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Laboratory analysis and outcomes of pregnant women with asymptomatic COVID-19 in the peripartum period

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Abstract

Objective: In this study, we aim to assess the relationship between laboratory results and pregnancy outcomes of the asymptomatic preripartum women who have been diagnosed incidentally by universal COVID-19 screening upon admission for delivery.

Methods: This is a case-control study conducted between January 2021 and March 2022. The study group consisted of the peripartum women with positive PCR result for SARS CoV-2 without the COVID-19 symptoms. Age and gestational age-matched peripartum women were included as the control group (1:3). The primary outcomes measures are inflammatory laboratory parameters (lymphocyte, neuthrophyl, eosinophyl, aspartate aminotransferase, alanin aminotransferase, lactate dehydrognase, neuthrophyl lymphocyte ratio, platelet lymphocte ratio, eosinophyl lymphocyte ratio, monocyte eosinophyl ratio) and their association with a positive PCR result for SARS CoV-2. Additional outcome measures were the associations between asymptomatic COVID-19 and pregnancy, maternal and neonatal outcomes.

Results: A total of 369 (95 in study, 274 in control group) women were analyzed. The ROC curve and multivariate logistic regression analysis have shown that increased monocyte-to-eosinophile ratio (MER, 914.7, aOR: 3.49 (95% CI 1.893-6.435)) and lactate dehydrogenase (LDH9214 U/L, aOR: 15.869 (95% CI 8.529-29.524)) levels; and decreased lymphocyte count (41.7 103/mm3, aOR:1.8 (95% CI1.27-3.437)) were associated with COVID-19 in asymptomatic peripartum woman. Asymptomatic COVID-19 was associated with an increase in late preterm delivery (p<0.001).

Conclusion: Asymptomatic COVID-19 do not cause an increase in maternal and neonatal mortality and major morbidity in peripartum women. Increased monocyte-to-eosinophile ratio (MER, 914.7) and LDH (9214) levels; and decreased lymphocyte count (41.7) are associated with COVID-19 in asymptomatic peripartum woman.

Keywords: Asymptomatic COVID-19, pregnancy, pregnancy outcomes, monocyte-eosinophil ratio, lymphocyte count

Introduction

Pregnant women face physiological alterations that may cause different reactions to infectious diseases like COVID-19. Studies and reviews have been designed to understand the effect of the hematological parameters and biomarkers to point the severity of the SARS-CoV-2 disease, on non-pregnant individuals.[1-5] The importance of screening COVID-19 in asymptomatic peripartum women has been addressed since the pandemic, and screening upon admission for delivery is now a dilemma; some studies advising universal screening, and some do not.[6, 7] Nine out of 10 COVID-19 positive pregnant women were found to be asymptomatic.[8] Identifying the asymptomatic positive population in delivery ward would offer a great opportunity to protect newborns and other pregnant women. Incidental COVID-19 diagnosis and relationship between laboratory findings and pregnancy outcomes are also worth investigating.

The purpose of this study is to assess if asymptomatic COVID-19 has any effect on pregnancy outcomes. In addition, we sought to determine which laboratory assays may be useful for predicting COVID-19 infection in asymptomatic pregnant women.

Methods

Settings and Study participants

Our research was designed as a case control study, and enrollment period took place between January 2021 and March 2022 in Zeynep Kamil Women and Children's

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Diseases Training and Research Hospital. Study sample is chosen from the women who gave birth and followed in this hospital after birth. The participants were at the age from 19 to 45, gestational age from 23 to 42, and having singleton pregnancy, and SARS CoV-2 PCR test without COVID-19 symptoms.

Deliveries before the week 22 of gestational age, stillbirth, pregnancy terminations and fetus with major anomalies, multiple pregnancies, the pregnant women who has not delivered yet, and the women having COVID-19 symptoms at the time of admission were excluded.

SARS CoV-2 PCR test implies Rdrp fragment targeted real time PCR. At the time of the enrollment period, without the indication for a test, all the pregnant women admitting to our delivery ward had the SARS CoV-2 PCR test for screening. Oropharyngeal and nasopharyngeal swab tests were the material for PCR test. Our laboratory was authorized by Turkish Health Ministry Public Health Division.

Sample size was calculated using OpenEpi (Version 3). For sample size calculation in our case-control study, Seyit et al.'s SARS CoV-2 test included laboratory parameters in positive and negative groups [lymphocyte (p = 0.0001), NLR (p = 0.0001) and PLR (p = 0.001)). values] were calculated based on the data of the articles in which they were evaluated.[9] Considering the relatively limited number of peripartum women with asymptomatic COVID-19 forming the case group, we thought it appropriate to include the case and control groups at a ratio of 1:3. To determine the difference between groups, we planned to include at least 53 participants in the case group and at least 159 participants in the control group, with 95% confidence level, 80% power, and 5% type 1 margin of error, plus 20% for missing data.

At the time of the enrollment period, routine SARS CoV-2 PCR tests were performed for every women in the delivery ward. Case group includes the patients who are admitted to delivery ward and whose PCR test is positive for SARS CoV-2 without the COVID-19 symptoms. Control group consisted of the patients with a negative SARS CoV-2 PCR test. Control group were chosen by systematic sampling method. When a participant was enrolled, three other women in the admission book were added as control group participants, from their admission numbers 3, 6, 9.

The patients' laboratory findings, pregnancy and neonatal outcomes were obtained from the electronic health records. Sociodemographic, medical and obstetric (preterm delivery, preeclampsia, gestational diabetes mellitus, cholestasis) history of the participants were also assessed. In addition to sociodemographics, personal health, and obstetric information, the laboratory findings at the time of admission were evaluated. The definitions of the adverse pregnancy outcomes (gestational diabetes, preeclampsia, fetal growth restriction, intrahepatic cholestasis of pregnancy, preterm birth) were based on international criteria.[10-14]

The study was approved by the Institutional Review Board (decision number 65, 03/2021). All procedures in our study were carried out per the 1964 Declaration of Helsinki and subsequent amendments.

The primary outcomes measures are inflammatory laboratory parameters (lymphocyte, neuthrophyl, eosinophyl, aspartate aminotransferase, alanin aminotransferase, lactate dehydrognase, neuthrophyl lymphocyte ratio, platelet lymphocte ratio, eosinophyl lymphocyte ratio, monocyte eosinophyl ratio). Incidental SARS CoV-2 test positive patients' laboratory findings and pregnancy, delivery, postpartum and neonatal outcomes were assessed.

Statistical analysis was done using the Statistical Package for Social Sciences version 17 for Windows (SPSS Inc., Chicago, IL, USA). The conformity of the variables to the normal distribution was examined by visual (probability charts and histograms) and analytical methods (Kolmogorov Smirnov test). Descriptive statistics were given as median, range. Categorical variables were reported as percentages and frequencies. In comparison of quantitative data in paired groups, in the presence of normal distribution Student T test, in asymmetrical distribution, Mann Whitney U test were used. Qualitative data were compared with Chi square test and when the conditions did not meet Fishers Exact Chi square tests were used.

Laboratory findings predicting SARS CoV-2 positivity were analyzed with reciever operating characteristic (ROC) curve analysis and threshold levels were calculated with Youden Index method. Specific thresholds, specificity, sensitivity, positive predictive value and negative predictive value were evaluated separately. To define factors predicting SARS CoV-2 positivity, multiple variable logistic regression analysis (backward stepwise method) was performed. Association is reported by odds ratio (OR) and 95% confidence interval. P<0.05 was used as statistical difference level.

Results

During the study period, there were 7322 deliveries in total; and among pregnant women who were admitted to labor ward without any symptoms or history of exposure, screened for COVID-19 per universal screening protocol, there were 325 positive PCR results (4.4%). Of those who had a positive test result, 100 (30.7%) were asympto-

matic, and included in the case group. PCR negative 300 women who were admitted to labor ward were randomly selected as controls. After excluding 17 multiple pregnancies, 4 fetuses with major congenital abnormalities and 7 intrauterine fetal demise cases, a total of 369 women were analyzed (Figure 1).

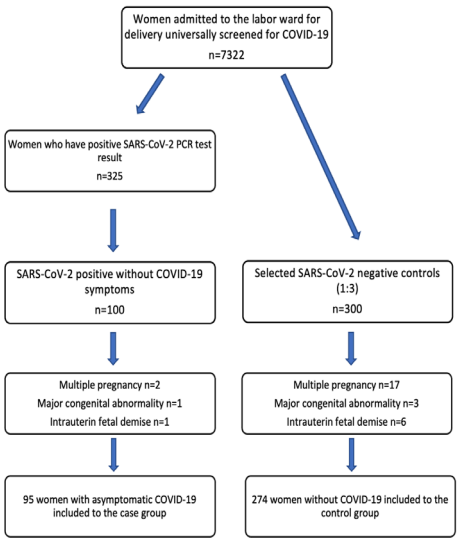

Fig 1. Flow diagram

Demographic and clinical characteristics of the groups are shown in Table 1. Baseline characteristics were similar between asymptomatic COVID-19 cases and controls, there were no statistically significant difference between groups in age, parity, ethnicity and presence of a chronic disease. Mean body mass index (BMI) in the case group was significantly higher (34.5 vs. 29.1, p 0.05). Vaccination rates were similar between the groups, only 28.4% of COVID-19 cases were fully vaccinated.

The pregnancy, maternal and neonatal outcomes of the groups are shown in Table 2. Frequency of adverse obstetric outcomes such as preeclampsia, gestational hypertension, fetal growth retardation (FGR), gestational diabetes mellitus (GDM), preterm birth, placental abruption and chorioamnionitis were similar between asymptomatic COVID-19 patients and controls. Delivery in late term gestation was observed significantly more in COVID-19 group compared to the control group (15.8% vs. 1.1%, p 0.001). There was no difference between groups in terms of mode of delivery. Length of hospital stay was significantly higher in COVID-19 group than the control group (2.3 days vs. 1.9 days, p 0.001).

Table 1. Sociodemographic and clinical charactheristics of peripartum women with and without asymptomatic COVID 19

	COVID-19 positive (n=95)	COVID-19 negative (n=274)	p value
Age (year)	28.85.2	29.25.6	.533
Gravidity	2 (1-9)	2 (1-8)	.785
Parity	1 (0-5)	1 (0-7)	.969
Body mass index (kg/m²)	34.57.7	29.15.9	.019
Ethnicity			
Turkish	90 (94.7)	245 (89.4)	.122
Syrian	5 (5.3)	29 (10.6)	
Maternal comorbidities			
Chronic hypertension	4 (4.2)	5 (1.8)	.244
Pulmonary disease	0 (0)	3 (1.1)	.572
Pregestational diabetes mellitus	0 (0)	8 (2.9)	.119
Gestational diabetes mellitus	10 (10.5)	21 (7.7)	.386
COVID-19 vaccination status			
Two or more doses	27 (28.4)	59 (21.5)	.267
One dose	10 (10.5)	23 (8.4)	
Not vaccinated	58 (61.1)	192 (70.1)	

Data are presented as meanstandard deviation, median (min-max), or number (percentage).

Table 2. Comparison of pregnancy, maternal and neonatal outcomes between women with and without asymptomatic COVID-19

	COVID-19 positive (n=95)	COVID-19 negative (n=274)	p value
Adverse pregnancy outcomes			
Preeclampsia	2 (2.1)	20 (7.3)	.065
Gestational hypertension	3 (3.2)	2 (0.7)	.110
Fetal growth restriction	4 (4.2)	18 (6.6)	.403
Placental abruption	1 (1.1)	1 (0.4)	.449
Preterm delivery	13 (3.7)	54 (19.7)	.218
Postpartum hemorrhage	2 (2.1)	2 (0.7)	.274
Surgical site infection (episiotomy or cesarean incision)	1 (1.1)	2 (0.7)	.1

Gestational age at delivery (week)	38.42.7	37.63.2	.03
Delivery in late term gestation	15 (15.8)	3 (1.1)	0.001
Mode of delivery			
Spontaneous vaginal	51 (53.7)	131 (47.8)	.324
Primary cesarean	19 (20)	43 (15.7)	.333
Repeat cesarean	25 (26.3)	100 (36.5)	.161
Maternal outcomes			
Venous thromboembolism	2 (2.1)	0 (0)	.066
Intensive care unit admission	3 (3.2)	20 (7.3)	.150
Oxygen supplementation	1 (1.1)	0 (0)	.257
Mechanical ventilation	1 (1.1)	0 (0)	.257
Neonatal outcomes			
Birthweight (gram)	3202632	3041690	.127
Neonatal intensive care unit admission	23 (24.2)	73 (26.6)	.642
Respiratory distress syndrome	9 (9.5)	39 (14.2)	.235
Neonatal sepsis	4 (4.2)	6 (2.2)	.296
Length of stay (day)	2.31.1	1.90.9	.001

Data are presented as meanstandard deviation, or number (percentage).

Worsening of COVID-19 clinical picture was rare, with only one patient requiring supplemental oxygen and eventually mechanical ventilation. However, a total of 23 patients were admitted to the intensive care unit (ICU) after delivery, 18 of whom had preeclampsia. Need for ICU was not significantly different between the groups.

We analyzed and compared complete blood count (CBC) parameters and biomarkers of inflammation derived from CBC such as neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ration (PLR), eosinophil-to-lymphocyte ratio (ELR) and monocyte-to-eosinophil ratio (MER), as well as alanine transaminase (ALT), aspartate transaminase (AST) and lactate dehydrogenase (LDH) levels (Table 3). PLR, MER, AST and LDH were significantly increased in patients with COVID-19 (p=0.003, p 0.001, p=0.002 and p 0.001, respectively). In contrast, leukocyte, neutrophil, eosinophil and lymphocyte count was significantly lower (p 0.001, p=0.005, p 0.001 and p 0.001 respectively). The ROC curve analysis and optimal cut-off values of these parameters for prediction of positive PCR results are shown in Figure 2 and Table 4. Variables included in multivariate analysis were age, body mass index and gestational age at the time of delivery and laboratory parameters that were found to be significantly different between groups in univariate analysis (eosinophil, lymphocyte, PLR, MER, AST and LDH). Multivariate logistic regression analysis showed that MER, LDH and lymphocyte count were significantly associated with positive SARS CoV-2 PCR result (Table 5).

Table 3. Laboratory charactheristics of women with and without COVID-19

	COVID-19 positive (n=95)	COVID-19 negative (n=274)	p value
Hemoglobin (g/dL)	11.61.5	11.61.5	.684
Platelet (10^3/mm^3)	22679	23467	.084
Leukocyte (10^3/mm^3)	10.33.7	11.53.3	0.001
Neutrophil (10^3/mm^3)	7.93.5	8.83	.005
Lymphocyte (10^3/mm^3)	1.70.7	2.00.6	0.001
Monocyte (10^3/mm^3)	0.50.2	0.60.2	.156
Eosinophil (10^3/mm^3)	0.060.07	0.080.07	0.001
Basophil (10^3/mm^3)	0.0210.015	0.0230.012	.058
NLR	5.743.91	4.792.57	.204
PLR	159.0184.69	124.3544.07	0.001
ELR	0.0630.114	0.040.032	.245
MER	20.35817.669	12.61712.987	0.001
ALT (U/L)	13.421	1213.9	.602
AST (U/L)	22.926.4	17.610.3	.002
LDH (U/L)	262.551.7	199.843.4	0.001
CRP (mg/L)[a]	53.943.2		
D-Dimer (≤g/mL)[b]	2.52.3		
Procalcitonine (ng/mL)[c]	0.1050.107		

Abbreviations: NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; ELR, eosinophil-to-lymphocyte ratio; MER, monocyte-to-eosinophil ratio; ALT, alanine transaminase; AST, aspartate transaminase; LDH, lactate dehydrogenase; CRP, C- reactive protein. Data are presented as meanstandard deviation.
[a] Cut-off value of the lab is 0-5 mg/L.
[b] Cut-off value of the lab is 0.5 ≤g/mL.
[c] Cut-off value of the lab is 0.5 ng/mL.

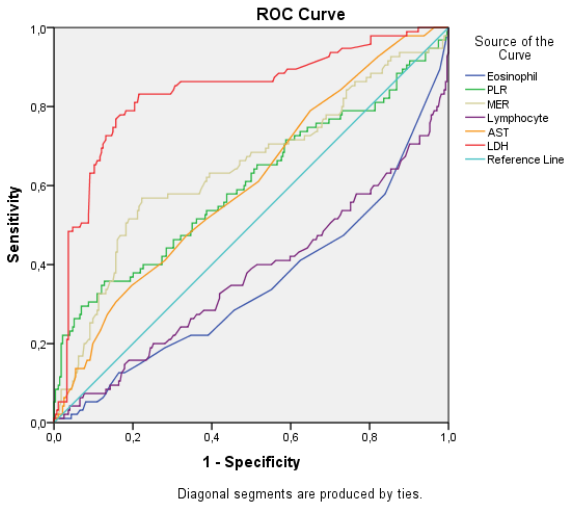

Fig 2. The ROC curve of eosinophil, platelet-to-lymphocyte ratio (PLR), monocyte-to-eosinophil ratio (MER), lymphocyte, aspartate transaminase (AST) and lactate dehydrogenase (LDH), for prediction of positive PCR result for SARS-CoV-2

Table 5. Multivariate logistic regression analysis for prediction of positive PCR result for SARS-CoV-2

	SARS-CoV-2 PCR positive aOR* (95% CI)	p value
MER ≥14.7	3.49 (1.893-6.435)	<0.001
LDH ≥214	15.869 (8.529-29.524)	<0.001
Lymphocyte ≤1.7	1.879 (1.27-3.437)	0.041

Abbreviations: aOR, adjusted odds ratio; MER, monocyte-to-eosinophil ratio; LDH, lactate dehydrogenase.

* Adjusted for maternal age, body mass index and gestational age at the time of birth

Table 4. ROC analysis of laboratory charactheristics in women with COVID-19

	AUC (95% CI)	Cut-off	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	p value
Eosinophil	0.651(0.583-.719)	≤0.05	66.32	55.11	33.87	82.51	<0.001
PLR	0. 602 (0.530-0.647)	≥124.24	57.89	79.38	31.43	79.38	0.027
MER	0. 643 (0.574-0.713)	≥14.7	56.84	77.74	46.96	83.86	<0.001
Lymphocyte	0. 627 (0.556-0.697)	≤1.7	58.95	59.85	33.73	80.79	<0.001
AST	0.605 (0.540–0.671)	≥17	51.58	61.31	31.61	78.50	0.028
LDH	0.835 (0.783–0.886)	≥214	81.05	79.56	57.89	92.37	<0.001

Abbreviations: AUC, area under the curve; PPV, positive predictive value; NPV, negative predictive value; PLR, platelet-to-lymphocyte ratio; MER, monocyte-to-eosinophil ratio; AST, aspartate transaminase; LDH, lactate dehydrogenase

C- reactive protein (CRP), D-Dimer and procalcitonine levels were only ordered for COVID-19 patients, therefore mean values of these parameters are not reported for the control group (Table 3). When these parameters are dichotomized as high or low according to standardized cut-off values of our lab, CRP and procalcitonine were high in the majority of asymptomatic COVID-19 patients (CRP in 97.9% and procalcitonine in 67.4%).

Discussion

Since the pandemic, obstetric and neonatal outcomes of asymptomatic COVID-19 cases remain unclarified. Our study shows that maternal and neonatal mortality, and major morbidity was not increased in women with COVID-19 who are asymptomatic. Also, MER, lymphocyte count, and LDH levels- which are simple, readily available blood assays– have a role in predicting asymptomatic COVID-19.

One aim of our study was to predict COVID-19 in asymptomatic women in admitted to labor ward in a cost-effective and timely manner, since women in labor might present themselves late in labor, thus the need for quick results upon admission. Even when COVID-19 is asymptomatic, the high infectivity to pregnant and postpartum women, as well as the high morbidity in this population relative to the general population, should not be overlooked.[15] When there is no opportunity to perform PCR testing on asymptomatic COVID-19 cases or there is insufficient time to obtain PCR results, these lab tests can be obtained promptly, affordably, and without difficulty. We found that some basic lab parameters can predict COVID-19, albeit weakly.

Some peripheral blood inflammation biomarkers is the kind of information that can be obtained from the most basic laboratory test result, CBC. At the same time CRP and LDH can also be helpful for defining COVID-19 positive patients and predicting their clinical phenoty-

pe. In our study MER and LDH were found to be useful for predicting COVID-19 PCR positive patients. Seyit et al., investigated the similar hypothesis in emergency department among non-pregnant adults and found that, CRP, LDH, PLR and NLR levels were higher in COVID-19 patients.[9] Covali et al., stated that components of the CBC did not differ in the term pregnancies with COVID-19 other than the increase in the MCHC and decrease in WBC, neuthrophyl and lymphocyte count.[16] A systematic review and meta-analysis published in 2021, revealed that the most common laboratory findings were elevated CRP and lymphocytopenia (57% and 50% in COVID-19 cases, respectively).[17] Shang et al. pointed out that NLR was the best determinant of all biomarkers to predict the severity of the disease.[18]

We compared pregnancy and neonatal outcomes between women with or without COVID-19. Mainly, outcomes did not differ between groups as discussed in the previous work.[19-23] Son et al. analyzed the results of 838,489 women giving birth during pre-COVID and COVID-19 period; and pregnancy related adverse outcomes were found to be similar in two groups, there were no significant differences in the frequency of preterm birth, stillbirth, pregnancy related hypertensive disorders, placental abruption and postpartum hemorrhage.[24] One meta-analysis has shown that preterm birth rates are higher in COVID-19 population.[17] In a similar manner to our study, Koç et al. investigated hematological parameters and perinatal outcomes of COVID-19 and they also revealed that asymptomatic COVID-19 was not associated with adverse perinatal outcomes.[25] Hill et al. also pointed out that asymptomatic patients screened positive at the time of delivery, were not at risk of adverse maternal and neonatal outcomes.[26] These studies reflect heterogenous groups of pregnant women with COVID-19, in terms of being symptomatic or asymptomatic; yet our findings were consistent with the existing literature. However, even though our results do not show any increase in maternal mortality and major morbidity, two cases of venous thromboembolism and one case that needed mechanical ventilation- both of whom were aymptomatic upon admission is remarkable.

Even though vaccination had widespread availability during our study period, 61% of COVID-19 positive patients and 70% of negative ones were not vaccinated. This may be attributable to pregnant women's reluctancy to try new drugs and/or vaccines. Mediu et al. addressed NLR changes based on vaccination status but did not find any difference between groups.[27]

Remarkably, we discovered a statistically significant difference between groups for late-term delivery. According to institutional protocol, fetal surveillance is conducted twice per week in late-term pregnancies. We hypothesized that these women are more vulnerable to the risk of being COVID-19 positive due to their increased exposure to hospital environment.

Our research has strengths. There are insufficient high-quality and consistent studies evaluating the effect of asymptomatic COVID-19 disease on maternal and neonatal outcomes during the peripartum period, which was the purpose of our study. Data from hospitals where all pregnant women admitted to labor ward had routine PCR testing revealed that 88% of those who tested positive were asymptomatic.[28] This implies that the cases documented in the literature are most likely a small proportion of total cases, and results extracted from those should be interpreted carefully keeping in mind that clinical significance of asymptomatic infection during pregnancy is still unclear. In addition, there is insufficient research on laboratory parameters and disease estimation in asymptomatic COVID-19 cases. Our study is one of the first to evaluate the maternal and neonatal outcomes and laboratory parameters of peripartum women whose SARS-CoV-2 infection was confirmed by PCR test positivity during the COVID-19 outbreak. The findings of this study allow for the identification and possible early isolation of women suspected of having peripartum asymptomatic COVID-19, for whom we no longer routinely screen, and who will be referred for PCR testing to diagnose the disease.

There are also limitations of our study. Due to the retrospective nature of our study, the data are based on electronic health records. The fact that our research was conducted in a limited time period and in a single center brings a further limitation on the generalizability of our results to the population. Since our study was carried out in a tertiary center in the region where high-risk pregnant women (women with diabetes, hypertension etc.) are referred, the confounding factors that may result from additional morbidities should be kept in mind. Since the diagnostic value of the PCR test was approximately 50% in our study, we may not have been able to correctly distinguish those with a negative test even though they were sick.

Due to the fact that we no longer conduct routine SARS CoV-2 PCR testing upon admission to the labor ward, evaluating routine labs ordered may provide insight into the possibility of COVID-19 infection. Increased monocyte-to-eosinophile ratio (MER, ≥14.7) and LDH(≥214) level; and decreased lymphocyte count (≤1.7) was associated with COVID-19 in asymptomatic peripartum woman. This type of information might aid

in preventing the disease's spread in the vulnerable population of peripartum women by giving us the chance of early isolation.

Although we found that asymptomatic cases of COVID-19 did not cause an increase in maternal and neonatal mortality and major morbidity in peripartum asymptomatic women, we believe that a possible type 2 error should not be disregarded and that this issue should be revisited with larger samples and prospective studies.

Conclusion

Asymptomatic COVID-19 do not cause an increase in maternal and neonatal mortality and major morbidity in peripartum women. Increased monocyte-to-eosinophile ratio (MER, ≥14.7) and LDH (≥214 U/L) levels; and decreased lymphocyte count (≤1.7 103/mm3) are associated with COVID-19 in asymptomatic peripartum woman.

References

1. Palladino, M., Complete blood count alterations in COVID-19 patients: A narrative review. Biochem Med (Zagreb), 2021. 31(3): p. 030501.[PubMed][CrossRef]
2. Dadkhah, M., et al., Hematological Parameters as Diagnostic Factors: Correlation with Severity of COVID-19. Acta Biomed, 2022. 93(2): p. e2022061.
3. Kumar, A., et al., Role of Hematological and Immunological Parameters in COVID-19 Patients. J Pharm Bioallied Sci, 2021. 13(2): p. 238-243. [PubMed][CrossRef]
4. Blomme, S., et al., The influence of COVID-19 on routine hematological parameters of hospitalized patients. Acta Clin Belg, 2022. 77(2): p. 241-246.[PubMed][CrossRef]
5. Mermutluoğlu, Ç., et al., Evaluation of inflammatory and hematological parameters in patients diagnosed with COVID-19. J Infect Dev Ctries, 2022. 16(10): p. 1564-1569. [PubMed][CrossRef]
6. Jenabi, E., et al., Pregnancy outcomes among symptomatic and asymptomatic women infected with COVID-19 in the west of Iran: a case-control study. J Matern Fetal Neonatal Med, 2022. 35(24): p. 4695-4697. [PubMed][CrossRef]
7. Hashim, N.A.F., et al., Universal Testing Policy for COVID-19 in Pregnancy: A Systematic Review.Front Public Health, 2022. 10: p. 588269. [PubMed][CrossRef]
8. Sutton, D., et al., Universal Screening for SARS-CoV-2 in Women Admitted for Delivery. N Engl J Med, 2020. 382(22): p. 2163-2164. [PubMed][CrossRef]
9. Seyit, M., et al., Neutrophil to lymphocyte ratio, lymphocyte to monocyte ratio and platelet to lymphocyte ratio to predict the severity of COVID-19. Am J Emerg Med, 2021. 40: p. 110-114. [PubMed][CrossRef]
10. Carpenter, M.W. and D.R. Coustan, Criteria for screening tests for gestational diabetes. Am J Obstet Gynecol, 1982. 144(7): p. 768-73. [PubMed][CrossRef]
11. Hypertension in pregnancy. Report of the American College of Obstetricians and Gynecologists' Task Force on Hypertension in Pregnancy. Obstet Gynecol, 2013. 122(5): p. 1122-1131.
12. Hadlock, F.P., et al., Estimation of fetal weight with the use of head, body, and femur measurements--a prospective study. Am J Obstet Gynecol, 1985. 151(3): p. 333-7. [PubMed][CrossRef]
13. Girling, J., C.L. Knight, and L. Chappell, Intrahepatic cholestasis of pregnancy: Green-top Guideline No. 43 June 2022. Bjog, 2022. 129(13): p. e95-e114. [PubMed][CrossRef]
14. Villar, J., et al., International standards for newborn weight, length, and head circumference by gestational age and sex: the Newborn Cross-Sectional Study of the INTERGROWTH-21st Project.Lancet, 2014. 384(9946): p. 857-68. [PubMed][CrossRef]
15. Villar, J., et al., Maternal and Neonatal Morbidity and Mortality Among Pregnant Women With and Without COVID-19 Infection: The INTERCOVID Multinational Cohort Study. JAMA Pediatrics, 2021. 175(8): p. 817-826.
16. Covali, R., et al., Complete Blood Count Peculiarities in Pregnant SARS-CoV-2-Infected Patients at Term: A Cohort Study. Diagnostics (Basel), 2021. 12(1). [PubMed][CrossRef]
17. Matar, R., et al., Clinical Presentation and Outcomes of Pregnant Women With Coronavirus Disease 2019: A Systematic Review and Meta-analysis. Clin Infect Dis, 2021. 72(3): p. 521-533. [PubMed][CrossRef]
18. Shang, W., et al., The value of clinical parameters in predicting the severity of COVID-19. J Med Virol, 2020. 92(10): p. 2188-2192. [PubMed][CrossRef]
19. Khalil, A., et al., Change in the Incidence of Stillbirth and Preterm Delivery During the COVID-19 Pandemic. Jama, 2020. 324(7): p. 705-6. [PubMed][CrossRef]
20. Hedermann, G., et al., Danish premature birth rates during the COVID-19 lockdown. Arch Dis Child Fetal Neonatal Ed, 2021. 106(1): p. 93-95. [PubMed][CrossRef]
21. Handley, S.C., et al., Changes in Preterm Birth Phenotypes and Stillbirth at 2 Philadelphia Hospitals During the SARS-CoV-2 Pandemic, March-June 2020. Jama, 2021. 325(1): p. 87-89. [PubMed][CrossRef]
22. Matheson, A., et al., Prematurity Rates During the Coronavirus Disease 2019 (COVID-19) Pandemic Lockdown in Melbourne, Australia. Obstet Gynecol, 2021. 137(3): p. 405-407. [PubMed][CrossRef]
23. Wood, R., et al., Preterm Birth During the Coronavirus Disease 2019 (COVID-19) Pandemic in a Large Hospital System in the United States. Obstet Gynecol, 2021. 137(3): p. 403-404. [PubMed][CrossRef]
24. Son, M., et al., Coronavirus Disease 2019 (COVID-19) Pandemic and Pregnancy Outcomes in a U.S. Population. Obstet Gynecol, 2021. 138(4): p. 542-551. [PubMed][CrossRef]
25. Erol Koç, E.M., et al., Comparison of hematological

parameters and perinatal outcomes between COVID-19 pregnancies and healthy pregnancy cohort. J Perinat Med, 2021. 49(2): p. 141-147. [PubMed][CrossRef]

26. Hill, J., et al., Obstetrical outcomes and follow-up for patients with asymptomatic COVID-19 at delivery: a multicenter prospective cohort study. Am J Obstet Gynecol MFM, 2021. 3(6): p. 100454. [PubMed][CrossRef]

27. Mediu, R., A. Rama, and E. Puca, Evaluation of neutrophil-to-lymphocyte ratio and immune response in patients vaccinated with Pfizer-Biontech vaccine. J Infect Dev Ctries, 2022. 16(5): p. 745-751.[PubMed][CrossRef]

28. Khalil, A., et al., Severe acute respiratory syndrome coronavirus 2 in pregnancy: symptomatic pregnant women are only the tip of the iceberg. Am J Obstet Gynecol, 2020. 223(2): p. 296-297. [PubMed][CrossRef]