         | 32.1 ( $\pm$ 6.3)                       | 98 (40,5%)                           | 39 (38-40)**                             | 63 (26.0%)            | 248               |
| Marín Gabriel et al (2020)      | Descriptive study               | March 13 to May 31, 2021         | Spain    | 42                                          | 33.6 ( $\pm$ 4.9)                       | NR                                   | 38 ( $\pm$ 3.1)                          | 20 (47.6%)            | 42                |
| Martenot et al (2021)           | Retrospective study             | March 15 to April 24, 2020       | France   | 26                                          | 30.6 ( $\pm$ 7.9)                       | NR                                   | 39 ( $\pm$ 2)                            | 10 (38.6%)            | 26                |
| Nayak et al (2021)              | Prospective observational study | May 1 to October 20, 2020        | India    | 162                                         | 39 (19 - 41)*                           | NR                                   | 37.5 (25 - 41)*                          | 103 (63.6%)           | 165               |
| Pereira et al (2020)            | Retrospective case series study | March 14, to April 14, 2020      | Portugal | 22                                          | 34 (19 - 43)*                           | 11 (50.0%)                           | 38 (31-41)*                              | 4 (18.2%)             | 22                |
| Ronchi et al (2020)             | Prospective, cohort study       | March 19 to May 2, 2020          | Italy    | 61                                          | 32 (28 - 36)**                          | 34 (55.7%)                           | 39 (35-41)**                             | 15 (24.6%)            | 62                |
| Salvatore et al (2020)          | Observational cohort study      | March 22 to May 17, 2020         | USA      | 78                                          | NR                                      | 20 (25.6%)                           | 38 (27-41)*                              | 36 (43.9%)            | 82                |
| Sánchez García et al (2021)     | Prospective case-control study  | April to July, 2020              | Spain    | 37                                          | 33.9 ( $\pm$ 5.4)                       | 16 (43.2%)                           | 39.1 ( $\pm$ 1.8)                        | 10 (27.0%)            | 37                |
| Sánchez-Luna et al (2021)       | Prospective cohort study        | March 8 to May 26, 2020          | Spain    | 497                                         | 33                                      | 245 (49.3%)                          | 49 ( $\pm$ 3.7)                          | 164 (33.0%)           | 503               |
| Shlomain et al (2021)           | Observational cohort study      | March 5 to May 30, 2020          | Israel   | 53                                          | 29.7 ( $\pm$ 7.3)                       | 40 (75,5%)                           | 39 ( $\pm$ 1.0)                          | 10 (18.9%)            | 55                |

|                                                         |                          |                             |       |    |              |            |              |            |    |
|---------------------------------------------------------|--------------------------|-----------------------------|-------|----|--------------|------------|--------------|------------|----|
| Solis-Garcia et al (2021)                               | Prospective cohort study | March 15 to August 17, 2020 | Spain | 73 | 34 (27-37)** | 32 (43,8%) | 38 (37-40)** | 26 (35.6%) | 75 |
| *Median (Min – Max); **Median (IQR)<br>NR: Not reported |                          |                             |       |    |              |            |              |            |    |

A total of 2763 neonates, 79 (2,8%) had positive COVID-19 test. According to the maternal practices, 54,7% of neonates (440/804) separated early from mothers [18,24,27,28,30,33], 56,0% (564/1007) neonates was dried and laid directly on the mother's bare chest after birth (skin-to-skin) [19,20,21,24,31], 66,69% (1199/1798) neonates stay with mothers the same room for 24 hours a day from the time they arrive in mothers room after delivery (rooming in), and 51,5% (971/1886) breastfed exclusively [17,18,22,23,24,25,27,29,30,31,35].(Table 2)

**Table 2: Rate of infected infants and the practices who used by mothers.**

| First Author (publication year) | Number (%) of infected infants | Skin-to-skin, N(%) | Early separation, N(%) | Rooming in with mother, N(%) | Exclusive breastfeeding, N(%) | Breastfeeding (exclusive or complementary), N (%) |
|---------------------------------|--------------------------------|--------------------|------------------------|------------------------------|-------------------------------|---------------------------------------------------|
| Angelidou et al (2021)          | 6 (2,7%)                       | NR                 | NR                     | 167 (66,8%)                  | 152 (66,8%)                   | 230 (90,2%)                                       |
| Congdon et al (2021)            | 0 (0,0%)                       | NR                 | 33 (47,1%)             | 33 (47,1%)                   | 21 (30,0%)                    | 33 (47,1%)                                        |
| Conti et al (2021)              | 1 (2,7%)                       | NR                 | 37 (100,0%)            | NR                           | 1 (2,7%)                      | 10 (27,0%)                                        |
| Dumitriu et al (2021)           | 0 (0,0%)                       | NR                 | NR                     | 82 (81,2%)                   | 41 (40,6%)                    | 91 (90,1%)                                        |
| Donati et al (2021)             | 18 (3,4%)                      | NR                 | 279 (51,9%)            | 379 (72,2%)                  | NR                            | 428 (79,6%)                                       |
| Ferazzi et al (2020)            | 3 (7,1%)                       | NR                 | NR                     | NR                           | 11 (26,2%)                    | NR                                                |
| Jiménez et al (2020)            | 6 (1,5%)                       | 251 (62,3%)        | NR                     | NR                           | 249 (61,8%)                   | NR                                                |
| Marin Gabriel et al (2020)      | 13 (5,2%)                      | NR                 | NR                     | NR                           | 103 (41,5%)                   | 179 (72,2%)                                       |

|                             |           |             |            |             |             |             |
|-----------------------------|-----------|-------------|------------|-------------|-------------|-------------|
| Marín Gabriel et al (2020)  | 0 (0,0%)  | NR          | 37 (88,1%) | NR          | 6 (14,3%)   | 19 (45,3%)  |
| Martenot et al (2021)       | 1 (3,9%)  | 10 (38,5%)  | NR         | NR          | 11 (42,0%)  | 23 (88,5%)  |
| Nayak et al (2021)          | 9 (5,5%)  | NR          | NR         | 138 (83,4%) | NR          | 125 (75,8%) |
| Pereira et al (2020)        | 0 (0,0%)  | NR          | NR         | 13 (59,1%)  | 11 (50,0%)  | 17 (77,3%)  |
| Ronchi et al (2020)         | 3 (4,8%)  | NR          | 7 (11,3%)  | 55 (87,1%)  | 45 (72,6%)  | 59 (95,2%)  |
| Salvatore et al (2020)      | 0 (0,0%)  | NR          | NR         | 68 (82,4%)  | NR          | 64 (78,0%)  |
| Sánchez García et al (2021) | 0 (0,0%)  | NR          | NR         | NR          | NR          | NR          |
| Sánchez-Luna et al (2021)   | 18 (3,6%) | 252 (50,0%) | NR         | 264 (52,3%) | 272 (54,1%) | 393 (78,1%) |
| Shlomain et al (2021)       | 0 (0,0%)  | NR          | 47 (85,5%) | NR          | NR          | 41 (74,5%)  |
| Solis-Garcia et al (2021)   | 1 (1,3%)  | 51 (68,0%)  | NR         | NR          | 48 (64,0%)  | 55 (73,3%)  |

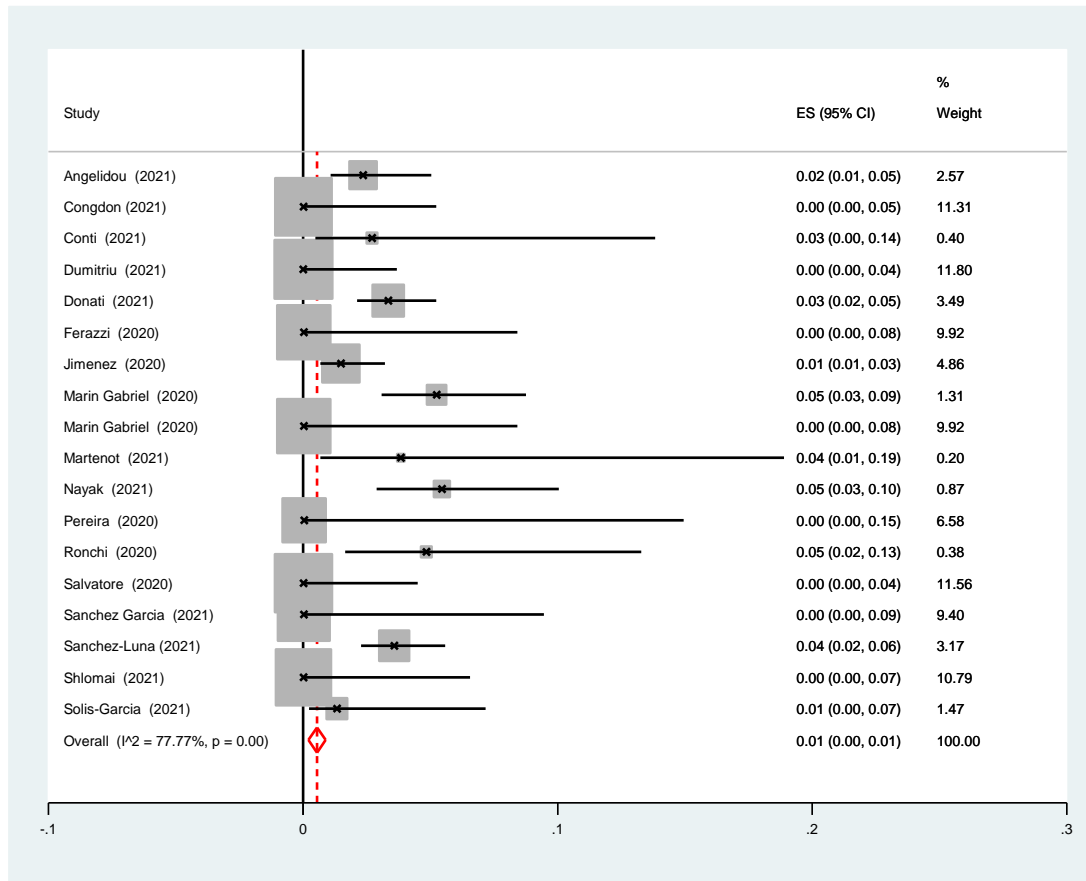
Only one study examined the factors associated with positive sars-cov-2 results among neonates [23]. This study showed that the only factor associated with positive sars-cov-2 was maternal SVI >90th percentile vs other (OR=4.95; 95% CI: 1.53 - 16.01; p=0.008). The type of delivery (vaginal vs cesarean delivery: OR=0.47; 95% CI: 0.16 - 1.40; p=0.18), rooming-in (any vs no: OR=0.29; 95% CI: 0.04 - 2.29; p=0.24) and maternal symptoms (symptomatic vs asymptomatic: OR=0.71; 95% CI: 0.49 - 1.02; p=0.07) were not associated with positive sars-cov-2 results among neonates [23].

For the spread of the disease the hospitals had taken measures such as the infected mothers were separated from their newborns immediately after birth and during the entire hospitalization [27,33,34], mothers wear surgical face masks [21,26,28,30,31,32], disinfect their hands [26,30,31], and wash their nipples with odorless soap during breastfeeding [26,31], and newborns placed at least 2m away from mothers bed during sleeping [30,31,32], use personal protective equipment [25].

## 4. Meta-analysis

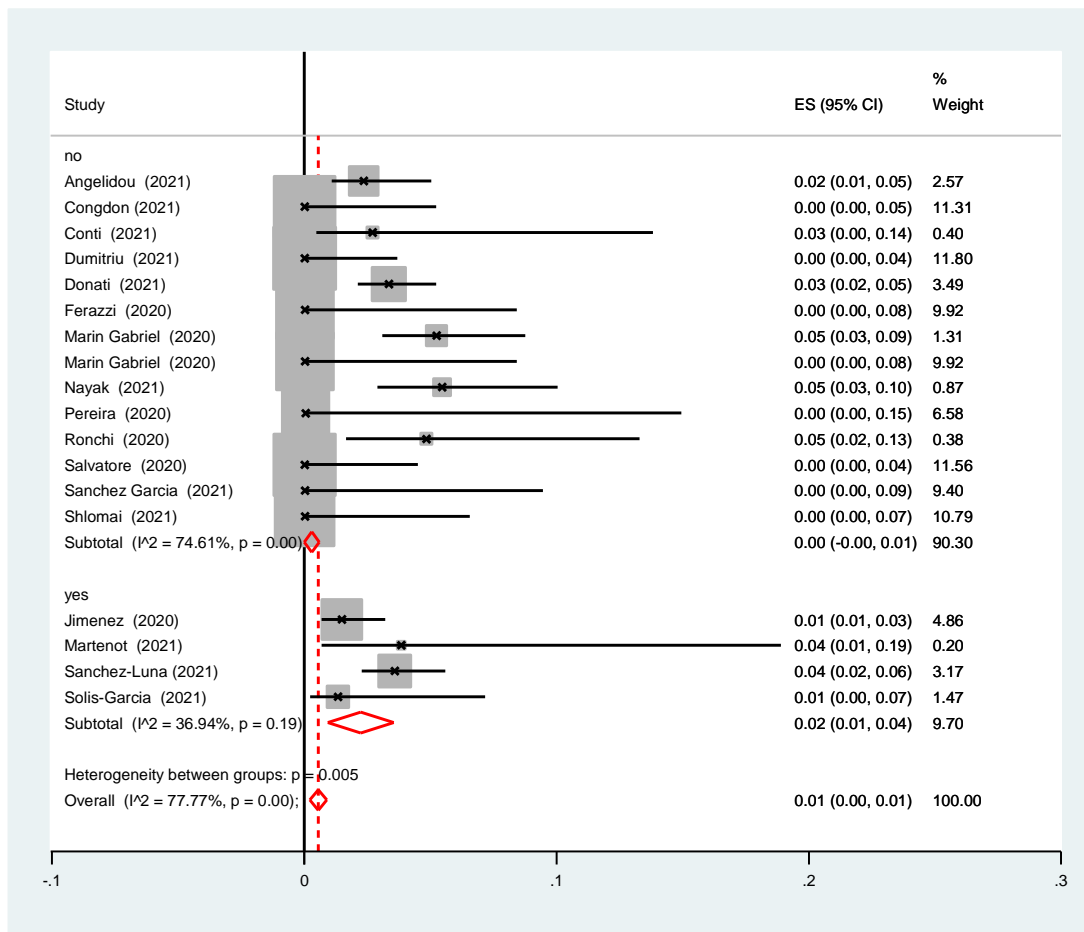
The pooled proportion of SARS-CoV-2 infection among infants born to infected mothers of 1.0% (95% CI: 0.0 – 1.0%) (Fig. 2).

**Figure 2: Proportion metanalysis of the overall estimate of SARS-CoV-2 infection among infants born to infected mothers**

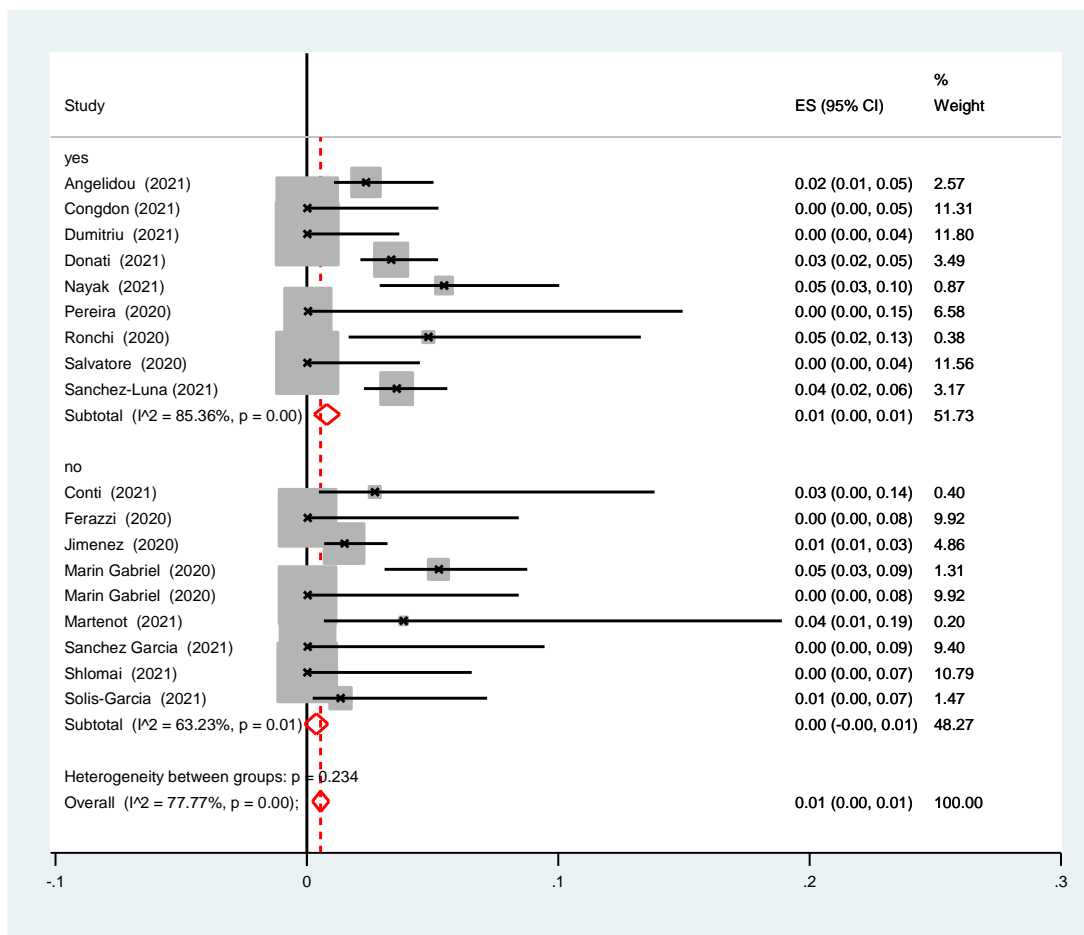


The I<sup>2</sup>-test was 77.77%, demonstrating a high heterogeneity. The sub-analysis showed that the proportion of infected neonates was similar between the studies with (1%, 95% CI: 0.0%-1%, I<sup>2</sup>-test 36.94%) and without (0.0%, 95% CI: 0.0%-1.0%, I<sup>2</sup>-test 74.61%) (Fig. 3) data for rooming-in, with (1%, 95% CI: 0.0%-1%, I<sup>2</sup>-test 85.36%) and without (0.0%, 95% CI: 0.0%-1.0%, I<sup>2</sup>-test 63.23%) (Fig. 4) for skin-to-skin, and with (1%, 95% CI: 0.0%-1%, I<sup>2</sup>-test 75.52%) and without (1.0%, 95% CI: 0.0%-1.0%, I<sup>2</sup>-test 85.43%) for exclusive breastfeeding (Fig.5).

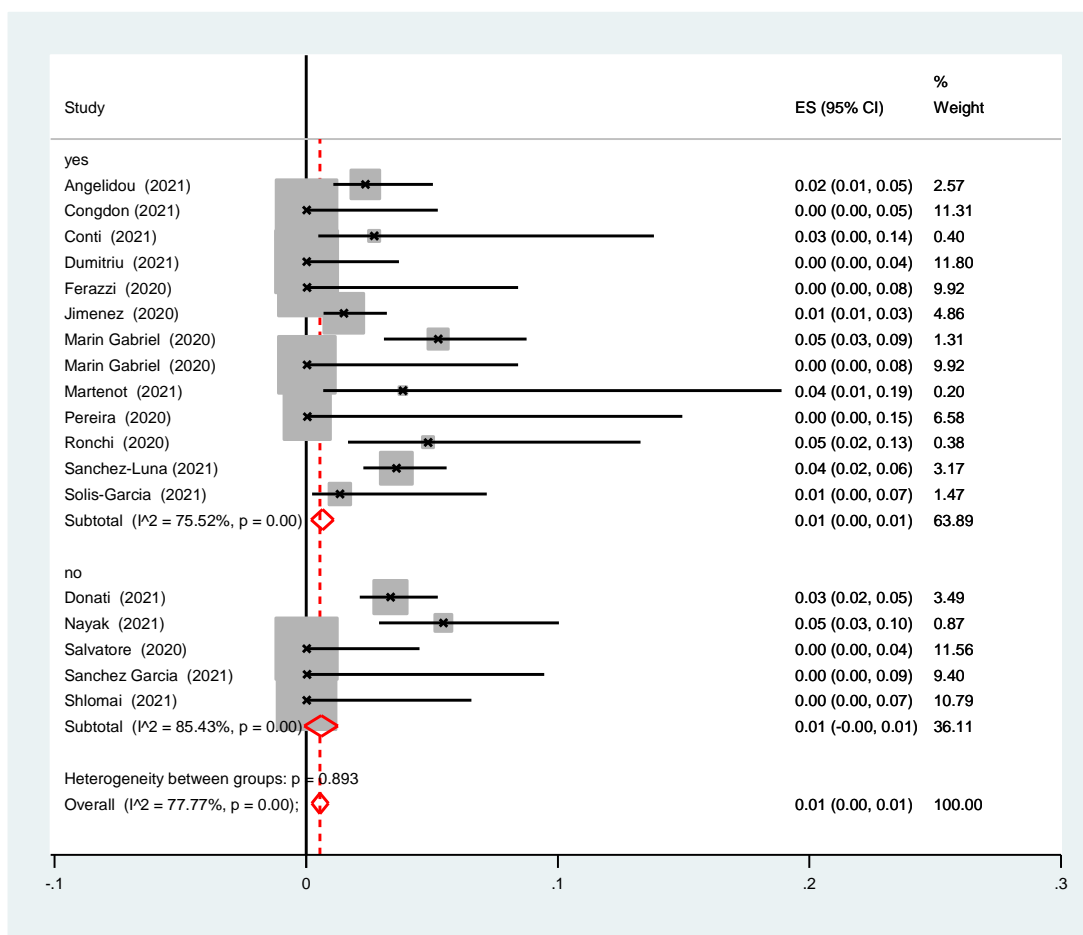
**Figure 3: Proportion of the estimate of SARS-CoV-2 infection among infants born to infected mothers in subgroups analyses from studies with and without rooming-in.**



**Figure 4: Proportion of the estimate of SARS-CoV-2 infection among infants born to infected mothers in subgroups analyses from studies with and without skin-to-skin.**



**Figure 5: Proportion of the estimate of SARS-CoV-2 infection among infants born to infected mothers in subgroups analyses from studies with and without exclusive breastfeeding.**



## 5. DISCUSSION

The objective of this systematic review and meta-analysis was to examine the risk of transmission of SARS-CoV-2 from infected mother to neonate during the breastfeeding, the skin-to-skin contact, and the rooming-in. We found that the SARS-CoV-2 infection among neonates born to infected mothers was found to be 1.0%. This indicate that mother-to-child transmission in the neonatal period is low.

Concerning breastfeeding, it is well known that covid-19 is transmitted mainly through horizontal transmission and specifically through aerosols. In our review, the most articles referred that the vertical transmission through breastmilk cannot be excluded/or limited as well as there are searches which the virus was detected in breastmilk and the infants were diagnosed with covid-19 but it was unclear, the exact way of transmission. However, the benefits of breastfeeding outweigh the potential transmission. Because of this, the major organizations such as WHO and RCOG support the direct breastfeeding following protective measures such as strict hand hygiene and wearing mask [36]. In addition, it is

important that anti-SARS-CoV-2 antibodies have found in breastmilk and these might offer protection in infants [37].

Since the beginning of COVID-19 until the moment of the writing of this review have adopted various recommendations for breastfeeding. Most researches and international organizations such as WHO, RCOG (Royal College of Obstetricians and Gynecologists) and the American Academy of Pediatrics support direct breastfeeding following individual protective measures such as strict hand hygiene, wearing mask and breast cleaning when it is necessary such as when mother coughs or sneezes on breast [36]. For mothers who are not in condition to breastfeed immediately or it is not their desire, it is recommended the expression of milk following not only protection measures but also the thorough pump cleaning and feeding of breastmilk to the infant by a caregiver without boiling or pasteurizing breastmilk [38]. In case, breastmilk is not available or sufficient, it is suggested the use of pasteurized human milk from bank milk against using formula [39]. The study by Salvatore et al. reports on a cohort of neonates born to SARS-CoV-2 positive mothers and follows the outcomes of staying and breastfeeding up to one month after birth. All newborns tested negative for SARS-CoV-2, either immediately after birth or fourteen days later. This shows that staying and breastfeeding can be safe when the necessary precautions are taken, including hand hygiene and the use of surgical masks [26].

The early separation of the dyad adopted in our management negatively affected the percentage of women who were able to breastfeed, with only a mild recovery in total breastfeeding rate being observed after the mother-infant reunification probably due to the decrease in breastfeeding support that occurred during the pandemic [40]. The WHO recommends breastfeeding of infants and young children also in case of suspected or confirmed maternal SARS-CoV-2 infection. The beneficial properties of breastfeeding including the practice of skin-to-skin care and the transfer of protective maternal antibodies via breast milk (especially secretory IgA (sIgA) and, to a lesser extent, IgM and IgG isotype immunoglobulins) are well established [41]. Recent evidence indicates that breastfeeding does not seem to be associated with neonatal SARS-CoV-2 infection because viral transmission through the milk, if



any, should be rare and because a robust sIgA-dominant SARS-CoV-2 antibody response is detectable in human milk soon after infection in a significant majority of individuals [42].

There are some limitations to this review. As the pandemic continues the data is rapidly changing. As our search for this review ended on November 30,2021, it is potent that some of these suggestions may be outdated by the moment this review is published. However, the summary of all suggestions is important as we can understand ways of managing covid-19 from the beginning of pandemic until the moment of writing this re-view as well as how the suggestions could be modified in the future. Furthermore, the study period ended few months after the appearance first vaccine. Therefore, further re-search is needed for women who are with covid-19 in early post-partum period and were previously vaccinated during or before pregnancy.

## **6. Conclusion**

The results of this study show a low rate of perinatal infection, support the rooming-in and skin-to-skin confirm the effectiveness of preventive measures in reducing the risk of mother-to-child viral transmission. We suggest the encouragement of direct breast-feeding as well as breastmilk may provide specific antibodies to infants, the immediate skin-to-skin and rooming in when the condition of mother and newborn permits it and following all protective measures and specifically strict hand hygiene, wearing a mask and breast cleaning when need it and not before every breastfeeding. The literature indicates that while vertical transmission cannot be excluded however, if it exists, it might be rare and we should focus on horizontal transmission. For this reason, it is utmost im-portance that women strictly observe personal protection measures. In addition, in case if these practices are avoided, breastfeeding is adversely affected. With these practices and following mothers all protection measures the potential of transmission of covid-19 in infant is almost impossible. However, even if newborns have covid, they have no or mild symptoms and recover well. We hope that the findings of this review could help medical staff and government officials making protocols for patient care. Authors should discuss the results and

how they can be interpreted from the perspective of previous studies and of the working hypotheses. The findings and their implications should be discussed in the broadest context possible. Future research directions may also be highlighted.

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