BIOPSYCHOSOCIAL PROFILE OF A COHORT OF CHILDREN BORN PRETERM DUE TO COVID-19 IN PREGNANT WOMEN

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ABSTRACT

The study sought to identify the biopsychosocial profile of infants born preterm due to COVID-19 during pregnancy. The inclusion criteria were: premature birth, period from 2021 to 2022, COVID-19 during pregnancy. Participants were 11 children, with a mean gestational age of 31.34 (±2.16) weeks, chronological age 32.18 (± 5.68) months, birth weight 1536.82 (±304.30) grams, Apgar score at the 1st minute 5.55 (±2.94), 7.82 (±1.47) at the 5th minute, and length of hospital stay of 45.0 (±18.72) days. 81.81% of the children had neonatal jaundice, 72.72% had sepsis, and 54.54% required resuscitation. The findings related to pregnancy, birth, socioeconomic and ICF allowed us to classify the population as at biopsychosocial risk, justifying the importance of continuous monitoring of this population, seeking to avoid or minimize delays.

Keywords: Infant. Prematurity. COVID-19. Pregnant.

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INTRODUCTION

COVID-19 is a viral infectious disease that has caused worldwide apprehension, due to its high transmission rate, wide variety of symptoms and mortality, the most common symptoms being: fever, cough, dyspnea, fatigue, sputum, headache, hemoptysis and diarrhea (World Health Organization, 2020). In view of this, measures were necessary to control transmission, such as social isolation, systematic hand washing, the continuous use of masks, gloves, and also eye protection (Noronha *et al*., 2020; Lu; Liu; Jia, 2020).

In 2020, the Ministry of Health (MoH) included pregnant and postpartum women as a risk group for COVID-19, since complications were observed during pregnancy, during childbirth and postpartum, and can affect newborns, mainly increasing the risk of prematurity (Avila; Carvalho, 2020; Woodworth *et al*., 2020; Brazil, 2020). Studies have pointed out that pregnant women who test positive for COVID-19 can face obstetric complications, such as premature rupture of the membrane, preeclampsia, miscarriage, and premature labor. In the fetus, fetal distress, low birth weight (less than 2500 grams), and the need for hospitalization in intermediate or intensive care units may occur (Wastnedge *et al*., 2021; Dávila-Aliaga *et al*., 2021).

When viral infection occurs, especially in the third trimester of pregnancy, it can cause complications such as the need for maternal hospitalization in the ICU, intrauterine and neonatal death, thus confirming the increased severity and risk of the disease in pregnant women (Zaigham; Andersson, 2020). It was also observed that respiratory complications and fever, as a result of infection, during pregnancy, were correlated with the increased risk of attention deficit disorder and autism spectrum disorder in infants born preterm (Horning *et al*., 2018; Dreier *et al*., 2016).

Other risk factors considered for the pregnant woman and the fetus are comorbidities such as obesity, diabetes, and hypertension (Pitilin *et al*., 2021), which can contribute to the evolution of more severe conditions and complications (Costa *et al*., 2022). Among the complications in pregnant women, the most observed has been emergency preterm birth, increasing the risk of maternal and neonatal death (Li *et al*., 2020).

Prematurity is responsible for more than one in five of all deaths of children under 5 years of age, and is considered an important indicator of maternal and child health (Ramos; Cuman, 2009; World Health Organization, 2023), reflecting socioeconomic conditions, aspects related to reproductive health, and the quality of care offered during prenatal care, childbirth, and newborn care (Kerber *et al*., 2015).

According to Formiga, Silva and Linhares (2018), prematurity and low birth weight are the main risk conditions associated with a longer period of hospitalization of the

newborn, leading to a series of challenges for the health and functionality of babies, due to biological fragility, and it is common to observe motor deficiencies resulting from the immaturity of the central nervous system (Santos *et al*., 2021).

It is worth mentioning another risk factor for prematurity, which is the low socioeconomic level (Cascaes *et al*., 2008), as it contributes to poor nutrition, greater physical and psychological stress, inadequate health care during pregnancy, among others. In addition, during the pandemic, among the measures adopted to contain contamination by COVID-19, social isolation impacted the health care of this population (Noronha *et al*., 2020; Anderson *et al*., 2020), with a consequent decrease in the continuity of prenatal consultations, putting the health of the mother and child at risk (Honorato, 2022).

Considering the biopsychosocial aspect, it is observed that social isolation limited the child's interaction with family and friends, causing deceleration, absence or delay in their development. The most observed changes in the child's behavior are difficulty concentrating, changes in sleep and eating patterns, greater attachment to parents, irritability, and greater exposure to screens, indicating the influence of the environmental context on the child's sensorimotor development (Da-Mata *et al*., 2020).

Based on these premises, it is necessary to take a comprehensive look to understand the impacts caused on infants born to mothers infected by the virus. To identify such impacts, it is important to use a multidimensional, multidirectional and dynamic instrument such as the International Classification of Functioning, Disability and Health (ICF). This is a biopsychosocial model, which in a multidisciplinary view of disability, allows us to understand the complex relationship between the individual's health condition, personal factors and external factors that influence their life, addressing four components: Body Functions and Structures, Activity and Participation, Environmental Factors and Personal Factors (Jardim, P; Jardim, K, 2022; World Health Organization, 2001).

Thus, the present study is justified by the scarcity of conclusive studies relating COVID-19 in pregnant women and its repercussions on infants, seeking to understand the biopsychosocial aspects of possible maternal and/or infant sequelae resulting from the infection.

The aim of the study was to identify the biopsychosocial profile of infants born prematurely, whose mothers were diagnosed with COVID-19 during pregnancy.

METHODOLOGY

This is a cohort study, which seeks to measure the risk that an exposure or risk factor can trigger a disease (Hochman *et al.,* 2005), of a descriptive nature with a qualitative-

quantitative approach, whose population was selected by convenience. This is part of the research project "*Evaluation and monitoring of the sensorimotor development of infants born preterm due to COVID-19 in pregnant women – Multicenter cohort study",* approved by the Research Ethics Committee (CAAE 58300622.6.0000.5154), opinion no. 5.487.649.

The inclusion criteria were: premature birth with a gestational age of less than 37 weeks, due to COVID-19 in the pregnant woman, chronological age of up to three years and eleven months, and authorization from parents/guardians to participate in the study through the signing of the Informed Consent Form (ICF). The non-inclusion criteria were non-compliance with the inclusion criteria, lack of response to contact, and non-acceptance to participate in the study. And, as an exclusion criterion, the absence on the date scheduled for the evaluation.

Based on a preliminary survey of hospitalizations in the NICU of the Clinical Hospital of a Federal University, in the State of Minas Gerais, the electronic medical records of pregnant women who tested positive for COVID-19 and progressed to premature birth were consulted. Thus, the eligible cases were selected for the study and the parents/guardians were contacted by telephone. During this contact, everyone was informed about the objectives of the study and invited to participate in the research. Those who agreed to participate signed the informed consent form authorizing the child's participation in the research. The scheduling for the evaluation was carried out according to the availability of those responsible, and the evaluation was carried out online by video call on *Google Meet* or in person.

The data on the children were obtained through an anamnesis, the parents or guardians also answered the questionnaire on socioeconomic criteria (ABEP, 2020), and then the interview with the *ICF (International Classification of Functioning, Disability and Health)* Checklist.

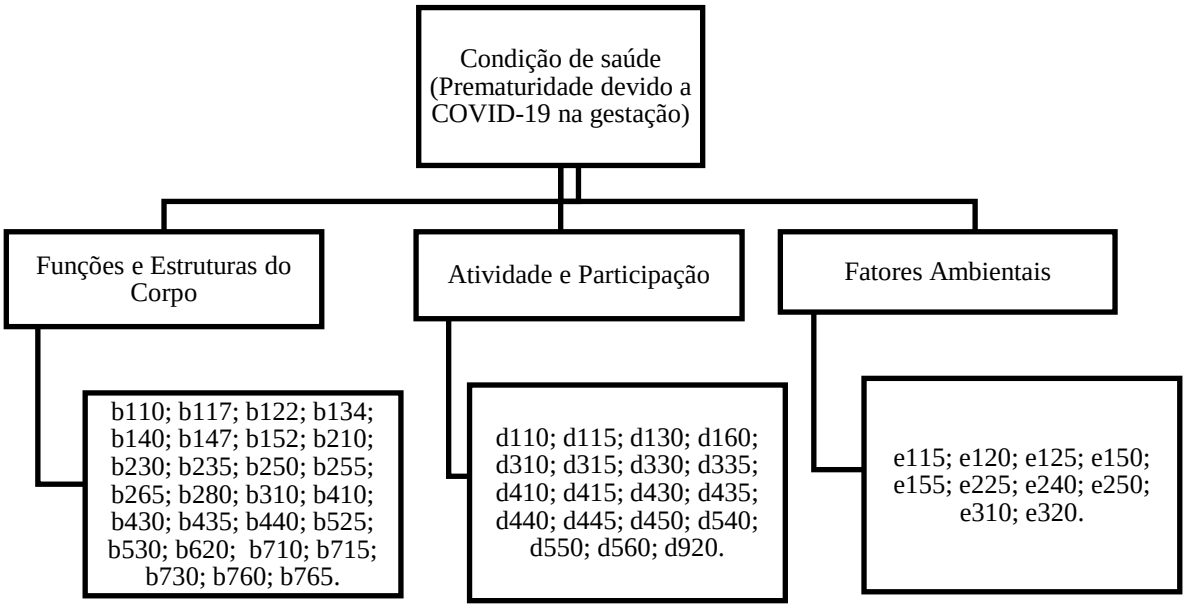
The evaluation was based on the biopsychosocial health model using the ICF and its specific variant for children and young people, the International Classification of Functioning, Disability and Health for Children and Young People (ICF-CJ). Both classifications categorize the main domains related to health aspects, covering Body Functions and Structures, as well as Activity and Participation. This approach also takes into account Environmental Factors and Personal Factors (WHO, 2011).

Based on the age group of the participants, the objectives of the study and the available scientific production, 56 categories were selected from the *ICF* Checklist, in order to collect data on: Body Functions and Structures (27 categories), Activity and Participation (19) and Environmental Factors (10), seeking to verify the biological and social

characteristics of the study population, as well as to identify health demands, describe and analyze the child's biopsychosocial and socioeconomic profile.

The data were analyzed according to the answers obtained in the previously selected categories following the following quantifiers: 0 – No disability/difficulty (0 - 4%); 1 – Mild disability / difficulty (5 – 24%); 2 – Moderate disability / difficulty (25 – 49%); 3 – Severe disability / difficulty (50 – 95%); 4 – Complete disability / difficulty (96 – 100%); 8 – Unspecified (Should be used whenever there is not enough information to specify the severity of the disability); 9 – Not applicable (Should be used in situations where it is inappropriate to apply a specific code) (Figure 1). In addition to the quantifiers, the different categories of Environmental Factors were considered as barriers (-) or facilitators (+).

Figure 1 – Interaction model of the ICF components and previously selected categories in each domain, Uberaba, MG, 2024.



Legend: b110 (functions of consciousness); b117 (intellectual functions); b122 (global psychosocial functions); b134 (functions of sleep); b140 (functions of attention); b147 (psychomotor functions); b152 (emotional functions); b210 (functions of vision); b230 (auditory functions); b235 (vestibular functions); b250 (gustatory function); b255 (olfactory function); b265 (tactile function); b280 (sensation of pain); b310 (voice functions); b410 (cardiac functions); b430 (functions of the hematological system); b435 (functions of the immune system; B440 (Breathing Functions); B525 (defecation functions); B530 (Weight Maintenance Functions); B620 (voiding functions); b710 functions related to joint mobility); B715 (stability of joint functions); B730 (functions related to muscle strength); B760 (functions related to the control of voluntary movement); B765 (functions related to the control of involuntary movement). D110 (observe); D115 (listen); D130 (imitate); D160 (focus attention); D310 (communicate and receive oral messages); D315 (communicate and receive non-oral messages); d330 (talk); d335 (produce non-verbal messages); D410 (change the basic body positions); D415 (maintain basic body position); D430 (lifting and transporting objects); D435 (moving objects with the lower limbs); D440 (fine hand motor activities); D445 (use of the hand and arm); D450 (floor); D540 (dressing); D550 (eat); D560 (drinking); D920 (Recreation and Recreation). E115 (products and technologies for personal use in daily life); E120 (products and technologies to facilitate mobility and personal transportation); E125 (products and technologies for communication); E150 (architecture, construction, materials and architectural technologies in public buildings); e155 (architecture, construction, materials and architectural technologies in private buildings); E225 (weather); E240 (light); E250 (sound); E310 (close family); E320 (friends).
Source: The authors (2024).

The answers obtained were stored in a database in *Excel® format for later analysis. The data were submitted to descriptive statistics identifying absolute and relative frequency, position measures (mean and median) and variability (standard deviation).*

RESULTS

Based on the survey of NICU admissions in the period between 2021 and 2022, 317 medical records were consulted. Of these, 29 were eligible for the study, but only 10 mothers agreed to participate in the study, one of them with twin birth, totaling 11 participants. Table 1 shows the sociodemographic and clinical-functional profile of the participants.

Table 1 - Sociodemographic and clinical-functional profile of the infants evaluated, Uberaba, MG, 2024.

Variable	N (total = 11)	Frequency (%)
Gender		
Female	4	36,36%
Male	6	54,54%
Gestational Age		
Between 28 to 32 weeks and six days	6	54,54%
Between 32 to 36 weeks and six days	5	45,45%
Birth Weight		
Between 2499 and 1500 grams	6	54,54%
Between 1499 and 1000 grams	5	45,45%
Apgar 1st minute		
Greater than 7	7	63,63%
Less than or equal to 7	4	36,36%
Apgar 5th minute		
Less than 7	3	27,27%
Greater than or equal to 7	8	72,72%
Length of Stay		
Less than or equal to 30 days	3	27,27%
Longer than 30 days	8	72,72%
Jaundice		
Yes	9	81,81%
No	2	18,18%
Need for resuscitation		
Yes	5	45,45%
No	6	54,54%
Because		
Yes	8	72,72%
No	3	27,27%
O2 supplementation		
Yes	8	72,72%
No	3	27,27%
Non-invasive ventilation		
Yes	7	63,63%
No	4	36,36%
Mechanical Ventilation		
Yes	3	27,27%
No	8	72,72%

Source: The authors (2024).

Table 2 presents the sociodemographic and clinical-functional characterization of the 10 mothers who participated in the study.

Table 2 - Sociodemographic and clinical-functional profile of the pregnant women evaluated, Uberaba, MG, 2024.

Variable	N (total = 10)	Frequency (%)
Age		
Older than 27 years	4	40%
Less than or equal to 27 years old	6	60%
Schooling		
Fundamental I	1	10%
Fundamental II	1	10%
Medium	6	60%
Superior	2	20%
Infection period		
Less than or equal to 25 weeks of GA	4	40%
Greater than 25 weeks of GI	6	60%
Symptoms		
Difficulty breathing	5	50%
Dry cough	4	40%
Fever	4	40%
Headache	4	40%
Complications		
Bradicardia fetal	2	20%
IUGR	2	20%
Preeclampsia	2	20%

Legend: GA – gestational age; IUGR – intrauterine growth restriction.
Source: The authors (2024).

The socioeconomic conditions of the 11 participants were obtained from the ABEP questionnaire (2020), with 63.63% having an average family income of R$1,805.91 (Class C2) and 18.18% having an average family income of R$5,449.74 (Class B2), as shown in table 3.

Table 3 – Socioeconomic classification of participants according to ABEP, Uberaba, MG, 2024.

Participants	Punctuation	Classification
1	23	C1
2	19	C2
3	21	C2
4	20	C2
5	29	B2
6	29	B2
7	20	C2
8	21	C2
9	22	C2
10	17	C2
11	34	B2

Legend: ABEP classification: A - 45 to 100 points; B1 – 38 to 44 points; B2 – 29 to 37 points; C1 – 23 to 28 points; C2 – 17 to 22 points; D/E – 0 to 16 points.
Source: The authors (2024).

Regarding the *ICF Checklist* , in the "Body Functions and Structures" component, it was possible to observe that 45.45% of the participants presented alterations in categories

b140, b152 and b440; 27.27% of the participants in categories b122, b134, b235, b280 and b435 (Table 4).

Table 4 – Results related to the "Functions and Structures of the Body" component, according to the number of participants who presented changes in relation to disability in the respective items, Uberaba, MG, 2024.

Categories	No	Lightweight	Moderate	Grave	Complete	Frequency (%)
Intellectual Functions (b117)	10	1	0	0	0	9,09
Global Psychomotor Functions (b122)	8	2	0	1	0	27,27
Sleep Functions (b134)	8	1	1	0	1	27,27
Attention Functions (b140)	6	2	3	0	0	45,45
Psychomotor Functions (b147)	9	1	0	1	0	18,18
Emotional Functions (b152)	6	2	2	0	1	45,45
Vision Functions (b210)	0	0	1	0	0	9,09
Vestibular Functions (b235)	8	2	1	0	0	27,27
Gustatory Function (b250)	11	0	1	0	0	9,09
Touch Function (b265)	0	2	0	0	0	18,18
Pain Function (b280)	8	0	3	0	0	27,27
Voice Functions (b310)	9	1	1	0	0	18,18
Cardiac Functions (b410)	9	1	0	1	0	18,18
Functions of the Hematology System (b430)	10	0	1	0	0	9,09
Functions of the Immune System (b435)	8	0	1	1	1	27,27
Breathing Functions (b440)	6	3	0	1	1	45,45
Defecation Functions (b525)	7	2	2	0	0	36,36
Weight Maintenance Functions (b530)	9	1	1	0	0	18,18
Joint Mobility Functions (b710)	10	0	0	1	0	9,09
Joint Stability Functions (b715)	10	0	0	1	0	9,09
Functions of Muscle Strength (b730)	10	1	0	0	0	9,09
Functions of Voluntary Motion Control (b760)	9	0	2	0	0	18,18
Functions of Involuntary Movements (b765)	10	0	1	0	0	9,09

Source: The authors (2024).

In the "Activity and Participation" component, the results showed that 81.81% of the participants presented alterations in the "Dressing" category, with 6 participants qualifying it as moderate disability, and 45.45% in the "Speaking" category (Table 5).

Table 5 – Results related to the "Activity and Participation" component, according to the number of participants who showed changes in relation to disability in the respective items, Uberaba, MG, 2024.

Categories	No	Light weight	Moderate	Grave	Complete	Frequency (%)
Imitate (d130)	10	0	0	1	0	9,09
Focus Attention (d160)	10	0	1	0	0	9,09
Communicating and Receiving Oral Messages (d310)	9	0	0	2	0	18,18
Communicating and Receiving Non-Verbal Messages (d315)	7	0	1	0	3	36,36
Talking (d330)	6	1	1	0	3	45,45
Producing Non-Verbal Messages (d335)	8	0	1	0	2	27,27
Change Basic Body Position (d410)	10	1	0	0	0	9,09
Floor (d450)	8	1	0	2	0	27,27
Dress-Up (d540)	2	0	6	2	1	81,81
Eat (d550)	8	1	1	1	0	27,27
Beber (d560)	10	0	0	1	0	9,09
Recreation & Recreation (d920)	8	0	1	1	1	27,27

Source: The authors (2024).

Regarding the facilitators and barriers of the "Environmental Factors" component (Table 6), the categories "Close family" (90.90%) and "Friends" (72.72%) stood out as facilitators, and the "Climate" category (72.72%) stood out as barriers. On the other hand, the "Light" category was scored as a barrier for 9.09%, but also as a facilitator for 27.27%, indicating diversity in the context and reality of each participant.

Table 6 – Results referring to the categories of the "Environmental Factors" component considering it to be a facilitator or barrier, Uberaba, MG, 2024.

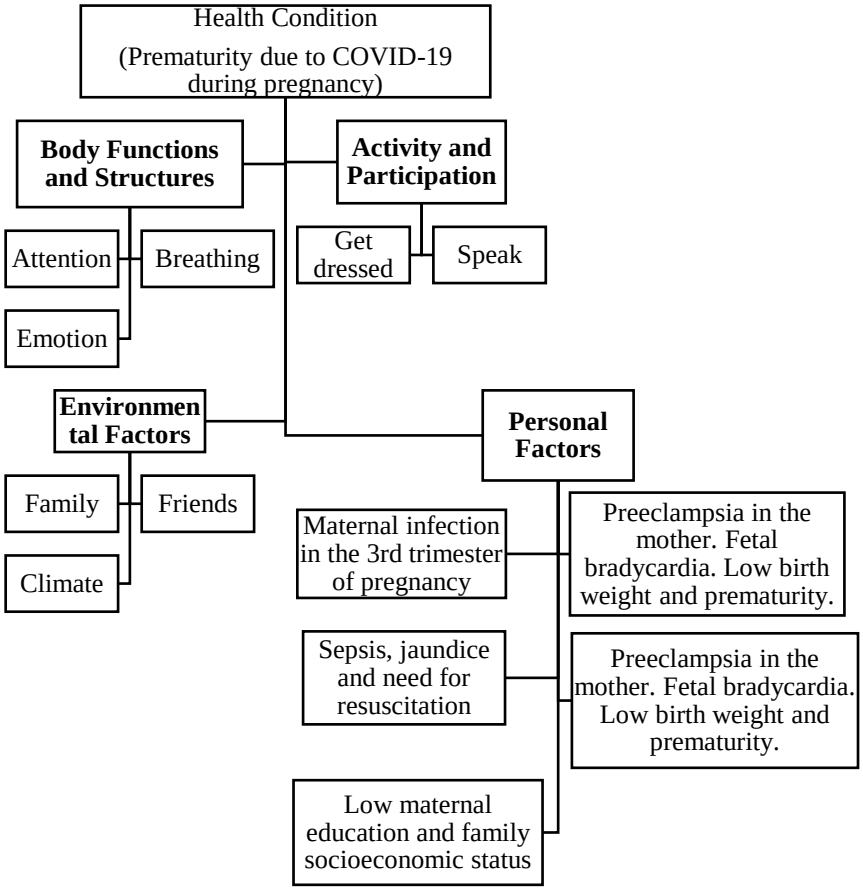
Categories	Facilitator	Barrier	None
Products and Technologies to Facilitate Mobility and Personal Transport (e120)	1	0	10
Architecture, Construction, Materials and Architectural Technologies in Public Buildings (e150)	0	2	9
Climate (e225)	0	8	3
Light (e240)	1	3	7
Sound (e250)	0	3	8
Close Family (e310)	10	1	0
Friends (e320)	8	1	2

Source: The authors (2024).

In summary, the profile of the study population is the low socioeconomic level of the family, higher incidence of infection of the mother by COVID-19 at the beginning of the third trimester of pregnancy, with complications in the pregnant woman and repercussions on the fetus and baby. In addition, the little social interaction due to the isolation imposed by the pandemic significantly influenced the development of infants. Negative aspects were also found in functionality (alterations in attention, breathing and emotional issues), disability (difficulty in dressing, verbal communication and social interaction) and health (prematurity,

low birth weight, longer hospitalization, need for resuscitation and ventilatory support and greater predisposition to sepsis and jaundice) (Figure 2).

Figure 2 – Biopsychosocial profile of infants whose mothers were infected with COVID-19 during pregnancy, Uberaba, MG, 2024.



Source: The authors (2024).

DISCUSSION

The identification of risk conditions for sensorimotor development, as early as possible, allows the planning of strategies in order to mitigate the impact of future consequences on the child. Seeking to contribute to a comprehensive look at the health condition of infants born prematurely due to COVID-19 during pregnancy, the present study aimed to outline the biopsychosocial profile of this population, and, to this end, used the biopsychosocial approach through the *ICF* checklist.

It is known that prematurity and low birth weight are risk conditions for newborns and infants, as it requires a longer hospitalization period and, consequently, greater exposure to external factors that can compromise their development (Formiga; Silva; Linhares, 2018). Such conditions have also been considered for those born due to complications of COVID-19 during pregnancy.

Considering the classification of premature infants according to the WHO (2023), it was found in the present study that 54.54% of the children were born very prematurely (with a gestational age between 28 and 31 weeks and six days) and 45.45% moderately preterm (between 32 and 36 weeks and six days). In addition, six children had low birth weight (between 2499 and 1500 grams) and five had very low birth weight (between 1499 and 1000 grams) (Brasil, 2023), which contributed to the longer hospitalization time of infants, in addition to greater exposure to harmful external factors. These results corroborate what has been described in the literature on the consequences of pregnant women's infection with COVID-19 in the fetus, such as: prematurity, fetal distress, low birth weight, need for ventilation, and hospitalization in the NICU (Wastnedge *et al*., 2021; Dávila-Aliaga *et al.,* 2021).

Regarding the complications observed during hospitalization, such as neonatal jaundice (81.81%), sepsis (72.72%), and need for resuscitation (45.45%), similarities were found with the study by Ferrugini et al. (2022), observing the frequency of unfavorable outcomes in pregnant women exposed to the virus, higher incidence of newborn resuscitation, and jaundice. Among the complications observed, respiratory complications stand out, requiring O2 supplementation (72.72%), noninvasive ventilation (NIV) (63.63%), and mechanical ventilation (27.27%), such results are similar to those observed in studies on the subject, with the need for ventilatory support by means of continuous positive airway pressure (CPAP), due to respiratory distress in the newborn (Gidlof *et al.,* 2020; Diaz *et al*., 2020).

Regarding the period of contamination by COVID-19 in pregnant women, it was found that on average it was at 26.82 (±5.40) weeks of gestational age, that is, the beginning of the third trimester of pregnancy, a period considered at risk for complications, including fetal and neonate death, thus confirming the increased severity and risk of the disease in pregnant women (Zaigham; Andersson, 2020). Among the complications in the mothers of the study participants, in addition to emergency preterm birth (100%), which in itself already increases the risk of maternal and neonatal death (Li *et al*., 2020), preeclampsia was also observed in the mother (20%), and in the fetus IUGR and bradycardia (20%), confirming what has been described in the literature, that such complications compromise the oxygenation and well-being of the fetus (Dashraath *et al.,* 2020; Elshafeey *et al.,* 2020).

The most frequent symptoms reported by the mothers in the present study were difficulty breathing, dry cough, fever and headache, and only one mother had associated comorbidity. The same symptoms were also observed in the study by Costa et al. (2022),

highlighting headache followed by cough as the first symptoms, and approximately 85% of pregnant women had no associated comorbidities.

According to socioeconomic status, most participants were found to fall into Class C2, confirming the association between low socioeconomic status and the incidence of preterm birth (Cascaes *et al*., 2008; Almeida *et al.,* 2012), added to the higher risk of contracting COVID-19 due to social vulnerability.

Another important factor is the mother's level of education, which may be related to the structuring of an environment favorable to children's motor development (Corsi *et al.,* 2016). According to Dinkel, Snyder and Cacola (2017), there is a correlation between the economic factor, the level of education of the parents, the high number of premature births, the predisposition to neuromotor alterations, and, consequently, delay in motor development, so it is important to understand the contextual factors to the child's development, in order to establish strategies in relation to child care. In the present study, despite the socioeconomic classification of the families, it was observed that 60% of the mothers had completed high school or incomplete higher education, which may have contributed to greater care and prevention of delays in the infants in the study.

Considering that social isolation was, among other measures, the most adopted to control the transmission of COVID-19, the repercussion of the child's proximity to family members, as well as the distance from friends, significantly impacting children's motor development (Da-Mata *et al*., 2020), is noticeable. These repercussions were also observed in our study, where 90.90% of the answers indicated the proximity to the family as a facilitator for life and, as a barrier, 27.27% considered the lack of contact with friends.

It is worth mentioning that children's behavioral changes can be observed and attributed to the little social interaction imposed by the pandemic, highlighting among these, difficulty concentrating, changes in sleep and eating patterns, greater attachment to parents, irritability, and greater exposure to screens (Da-Mata *et al*., 2020). Such changes were also observed in the present study, where 27.27% of the participants reported changes in relation to sleep and 45.45% in relation to attention and speech, results similar to those observed in the study by Evaristo, Queiroga, and Capellini (2023).

Based on the results observed, despite the limitation due to the small number of participants in the study, it is possible to affirm the importance of continuous surveillance of the development of children born during the COVID-19 pandemic whose mothers were infected by the virus, as there are several factors that can contribute to global developmental delay, in addition to prematurity and low weight.

FINAL CONSIDERATIONS

The results allowed us to verify a risk profile for delays in neurosensorimotor development in the population studied, justifying the need and importance of expanding public health policies for newborns and infants at risk due to exposure to COVID-19. The identification of possible risks guides the early and personalized planning of strategies, considering individuality, family and social context, seeking to mitigate and/or prevent impacts on development and also implement monitoring and early intervention measures.

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