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Incidence and Clinical Characteristics of and Risk Factors for Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Infection Among Pregnant Individuals in the United States

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Background. Data about the risk of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection among pregnant individuals are needed to inform infection-prevention guidance and counseling for this population.

Methods. We prospectively followed a cohort of pregnant individuals during August 2020–March 2021 at 3 US sites. The 3 primary outcomes were incidence rates of any SARS-CoV-2 infection, symptomatic infection, and asymptomatic infection, during pregnancy during periods of SARS-CoV-2 circulation. Participants self-collected weekly midturbinate nasal swabs for SARS-CoV-2 reverse transcription–polymerase chain reaction testing, completed weekly illness symptom questionnaires, and submitted additional swabs with coronavirus disease 2019 (COVID-19)–like symptoms. An overall SARS-CoV-2 infection incidence rate weighted by population counts of women of reproductive age in each state was calculated.

Results. Among 1098 pregnant individuals followed for a mean of 10 weeks, 9% (99/1098) had SARS-CoV-2 infections during the study. Population-weighted incidence rates of SARS-CoV-2 infection were 10.0 per 1000 (95% confidence interval, 5.7–14.3) person-weeks for any infection, 5.7 per 1000 (1.7–9.7) for symptomatic infections, and 3.5 per 1000 (0–7.1) for asymptomatic infections. Among 96 participants with SARS-CoV-2 infections and symptom data, the most common symptoms were nasal congestion (72%), cough (64%), headache (59%), and change in taste or smell (54%); 28% had measured or subjective fever. Median symptom duration was 10 (interquartile range, 6–16) days.

Conclusions. Pregnant individuals in this study had a 1% risk of SARS-CoV-2 infection per week, underscoring the importance of COVID-19 vaccination and other prevention measures during pregnancy while SARS-CoV-2 is circulating in the community.

Keywords. pregnancy; incidence rates; COVID-19.

Emerging data from the coronavirus disease 2019 (COVID-19) pandemic suggest that pregnant individuals are at increased risk for severe illness from severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) compared to nonpregnant individuals. [1] Pregnant individuals may also be at increased risk for some adverse pregnancy outcomes after SARS-CoV-2 infection. [2–5]. While these data provide important information about risks to pregnant individuals once infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), data about community incidence of SARS-CoV-2 infection and risk factors for infection among pregnant individuals are needed to inform infection-prevention counseling and guidance [6]. In addition, data that quantify the risk of SARS-CoV-2 infection during pregnancy might inform decisions by pregnant individuals about whether to get the COVID-19 vaccine.

Estimating SARS-CoV-2 infection incidence is challenging because it requires large-scale longitudinal community studies with systematic testing [6]. In addition, a substantial fraction of SARS-CoV-2 infection is asymptomatic [7–11]. Serologic studies might not capture the true incidence and full burden of infections because asymptomatic infection might not consistently elicit antibodies to SARS-CoV-2 and detectable antibody titers after mild or asymptomatic infection might wane over time [12, 13]. In addition, serologic studies are unable

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to precisely identify the timing of incident infections. Thus, studies designed to identify the true incidence and full burden of SARS-CoV-2 infection ideally should include systematic molecular testing for asymptomatic infections. The Epidemiology of SARS-CoV-2 in Pregnancy and Infancy Community cohort is a prospective multisite cohort study of pregnant individuals who participate in intensive surveillance for SARS-CoV-2 infection that includes weekly midturbinate nasal swab specimen collection regardless of symptoms and weekly surveillance for illness symptoms. Using data from this cohort, we aimed to estimate incidence rates of asymptomatic and symptomatic SARS-CoV-2 infections as a measure of the overall risk of infection during pregnancy and describe the clinical characteristics of infections. In addition, we conducted an exploratory analysis to examine selected exposures and practices as risk or protective factors for SARS-CoV-2 infection.

METHODS

Participants and Study Setting

Participants were enrolled during August 2020–February 2021 at 3 US medical centers in Salt Lake City, Utah; New York City, New York; and Birmingham, Alabama. Individuals had to be pregnant at less than 28 weeks' gestation to be eligible. (See Supplementary Methods/Results for recruitment methods and additional eligibility criteria.) During the study follow-up period from September 2020 through March 2021, local community mitigation measures varied by study location (see Supplementary Table 1).

Data Collection Procedures

Before data collection, individuals provided written informed consent to study participation. At enrollment, participants completed web-based or telephone surveys about their sociodemographic characteristics, past medical and obstetrical histories, prenatal care, whether they were told by a healthcare provider they had suspected or confirmed COVID-19 before enrollment and if they had a confirmatory laboratory test. Participants received an orientation about the study surveillance, including how to self-collect and mail midturbinate nasal swab specimens. Participants were asked to self-collect swab specimens every week during pregnancy; self-collection of nasal swabs has been previously validated for detection of SARS-CoV-2 infection [14]. The participants were given prepared kits and materials to ship specimens on ice packs by overnight courier to a central laboratory. Participants were also asked to collect and ship additional swab specimens if they experienced onset of COVID-like illness (CLI) symptoms.

CLI was defined as 1 or more of measured or subjective fever, cough, shortness of breath, sore throat, diarrhea, muscle aches, chills, or change in taste or smell. Participants were contacted weekly until the end of pregnancy by text message, phone call, or email to ascertain whether they had CLI symptoms or any other illness symptoms during the preceding 7 days. Every fourth week, participants were asked, "In the past month, when you left your home for activities that involved interacting with other people, how often did you use a mask or other covering over your nose and mouth?" Response options were as follows: always, sometimes, or never. (See Supplementary Methods/Results for additional surveillance methods.)

Data about receipt of COVID-19 vaccines during pregnancy were collected at the end of pregnancy by survey and by data abstraction from medical records or participants' COVID-19 vaccination cards (see Supplementary Methods/Results).

Laboratory Methods

Respiratory swab specimens were tested by reverse transcription–polymerase chain reaction (RT-PCR) for SARS-CoV-2 using assays previously approved under Emergency Use Authorization: Quidel Lyra SARS-CoV-2 Assay or the ThermoFisher Combo Kit platform with ThermoFisher probes and primers (see Supplementary Methods/Results) [15].

Sample Size Estimates

Sample size estimates were based on achieving precision around incidence rate estimates of SARS-CoV-2 infection by site. Sample size calculations indicated that 280 participants per site would be needed to estimate a cumulative incidence of SARS-CoV-2 infection of 10% with ±4% precision after accounting for 10% cohort attrition.

Outcomes and Exposures of Interest

The 3 primary incident outcomes of interest were any RT-PCR–confirmed SARS-CoV-2 infection, symptomatic infections, and asymptomatic infections. (See Supplementary Methods/Results for outcome definitions.) Clinical measurements of interest were frequencies of fever and other acute symptoms, duration of symptoms and SARS-CoV-2 viral RNA detection from nasal swabs, missed workdays, outpatient medically attended infection (including telemedicine and ambulatory care visits), and hospitalization.

In an exploratory analysis of risk and protective factors for SARS-CoV-2 infection, the primary outcome was any SARS-CoV-2 infection and exposures hypothesized to be possible risk or protective factors for SARS-CoV-2 infection included employment and telework status, residing in a household with a preschool-aged child younger than 5 years or with a school-aged child aged 5–17 years, and mask wearing when outside the house.

Analytic Populations and Statistical Analysis

Individuals were considered enrolled if they met eligibility criteria, consented, and completed the enrollment questionnaire. Among enrolled participants, baseline characteristics

were compared between participants who did and did not participate in surveillance to identify potential biases in the population available for analysis. All subsequent analyses were limited to enrolled individuals who participated in surveillance by submitting at least 1 weekly or acute illness swab specimen and did not report a diagnosis of laboratory-confirmed COVID-19 before enrollment. Among this analytic population, baseline characteristics were compared between participants who had incident SARS-CoV-2 infections with those who did not. Underlying medical conditions were defined as those classified by the Centers for Disease Control and Prevention (CDC) as conferring an increased risk for severe COVID-19 [5]. Chi-square, Fisher's exact test, or the Wilcoxon rank-sum test were used to test for statistical significance. A *P* value less than .05 was considered statistically significant.

Incidence rates per 1000 person-weeks for each incident outcome were calculated with outcomes as the numerator and person-weeks at risk for events as the denominator. Person-weeks at risk for each outcome were calculated from the start of surveillance for each individual through their last week in which they participated in surveillance or through the first incident case of SARS-CoV-2 infection (based on date of first positive test). To estimate incidences of any and asymptomatic SARS-CoV-2 infection, person-time was discounted for weeks in which participants did not submit a respiratory specimen. To estimate incidence of symptomatic SARS-CoV-2, person-time was discounted for weeks in which participants did not respond to weekly surveillance questionnaires or had symptomatic illness.

Incidence rates were calculated for the cohort overall and by site using data available through 28 March 2021. Age- and race/ethnicity-adjusted incidence rates by site were calculated using negative binomial models. To give a representative estimate for individuals of childbearing age in the United States, an aggregate age- and race/ethnicity-adjusted incidence rate across all sites was also calculated by weighting age- and race/ethnicity-adjusted estimates from each site by the US 2019 Census population count of women aged 15–49 years in each state [16]. As a sensitivity analysis, incidence rates were calculated after restricting to periods of increased SARS-CoV-2 circulation at each site (see Supplementary Methods/Results). Additional sensitivity analyses were conducted to examine the impact on incidence rate estimates of including participants with COVID-19 infection before cohort enrollment and COVID-19 vaccination during the study period (see Supplementary Methods/Results).

The asymptomatic fraction of infection was calculated by dividing incidence rates of asymptomatic infection by rates of any infection. Ninety-five percent confidence intervals were calculated for selected frequencies and all incidence estimates assuming a binomial distribution.

To explore selected exposures as risk and protective factors for SARS-CoV-2 infection, discrete time-to-event proportional-hazards Cox models were used with a time scale of calendar weeks. Models compared the hazard of incident SARS-CoV-2 infection among participants with each exposure (Supplementary Methods/Results). The final base model included site and race and ethnicity. COVID-19 vaccination status was not included in the model because of incomplete data about vaccination for more than half of participants in the analysis due to ongoing cohort follow-up.

Descriptive statistics were used to characterize infections. The median duration of SARS-CoV-2 detection by RT-PCR was estimated for all infections using nonparametric survival analyses after accounting for interval censoring resulting from weekly swab specimen collection.

Analyses were conducted in SAS version 9.4 (SAS Institute, Cary, NC).

Ethical Review

The study protocol was reviewed and approved by the Columbia University Irving Medical Center Institutional Review Board (IRB), which served as the central IRB for all study sites. The CDC IRB relied on the review of the Columbia University Irving Medical Center IRB (see 45 CFR part 46; 21 CFR part 56).

RESULTS

Participant Characteristics

Overall, 1413 participants were enrolled in the cohort, of whom 1169 (83%) participated in SARS-CoV-2 surveillance by submitting at least 1 weekly or acute illness specimen (Figure 1). (See Supplementary Methods/Results and Supplementary Table 2 for additional recruitment and enrollment details.) Of the 1169 participants who participated in SARS-CoV-2 surveillance, 71 were excluded from subsequent analyses because they had a self-reported diagnosis of COVID-19 with laboratory confirmation before enrollment. Of the remaining 1098 participants, the median age was 30 years (interquartile range [IQR]: 26–34 years) and 706 (64%) were employed, of whom 442 (62%) were not teleworking at enrollment (Table 1). Most participants (67%, 732/1098) enrolled during their second trimester (median gestational age: 19 weeks; IQR: 13–24 weeks). Among 400 participants with information available as of 15 July 2021 about COVID-19 vaccine receipt, 66 (17%) were fully vaccinated, including 3 with incident SARS-CoV-2 infections, all occurring before vaccination. Among 808 (74% of 1098) participants who responded at least once about mask use while outside the home, 551 (68%) reported always wearing masks for every month that they responded, 65 (8%) reported sometimes wearing masks for every month, 159 (20%) reported a mix of always or sometimes wearing masks, and 33 (4%) reported never wearing masks for at least some months.

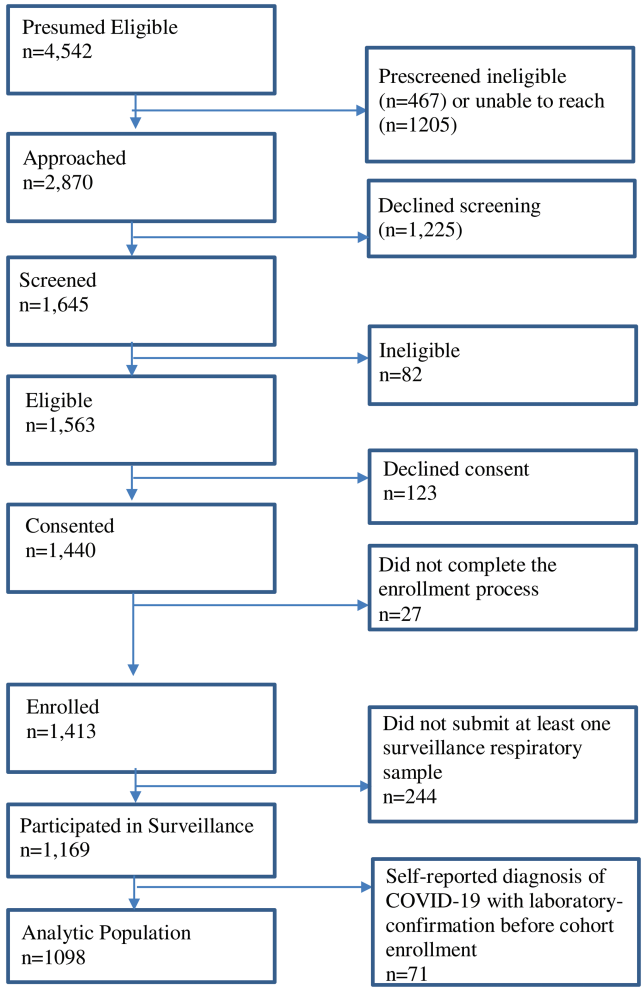

Figure 1. Cohort recruitment, screening, consent, and surveillance participation: Epidemiology of SARS-CoV-2 in Pregnancy and Infancy community cohort, Utah, New York, and Alabama—August 2020–March 2021. [a]Prescreened includes all individuals who study staff screened for selected eligibility criteria such as age before formal eligibility screening. [b]Ineligible because individual was not planning to deliver at the study site (n = 29), not willing to self-collect and mail respiratory specimens (n = 49), had unknown gestational age (n = 1), or was currently enrolled in an influenza or COVID-19 vaccine trial (n = 3). Abbreviations: COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

SARS-CoV-2 Infection and Incidence

The 1098 participants in this analysis contributed 10 901 person-weeks of cohort observation time (mean per participant 10; standard deviation: 6). County-level surveillance data indicate that the period of cohort follow-up included a defined wave of SARS-CoV-2 circulation at each site (Supplementary Figure 1).

Of the 1098 participants in the cohort, 99 (9%; 95% confidence interval [CI]: 7–11%) had RT-PCR–confirmed SARS-CoV-2 infection while in the cohort. The overall population-weighted incidence of SARS-CoV-2 infection was 10.0 per 1000 (95% CI: 5.7–14.3) person-weeks (Supplementary Table 3, Figure 2), indicating a 1% risk of infection per week of pregnancy. Overall weighted incidences of asymptomatic and symptomatic SARS-CoV-2 were 3.5 per 1000 (95% CI: 0–7.1) and 5.7 per 1000 (95% CI: 1.7–9.7) person-weeks. The asymptomatic fraction of SARS-CoV-2 infections was 35%. Incidence rates at each site adjusted for participants' age and race/ethnicity ranged from 5.4 to 10.8 per 1000 person-weeks (Figure 2, Supplementary Table 3). After restricting analyses to periods of increased SARS-CoV-2 circulation based on local surveillance data, the overall population-weighted incidence of SARS-CoV-2 infection was 11.0 per 1000 (95% CI: 6.2–15.8) and site incidence rates adjusted for age and race/ethnicity ranged from 5.7 to 11.8 per 1000 person-weeks (Supplementary Table 4). See Supplementary Methods/Results for additional sensitivity analyses.

Risk Factors for SARS-CoV-2 Infection

After adjusting for site and race/ethnicity, being employed, and either teleworking or not teleworking (adjusted hazard ratio [aHR]: 1.1 [95% CI: .6–2.0] and 1.4 [95% CI: 0.9–2.3], respectively; P = .35) and residing in a household with a child aged younger than 5 years (aHR: .8; 95% CI: .5–1.2; P = .32) were

Table 1. Baseline Characteristics of Pregnant Individuals Enrolled and Participating in Surveillance for SARS-CoV-2 Infection in the Epidemiology of SARS-CoV-2 in Pregnancy and Infancy Community Cohort

	All Participants,[a] n (col%)	SARS-CoV-2 Infection, n (row%)	No SARS-CoV-2 Infection, n (row %)	*P*[b]
Baseline characteristics				
All	1098	99	999	
Site				
Salt Lake City, UT	470 (43)	35 (7)	435 (93)	.003
Birmingham, AL	274 (25)	17 (6)	257 (94)	
New York City, NY	354 (32)	47 (13)	307 (87)	
Age, median (interquartile range), years	30 (26–34)	31 (26–33)	30 (26–34)	.87
Age group				
18–24 years	182 (17)	13 (7)	169 (93)	.51
25–34 years	688 (63)	67 (10)	621 (90)	
>35 years	228 (21)	19 (8)	209 (92)	
Highest educational level				
Less than college	561/1091 (51)	56 (10)	505 (90)	.23
Some college or college graduate	530/1091 (49)	42 (8)	488 (92)	
Race/ethnicity				
Hispanic/Latina	339/1049 (32)	43 (13)	296 (87)	.008
White, non-Hispanic	501/1049 (48)	41 (8)	460 (92)	
Black, non-Hispanic	166/1049 (16)	7 (4)	159 (96)	
Other, non-Hispanic	43/1049 (4)	2 (5)	41 (95)	
Employment and telework status				
Employed, teleworking	264/1080 (24)	21 (8)	243 (92)	.46
Employed, not teleworking	442/1080 (41)	45 (10)	397 (90)	
Not employed	374/1080 (35)	30 (8)	344 (92)	
Underlying medical conditions[c]				
None	849 (77)	83 (10)	766 (90)	.1
At least 1	249 (23)	16 (6)	233 (94)	
Household with child aged <5 years				
Yes	413/1086 (38)	33 (8)	380 (92)	.35
No	673/1086 (62)	65 (10)	608 (90)	
Household with child aged 5–17 years				
Yes	337/1086 (31)	40 (12)	297 (88)	.028
No	749/1086 (69)	58 (8)	691 (92)	
Current pregnancy characteristics				
Trimester at enrollment				
First (0 to 13 6/7 weeks' gestation)	366 (33)	45 (12)	321 (88)	.007
Second (14 to 27 6/7 weeks' gestation)	732 (67)	54 (7)	678 (93)	
Trimester at first prenatal visit				
First (0 to 13 6/7 weeks' gestation)	958/1042 (92)	90 (9)	868 (91)	.18
Second (13 6/7 to 27 6/7 weeks' gestation)	83/1042 (8)	3 (4)	80 (96)	
Third (≥28 weeks' gestation)	1/1042 (<1)	0 (0)	1 (100)	
Multiple gestation pregnancy				
Yes	26/1093 (2)	2 (8)	24 (92)	1.00
No	1067/1093 (98)	0 (0)	5 (<1)	
First pregnancy				
Yes	327/1096 (30)	27 (8)	300 (92)	.56
No	769/1096 (70)	72 (9)	697 (91)	
Self-reported receipt of COVID-19 vaccination during pregnancy[d]				
Partially vaccinated	25/400 (6)	0 (0)	25 (100)	.09
Fully vaccinated	66/400 (17)	3 (5)	63 (95)	
Not vaccinated	309/400 (77)	32 (10)	277 (90)	

Table 1 Continued

	All Participants,[a] n (col%)	SARS-CoV-2 Infection, n (row%)	No SARS-CoV-2 Infection, n (row %)	*P*[b]
Month full vaccination was attained among fully vaccinated participants[d]				.37
January 2021	27/66 (41)	0 (0)	27 (100)	
February 2021	29/66 (44)	2 (7)	27 (93)	
March 2021	10/66 (15)	1 (10)	9 (90)	

n = 1098 individuals; excluding 71 participants with self-reported diagnosis of COVID-19 with laboratory-confirmation before cohort enrollment.
Abbreviations: COVID-19, coronavirus disease 2019; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

[a]Column percentages are calculated out of participants with available data for each variable. Denominators indicate number of participants with available data if different from n = 1098.

[b]*P* values comparing the frequency of baseline characteristics among individuals with and without SARS-CoV-2 infection.

[c]Underlying medical conditions classified by the Centers for Disease Control and Prevention as conferring an increased risk for severe COVID-19, including cancer, chronic kidney disease, chronic lung disease, dementia or neurological conditions, diabetes (types 1 or 2), Down syndrome, heart conditions including hypertension, human immunodeficiency virus (HIV) infection, immunocompromised state, liver disease, sickle cell disease or thalassemia, solid-organ or blood stem cell transplant, and stroke or cerebrovascular disease. Centers for Disease Control and Prevention list available at: https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/people-with-medical-conditions.html.

[d]COVID-19 vaccination status was based on participant report as the primary data source for information about receipt, vaccine type, number of doses, and dates of vaccination using data available for the cohort as of 15 July 2021. If dates of vaccination were not available from participant report, abstracted information from electronic medical records or COVID-19 vaccination cards was used to determine timing of vaccination. Data from electronic medical records or COVID-19 vaccination cards were also prioritized if vaccine type was discordant from these sources compared with participant self-report. Fully vaccinated was defined as receipt of 2 doses of vaccines with a recommended 2-dose series or 1 dose of a vaccine for which only a single dose is recommended. Partially vaccinated was defined as receipt of 1 dose of vaccines with a recommended 2-dose series. Of the 99 participants with SARS-CoV-2 infection, 35 had information about receipt of COVID-19 vaccination during the study period. Of these 35 participants, 3 reported receipt of COVID-19 vaccine, all after their SARS-CoV-2 infections.

not associated with an increased risk of SARS-CoV-2 infection (Table 2). However, residing in a household with a child 5–17 years of age was associated with an increased risk of SARS-CoV-2 infection (aHR: 1.6; 95% CI: 1.0–2.4; *P* = .046). Nonadherence to mask wearing when outside the home was not statistically associated with risk of infection (never vs always wearing a mask—aHR: 1.7; 95% CI: .2–13.0; sometimes vs always wearing a mask—aHR: .6; 95% CI: .2–1.8; *P* = .60), although only 70% (721/1049) of individuals had available responses about mask-wearing practices.

Characteristics of SARS-CoV-2 Infection Episodes

Among the 99 participants with SARS-CoV-2 infections, 79 (80%) had symptomatic infection and 20 (20%) were asymptomatic throughout their infections. The median duration of viral RNA detection by RT-PCR was 14 days (IQR: 8–16 days). Among participants with SARS-CoV-2 infection excluding 3 with symptomatic illness without detailed symptom data (n = 96), the most common symptoms were nasal congestion (69; 72%), cough (61; 64%), headache (57; 59%), and change in taste or smell (52; 54%) (Figure 3). Twenty-eight percent

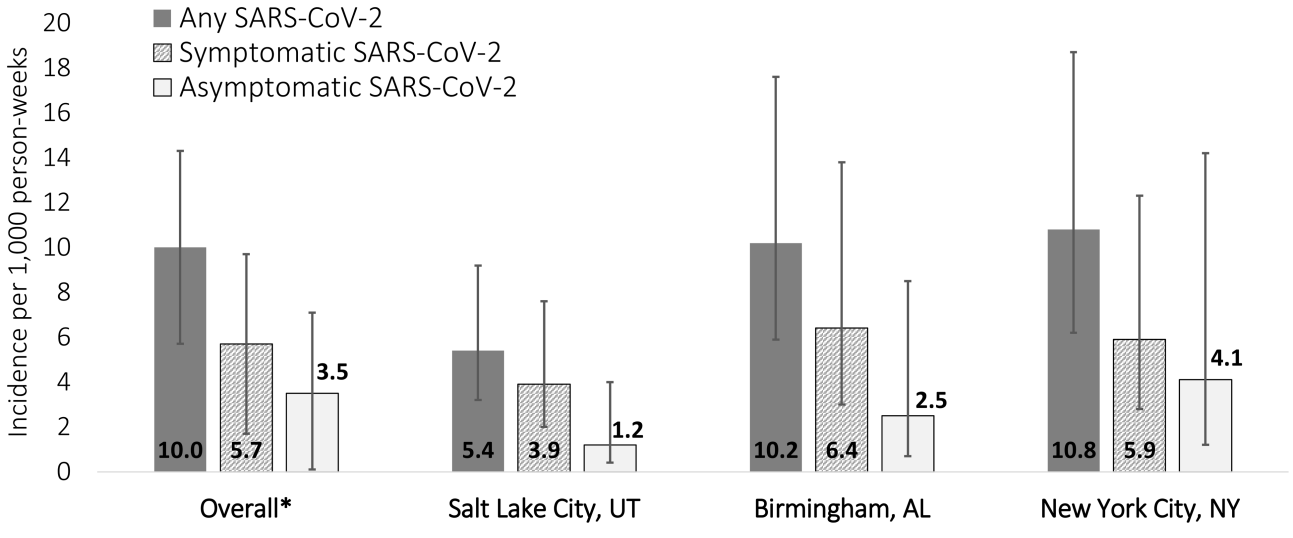

Figure 2. SARS-CoV-2 infection incidence rates per 1000 person-weeks adjusted for age and race/ethnicity among pregnant individuals enrolled and participating in the Epidemiology of SARS-CoV-2 in Pregnancy and Infancy community cohort, by site and symptom status—September 2020–March 2021; n = 1098 individuals. Error bars denote 95% confidence intervals. *Weighted for population counts of women aged 15–49 years in each state using US Census Bureau population estimates for 2019 (Annual Estimates of the Resident Population by Single Year of Age and Sex: April 1, 2010 to July 1, 2019; accessed at: https://www.census.gov/data/tables/time-series/demo/popest/2010s-state-detail.html.) Abbreviation: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

Table 2. Adjusted Risk of SARS-CoV-2 Infection Among Pregnant Individuals Enrolled and Participating in the Epidemiology of SARS-CoV-2 in Pregnancy and Infancy Community Cohort, by Selected Exposures and Preventive Practices

	n[a]	No. of SARS-CoV-2 Infections	Adjusted Hazard Ratio (95% CI)	*P*
Base model				
Site	1049	93		
Salt Lake City, UT			Ref	.051
Birmingham, AL			2.0 (1.0, 3.8)	
New York City, NY			2.1 (1.0, 4.3)	
Race/ethnicity	1049	93		
White, non-Hispanic			Ref	.54
Hispanic/Latina			1.3 (.6, 2.6)	
Black, non-Hispanic			.7 (.3, 1.7)	
Other, non-Hispanic			.6 (.1, 2.5)	
Variables in base model adjusting for site and race/ethnicity plus[b]				
Employment and telework status	1032	90		
Employed, teleworking			1.1 (.6, 2.0)	.35
Employed, not teleworking			1.4 (.9, 2.3)	
Not employed			Ref	
Household with child aged 5–17 years	1049	93		
Yes			1.6 (1.0, 2.4)	.046
No			Ref	
Household with child aged <5 years	1049	93		
Yes			.8 (.5, 1.2)	.32
No			Ref	
Mask use when outside the home	6705[c]	38		
Always			Ref	.60
Sometimes			.6 (.2, 1.8)	
Never			1.7 (.2, 13.0)	

n = 1049 individuals. Base models exclude participants with missing data on race/ethnicity (n = 49).

Abbreviations: CI, confidence interval; Ref, reference; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

[a]"n" corresponds to the number of participants included in each model for time-invariant factors (site, race/ethnicity, employment and telework status, and households with children aged 5–17 years or <5 years) and person-weeks for time-varying factors (mask use when outside the home). Participants with missing data for variables were excluded. Person-weeks with missing swab submission were also excluded.

[b]Base model includes site and race/ethnicity plus the variables listed in the table added individually to the base model.

[c]Denotes person-weeks of observation among a total of 721 participants included in the model.

(27/96) of participants had measured or subjective fever, of whom 14 of 21 (52%) who measured their temperatures had fever higher than 100.4°F.

Among 36 participants with symptomatic infection who completed illness follow-up surveys, the median symptom duration was 10 days (IQR: 6–16 days), 19 participants (53%) reported missing work due to illness and 14 (39%) reported seeking medical care for illness. One symptomatic infection was associated with a 2-day hospitalization for dehydration that did not require intensive care. There were no deaths.

DISCUSSION

Among a cohort of 1098 pregnant individuals at 3 US sites, the overall age- and race/ethnicity-adjusted incidence rate of SARS-CoV-2 infection weighted for state populations of women of child-bearing age was 10.0 per 1000 person-weeks, indicating a 1% risk of infection per week during the study period. The cumulative incidence of infection during pregnancy was at least 9% based on infections during the study period. Incidence rate estimates in this cohort are similar to modelled estimates for US adults of childbearing age during February–December 2020 that adjust for case underascertainment (4.6–6.2 per 1000 person-weeks) [17]. Incidence rates among this likely largely COVID-19–unvaccinated cohort are also similar to those among unvaccinated healthcare and frontline workers (9.7 per 1000 person-weeks) [18] and among adults aged 18–49 years (F. Dawood, unpublished data, 25 July 2021) in other contemporaneous US cohorts with similar methods of SARS-CoV-2 surveillance.

In December 2020, the US Advisory Committee on Immunization Practices stated that pregnant individuals should have the option to receive COVID-19 vaccine if they were in a group recommended for vaccination [19]. In July 2021, the CDC and the American College of Obstetrics and Gynecology recommended that all pregnant individuals receive a COVID-19 vaccine [20]. Despite these recommendations, vaccine hesitancy will likely remain a factor in pregnant individuals' decision making about vaccination. An analysis of vaccine acceptance among this cohort during August–December 2020 prior to Emergency Use Authorization of

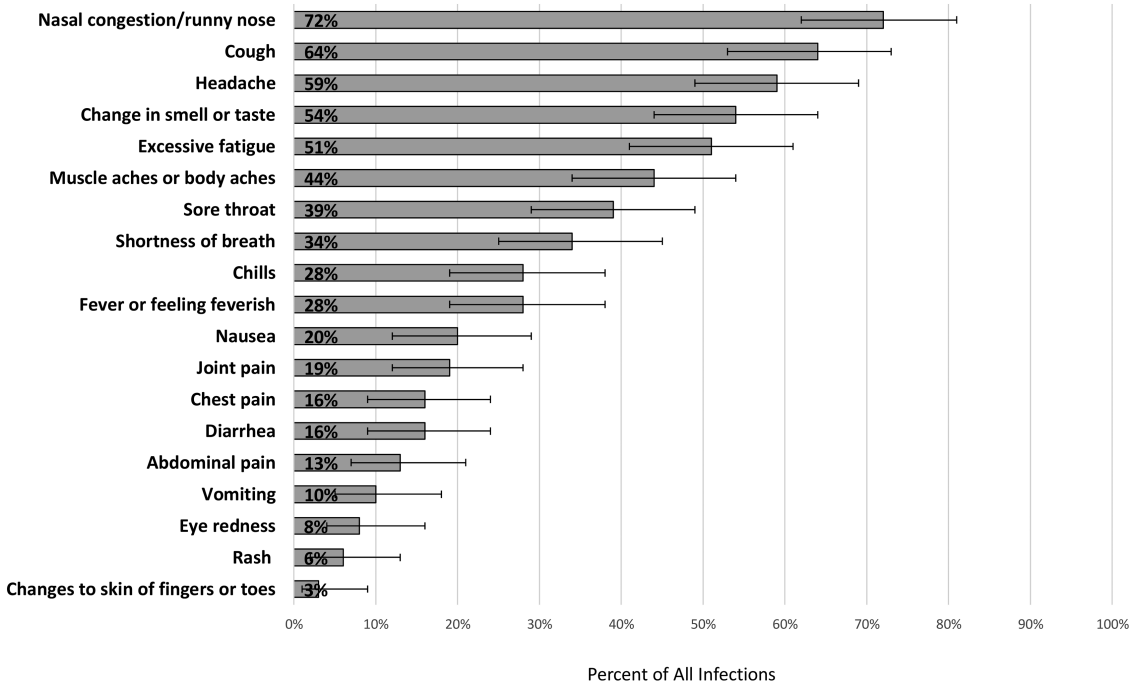

Figure 3. Symptom frequencies among pregnant individuals with incident SARS-CoV-2 infections in the Epidemiology of SARS-CoV-2 in Pregnancy and Infancy community cohort—September 2020–March 2021; n = 96 infections (excluding 3 symptomatic infections without detailed information about individual symptoms). Error bars denote 95% confidence intervals assuming a binomial distribution. Abbreviation: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2.

COVID-19 vaccines in the United States found that only 41% of participants would get a COVID-19 vaccine during pregnancy if given the opportunity [21]. Our findings suggest that pregnant individuals have a similar risk of becoming infected with SARS-CoV-2 compared with the general population, with almost 1 in 10 individuals in the cohort becoming infected during the study period. Although the SARS-CoV-2 infections in this study were largely self-limited, the long-term effects of SARS-CoV-2 infection and associated symptoms during pregnancy on perinatal and infant outcomes remain unclear [4, 22, 23]. Information from this study adds to the growing evidence base about SARS-CoV-2 infection during pregnancy that can inform counseling and risk communication for pregnant individuals as they make decisions about COVID-19 vaccination and other infection prevention measures, amidst evolving local guidance and mandates.

We estimated that 35% of SARS-CoV-2 infections during pregnancy are asymptomatic, which is consistent with findings from a meta-analysis of studies among adults of childbearing age with longitudinal follow-up (31%; 95% CI: 26–37%) [24]. This finding underscores the potential risks of SARS-CoV-2 transmission from pregnant individuals with asymptomatic infection to others in their households and community and the potential risks for horizontal transmission to their newborns. In addition, in this study, pregnant individuals residing in households with children aged 5–17 years had a higher risk of SARS-CoV-2 infection than those who did not, which may reflect an increased risk of infection from children in the home or differences in community social-mixing patterns among individuals with school-aged children.

Strengths of this study include enrollment of a large, demographically diverse community cohort of pregnant individuals, systematic surveillance and testing for asymptomatic and symptomatic SARS-CoV-2 infections, and a follow-up period that included periods of increased SARS-CoV-2 circulation at each study site. Cohort follow-up is ongoing and pregnancy outcomes will be reported once follow-up is complete. However, several study limitations should be considered. First, adherence rates to weekly swab specimen collection varied by site, and individuals who participated in surveillance differed from those who did not with respect to baseline characteristics and potential exposures that might influence the risk of SARS-CoV-2 infection. Thus, estimates of cumulative SARS-CoV-2 infection incidence should be considered minimum estimates and may not represent the range of risks among all pregnant individuals in the community. Second, the study sample size was selected to estimate infection incidence, and the analysis of risk factors for infection might have been underpowered to detect small effect sizes. In addition, 30% of participants were not included in the analysis examining the association between mask wearing and infection risk because they did not receive the monthly surveillance question about mask wearing due to a surveillance messaging error or did not respond to monthly surveillance contacts when the question was asked. Thus,

the absence of association between potential risk and protective factors and SARS-CoV-2 infection should be interpreted with caution.

Pregnant individuals in this study had a 1% risk of SARS-CoV-2 infection per week. Estimates of SARS-CoV-2 infection incidence among pregnant individuals in this study are similar to estimates among adults of child-bearing age in the general population. These findings, coupled with emerging data that pregnant individuals have an increased risk of some severe outcomes if infected with SARS-CoV-2 [1–4], provide information to inform counseling and risk communication for pregnant individuals making decisions about SARS-CoV-2 infection-prevention measures during the ongoing COVID-19 pandemic.

Supplementary Data

Supplementary materials are available at *Clinical Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

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Disclaimer. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention (CDC). Any references to specific commercial products are for identification purposes only and do not constitute an endorsement by CDC. CDC funded this study. CDC-affiliated authors were involved in study design, data collection, analysis and interpretation, report writing, and the decision to submit the paper for publication. The corresponding author had full access to all data used in the analysis and had final responsibility for the decision to submit for publication.

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