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Original Article

Amniotic Fluid Disorders in Pregnant Women With COVID-19 in Ardabil (Iran): A Descriptive Cross-Sectional Study (2020-2022)

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Abstract

Background and aims: Pregnant women faced heightened vulnerability during the coronavirus disease 2019 (COVID-19) pandemic, with evidence suggesting increased risks of adverse outcomes. However, the impact of COVID-19 on amniotic fluid disorders remains understudied. During the COVID-19 pandemic, oligohydramnios was more prevalent among pregnant women, and evidence indicates that COVID-19 increases the likelihood of adverse pregnancy outcomes. This study investigated the prevalence and characteristics of amniotic fluid disorders (oligohydramnios and polyhydramnios) among pregnant women with COVID-19 in Ardabil, Iran (2020–2022).

Methods: A descriptive cross-sectional study was conducted on 207 COVID-19-positive pregnant women admitted to Alavi Hospital. Data included demographics, clinical symptoms, disease severity (mild/moderate/severe), lung involvement, hospitalization, intensive care requirements, amniotic fluid disorders, and pregnancy outcomes (miscarriage, preterm delivery, cesarean section). Statistical analysis was performed using SPSS version 21, with $P<0.05$ considered statistically significant.

Results: The mean maternal age was 28.3 ± 6.5 years, with COVID-19 infections occurring during the first (3.9%), second (47.3%), and third trimesters (48.8%). Disease severity was mild (48.3%), moderate (40.6%), or severe (11.1%), with 3.4% of patients requiring intensive care unit (ICU) admission. Oligohydramnios was observed in 9.2% of cases, and it was significantly associated with third-trimester infection ($P=0.007$), shortness of breath ($P=0.004$), lung involvement ($P=0.027$), severe disease ($P<0.001$), ICU admission ($P<0.001$), cesarean section ($P=0.021$), and preterm birth ($P<0.001$). No significant correlations were found with maternal age, Body Mass Index (BMI), or underlying conditions ($P>0.05$).

Conclusion: This study observed that COVID-19-associated oligohydramnios affected nearly one in 10 pregnancies, with a higher prevalence in severe cases, third-trimester infections, and women exhibiting respiratory complications. Cesarean delivery and preterm birth rates were significantly elevated in these patients, underscoring the need for targeted monitoring in high-risk pregnancies.

Keywords: COVID-19, Pregnancy, Oligohydramnios, Preterm birth, Cesarean section, Maternal health

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Introduction

During the coronavirus disease 2019 (COVID-19) pandemic, pregnant women were recognized as one of the most vulnerable groups to this disease. Evidence suggests that COVID-19 increases the likelihood of adverse pregnancy outcomes; however, many of the effects of the disease during pregnancy are not yet well understood (1). The first cases of COVID-19 were reported in December 2019 in Wuhan, China, and then spread rapidly across the world. Finally, the World Health Organization (WHO) declared this disease a global pandemic on March 11, 2020 (2).

Oligohydramnios is a pregnancy condition characterized by abnormally low amniotic fluid volume, typically diagnosed when the amniotic fluid index (AFI) measures less than 5 cm or the single deepest pocket is under 2 cm on ultrasound. This condition can result from fetal abnormalities (such as renal dysplasia), placental

insufficiency, ruptured membranes, known as preterm premature rupture of membranes (PPROM), or post-term pregnancy. Clinically, it may present as reduced fetal movements, a smaller-than-expected uterine size, or visible fetal compression on imaging. Management includes close fetal monitoring (e.g., non-stress test, serial ultrasounds), amnioinfusion in select cases, and timely delivery if fetal compromise is suspected. Early diagnosis and intervention are crucial to prevent complications such as pulmonary hypoplasia or umbilical cord compression (3-4).

Due to physiological changes in the immune and cardiopulmonary systems during pregnancy, pregnant women may be prone to developing severe symptoms caused by the coronavirus infection. Some studies show that pregnant women exhibit a similar distribution of mild, moderate, and severe cases of COVID-19 as the general population. However, other studies have reported that the disease is more severe in pregnant women, with higher hospitalization rates in wards, greater need for specialized care, and increased use of medical devices and respiratory support compared to the normal and non-pregnant population (5-6). There is also evidence that pregnant women with COVID-19, especially during the second half of pregnancy, are at greater risk of complications and organ failures related to the disease (5).

In addition, recent studies have shown that COVID-19 can have maternal and fetal effects. For example, a syndrome similar to preeclampsia has been described in women with COVID-19, and transmission of the virus through the placenta, as well as its possible effects on the fetus in utero, have been observed (6). The presence of the virus in amniotic fluid and breast milk has also been reported (7). Moreover, results from a systematic review have demonstrated that pregnant women are at a higher risk of contracting COVID-19 compared to non-pregnant women (7).

In Spain, Mendoza et al examined the clinical, ultrasound, and laboratory findings related to preeclampsia in 42 pregnant women infected with COVID-19, who were classified into severe (8 cases) and non-severe (34 cases) groups. Five women (11.9%) showed signs and symptoms of preeclampsia, all of whom had the severe form of COVID-19. Abnormal levels of soluble Flt-1/PlGF and UtAPI were observed in only one patient. The result of this study indicated that a condition similar to preeclampsia may occur in pregnant women with severe COVID-19 (6).

COVID-19 infection poses a significantly greater risk to pregnancy, especially due to the cardiovascular, pulmonary, hormonal, and immunological changes that occur during pregnancy (8). These changes raise the susceptibility to infections that can lead to complicated conditions such as acute respiratory distress syndrome (ARDS), sepsis, and kidney damage (9). Patients with these conditions often display elevated expression of certain cytokines such as interleukin (IL-6) and tumor necrosis factor-alpha (TNF-α), along with reduced lymphocyte counts, which contribute to disease severity (10).

In a French study by Hcini et al, maternal and neonatal outcomes were examined in 507 pregnant women, of whom 137 tested positive for COVID-19. Among the COVID-19-positive individuals, 24.8% had symptoms at the time of diagnosis, and 15% developed symptoms afterward. The study found that the risks of postpartum hemorrhage exceeding 500 mL, the need for blood transfusion, and hospitalization in the intensive care unit (ICU) were higher in pregnant women with COVID-19 compared to those without infection. Furthermore, the risk of fetal intrauterine death (OR = 4.7) was significantly higher in the infected group (11).

In the female reproductive system, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection has been associated with various fetal complications, including an increased likelihood of stillbirth, preterm delivery, and intrauterine growth restriction (12). A review study reported a 23% prevalence of preterm births among pregnant women with COVID-19 (13). To date, evidence supporting the vertical transmission of the coronavirus from mother to fetus remains limited and warrants further investigation. Infants born to infected mothers may exhibit higher levels of immunoglobulin M (IgM) and immunoglobulin G (IgG), suggesting that mother-to-fetus transmission cannot be excluded (14).

Matar et al conducted a prospective observational study in Singapore involving 16 pregnant women diagnosed with COVID-19. Of these, 37.5% contracted the virus during the first trimester, 43.8% during the second trimester, and 18.7% during the third trimester. Two patients (12.5%) over the age of 35 developed severe pneumonia, while one patient with a body mass index (BMI) of 32.9 needed specialized care. Of the seven pregnancies that ended during the study period, five resulted in live births, while two ended in spontaneous abortion between 11 and 23 weeks of gestation (15).

In an observational study from Spain, Molina et al investigated the characteristics and outcomes of 20 pregnant women with COVID-19. The most common symptoms were fever (70%), cough (65%), and myalgia (35%). Eight women completed their pregnancies during the study period, of whom 25% delivered naturally, 12.5% by vaginal delivery, and 62.5% by cesarean section (16).

Despite the existence of the above studies, the nature of the relationship between COVID-19 and pregnancy outcomes, as well as its adverse effects on the mother and fetus, is unclear. The present study was conducted to determine the frequency of amniotic fluid disorders in pregnant mothers with COVID-19.

Materials and Methods

This cross-sectional descriptive study was conducted on 209 pregnant women diagnosed with COVID-19 who were hospitalized at Alavi Hospital in Ardabil, Iran, between

March 20, 2020, and September 22, 2022. All studied women had a confirmed diagnosis of COVID-19 through at least one of the following methods: polymerase chain reaction (PCR) testing, clinical symptoms, or computed tomography (CT) scan findings. The required data were collected using a checklist, including demographic characteristics, COVID-19-related clinical information, presence or absence of amniotic fluid disorders, and pregnancy outcomes. Diagnosis of amniotic fluid disorders in pregnant women with COVID-19 was checked by ultrasound examination.

Pregnant women without a history of COVID-19 or vaccination, but with a confirmed diagnosis of COVID-19, were included in this study. Women with pregnancy complications such as PPROM, vaginal discharge, diabetes, hypertension, multiple pregnancy, or fetal abnormalities were excluded from the study.

To diagnose oligohydramnios (low amniotic fluid), AFI or the maximum vertical pocket (MVP) was used. If the AFI value is less than 5 cm or the MVP is less than 2 cm, the condition is diagnosed as oligohydramnios. Statistical analyses were performed using statistical tests such as chi-square and Fisher tests in the Statistical Package for the Social Sciences (SPSS), version 21. The significance level less than 0.05 was considered significant.

Results

A total of 207 pregnant women were included in the study. Among them, 19 women (9.2%) had amniotic fluid disorders. Most affected cases (15 women; 79%) were in the 20-39- year age group and had a normal BMI, and about 84.2% these women had no underlying diseases. The incidence of oligohydramnios was not significantly related to maternal age, BMI, or underlying disease. Among all women, 19 women (9.2%) had amniotic fluid disorders, while 188 patients did not (Table 1).

Among pregnant women with amniotic fluid, 16 women (84.2%) were infected with COVID-19 during the third trimester. The history of pregnancy and childbirth ranged between one and two in 11 women (57.9%) and 13 women (68.4%), respectively. Oligohydramnios showed a significant relationship with the trimester of COVID-19 infection, disease severity, hospitalization ward, type of delivery, and gestational age. However, it was not associated with a history of pregnancy and delivery (Table 2).

Oligohydramnios was also significantly associated with shortness of breath and pulmonary involvement among the studied pregnant women (Table 3).

Table 1. Frequency of Amniotic Fluid Disorders by Age, BMI, and Mother's Underlying Diseases

Variables		Amniotic Fluid Disorders				*P* value
		+		-		
		n	%	n	%	
Mother Age (years)	15-19	2	10.5	18	9.6	0.36
	20-29	7	36.8	92	48.9	
	30-39	8	42.1	71	37.8	
	40-45	2	10.5	7	3.7	
BMI	Normal	9	47.4	92	49	0.86
	Overweight	5	26.3	57	30.3	
	Obese	5	26.3	39	20.7	
Mother Underlying Disease	-	16	84.2	178	94.7	0.104
	+	3	15.8	10	5.3	

Note. BMI: Body mass index.

Discussion

Principal Findings

This study demonstrates that COVID-19 infection can significantly affect various health conditions in pregnant patients. The findings revealed a significant relationship between oligohydramnios and the trimester of infection with COVID-19, shortness of breath, pulmonary involvement, disease severity, hospital ward admission, cesarean section delivery, and preterm birth. They also highlight that special attention should be paid to these patients.

Results in the Context of Existing Literature

The present study showed that 9.2% of pregnant women with COVID-19 had amniotic fluid disorder, all of which were cases of oligohydramnios. It is noteworthy that few studies have specifically addressed the relationship between amniotic fluid volume and SARS-CoV-2 infection. For example, the prevalence of oligohydramnios among pregnant women with COVID-19 was 4.4% in the study by Singh et al (17) in India, 4.5% in the study by Alibakhshi et al (18) in Ahvaz, and 7.4% in the study by Gomez et al (19), all of which are lower than the findings of our study. This difference could be due to the fact that the patients in those studies were mostly outpatients with mild disease, while the present study included inpatients with more severe diseases.

In contrast, a study by Soto-Torres et al (20) found no significant difference in the AFI between women infected with SARS-CoV-2 and those in the non-infected control group, which is not consistent with our findings. This discrepancy may be due to the fact that most participants in their study were asymptomatic or only mildly symptomatic.

Additionally, in the studies conducted by Jamal et al (21) and Khoiwal et al (22) in India, the prevalence of oligohydramnios was reported to be 25.4% and 33.3%, respectively, which are higher than those observed in our study. These discrepancies may also be attributed to differences in the severity of COVID-19 among the examined patients.

In studies conducted before the emergence of the COVID-19 pandemic, the prevalence of oligohydramnios among pregnant women was reported to range between 0.5% and 4% and 1% and 5% (23-25). Comparing the results obtained in the present study with these statistics shows an increase in the prevalence of oligohydramnios

Table 2. Frequency of Amniotic Fluid Disorders by COVID-19 Information, Pregnancy Outcome, and Hospitalization Section

Variables		Amniotic Fluid Disorders				*P* value
		+		-		
		n	%	n	%	
Trimester of Infection	First Trimester	0	0	8	4.26	0.007
	Second Trimester	3	15.79	95	50.53	
	Third Trimester	16	84.21	85	45.21	
Pregnancy History	0	4	21.05	51	27.13	0.554
	1-2	11	57.89	100	53.19	
	3-4	3	15.79	34	18.09	
	>=5	1	5.26	3	1.6	
Parity	0	4	21.05	61	32.45	0.29
	1-2	13	68.42	111	59.04	
	3-4	1	5.26	14	7.45	
	>=5	1	5.26	2	1.06	
Disease Severity	Mild	1	5.26	99	52.66	0.001
	Moderate	6	31.58	78	41.49	
	High	12	63.16	11	5.85	
Hospitalized Section	General	12	63.16	188	100	0.001
	ICU	7	36.84	0	0	
Type of Delivery	Cesarean Section	17	89.47	128	68.09	0.021
	Vaginal delivery	1	5.26	59	31.38	
Gestational Age	Term	9	47.37	166	88.3	0.001
	Preterm	9	47.37	21	11.17	

Note. ICU: Intensive care unit.

Table 3. Frequency of Amniotic Fluid Disorders by Clinical Features, COVID-19 Severity, and Pulmonary Involvement

Variables		Amniotic Fluid Disorders				*P* value
		+		-		
		n	%	n	%	
Shortness of Breath	-	1	5.26	72	38.3	0.004
	+	18	94.74	116	61.7	
Cough	-	5	26.32	71	37.77	0.324
	+	14	73.68	117	62.23	
Fever	-	10	52.63	121	64.36	0.314
	+	9	47.37	67	35.64	
Shake	-	10	52.63	123	65.43	0.27
	+	9	47.37	65	34.57	
Myalgia	-	17	89.47	133	70.74	0.08
	+	2	10.53	55	29.26	
Weakness and Lethargy	-	15	78.95	141	75	0.7
	+	4	21.05	47	25	
Sore Throat	-	17	89.47	156	82.98	0.47
	+	2	10.53	32	17.02	
Headache	-	19	100	170	90.43	0.38
	+	0	0	18	9.57	
Vomiting	-	19	100	183	97.34	0.47
	+	0	0	5	2.66	
Bleeding Pain	-	18	94.74	5	2.66	0.32
	+	1	5.26	3	1.6	
Diarrhea	-	19	100	4	2.13	0.52
	+	0	0	4	2.13	
Nausea	-	19	100	4	2.13	0.52
	+	0	0	4	2.13	
Pulmonary Involvement	-	1	5.26	4	2.13	0.03
	+	18	94.74	4	2.13	

during the COVID-19 era. It seems that changes in amniotic fluid volume may result from hypoxemic conditions associated with COVID-19, which may affect the maternal water balance through dehydration. This issue is more pronounced in patients with severe forms of the disease and may consequently lead to oligohydramnios (20).

In the present study, 14.5% of births were preterm, which was consistent with the results of Alibakhshi et al (14.4%) (18). In contrast, Singh et al's study reported a higher preterm birth rate of 22.5%, which was even higher than that in our findings (17). Several other studies have also reported increased rates of preterm delivery among pregnant women with COVID-19 (26,27). Furthermore, a systematic review and meta-analysis showed that as the condition of pregnant women with COVID-19 worsens, the likelihood of preterm delivery significantly increases (28). However, it is still unclear whether COVID-19 is a direct cause of preterm birth or indirectly increases it (18).

The present study revealed that 70% of pregnant women with COVID-19 underwent cesarean delivery. In a study conducted by Li et al in China, all women infected with COVID-19 had cesarean delivery, which is notably higher than the rate observed in our study (29). Similarly, a high rate of cesarean delivery among women with COVID-19 has been reported in other studies (17,18). A meta-analysis study examining the effects of COVID-19 on pregnancy outcomes identified cesarean section as the predominant method of delivery among infected women, which may be related to the presence of oligohydramnios and its related complications (28).

Although some cesarean deliveries are performed for medically relevant indications, concerns regarding the potential vertical transmission of the virus from mother to infant during labor appear to have led to cesarean being the preferred method of delivery among women with COVID-19 (18,29). This trend has happened despite experts recommending natural childbirth for most women with COVID-19.

Another noteworthy finding in the present study was that the incidence of oligohydramnios was significantly higher among patients who were infected with COVID-19 in the third trimester of pregnancy. Furthermore, patients with shortness of breath, pulmonary involvement, high severity of COVID-19, or those hospitalized in the ICU were significantly more affected by oligohydramnios. The results also showed that the rates of cesarean delivery and preterm birth were significantly higher among patients

diagnosed with oligohydramnios.

These findings are particularly significant, as few studies have investigated amniotic fluid disorders in pregnant women with COVID-19, and even fewer have investigated the associated factors and clinical consequences. Previous studies have also reported similar results. For example, Gomez et al (19) found a direct and significant relationship between the occurrence of oligohydramnios and disease severity in pregnant women with COVID-19, demonstrating that the incidence of oligohydramnios increases with greater disease severity. This finding aligns with other studies showing that oligohydramnios is associated with adverse perinatal outcomes, including higher rates of stillbirth, fetal growth restriction, abnormal fetal heart rate patterns, meconium aspiration syndrome, and increased risk of cesarean delivery (30).

The generalizability of the findings from this study on amniotic fluid disorders in pregnant women with COVID-19 should be considered in light of several contextual factors. The study population comprised pregnant women who tested positive for COVID-19 and were admitted to Alavi Hospital in Ardabil city, reflecting a specific demographic and geographic subset. Data collection was observational, using interviews, physical examinations, medical records, and laboratory tests rather than a controlled experimental intervention. The duration of follow-up was limited to hospitalization, which varied among patients according to disease severity and complications.

In addition, incentives for participation were not specified, and compliance levels depended on hospital protocols and patient cooperation. The findings may also have been influenced by the specific healthcare environment and clinical practices at Alavi Hospital, which could differ from those in other regional or international contexts. Therefore, while the study provides valuable insights into the prevalence and correlates of amniotic fluid disorders in this population, its external validity should be interpreted cautiously, considering varying healthcare systems, population demographics, and epidemiological conditions.

Strengths and Limitations

This study comprehensively examined multiple aspects of pregnant patients with COVID-19, including age, BMI, history of pregnancy and delivery, clinical symptoms, and disease severity. Using appropriate statistical analyses, the relationships between oligohydramnios and different variables were investigated, and significant results have been obtained. However, this study did not investigate the effect of underlying diseases on the occurrence of oligohydramnios, which can help in earlier diagnosis and better management of affected patients. By including patients with a wide range of clinical conditions and different histories, the results of this study can be more comprehensive and more generalizable.

Sampling from a single location or hospital may limit the results to a specific population, limiting their generalizability to other populations. The relatively short study period may not have captured the long-term effects of COVID-19 on pregnancy and childbirth. Other important factors, such as socioeconomic status, access to healthcare, and family support, were not considered. The restrictions imposed during the pandemic may have affected data collection and results.

Despite these limitations, this study provides a comprehensive picture of the effects of COVID-19 on pregnancy and childbirth. The obtained results can help improve the management and treatment of pregnant patients with COVID-19.

Conclusion

This study identified oligohydramnios as a clinically significant complication among pregnant women with COVID-19 infection. The condition was notably more prevalent in cases involving third-trimester COVID-19 diagnosis, patients exhibiting respiratory symptoms, those with radiographic evidence of pulmonary involvement, and women experiencing more severe disease manifestations requiring intensive care hospitalization.

The study further revealed important associations between oligohydramnios and increased rates of both cesarean delivery and preterm birth. These observations suggest that amniotic fluid abnormalities may serve as an important clinical marker in pregnancies affected by COVID-19. These findings underscore the critical need for vigilant monitoring of pregnant women with COVID-19, particularly those presenting with severe respiratory symptoms or advanced disease.

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Authors' Contribution

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Competing Interests
The authors declare no conflict of interests.

Ethical Approval
The study was approved by the Research Ethics Committee of Ardabil University of Medical Sciences (Approval No.IR.ARUMS.MEDICINE.REC.1401.102).

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Informed Consent to Participate
Informed consent was obtained from all individual participants included in the study.

Informed Consent to Publish
Participants consented to the publication of this study's results.

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