


## Original Research

# Antenatal Screening Tests Performance during the First Wave of Coronavirus Disease 2019: Lessons Learned for Future Pandemics

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## Abstract

**Background:** We aimed to explore screening test utilization and performance during pregnancy amidst pandemic, examining both nulliparous and multiparous women, and to compare screening test performance before and during the pandemic in multiparous women.

**Methods:** A cross-sectional study of 500 pregnant women at Galilee Medical Center, Israel, explored the effects of coronavirus disease 2019 (COVID-19) on screening test performance during the first wave of the pandemic. Sociodemographic and data regarding screening test performance (including nuchal translucency (NT)), first-trimester biochemical test, early fetal scan, alpha-fetoprotein testing, second fetal scan, glucose tolerance test, diphtheria, tetanus, and acellular pertussis (Tdap) vaccination, and third-trimester ultrasonographic fetal growth assessment) were collected via face-to-face interviews using a medical questionnaire. Logistic regression was performed to identify factors that influenced screening test performance. **Results:** 234 (46%) women did not perform at least one screening test during their pregnancy. Of these, 42% attributed their decision to the impact of the COVID-19 pandemic. Among these, 18.8% were anxious about potential exposure, 16.2% cited medical staff isolations and cancellations, 5.6% reported being infected with COVID-19 or in self-isolation, and 4.3% faced challenges related to local quarantine. Of our cohort, 9.2% reported refusing emergency department (ED) referral due to anxiety regarding possible exposure. Only 44.3% of multiparous women performed all the screening tests during the pandemic, compared with 70.8% before the pandemic ( $p < 0.001$ ). Nearly half of this inadequate screening were directly associated with the pandemic. Women who reported inadequate pandemic-related screening test performance tended to be multiparous (adjusted odds ratio [aOR] = 6.43), to have low-risk pregnancies (aOR = 2.6), and to be members of Muslim and Druze minorities (aOR = 4.89 and aOR = 3.83, respectively). **Conclusions:** This study highlights the negative effect of the COVID-19 pandemic on antenatal screening test performance especially among women of minority ethnic backgrounds. Optimizing antenatal care services, grouping of tests, and on-site vaccinations may increase the adequacy of screening test performance. Implementing telehealth strategies emerges as an essential tool to enhance antenatal care compliance during pandemics.

**Keywords:** antenatal care; COVID-19; pandemic; telehealth; public health policy

## 1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic have affected maternal and neonatal health services globally. Pregnant women have been recommended to follow standard recommendations to avoid exposure to the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1–3]. As the COVID-19 pandemic limited conducting face-to-face meetings, several adjustments were implemented to the traditional protocols for antenatal visits, including the integration of telehealth, fewer in-person visits, and grouping tests together [4,5].

Some countries have reported increased stillbirth rates post-lockdown, possibly linked to disruptions in prenatal care [6,7]. Of major concern is the fact that patients have avoided necessary medical care during the pandemic, since obstetrical patients constitute a unique group who require frequent in-person healthcare visits [7]. Insufficient staffing

in obstetric services may have contributed to the decreased frequency of antenatal visits, ultrasound (US) scans, and screening tests [6].

Several studies have demonstrated an association between inadequate antenatal care and preterm birth, low birth weight, and perinatal mortality [8–11]. In Israel, basic antenatal care is included within the health insurance framework, ensuring it is free-of-charge. During the first visit (0–10 weeks), the patients' medical history is reviewed, and an US is performed to determine the number and viability of embryos. A nuchal translucency (NT) US scan, combined with a biochemical blood test, is performed at 11–13 weeks. An early anatomical fetal scan is optional and performed at 14–16 weeks. A second anatomical scan is performed at 19–24 weeks. Alpha-fetoprotein and glucose tolerance tests are recommended for all women at 16–18 and 24–28 weeks, respectively. A vaccine against diphtheria, tetanus, and acellular pertussis (Tdap) is recommended



at 27–36 weeks. Ultrasonographic fetal growth assessment is recommended during the third US [12].

At the onset of the pandemic, the Israeli Association of Obstetrics and Gynecology released general recommendations [13] for both low- and high-risk pregnancies, aiming to minimize maternal contact with others. These recommendations included grouping tests for the same visit/day (e.g., combining first-trimester biochemical test with routine blood test), reducing third-trimester obstetric US examinations, and restricting visitors during visits and tests.

Due to these challenges in antenatal care, we aimed to explore screening test utilization and performance during the first wave of the pandemic in both nulliparous and multiparous women, and to compare screening test performance before and during the pandemic among multiparous patients. Moreover, we aimed to examine factors associated with non-performance of screening tests due to the pandemic, as understanding these factors could contribute to the development of strategies to ensure adequate antenatal care in future pandemics.

## 2. Materials and Methods

This cross-sectional study was conducted among women admitted to our Maternal Fetal Unit or those admitted to the maternity ward after giving birth, between October and November 2020. Our center serves a diverse population of 600,000 with various ethnicities, with approximately 5000 births annually. The questionnaire was completed by two maternal-fetal physicians and two trained midwives during face-to-face interviews, with participants providing previous consent to take part in the study.

The collected data included: age, ethnic background, gravity, parity, and the performance of screening tests, including NT, first-trimester biochemical tests, early fetal scans, alpha-fetoprotein testing, second fetal scans, glucose tolerance tests, Tdap vaccination, and third-trimester ultrasonographic fetal growth assessments. In cases where any screening tests or vaccines were omitted, the participants were asked to provide reasons for the omissions. Multiparous women (with a history of  $\geq 1$  delivery after 24 weeks of gestation) were also questioned about antenatal care utilization in their previous pregnancies (pre-pandemic). All the participants were queried about their acceptance or refusal of referral to the emergency department (ED) during their current pregnancy (see the **Supplementary Material**).

Given that the first case of COVID-19 was confirmed in Israel on February 21, 2020, and the subsequent declaration of national emergency on March 19, which marked the beginning of the first COVID-19 wave, our study included only women whose last menstrual period occurred after March 1. Those who declined participation were excluded from consideration.

## 2.1 Statistics

### 2.1.1 Sample Size Determination

We defined inadequate screening test performance as not performing at least two of the above-mentioned screening tests. According to a computerized data search of the year 2019, 10% of our department's patients fulfilled this criterion. We hypothesized that the COVID-19 pandemic would be associated with a 10% increase in inadequate screening test performance, compared with the pre-pandemic period (year 2019).

Based on the One-Sample Proportion test, a two-sided hypothesis, Alpha = 5%, and 130 multiparous women were required to achieve a power of 90%. Due to our heterogeneous population, we decided to include 500 women in our study to reflect all ethnic groups; sample size was calculated using SPSS software version 25 (IBM, Armonk, NY, USA).

### 2.1.2 Statistical Analysis

Statistical analysis was conducted using SPSS software version 25 (IBM, Armonk, NY, USA). Quantity variables are presented as the mean  $\pm$  standard deviation, or as median and range. Qualitative variables are presented as frequencies and percentages. Quantity variables between groups were compared using an independent sample *t*-test or the Mann-Whitney test as appropriate.

Categorical variables were analyzed using Pearson's Chi-squared or Fisher's exact test (if expectancy was  $< 5$ ); a two-tailed *p*-value  $< 0.05$  was considered statistically significant.

Among multiparous women, we compared before and during the pandemic, using the McNemar's test, factors such as concerns about infection and lockdown restrictions, that decreased screening test performance during the pandemic. Additionally, we conducted a multivariate logistic regression analysis to identify risk factors for inadequate screening test performance. In this analysis, inadequate screening test performance was defined as the failure to conduct at least one screening test due to the COVID-19 pandemic, adjusted for multiparity, age, ethnicity, and high-risk pregnancy.

## 3. Results

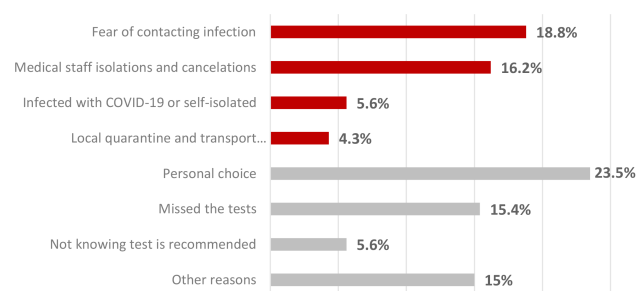
### 3.1 Study Population

500 pregnant patients were interviewed and answered the questionnaire, only 4 women refused to participate in the study. The mean maternal age of our study cohort was  $29.8 \pm 5.3$  years. 93.8% of the patients had spontaneous pregnancies. Median parity was 2 (range: 1–7), of which 66.4% were multiparous. Median gestational age was 38.5 (range: 24.0–42.5) weeks. Of the participants, 35.8% had high-risk pregnancies (e.g., gestational diabetes, chronic hypertension, history of preterm delivery, multiple preg-

nancy). Within our cohort, 40.6% were Jewish, 40.2% were Arab Muslims, 15.4% were Druze, and 3.8% were Arab Christians.

### 3.2 Screening Test Performance during the COVID-19 Pandemic

Screening test performance during COVID-19 pandemic is represented in Table 1. Among the 234 patients who did not undergo all screening tests, 42% attributed their decision to factors associated with the COVID-19 pandemic. Among these factors, 18.8% cited fear of infection, 16.2% mentioned medical staff isolations and cancellations, 5.6% were either infected with COVID-19 or in self-isolation, and 4.3% reported challenges related to local quarantine and transport restrictions. Reasons unrelated to the pandemic included personal choice (23.5%), having missed the tests or not realizing pregnancy until later stages (15.4%), lack of awareness regarding the recommended tests (5.6%), and various other reasons (15%) (Fig. 1).



**Fig. 1. Reasons for non-performance of screening tests during the pandemic.** The red bars represent reasons related to the coronavirus disease 2019 (COVID-19) pandemic. The gray bars reflect reasons unrelated to the pandemic.

**Table 1. Screening test performance in pregnancy during COVID-19 pandemic in the study population.**

	Screening test performance during the pandemic among 500 patients
Nuchal translucency	85.60%
First-trimester biochemical test	76.70%
Second-trimester biochemical test	84.70%
Early fetal scan	74.80%
Second fetal scan	93.60%
Glucose challenge test	88.20%
Tdap vaccine	80.00%
Third-trimester fetal growth	94.80%
Tdap, diphtheria, tetanus, and acellular pertussis.	

Additionally, 28.8% and 18.6% of our cohort did not perform at least two and three screening tests, respectively.

Furthermore, 9.2% of our cohort reported refusing ED referral, citing anxiety about possible exposure. A similar proportion of patients with low-risk (8.4%) and high-risk (10.6%) pregnancies refused ED referral for the same reason ( $p = 0.42$ ). Comparison of screening test performance among 332 self-controlled cases during and before the pandemic is represented in Fig. 2.

### 3.3 Screening Test Performance during and before the Pandemic: Self-Controlled Cases

To compare screening test performance during and before the first wave of the COVID-19 pandemic, a self-controlled case-series study was performed within a subgroup of our cohort. Multiparous women ( $\geq 1$  previous delivery after 24 weeks of gestation) were interviewed about the screening test performance during both their preceding and current pregnancy.

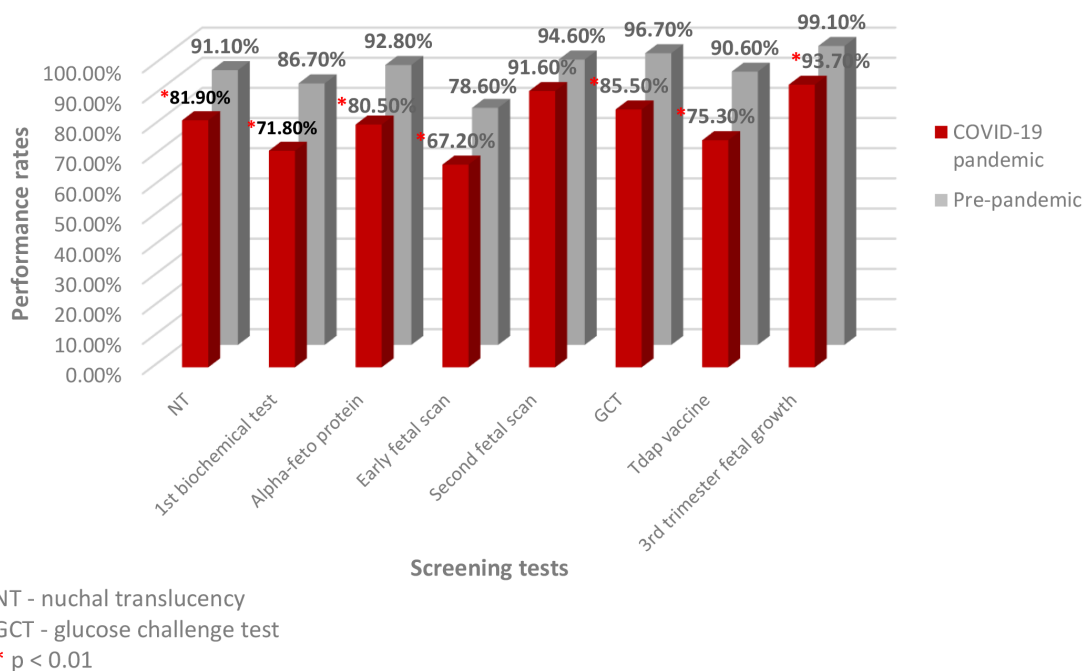
Of the 332 multiparous women in our study, 44.3% performed all screening tests during their current pregnancy, compared with 70.8% during their previous pregnancy ( $p < 0.001$ ). In total, 55.7% did not perform at least one test during the pandemic, compared with 29.2% before the pandemic ( $p < 0.001$ ). Moreover, 36.1% did not perform at least two tests during the pandemic, compared with 15.1% before the pandemic ( $p < 0.001$ ); 26.5% linked this avoidance to the pandemic (Fig. 3).

Among multiparous women who had not performed at least one test during the pandemic, 47.8% linked this to the pandemic, 21.2% reported fear of contracting infection, 17.4% reported medical staff isolations and cancellations, 5.8% were infected with COVID-19 or were self-isolating, and 5.3% reported challenges related to local quarantine. Reasons unrelated to the pandemic included personal choice (24.2%), missing the tests or realizing pregnancy at a later stage of pregnancy (12.1%), lack of awareness regarding the recommended tests (4.2%), or other reasons (14.8%).

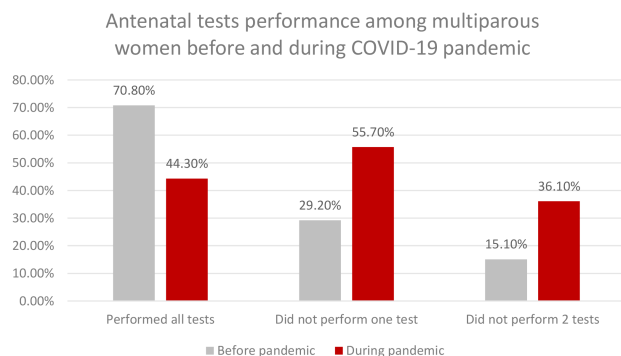
Among women who did not perform at least one test before the pandemic, 65.6% stated they did not perform the tests due to personal choice, 12.5% stated they discovered they were pregnant at a later stage of pregnancy or missed the tests, 7.3% stated they did not know that the test is recommended, and 14.6% stated various other reasons.

### 3.4 Comparing Screening Test Performance of Primiparous Women, during and before the Pandemic

150 self-controlled cases were primiparous before the pandemic and 74.7% indicated full screening test performance in their antecedent pregnancy. During the pandemic, 168 patients were primiparous and 70.8% indicated full screening test performance in their antecedent pregnancy. No significant difference was found regarding full screening test performance of primiparous women, either during and before the pandemic ( $p = 0.45$ ).



**Fig. 2.** Screening test performance during and before the COVID-19 pandemic among 332 self-controlled cases.



**Fig. 3.** Screening test performance among multiparous women before and during the COVID-19 pandemic.

### 3.5 Risk Factors of Inadequate Screening Test Performance during the COVID-19 Pandemic

To examine factors associated with non-performance of screening tests due to the pandemic (e.g., fear of infection, lockdown restrictions, etc.), we performed a multivariate logistic regression study on all study participants (500 pregnant women). Ethnicity was a strong predictor for full screening test performance during the pandemic, with 84.2% of Arab Christian patients, 67.5% of Jewish patients, 46.8% of Druze patients, and 38.3% of Arab Muslim patients reporting full screening test performance ( $p < 0.001$ ). When compared with Jewish patients, Arab Muslims and Druze patients were at a higher risk of inadequate screening test performance due to the pandemic (adjusted odds ratio

[aOR] = 4.89, 95% confidence interval [95% CI]: 2.64–9.06 and aOR = 3.83, 95% CI: 1.84–7.9, respectively), as presented in Table 2.

Women with high-risk pregnancies had a significantly lower risk of inadequate screening test performance (aOR = 0.38, 95% CI: 0.22–0.67). The strongest predictor of inadequate performance was multiparity (aOR = 6.43, 95% CI: 3.14–13.1). Furthermore, age was not a risk factor for inadequate screening test performance. aORs and 95% CIs of this multivariate analysis are presented in Table 2.

## 4. Discussion

Despite screening care services being free-of-charge and well developed in Israel, we found that many patients in our cohort had not performed basic screening tests during the first wave of the COVID-19 pandemic. 234 patients had not performed at least one test, and 42% linked this to challenges associated to the pandemic. According to the self-controlled case study, the COVID-19 pandemic was responsible for a 26% increase in inadequate screening test performance, compared with the pre-pandemic period. Therefore, the COVID-19 pandemic poses considerable challenges with regard to maintaining appropriate screening care, even in high-resource countries.

A study from the United Kingdom (UK) [6] reported a decline in the diagnosis of hypertension among women during the pandemic compared to the pre-pandemic period. This may be explained by potential under-diagnosis, as women had fewer face-to-face antenatal visits. We found



**Table 2. Results of multivariate regression analysis (aOR and 95% CI) for inadequate screening test performance due to COVID-19 pandemic.**

Independent variables	Adjusted odds ratio (aOR)	95% confidence interval (95% CI)	p-value
Age	0.98	0.93–1.02	0.375
Multiparity	6.43	3.14–13.1	<0.001
Arab Muslims	4.89	2.64–9.06	<0.001
Arab Christians	1.38	0.28–6.78	0.692
Druze ethnicity	3.83	1.84–7.9	<0.001
High-risk pregnancy	0.38	0.22–0.67	0.001

that 18.8% of patients who did not perform at least one screening test reported avoidance due to fear of infection; a similar portion (21.2%) of multiparous women stated the same reason. Studies from Turkey and Italy [14,15], investigating the psychological impact of COVID-19, found increased anxiety levels among pregnant women. This underscores the profound psychological morbidity associated with pandemics.

Reports from Nepal and Ethiopia [16,17] demonstrated that a lack of transportation increases the risk of underutilizing antenatal care services, and the number of home births, with a concomitant increase in maternal mortality. As in many countries, the lockdown in Nepal was abrupt, imposing multiple restrictions, including a ban on all forms of travel other than emergency services. Additionally, prioritizing COVID-19 medical care resulted in limited access to antenatal care.

Several studies [6,16] have shown an increase in the incidence of stillbirths that could not be directly attributed to COVID-19 infection but is rather attributed to indirect effects of the pandemic. Additionally, our study well demonstrated a hospital avoiding-behavior, with 9.2% of the study cohort (46 patients) reporting reluctance to seek hospital care when needed.

A study from India [18] reported a 66.4% decrease in referred obstetrics emergencies, showing that women are avoiding hospital visits even when tertiary-level care was required. Furthermore, we found a substantial and statistically significant decrease in first-trimester biochemical testing and Tdap vaccinations, while efforts to combine NT with first-trimester biochemical testing might have contributed to an increased performance of both tests. Incorporating the Tdap vaccination into routine prenatal care visits would promote on-site vaccinations and likely improve its administration during pregnancy. Utilizing mobile healthcare services and incorporating mass media communication to identify danger signs during pregnancy are additional strategies to improve antenatal care [19]. Our findings revealed a significant association between inadequate screening test performance and multiparity. Additionally, we found that Muslim and Druze patients were more likely to miss tests due to the pandemic.

Different studies have shown an association between multiparity and inadequate antenatal care. Previous studies

from Southern Israel reported lower antenatal care utilization among certain ethnic groups (Bedouin Muslim women) and multiparous women [20–22]. Of note, the Northern Israeli population is more heterogeneous, with multiple ethnic groups. The reasons we found for not undergoing screening tests, unrelated to the pandemic, such as personal choice, missed tests, or a lack of awareness about recommended screenings, may reflect the diversity of ethnic backgrounds included in our study. It is essential to note that we did not collect data on whether women identified themselves as religious or secular, which could be a relevant factor influencing the screening test performance. Our findings of ethnic differences regarding screening test performance may be related to restrictions on “red” zones (high infection rates), as Arab Muslim and Druze communities were commonly included in the “red” cities list. Women with low-risk pregnancies also exhibited lower screening test utilization, related to the pandemic. However, it is possible that women with high-risk pregnancies fully utilized screening care, even during the pandemic, in order to ensure better pregnancy outcomes.

The COVID-19 pandemic has led to rapid adoption of telemedicine services. The use of telehealth is associated with the improvement in the quality of care and enhances screening care compliance [23]. Hybrid screening care programs, including blood pressure cuffs, handheld Doppler, and video visits have been implemented with preserved obstetric outcomes and increased patient satisfaction [24]. These strategies should be preserved and additional innovations should be considered by health policy experts to ensure adequate screening care in future pandemics.

The study is limited due to its cross-sectional nature, short timeframe, and the lack of information regarding certain demographic parameters, such as residence (urban or rural) and education status. Additionally, data on screening test performance before the pandemic may be subject to recall bias. Nevertheless, a strength of our study lies in its heterogeneous study population, as it includes women of different ethnic backgrounds. Furthermore, this is the first study to investigate detailed screening test performance during the COVID-19 pandemic and compare it with the pre-pandemic period in Israel.

## 5. Conclusions

This study was designed to explore factors affecting the utilization of screening care during the COVID-19 pandemic, aiming to shed light on appropriate interventions, and increase compliance with antenatal care. Our findings revealed that multiparous women with low-risk pregnancies from specific ethnic backgrounds tended to decrease the frequency of antenatal care. Additionally, the COVID-19 pandemic indirectly reduced care-seeking, decreasing screening test performance. Optimizing screening care services, grouping of tests, and on-site Tdap vaccinations may increase the adequacy of screening test performance. To raise awareness and increase screening care utilization, practitioners can take advantage of early antenatal visits, while grouping of tests should be determined and planned early. Furthermore, considering findings from several studies underscoring the significant role of telemedicine in enhancing antenatal care during COVID-19 pandemic [25,26], the implementation of telehealth in specific restricted “red” areas may ensure the safe and effective delivery of obstetric care.

## Abbreviations

COVID-19, coronavirus; ED, emergency department; NT, nuchal translucency; US, ultrasound.

## Availability of Data and Materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

## Author Contributions

IS – concept and design, acquisition of data, drafting the manuscript. ML – data collection. NK – data collection. JB – concept and design, critical revision of manuscript. LL – interpretation of data, critical revision of manuscript. MFW – concept and design, revision of manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approved the final manuscript.

## Ethics Approval and Consent to Participate

The study was approved by the local Helsinki committee at the Galilee Medical Center (reference no. NHR-0197-20). Verbal informed consent was approved by the Ethical board and was obtained from all participants. This study was conducted in accordance with the Declaration of Helsinki.

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## Conflict of Interest

The authors declare no conflict of interest.

## Supplementary Material

Supplementary material associated with this article can be found, in the online version, at <https://doi.org/10.31083/j.ceog5103073>.

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