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The association of COVID-19 restriction measures and postpartum depressive symptoms among mothers with preterm infants in Estonian NICUs

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Master's thesis

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Several studies have reported increased mental health issues among women around childbirth during the COVID-pandemic. Having a newborn admitted to a neonatal intensive care unit (NICU) can take an extreme toll on the parents. It is known that NICU families are at greater risk of stress, anxiety and depression. During the COVID-19 pandemic many hospitals changed their policies regarding labor, delivery, pre- and postnatal care and visitations. Much concern has been raised that the added stress related to COVID-pandemic restrictions may negatively affect the psychosocial health of NICU mothers. The aim of this study was to map COVID-19 restriction measures in Estonian NICUs and to assess whether the restriction measures were associated with postpartum depressive symptoms of the mothers.

The study was a comparative cohort study. The pre-pandemic cohort data was collected in 2018-2019 and the pandemic cohort data was collected between March and July 2021. Participants of this study were mothers of preterm infants born before 35 gestational weeks. Overall, 109 mothers were included in the study: 54 in the pre-pandemic cohort and 55 in the pandemic cohort. Depressive symptoms were measured at discharge using Edinburgh Postnatal Depression Scale (EPDS). Each participating unit kept a restriction log during the pandemic.

All units had some COVID-19 related restrictions in place during the entire data collection period. However, the results of the restriction mapping showed that the units adopted the infectious disease guidelines differently. At the beginning of data collection, half of the participating units limited fathers' presence in caretaking of the infant in NICU. Five out of six units required negative test results from mothers upon entering the unit which complicated mothers' ability to leave and re-enter the unit. Four out of six units prohibited other visitors from the unit. A change was observed in the COVID-19 restriction policies in June 2021 after which restrictions were lessened in most units making it easier for both parents to visit and care for their infant.

The findings of this study show that postpartum depressive symptoms of NICU mothers remained at the same level when compared with the pre-pandemic cohort despite various restrictive measures implemented at the height of the COVID-19 pandemic. Also, the number of mothers scoring above the generally used cut-off value 12 of clinical depression at EPDS remained at the same level between the two cohorts. These results were unexpected as we hypothesised that COVID-19 pandemic restrictions would be associated with a higher level of postpartum depressive symptoms.

It is important to note that even though visitation restriction were in place, mothers in most hospitals were allowed to enter the unit as frequently and long as they liked. This might be one explaining factor for why this study did not find association between mothers' postpartum depressive symptoms and the pandemic restrictions. Four out of six participating units also offer single-family rooms which enhances mothers' ability to be close to their infants. There are also other potential factors that could reduce maternal depressive symptoms in NICUs in times of pandemic, such as increased on-site or virtual psychosocial support. After the acute phases of the COVID-19 pandemic are over, it is worth studying further which health care driven interventions and mothers' own responses proved most beneficial in supporting the families' and mothers' psychological health. As restrictions mostly limited fathers' presence, future study should also examine the effect of COVID-19 restriction measures on fathers' mental wellbeing.

Key words: COVID-19, postpartum depression, NICU, preterm infant, pandemic, restriction

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Lapsen ennenaikainen syntymä ja vastasyntyneiden tehohoitoympäristö voivat olla hyvin kuormittavia kokemuksia vanhemmille. Keskoslasten vanhemmilla onkin kohonnut riski masentuneisuuteen ja ahdistuneisuuteen. Koronapandemian aikana monissa sairaaloissa jouduttiin muuttamaan käytäntöjä koskien synnytystä, synnytyksen jälkeistä hoitoa ja osastovierailuja. Pandemiarajoitusten vaikutuksesta keskoslasten vanhempien psyykkiseen terveyteen on vielä rajallisesti tietoa. Tämän tutkimuksen tavoitteena oli kartoittaa koronapandemiaan liittyviä rajoitustoimenpiteitä Viron vastasyntyneiden teho-osastoilla ja arvioida, vaikuttivatko rajoitustoimenpiteet äitien synnytyksen jälkeiseen masennusoireiluun.

Tämä tutkimus oli vertaileva kohorttitutkimus. Pandemiaa edeltävä kohortti kerättiin 2018-2019 ja pandemian aikainen kohortti kerättiin maalis- ja heinäkuun välisenä aikana 2021. Osallistujat olivat alle 35 raskausviikolla syntyneiden keskosten äitejä. Aineisto koostui 109 äidistä, joista 54 kuului pandemiaa edeltävään kohorttiin ja 55 pandemian aikaiseen kohorttiin. Äitien kokemaa masennusta mitattiin Edinburgh Postnatal Depression Scale -mittarilla (EPDS). Jokainen tutkimukseen osallistuva teho-osastoyksikkö piti kirjaa pandemiaan liittyvistä rajoituksista yksikössä.

Kaikissa yksiköissä oli koronapandemiaan liittyviä rajoituksia voimassa koko tiedonkeruujakson ajan. Rajoituskartoituksen tulokset kuitenkin osoittivat, että yksiköt omaksuivat tartuntatautiohjeistuksen eri tavoilla. Tiedonkeruun alussa puolet osallistuneista yksiköistä rajoitti isien läsnäoloa vastasyntyneiden teho-osastolla. Viisi kuudesta yksiköstä vaati äideiltä negatiiviset testitulokset ennen yksikköön saapumista, mikä hankaloitti äitien liikkumista. Neljässä kuudesta yksiköstä kiellettiin muiden vierailijoiden käynnit. Koronaan liittyvissä rajoituskäytännöissä havaittiin muutos kesäkuussa 2021, minkä jälkeen rajoituksia lievennettiin useimmissa yksiköissä. Tämä helpotti molempien vanhempien osallistumista lapsen hoitoon.

Tutkimuksen tulokset osoittavat, että pandemian aikana vastasyntyneiden teho-osastohoitoa tarvinneiden keskosten äitien synnytyksen jälkeiset masennusoireet pysyivät samalla tasolla verrattuna pandemiaa edeltävään aikaan. EPDS-mittarilla kliinisen masennuksen yleisesti käytetty raja-arvo on yli 12 pistettä. Myös tämän raja-arvon ylittävien äitien määrä pysyi samalla tasolla näiden kahden kohortin välillä. Tulokset olivat yllättäviä, sillä tutkimusoletus oli, että COVID-19-pandemiarajoitukset olisivat entisestään lisänneet ennenaikaiseen synnytykseen ja tehohoitoympäristöön liittyviä riskitekijöitä.

Vaikka vierailurajoitukset olivat voimassa, äidit saivat useimmissa sairaaloissa viipyä vastasyntyneiden teho-osastolla niin kauan kuin halusivat. Tämä saattaa olla yksi selittävä tekijä, miksi tässä tutkimuksessa ei havaittu äitien synnytyksen jälkeisten masennusoireiden lisääntymistä pandemian aikana. Neljässä kuudesta tutkimukseen osallistuneesta yksiköstä oli mahdollisuus yhden perheen huoneeseen, mikä turvaa äidin ja lapsen välistä läheisyyttä. Myös muut mahdolliset tekijät, kuten psykososiaalisen tuen lisääminen, voivat vähentää keskoslasten äitien masennusoireita pandemian aikana. Kun COVID-19-pandemian akuutti vaihe on ohi, on syytä tutkia tarkemmin, mitkä terveydenhuollon toimenpiteet ja äitien omat toimet osoittautuivat hyödyllisimmäksi perheiden ja äitien psyykkisen terveyden tukemisessa. Koska rajoitustoimenpiteet kohdistuivat enimmäkseen isien läsnäoloon, tulevissa tutkimuksissa tulisi tarkastella myös COVID-19-rajoitusten vaikutusta isien henkiseen hyvinvointiin.

Avainsanat: COVID-19, pandemia, synnytyksen jälkeinen masennus, vastasyntyneiden teho-osasto

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1 Introduction

Globally, more than one in ten babies are born preterm. Prematurity is the most common reason an infant is admitted to a neonatal intensive care unit (NICU) (Seaton et al., 2016). NICU exposes parents and infants to stressful environment and situations (Raiskila et al., 2014). Parents of preterm infants have reported feelings of separation when their infant is admitted to NICU (Flacking et al., 2012). Prolonged early separation between mother and infant has been shown to be related to higher number of maternal depressive symptoms, stress, and anxiety (Flacking et al., 2012).

Accumulating evidence on the benefits of early parent-preterm infant closeness during the hospital care has started to influence care practices in NICUs. In 2018, the European Foundation for the Care of Newborn Infants (EFCNI) launched standards of care for newborn health which define parental presence and participation as the European standard of care for hospitalized newborn infants (Tandberg et al., 2019). Family-centered care can be seen as the state-of-the-art approach that aims to include parents as partners in the care of their infant during hospitalization and reduce the risk of parental depression (Axelin et al., 2021).

During the COVID-19 pandemic many hospitals, including their NICUs, limited parental presence and visitation privileges (Murray & Swanson, 2020). Much concern has been raised that the added stress related to COVID-pandemic restrictions may negatively affect the psychosocial health of NICU mothers. Studies show that care practices which support the physical and emotional closeness between the parents and preterm infant decrease maternal depression symptoms and support infant development (De Alencar et al., 2009; Flacking et al., 2012). As neonatology moved toward more inclusion of the family at the bedside, hospital policies that limit parental presence and participation can be seen as a step backwards in the process that aims to implement strategies to support family closeness and change the parents' role from a visitor to a crucial part of the care giving team. Because parental involvement in NICUs has been proven to be beneficial for the infant and the parents, it is important to know how pandemic restrictions affect infant and parental health. It is also important to gather information of the various ways NICUs can support infant and parent wellbeing in situations when parents are not able to visit.

1.1 Postpartum depression among mothers with preterm infant

Maternal anxiety and postpartum depression (PPD) are the most common complications of childbirth, impacting approximately 1 in 7 women in developed countries within the first year after childbirth (Kroska & Stowe, 2020). First symptoms, such as anxiety, significant decrease in participation in desirable activities, sleep disturbance, appetite change and feelings of worthlessness, generally appear during pregnancy or within four weeks after delivery (Falana & Carrington, 2019). Criteria include 5 out of 9 symptoms for most of two weeks and elimination of alternative causes (Kroska & Stowe, 2020). Postpartum depression is linked to biological, social, and psychological changes that happen when having an infant (Pearlstein et al., 2009).

An increasing body of evidence suggests that, compared to full-term mothers, mothers of preterm infants show an even higher risk of postpartum depression with rates varying from 18.9% to 75% (de Paula Eduardo et al., 2019). In addition to immediate effects of postpartum depression on maternal-infant interaction, accumulating evidence is being provided for potential long-term disruption of the cognitive, social and emotional development of children (Beck, 2003; Van den Bergh et al. 2020). This makes postpartum depression especially concerning.

There are many factors that have been shown to be linked with postpartum depression among mothers of full-term infants, including low socio-economic situation, maternal age, ethnicity, low maternal education, relationship status, previous history of depression, length of stay in hospital, low self-esteem, and stressful life events (Ionio et al., 2019; Kim et al., 2020). Among mothers of preterm infants the mother's perception of the severity of the infant's illness is thought to be a key predictor of parental stress (Beck, 2003; Ionio et al., 2019). Researchers have pointed out that there are also other factors that play a role in postpartum depression among mothers of preterm infants, such caring for other children at home, lack of support, younger gestational age and low birth weight. Research shows that mothers who reported more parental role alteration stress during infant's hospitalization were more likely to be at risk for depression (Miles et al., 2007). There are also institutional risk factors which play a role in PPD among mothers of preterm infants. These factors refer to the stressful NICU environment, lack of family-centered care practices, and low quality in infant pain management during hospital stay (Axelin et al., 2021). In a systematic review, social support

was found to alleviate the effects of PPD among mothers of full-term and preterm infants (Axelin et al., 2021; Beck, 2003; Kim et al., 2020).

1.2 Pre- and postnatal care during COVID-19 pandemic

Coronavirus disease 2019 (COVID-19) is caused by severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) (Dinakaran et al., 2020). The outbreak of COVID-19 was first identified in China in 2019 and since then the virus has spread to various countries across the globe (Sharma et al., 2021). After COVID-19 was declared a global pandemic by the World Health Organization (WHO) on 11 March 2020, many governments followed the WHO's recommendations on curfews and lockdowns of varying stringency (Sharma et al., 2021). As part of COVID-19 restriction measures, most Estonian hospitals changed their policies regarding labor, delivery, pre- and postnatal care, and visitations. Implementation of restriction measures differed between hospitals. In general, prenatal care visits were decreased and physical distancing was recommended when possible. Mostly, visitation restrictions limited the presence of fathers, doulas, and visitors in prenatal check-ups, delivery rooms, and postpartum units, including NICUs. While mothers' access to their infants was not limited in most hospitals, hospital restrictions made it more difficult for mothers to leave and re-enter specific units such as NICU. All these measures impacted parents' ability to access, care for, and bond with their infant. In addition, it impacted mothers' access to support from their close ones.

1.3 The effect of COVID-19 restrictions on maternal wellbeing in NICU

Over the last two years, many studies have focused on the effects of the COVID-19 pandemic restrictions on pregnant women. Several studies have found elevated symptoms of anxiety and stress among women around childbirth during the pandemic (Durankuş & Aksu, 2020; Kotlar et al., 2021; Lebel et al., 2020) So far, significantly fewer studies have focused on the effect of the COVID-19 pandemic on the mental health of the already-vulnerable population of mothers with preterm infants. A study done in Italy found no difference in parental stress, depression and participation in care among NICU mothers over three time-points: pre-pandemic, low COVID-19 incidence, and high COVID-19 incidence (Bua et al., 2021). Similarly, a study done in Switzerland which compared maternal stress, depression, and attachment in NICUs before and during the COVID-19 pandemic found no significant difference between the two groups (Manuela et al., 2021). A recent cross-sectional study done

in Belgium found that among mothers of extreme and early preterm infants born before 32 gestational weeks the COVID-19 pandemic was associated with higher risk of postpartum depression (Vatcheva et al., 2021).

A growing body of evidence has shown that social isolation may lead to psychiatric disorders (Bzdok & Dunbar, 2020; Esterwood & Saeed, 2020). Hence, it can be assumed that the social isolation followed by the COVID-19 restriction measures combined with concerns about risk of exposure to COVID-19 has worsened the risk factors linked with preterm birth (Vatcheva et al., 2021). Table 1 shows a simple theoretical model of the various ways restriction measures could negatively affect the wellbeing of mothers in NICU.

Table 1. Restriction measures affecting the wellbeing of mothers in NICU based on literature

Restriction measure	Possible effect of the restriction measure
Being in quarantine and having concerns about the virus	Quarantine measures enhance psychological distress
Mother's limited presence and involvement	Separation from the infant increases parental stress
Father's limited presence and involvement	Lack of social support can aggravate the effects of postpartum depression among mothers
Limited visitation of other family members	Lack of social support can aggravate the effects of postpartum depression among mothers
Restricted interaction with the staff	Restricted interaction with staff can exacerbate parents' sense of isolation from their infant and complicate the development of parental roles

First, being in quarantine and having concerns about being exposed to, and possibly transmitting, a contagious virus is a stressful experience on its own. A natural disaster like the COVID-19 crisis can add a new layer of mental distress and worry about how the virus might impact the health of the infant. At the end of 2002 Severe Acute Respiratory Syndrome (SARS) was first discovered in Asia. The outbreak was brought under control in July 2003 by introducing widespread quarantine measures. The terms *isolation* and *quarantine* mean two different things. Quarantine refers to limiting the mobility of people who are not infected with the pathogen, whereas isolation aims to lessen the impact of the pandemic by preventing movement of those who are infected (Murray & Swanson, 2020). It is normal for people in quarantine to experience a wide range of negative effects including anxiety, isolation, fear, anger, sadness or guilt (Zanardo et al., 2020). A study examining the psychological effects of SARS quarantine found that the quarantined people showed a higher prevalence of

psychological distress (Hawryluck et al., 2004). The study suggested that quarantine measures themselves, such as instructions to wash hands frequently, wear masks, not to share personal items, and not to leave home or have visitors, may be perceived as a personalized trauma (Hawryluck et al., 2004).

Secondly, limitations regarding a mother's presence and involvement at the bedside of her newborn compromises the benefits of early parent-infant closeness. A growing body of evidence has proved that closeness is crucial to the physical and emotional wellbeing of both the infant and parents (Flacking et al., 2012). Separation from the infant has been argued to add parental stress in two ways: early separation within 24 hours of birth causes increased parental NICU-related stress, whereas prolonged physical separation is known to cause maternal stress and depression (Flacking et al., 2012). Therefore it can be hypothesized that mothers' restricted participation in the infant's care would further increase maternal stress and anxiety (Toivonen et al., 2020).

Thirdly, social support after birth has been found to play an essential role in reducing the symptoms of PPD (Kim et al., 2020). Partners are essential figures in providing social support for mothers who are recovering from complications in pregnancy and dealing with immediate separation from their infant. It has been found that fathers' supportive involvement in the care of their newborns in the NICU is significantly associated with lower PPD symptoms among mothers (Kim et al., 2020). A study examining the effect of fathers' presence and involvement in the care of the newborn in the NICU reported a significant correlation between active involvement of the father and fewer postpartum depressive symptoms in the mother (Kim et al., 2020).

Fourthly, visitation restrictions also mean that families miss out on interacting with other family members, friends and peers and benefiting from their valuable support. In addition, trust between parents and health care providers may be harder to build when contact is restricted. Neonatal care providers are in a unique position to offer mothers material, and informational as well as emotional support. Care providers also have the training to identify which parents are at increased risk of mental health problems. Restricted interaction between parents and staff can exacerbate parents' sense of isolation from their infant and complicate the development of parental roles (Flacking et al., 2012). Fatema et al. (2019) concluded that mental health condition of women deteriorates when they do not receive support within a

certain period of time. In addition, the psychological health of mothers has been found to be worse when compared with other women (Fatema et al., 2019).

1.4 Aims and research questions

The aim of this comparative cohort study was to explore whether the visitation restrictions adopted in Estonian NICUs were associated with maternal postpartum depression symptoms. More precisely, the first research question is what COVID-19 restriction measures were implemented in Estonian NICUs between March and July 2021. The second research question is to assess whether the mothers of preterm infants had more depressive symptoms during the COVID-19 restrictions compared to the mothers in the pre-pandemic cohort.

2 Materials and methods

2.1 Participants

The participants of this study were 109 women whose infants were born before 35 gestational weeks and were cared for in an Estonian NICU. From these women 54 belonged to the cohort collected between January 2018 and May 2019 (hereafter pre-pandemic cohort) and 55 women to the cohort that was collected during the COVID-19 pandemic (hereafter pandemic cohort).

The pre-pandemic cohort data was collected as part of The 2nd International Closeness Survey. In this study parent-infant closeness during NICU care was studied in 23 neonatal intensive care units in 15 countries, Estonia being one of them. For this research, only mothers with an infant born before 35 gestational weeks were included. Families were excluded if the expected duration of hospitalization was less than 3 days, the infants were triplets, the parents could not speak fluent Estonian or Russian, or the infant's condition was critical and survival uncertain.

The pandemic cohort data was collected between March and July 2021 as part of The Impact of the Close Collaboration with Parents Intervention - Estonian Study. For this research, inclusion criteria were 1) the newborn was hospitalized during the first 28 days of infant life, 2) expected length of stay of the newborn was at least three days, 3) discharge was planned to happen within a week and 4) at least one of the parents agreed to participate in the study. From this data only families with infants born before 35 gestational weeks were selected for analysis. The flow of participants in both cohorts is represented in Figure 1.

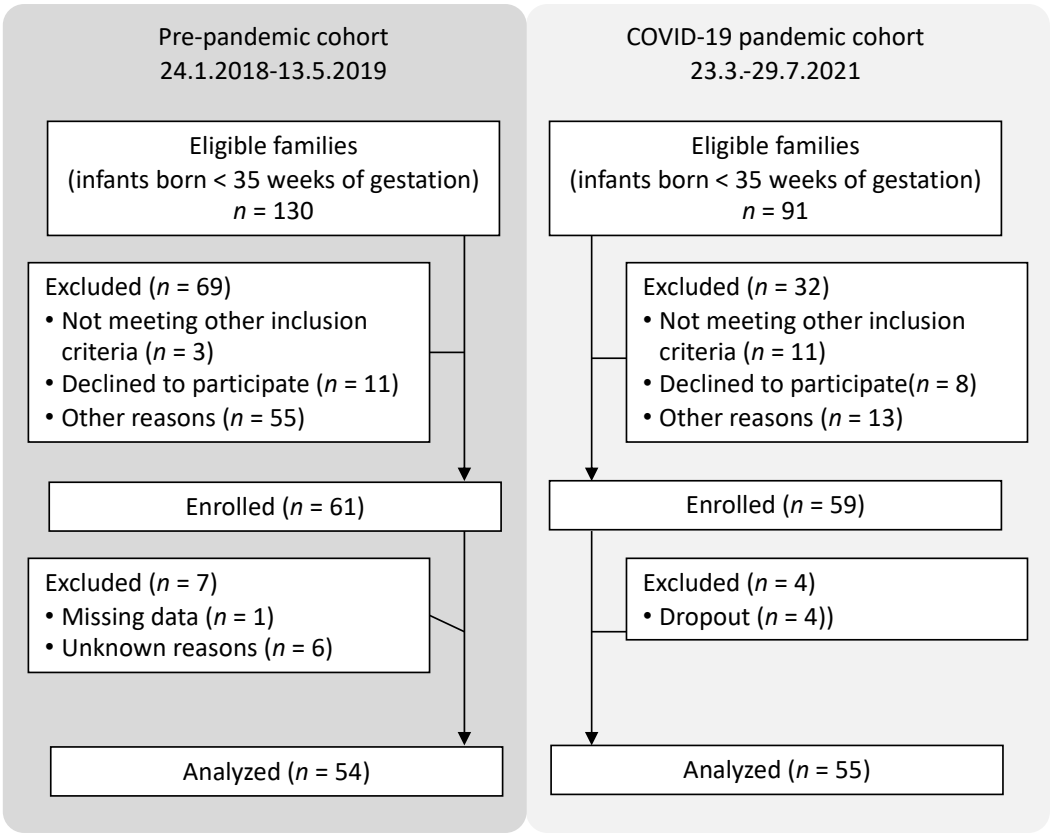


Figure 1. Flowchart of participants in both cohorts

2.2 Data collection

In both studies, data was collected from units A and B, which are parts of the same hospital in Tallinn, and units D, E, and F which belong to the same hospital in Tartu. The 2nd International Closeness Survey study also collected data from unit G in Tallinn and The Impact of the Close Collaboration with Parents Intervention Estonian Study collected data from unit C in Tallinn. These hospitals have the only delivery and maternity units in Tallinn and are comparable based on their patient and care structure.

The units included in this study offer care at the following levels: unit A is a pediatric intensive care unit (PICU) providing care at level III. Unit B is a neonatal care unit (NICU) providing care at level II. Unit D is a level III unit (PICU) while units E and F provide care at level II (NICU). Units C and G in Tallinn have the same care structures: the unit is connected to maternity units and it provides care at level II. From these units, units B, C, E, F, and G have single family rooms for some or all patients where parents can stay with their infant 24/7. Altogether, these units represent the Estonian neonatal care pathway from delivery to intensive neonatal care.

In both cohorts, a local research assistant or staff member approached the eligible parents with an informed consent form and collected the signed consent on the following day from those who agreed to participate. Questionnaires were handed out to participating parents approximately a week before the expected discharge and collected before the infant was discharged home. The local researchers entered the anonymous data into the secure Research Electronic Data Capture (REDCap) system.

2.3 Study procedures and measures

All units kept a restriction log during the pandemic. In this study, the term *COVID-19 restriction measures* was used to include all the hospital policies which resulted in family separation: measures that limited fathers' presence during birth or caretaking of the infant in the NICU, visitation restrictions, COVID-19 testing, and policies which made it more difficult for mothers to leave and re-enter infant care units. The model of the restriction log can be found in the Appendices (Appendix 1).

The depressive symptoms were measured at discharge using Edinburgh Postnatal Depression Scale (EPDS). EPDS has been proven to be a valid method to measure postnatal depressive symptoms (Cox et al., 1987). The 10-question scale questionnaire includes symptoms such as insomnia, mood, and thoughts of self-harm during the previous week. Responses to items are scored from zero to three. The minimum score on the EPDS is zero and maximum score 30. Higher scores reflect more symptoms. The majority of studies utilizing the EPDS use a total score greater than 12 to identify women with clinically probable postpartum depression (Cox et al., 1987; Manuela et al., 2021). In this study, we were also interested in how many mothers in each cohort scored above the EPDS total score 12.

Each participating parent was asked to fill out a background questionnaire related to the infant, the family and the hospital stay. The background questionnaire included questions about the infant's gestational age, birth measurements, sex, delivery, possible multiple births and units where the infant received care. Parents were asked when they first saw, held and had their infant in skin-to-skin contact. The questionnaire also included questions about sociodemographic characteristics of the parents (e.g., age, smoking, native language, relationship status and working situation before birth). Higher education category was used when a participant's total years of education exceeded 12 years. Parents were also asked about visiting difficulty and number of children living at home. The Impact of the Close

Collaboration with Parents Intervention - Estonian Study also included questions about the previous mental health of parents in the background questionnaire.

2.4 Ethical considerations

Ethics approval for The 2nd International Closeness Survey was obtained at the principal investigator's site (the Hospital District of Southwest Finland, registration number T08/011/18). In addition, each study site sought approval from their local research ethics board (Axelin et al., 2021).

Ethical properties of The Impact of the Close Collaboration with Parents Intervention – Estonian Study have been evaluated by Tartu University. The approval number of the study is 333/T-21.

Parents were informed that participation in the study is voluntary and they had the right to refuse or withdraw from the study at any time. Parents were also informed that information collected is handled confidentially and anonymously and collected research data is stored and disposed of properly either at the end of the study or when the parent decides to withdraw from participation. Those parents who exceeded the EPDS clinical cut-off score of 12 were contacted and offered support.

2.5 Statistical analysis

The difference in the median/ mean values between the two cohorts was evaluated using the Mann-Whitney U test or Student's independent samples t-test. The difference in binary variables between the two groups was evaluated using Fisher's exact test or chi-squared test. To assess the effect of the restriction measures on mothers' postpartum depressive symptoms, participants were divided into three groups: pre-pandemic group (n = 54), high restriction group (n = 31) and low restriction group (n = 24). The Kruskal-Wallis H test was used to analyze whether there was a difference in EPDS between the three restriction groups. Statistical analyses were conducted using SPSS version 27.0.1.0 for Mac (SPSS Inc, Chicago, IL, USA).

3 Results

3.1 Descriptive results

Participants of this study were mothers with preterm infants. Overall, 109 mothers were included in the study: 54 in the pre-pandemic cohort and 55 in the pandemic cohort. As shown in Table 2, parental and infant characteristics did not differ significantly between the two cohorts except for longer length of stay in the pandemic cohort.

Table 2. Characteristics of Pre-Pandemic and Pandemic Cohorts

Variables	Pre-pandemic cohort (*n* = 54)	Pandemic cohort (*n* = 55)	*p*-value
Infant			
Male sex, no. (%)	27 (50.0)	29 (52.7)	.776
Gestational age, mean (SD), week	30.9 (3.2)	30.1 (3.1)	.234
Birth weight, mean (SD), g	1715.8 (563.9)	1527.0 (593.2)	.092
Length of stay, mean (SD), day	34.8 (34.8)	52.6 (45.4)	.008
Mother			
Age, mean (SD), yr	32.1 (5.6)	31.8 (5.9)	.764
Singleton pregnancy, no. (%)	41 (75.9)	43 (78.2)	.779
Vaginal birth, no. (%)	26 (48.1)	21 (38.2)	.294
Smoking, no. (%)	2 (3.7)	5 (9.1)	.251
Single parent, no. (%)	2 (3.7)	1 (1.8)	.547
Higher education, no. (%)	25 (46.3)	27 (49.1)	.843
First pregnancy, no. (%)	16 (34.0)	24 (44.4)	.286
Visiting difficulty, no. (%)	5 (9.3)	3 (5.6)	.462

Note. SD = standard deviation

3.2 Restriction measures in each participating unit

Each participating unit kept a restriction log during the pandemic. Details of restriction measures are explained in Table 3. All units had some COVID-19 related restrictions in place during the entire data collection period. There were differences between units in relation to the severity of restrictions. During the high restriction period, three out of six units limited fathers' ability to visit their infant in the unit. Most of the units required negative test results from mothers upon entering the unit which complicated mothers' ability to leave and re-enter the unit. One unit did not allow mothers to stay 24/7 or both parents to be present in the unit

at the same time. A change was observed in the COVID-19 restriction policies in June 2021. After 11th of June 2021, restrictions were lessened in most units making it easier for fathers to visit and care for their infants. During the low restriction period, half of the units still prohibited other visitors and required parents to submit negative COVID-19 test results before entering the unit.

Table 3. COVID-19 related restrictions in units included in the study during high restriction period (29.3.-11.6.2021) and low restriction period (12.6.-29.7.2021)

Restriction	Unit A		Unit B		Unit C		Unit D		Unit E		Unit F	
	high	low	high	low	high	low	high	low	high	low	high	low
Mother not allowed to visit her infant 24/7							x	x				
Negative test result required before entering or returning to unit	x	x	x	x			x	x	x		x	
Both parents not allowed in the unit at the same time							x	x				
Father not allowed in birth									x			
Father not allowed to visit the unit					x				x		x	
Other visitors not allowed	x	x			x	x	x	x	x			

Note. x = restriction was applied in the unit

In Units A and B, parents could visit and stay with their infant after providing a negative COVID-19 test. In these units, restrictions did not change during the data collection. During more severe restrictions between March 29 and June 11, 2021 unit C allowed fathers to stay with their partner at birth and two hours after it. Fathers and other visitors were not allowed in the NICU. The hospital guidelines changed at the beginning of July. This allowed fathers to enter and stay in the NICU with the infant.

In unit D visitors were not allowed and usually only one parent was allowed to stay at the hospital. Those parents who wanted to stay full time in the hospital were required to provide a negative COVID-19 test result. Visiting the infant in the unit was possible during the day until 22:00. Walking on the hospital yard was allowed but contact with people from outside was not permitted. Restrictions didn't change in the unit during the data collection period.

In the unit E, fathers were not permitted to enter the maternity hospital between March 29 and May 15, 2021. From mid-May until June 11, fathers were allowed to be with their partner at birth and two hours after birth. Restrictions changed again on the 11th of June allowing fathers to visit their infants in the neonatal ward. From the end of June onwards fathers were allowed to stay with their partner and infant in the unit. Similar restrictive measures were issued in unit F. Until the beginning of June, fathers were not allowed to visit their infants in the unit. Mothers were advised not to leave the unit but if the mother left the hospital and wanted to return to the unit, she had to provide a negative COVID-19 test result. At the beginning of June, fathers and other family members were allowed to visit the infant at certain visiting hours, one visitor at a time.

3.3 The effect of restriction measures on mothers' postpartum depressive symptoms

The mean score of EPDS in the pre-pandemic cohort was 8.8 (*SD* = 5.5) and in the pandemic cohort 7.9 (*SD* = 4.6) without significant difference $U = 1361.50$, $z = -.75$, $p = .453$.

We were also interested in total EPDS scores in each participating hospital. EPDS score was classified according to the discharge hospital. Mean values and standard deviations of the total score of EPDS in each participating hospital are represented in Table 4. The differences of EPDS total scores between pre-pandemic and pandemic cohorts in each participating unit were not statistically significant.

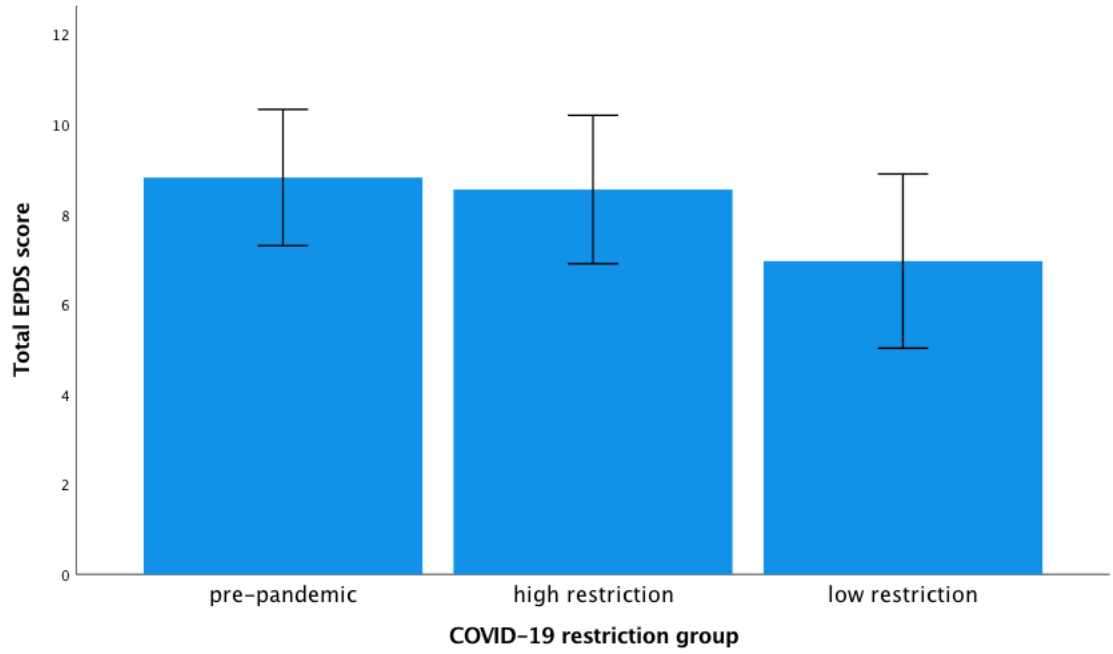
Table 4. Total EPDS scores in each participating hospital

Unit	Pre-pandemic cohort		Pandemic cohort		*p*-value
	M	*SD*	*M*	*SD*	
Units A and B	6.3	3.7	7.9	5.0	.348
Units G and C	8.8	4.5	8.7	5.0	.941
Units D, E and F	9.9	6.5	7.5	4.1	.128

Note. SD = standard deviation; M = mean

The proportion of mothers with EPDS ≥ 13 was 26% in pre-pandemic cohort and 22% in pandemic cohort. The difference between cohorts was not statistically significant $p = .66$, $OR = .80$, 95% CI [0.33, 1.93].

After analysing the logs and timeline of restriction measures, participants were divided into three groups: pre-pandemic group (n = 54), high restriction group 29.3.-11.6.2021 (n = 31), and low restriction group 12.6.-29.7.2021 (n = 24). As represented in Figure 2, mothers' mean (SD) EPDS total score in pre-pandemic group was 8.8 (5.5), in high restriction group 8.6 (4.5), and in low restriction group 7.0 (4.6) There was no significant difference in EPDS total scores between these three restriction groups $H(2) = 2.16$, $p = .340$.



Note. Error bars represent 95% confidence intervals

Figure 2. Mean EPDS total scores in each restriction group

4 Discussion

Despite much concern, the findings of this study show that postpartum depressive symptoms of NICU mothers were not associated with COVID-19 restriction measures in Estonia. These results were unexpected as evidence indicates that parents of preterm infants are at high risk for developing postpartum depression due to parental stress related to separation from the infant and inability to realize their full parental role in a professional-centred environment like NICU (Axelin et al., 2021). Based on the literature, restriction measures can negatively affect the psychological wellbeing of mothers in NICUs. This can happen through limitations on parental presence and involvement, peer-to-peer support, and interaction with the staff. In addition to these stressors, it has been documented that being in quarantine can enhance psychological distress (Hawryluck et al., 2004).

However, the results of the current study are in line with the majority of existent literature. A recent study done in Italy found no difference in parental stress, depression and participation in care among NICU mothers over three time-points: pre-pandemic, low COVID-19 incidence, and high COVID-19 incidence (Bua et al., 2021). Parental depression was measured with the Edinburgh Postnatal Depression Scale close to discharge. In this study done in Italy, restriction measures did not dramatically change before and during the pandemic. Parents were required to take a COVID-19 test either every two weeks or weekly, depending on the timepoint. Cleaning procedures were intensified but no other major changes in care occurred. Visits were restricted to one parent per infant but parents were allowed to enter as frequently and as long as they liked. During the study period, other organizational changes were enacted to mitigate the impact of the restrictions. Psychologists were present in the NICU and offered parental support also by phone. When parents were not present, daily updates on the infant's condition were provided by video call (Bua et al., 2021).

A study done in Switzerland which compared maternal stress, depression, and attachment in NICUs before and during the COVID-19 pandemic found no significant difference between the two groups (Manuela et al., 2021). However, a trend was present with an increase in the percentage of mothers in the "at risk" category (EPDS score ≥ 10) for depression in the during-COVID group (Manuela et al., 2021). The prevalence of PPD (22%) in the pandemic cohort in this current Estonian study was slightly lower compared to several other studies that reported a prevalence of postpartum depressive symptoms (EPDS total score ≥ 13) ranging from 28.6% to 44% during pandemic (Vatcheva et al., 2021). In the study done in

Switzerland, mothers were screened for postnatal depressive symptoms after their infant's birth. The sample size was small (N = 34), perhaps due to the inclusion criteria which was mothers of infants born before 32 gestational weeks (Manuela et al., 2021). Participants were recruited at the Geneva University Hospital which is organized in single-family rooms and open access 24/7. During the pandemic period, psychological support was guaranteed to both parents and there were no restrictions on visitations which enabled both parents to be present at the same time as long as they wanted. Parents were only required to use a face mask inside the room when a member of the medical team was present (Manuela et al., 2021).

A recent cross-sectional study done in Belgium found that among mothers of extreme and early preterm infants born before 32 gestational weeks the COVID-19 pandemic was associated with higher risk of postpartum depression (Vatcheva et al., 2021). However, in this study, postpartum depressive symptoms were assessed at 3-6 month follow-up consultations, which might be too late a timepoint to assess the impact of the restriction measures. According to this study, most hospitals in Belgium restricted women's partner presence in postpartum units (Vatcheva et al., 2021). Restriction measures were not described more specifically.

Different studies on this topic are difficult to compare because restriction measures vary between countries and timepoints and studies include different populations of mothers. In different studies, parental wellbeing has been assessed at different time points. Also, in the majority of studies done on this topic restriction measures did not dramatically change before and during the pandemic or they were not clearly described. Studies in this field are also difficult to compare because of the variation in family-centered care practices such as single-family rooms. There are also differences between countries and hospitals in adoption of protective factors such as increased psychosocial support and use of technological devices to maintain both parents' visual and vocal contact with their infant. These actions potentially protected parents against the negative effect of the pandemic and restrictions. All these differences complicate comparison of studies done in this field.

To our knowledge, this is the first study in this field where restrictions were documented by the staff in each participating unit. Before data collection began, the Estonian government had issued infectious disease guidelines which changed the way care was given in the units. All units had some COVID-19 related restrictions in place during the entire data collection period. However, the results of the restriction mapping showed that the units adopted the

infectious disease guidelines differently. At the beginning of data collection, fathers' presence in caretaking of the infant in the NICU was limited in half of the participating units. Five out of six units required negative test results from mothers upon entering the unit and four out of six units prohibited other visitors. A change was observed in the COVID-19 restriction policies in June 2021 after which restrictions were lessened in most units, making it easier for both parents to visit and care for their infant. Half of the units still prohibited other visitors and required parents to submit negative COVID-19 test results before entering the unit. However, it is important to note that even though visitation restriction were in place, mothers in most hospitals were allowed to enter the unit as frequently and as long as they liked which might be one explaining factor for why this study did not find association between mothers' postpartum depressive symptoms during the pandemic period. Four out of six participating units also offer single-family rooms which enhance mothers' ability to be close to their infants. It has been documented that single-family rooms contribute to parents' psychological wellbeing by reducing parental stress and risk of postpartum depression (Tandberg et al., 2019). Single-family rooms also allow parents to remove their face masks when alone with their infant to enhance the bonding and intimate communication.

It is possible that other changes in care practices mitigated the negative influence of the restrictions in Estonia. For example, Tallinn Children's Hospital reported that, during the restriction period, parents were supported by everyday access to a psychologist or spiritual counsellor at the unit. Perhaps it was also the case in Estonia that the pandemic restriction measures made the staff more sensitive in their communication which resulted in mothers feeling supported. In previous studies, perceived support provided by healthcare staff was found to be a protective factor against depression (Ostacoli et al., 2020). Perhaps the restriction measures encouraged parents and medical staff to also utilize other channels of communication, such as video calls, when both parents couldn't be present in the unit. The adoption of these kinds of protective measures was not mapped in the current study.

Relationship-building is especially vulnerable to distractions in NICU and it could also be possible that restrictive measures and social isolation can function as protective factors making mothers feel safer and better able to concentrate on their infant at times of pandemic. According to a study done in Italy, quiet on the ward due to the absence of hospital visitors was found to be a protective factor against post-traumatic stress symptoms (Ostacoli et al., 2020). Perhaps being isolated may protect maternal psychological wellbeing in a high-need situation and period when the safety of the infant and mother is a priority (Ostacoli et al.,

2020). It has also been reported that postnatal psychological distress seems to be more associated with the prenatal experience and other individual factors, such as attachment style and perceived pain during birth, than with the pandemic hospital restrictions (Ostacoli et al., 2020).

In this study, the pandemic cohort data was collected in 2021, one year into the pandemic. It is possible that by this time pregnant women and new mothers had found other ways to adapt and utilize other coping mechanisms and resources to support their mental health. This view offers a new interesting research question: what are the agentic responses that women and health care professionals around childbirth have utilized to protect the functioning and wellbeing of mothers in these trying times? Further study could bring more understanding on the complex interplay between these risk factors, family's ability to cope with stress, and protective measures adopted by health care staff.

In the present study, length of stay was found to be significantly longer in the pandemic cohort. Research shows that inherent factors, particularly gestational age, birthweight, and sex, influence length of stay for premature infants (Seaton et al., 2016). In addition, other factors such as early respiratory support and multiple birth have been found to be associated with length of stay (Manktelow et al., 2010). In the current study, infant birth weight was found to be slightly lower in the pandemic cohort but the difference was not statistically significant. This finding opens up another interesting research question: what other factors could possibly impact longer length of stay? Perhaps restriction measures that impact parents' ability to care for their infant have the power to disrupt psychological processes involved in mothers' readiness to take care of the infant. To assess the real effect of the COVID-19 restriction measures on length of stay, further statistical analysis is required to adjust existing predictive factors for length of stay.

Most of the studies focusing on the impact of the COVID-19 pandemic on postpartum depression among mothers of preterm infants have used data from a single centre whereas data in the present study is collected from six units in three hospitals in Estonia. Another strength of the current study is that all the units kept a restriction log during the pandemic which enables proper assessment of the relationship between COVID-19 restriction measures and postpartum depressive symptoms. Depressive symptoms were measured using a uniform measure at the end of hospitalization. One limitation of the current study is that one participating hospital was different between the cohorts. However, these units represented the

same level of care. Also, the relatively small sample size (N=109) undermines generalizability of results. There are disadvantages related to retrospective studies. For example, since data is collected retrospectively the study is limited by what information is available. Previous history of depression has been shown to be linked with postpartum depression among mothers with full-term infants (Kim et al., 2020). Unfortunately, no information about mothers' previous mental illnesses was available for the pre-pandemic cohort. In addition, most parents who participated were in a relationship and reported no visiting difficulty, which raises a question whether these results are representative among parents who are more socially disadvantaged.

5 Conclusion and clinical implications

Overall, this multicenter cohort study done in Estonia provided evidence that pandemic restrictions were not associated with increased risk of postpartum depression in preterm mothers.

All units had some COVID-19 related restrictions in place during the entire data collection period. At the beginning of data collection, half of the participating units limited fathers' presence in caretaking of the infant in the NICU. Five out of six units required negative test results from mothers upon entering the unit which complicated mothers' ability to leave and re-enter the unit. In four out of six units, other visitors were prohibited. A change was observed in the restriction policies in June 2021 after which restrictions were lessened in most units, making it easier for both parents to visit and care for their infant. Half of the units still prohibited other visitors and required parents to submit negative COVID-19 test results before entering the unit.

Despite the restrictions, mothers' unrestricted access to their infants and the fact that four out of six participating units offer single-family rooms could be explaining factors for why this study didn't find an increase in mothers' postpartum depressive symptoms during the pandemic period. There are also other potential factors that could reduce maternal depressive symptoms in NICUs during times of pandemic. Supportive communication with healthcare staff has been found to be a protective factor against depression (Ostacoli et al., 2020). Increased on-site or virtual psychosocial support can mitigate the negative influence of the restrictions and foster family resilience in a pandemic era. It is also possible that in a high-need situation when safety of the mother and infant is priority, social isolation can work as a protective factor enabling mothers to better concentrate on their infant.

After the acute phases of the COVID-19 pandemic are over, it is worth studying further which health care driven interventions and mothers' own agentic responses proved most beneficial in supporting the families and maternal psychological health. As restrictions mostly limited the fathers' presence, future study should examine the effect of COVID-19 restriction measures on fathers' mental wellbeing.

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Appendices

Appendix 1 Model of restriction log

Table 5. Model of restriction log sent to each participating unit

Hospital name		
Today	Press the button "Today" or enter the date, and write the details of the change	
Date of change	**Details of the restriction change of the unit**	**Reason for restriction**
Example	e.g. if limited, who can visit, how many persons at a time or per day, for how long time, or at what time of day.	covid19 or other
At the beginning		