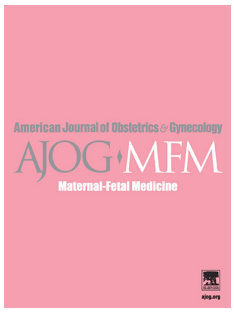

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Risk Factors for SARS-CoV2 Infection in Pregnant Women

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Condensation: In addition to previously identified risk factors, having living children at home represents a significant risk factor for infection with SARS-CoV2 among pregnant women.

Short Title: SARS-CoV2 Risk Factors in Pregnancy

AJOG at a Glance:

A. Why was the study conducted?

Risk factors for SARS-CoV2 infection in pregnancy remain poorly understood. Identifying those populations at heightened risk of acquisition is essential to effectively target outreach and prevention efforts.

B. What are the key findings?

Compared to women who tested negative for SARS-CoV2, women who tested positive were younger and were more likely to have public insurance, to identify as Black/African-American or Latina, to be unmarried, to be obese, have pre-existing pulmonary disease, and have living children. An increasing number of living children was associated with an increasing risk of SARS-CoV2 infection and this finding persisted after controlling for potential confounders.

C. What does this study add to what is already known?

In addition to previously identified risk factors, having living children at home represents a significant risk factor for infection with SARS-CoV2 among pregnant women.

Keywords: COVID-19, health disparities, perinatal epidemiology, social determinants of health

Abstract

Background: Risk factors for SARS-CoV2 infection in pregnancy remain poorly understood. Understanding populations at heightened risk of acquisition is essential to more effectively target outreach and prevention efforts.

Objective: To compare sociodemographic and clinical characteristics of pregnant women with and without SARS-CoV2 infection and, among those with SARS-CoV2, to compare characteristics of those who reported COVID-19 symptoms and those who were asymptomatic at diagnosis.

Study Design: This retrospective cohort study includes pregnant women who delivered or intended to deliver at Northwestern Memorial Hospital after initiation of a universal testing protocol on admission (April 8, 2020 - May 31, 2020). Women were dichotomized by whether they tested positive for SARS-CoV2. Among women who tested positive, women were further dichotomized by whether they endorsed symptoms of COVID-19. Bivariable analysis, and non-parametric tests of trend were used for analyses. Logistic regression was used to control for potential confounders as well as to examine effect modification between race and ethnicity and any other identified risk factors.

Results: During the study period, 1,418 women met inclusion criteria, of whom 101 (7.1%) tested positive for SARS-CoV2. Of the 101 women who tested positive, 77 (76.2%) were symptomatic at the time of diagnosis. Compared to women who tested

negative for SARS-CoV2, women who tested positive were younger and were more likely to have public insurance, to identify as Black/African-American or Latina, to be unmarried, to be obese, have pre-existing pulmonary disease, and have living children. An increasing number of living children was associated with an increasing risk of SARS-CoV2 infection and this finding persisted after controlling for potential confounders. There was no effect modification between race or ethnicity and having living children with regard to the risk of infection. There were no significant differences identified between women who were symptomatic and asymptomatic.

Conclusion: Many risk factors for SARS-CoV2 infection in pregnancy are similar to the social and structural determinants of health that have been reported in the general population. The observed association between SARS-CoV2 infection and having children raises the possibility of children themselves as vectors of viral spread or behavior patterns of parents as mediators of acquisition.

Introduction

Since December 2019, Coronavirus Disease 2019 (COVID-19) has spread rapidly throughout the world. It has now caused over fourteen million infections worldwide, with over three million infections in the United States[1,2]. Emerging antibody surveillance data have suggested that many individuals infected with severe acute respiratory syndrome coronavirus 2 (SARS-CoV2) do not manifest clinical symptoms. As such, many cases of the infection are thought to be as a result of spread from asymptomatic individuals[3,4]. Infection with SARS-CoV2 in pregnancy has been associated, in some studies, with higher rates of miscarriage, preterm birth, and preeclampsia[5]. The neonates born to women with SARS-CoV2 have been found to have higher rates of perinatal mortality and admission to the neonatal intensive care unit[5]. Accurately identifying pregnant women infected with SARS-CoV2 is imperative for appropriate management and treatment. Their identification also allows frontline healthcare workers to improve their protection and take precautions to mitigate the spread of the virus.

Little research has been conducted on risk factors for SARS-CoV2 infection specific to pregnant women. Whether observed associations in the general population apply to pregnant women, or whether unique risk factors can be identified specific to pregnant women, is unknown. For example, an overrepresentation of racial and ethnic minority groups in COVID-19 hospitalizations and deaths has been demonstrated in the general population[6,7]. However, whether these disparities remain true among pregnant women, who may have different behaviors and exposures, has not been investigated. The American College of Obstetrics and Gynecology (ACOG) recently called for health

institutions to collect data on SARS-CoV2 testing and outcomes that can recognize and examine the ways in which health care systems perpetuate racial inequalities in access to care and in health outcomes[8]. Robust research on these factors can help institutions determine the most efficient way to distribute scarce resources to those women most in need.

Public health interventions, such as school closures, have been shown to decrease the risk of community viral spread on a population level[9]. Epidemiologists have found that while children are less likely to exhibit SARS-CoV2 symptoms compared to adults[10,11], they also have more subtle presentations[11–13] and may spread disease to family members at home[14,15]. On an individual level, these data suggest that families with children at home, particularly families who are not able to physically distance, may be at higher risk of SARS-CoV2 acquisition. As many pregnant women in the United States have young children at home, they may be a particularly vulnerable population for SARS-CoV2 acquisition, but this association has not been previously evaluated.

Universal SARS-CoV2 testing among pregnant women represents an opportunity to better understand epidemiologic risk factors. As our hospital is a large volume center located in a high prevalence region of the United States, our objective was to leverage data ascertained from our testing policies to characterize the epidemiology of SARS-CoV2 infection overall, as well as symptomatic infection, among pregnant women.

Materials and Methods

Study Design

This retrospective cohort study includes pregnant women who were tested for SARS-CoV2 at Northwestern Memorial Hospital or affiliated outpatient clinics between March 19, 2020 and May 31, 2020. Northwestern Memorial Hospital is a tertiary care referral center in which approximately 12,000 deliveries are performed annually. Routine care during the entire study period was to perform systematic screening using a comprehensive list of reported symptoms for COVID-19, including fever, shortness of breath, cough, sore throat, body aches, chills, new onset vomiting, diarrhea, loss of taste or smell, or red or painful eyes.

Beginning on March 19, 2020, women who presented with clinical concern for COVID-19 underwent testing for SARS-CoV2. Universal point-of-care testing for SARS-CoV2 was performed for all women presenting for delivery or with pregnancy complications necessitating admission to the Labor & Delivery or Antepartum unit after April 8, 2020. During the time period of March 19 to April 7, 2020, women who were symptomatic and tested positive for SARS-CoV2 were included. During the time period of April 8 to May 19, 2020, all women who were tested for SARS-CoV2, including symptomatic and asymptomatic positive patients as well as patients who tested negative, were included. During the time period of May 20 to May 31, 2020, only women who tested positive for SARS-CoV2, both symptomatic and asymptomatic, were included. Women with scheduled admissions were tested 12-36 hours prior to the admission at a designated drive-through testing center using an in-house polymerase chain reaction (PCR)-based

platform with an 8-hour turnaround time. Women who presented in labor or with another unscheduled indication for admission were tested either in obstetric triage or on the Labor & Delivery unit using a commercially available PCR-based platform with a 2-3 hour turnaround time. Women who tested negative at admission but who developed possible symptoms of COVID-19 (e.g., an intrapartum fever without an alternative diagnosis) were retested as clinically indicated.

Testing was performed on nasopharyngeal specimens that were collected by registered nurses with special training in the proper collection and handling of the specimen.

Data Collection

Electronic health records were reviewed for all pregnant women identified to have a SARS-CoV2 test performed. Demographic and clinical data included maternal age, self-reported race/ethnicity, and insurance status. Medical history data included body mass index at delivery, tobacco use, and any identified maternal pre-existing disease (e.g., diabetes, hypertension, pulmonary disease). Obstetric data included parity (e.g., term births, preterm births, and living children). The systematic symptom assessment was entered into the EHR in a form completed by the admitting nurse and was abstracted to the database. Details of the SARS-CoV2 testing platform utilized, as well as test results, were also abstracted. Data were entered into the research electronic data capture system (REDCap)[16] and missing or aberrant data were re-reviewed by systematic assessment of the database.

Statistical Analysis

Women were dichotomized by their SARS-CoV2 test results. For women who tested positive, they were further dichotomized by whether they exhibited any symptoms of COVID-19 on the systematic review. Bivariable analyses were used to compare the clinical characteristics associated with women who did and did not test positive for SARS-CoV2. Mann Whitney U tests were used for continuous variables and chi squared or Fisher's exact tests were used for categorical variables. A non-parametric test of trend was performed to identify whether an increasing number of children was associated with SARS-CoV2 positivity.

Logistic regression was performed to control for potential confounders in the relationship between having children and SARS-CoV2 infection. Race, ethnicity, public insurance, and marital status ultimately reflect overlapping constructs without direct biological mechanisms for SARS-CoV2 acquisition. Accordingly, only insurance was included in the primary model as it was felt to best reflect social and structural determinants of health. This regression otherwise included variables associated with SARS-CoV2 infection in bivariable analysis with $p<0.05$. A sensitivity analysis was performed including all variables associated with SARS-CoV2 infection ($p<0.05$). Interaction terms were used to evaluate potential effect modification between race or ethnicity and having living children. Data were analyzed with Stata Version 15 (College Station, TX). This study was approved by the Northwestern University Institutional Review Board with a waiver of consent prior to its initiation.

Results

Patient Characteristics

During the study period, 1,510 SARS-CoV2 tests were performed on 1,418 unique pregnant women at Northwestern Memorial Hospital. Of these 1,418 women, 101 (7.1%) tested positive for SARS-CoV2. No patients declined SARS-CoV2 testing during the study period.

Women with SARS-CoV2 infection

The demographic characteristics of the cohort are presented in Table 1. Compared to women who tested negative, women who tested positive for SARS-CoV2 were younger and more likely to be publicly insured, to identify with a racial or ethnic minority group, and to be unmarried. In addition, women who tested positive for SARS-CoV2 were more likely to be obese and to have a pre-existing pulmonary disease. In terms of obstetric characteristics, women who tested positive for SARS-CoV2 were less likely to be nulliparous and, accordingly, were more likely to have living children. Furthermore, an increasing number of living children was associated with an increased prevalence of SARS-CoV2 infection (Figure 1, $p<0.001$ for test of trend). Specifically, compared to women without any living children, women with more living children exhibited an increasing odds of testing positive for SARS-CoV2 [OR 2.5 (95% CI 1.5-4.0); OR 2.1 (95% CI 1.0-4.1); OR 4.1 (95% CI 1.6-10.5); OR 7.0 (95% CI 2.8-17.7), for having 1, 2, 3, or at least 4 living children, respectively).

In multivariable analyses of the relationship between having living children and SARS-CoV2 infection (including maternal age, insurance, obesity, and pulmonary disease as potential confounders), having living children remained significantly associated with SARS-CoV2 infection (Table 2). Inclusion of all variables in the model that were significantly associated with SARS-CoV2 infection did not substantively change the association (aOR 2.29, 95% CI 1.11-4.74). There was no significant effect modification between race or ethnicity and number of living children with respect to SARS-CoV2 infection.

Demographics of asymptomatic women with SARS-CoV2 infection

Among women diagnosed with SARS-CoV2, 77 (76.2%) were symptomatic upon presentation (Table 3). Importantly, these data included epochs wherein only women with overt symptoms of COVID-19 could be tested for SARS-CoV2. Accordingly, 76.2% is not reflective of population level symptom prevalence. No significant differences between women who presented with and without symptoms were found in terms of maternal age, use of public insurance, nulliparity, number of living children, race, ethnicity, marriage status, BMI at delivery, rates of obesity, tobacco use, presence of any maternal chronic disease, rates of pre-existing diabetes, rates of hypertension, rates of pulmonary disease, and rates of gestational diabetes.

Discussion

Principal Findings

In this large observational cohort of pregnant women tested for SARS-CoV2 in an epidemiologic epicenter within the United States, we identified several risk factors for SARS-CoV2 infection including identifying with a racial or ethnic minority subgroup or having living children. SARS-CoV2 has previously been documented to disproportionately affect racial and ethnic minorities[17], but to the best of our knowledge, this is the first study that identifies these associations in pregnant women. Moreover, this is the first study to identify having living children as a risk factor for SARS-CoV2 infection.

Results and Clinical Implications

These data demonstrate that women with living children at home were more likely to be infected with SARS-CoV2. Although children make up only 1-2% of all known SARS-CoV2 cases[14], their presentation is often more subtle and may be missed, potentially allowing them to act as vectors of asymptomatic spread. Of children with SARS-CoV2, 5-7% are asymptomatic, and 51-65% have only routine upper respiratory symptoms without cough or auscultatory abnormalities[10,18]. Of children who are symptomatic, the presentation typically includes fever, but they are otherwise less visibly ill and their symptoms are often atypical[12]. A recent clinical report describes five children in China who were originally admitted for non-respiratory symptoms, but ultimately tested positive for SARS-CoV2. In this report, four out of the five children studied had GI symptoms as the first manifestation of disease, raising the possibility SARS-CoV2 may not be identified in children at symptom onset[13]. Ultimately, the average number of secondary infections transmitted within a family when a child is diagnosed with SARS-

CoV2 is 2.4[12]. These data become increasingly important in the context of discussions on school and daycare re-opening across the United States. A recent study from South Korea demonstrated that young children with COVID-19 (under age 10) were roughly half as likely to spread the infection to others, but older children (ages 10 to 19) were more likely to infect other household contacts compared to adults[15]. We do not have the age of living children available in our data, and so we are unable to assess whether the age of living children moderates the observed risk. In addition, we are unable to assess whether it is the number of children within the household itself that is a risk factor for SARS-CoV2 acquisition, or whether the number of children at home is a surrogate marker for other structural determinants of health such as decreased capacity to physically distance within the home or increased exposures outside of the home to support the needs of the family. These findings suggest that having children at home may partially explain the increased rate of infection amongst women with living children. While causal attribution cannot be made, the finding of an increasing prevalence of SARS-CoV2 infection with increasing numbers of living children suggests that children may contribute to viral spread among pregnant women.

Other data has shown that the COVID-19 pandemic is disproportionately affecting individuals who identify as a racial or ethnic minority[19]. This relationship has been demonstrated in other pandemics, including the 1918 and 2009 influenza pandemics[20,21]. Individuals who identify as a minority race or ethnicity may have less of an opportunity to engage in public health prevention strategies due to social and structural determinants of health. One example of this pertains to differences in occupations. According to CDC

data, racial/ethnic minority populations in the United States workforce are overrepresented in essential industries. Nearly a quarter of employed Latino/a and Black or African-American workers are employed in service industry jobs as compared to 16% of non-Hispanic white workers[22]. These workers may not be as readily able to practice risk-reducing social distancing behavior or work from home, increasing their likelihood of exposure to SARS-CoV2. Additionally, they may work within industries that are less likely to have benefits such as paid sick leave[22], a measure proven to mitigate contagion of viral respiratory illnesses[23,24]. Alternatively, the number of living children may reflect a higher household density, independent of children themselves as a vector. This may inhibit ability of pregnant women to social distance and isolate children infected with SARS-CoV2. Finally, residential segregation by race or ethnicity may also contribute to disparities in SARS-CoV2 prevalence.

These data also reinforce prior findings that SARS-CoV2 infection cannot be reliably identified based on symptomatic screening alone[25,26]. Universal testing for pregnant women being admitted for labor should be considered in areas of high disease burden as symptomatic screening alone is insufficient to identify all women with SARS-CoV2 infection.

Strengths & Limitations

An important strength of this study is the large sample size with a relatively high prevalence of SARS-CoV2 infection in our geographic region. However, this study is also subject to limitations. First, these data are limited to a single tertiary care center, and

293 may not be generalizable to other populations. Our data may differ from other institutions
294 given the differences in patient populations between institutions. Future work in other
295 settings may uncover other risk factors not observed in our cohort. Larger multi-center
296 studies focused on pregnant women are an important next step in epidemiologic analyses.
297 Secondly, SARS-CoV2 PCR assays have a wide range of measured false negative rates.
298 A case report has been published that describes a negative nasopharyngeal SARS-CoV2
299 reverse transcriptase (RT) PCR test followed by positive SARS-CoV2 RT PCR using a
300 bronchoalveolar lavage specimen in a pregnant woman[27]. False negative rates of 17-63%
301 have been reported when using this test in the non-pregnant population[28,29]. While false
302 negative results would potentially reduce the order of magnitude of identified risk factors,
303 they should not systematically bias our results. Next, this study uses the living children
304 component of parity as a proxy for living children in the home and thus does not account
305 for all social contexts, for example women with children in foster care or children of
306 other family members residing in the home. However, as these contexts are unlikely to
307 systematically bias the associations observed and are epidemiologically uncommon, we
308 do not think the use of this proxy substantially altered the true association. Finally, as
309 symptoms were recorded in a designated form at the time of admission, the possibility
310 remains that there are lapses in this recording system, and thus, women who are classified
311 as asymptomatic did have atypical or mild symptoms or developed symptoms after their
312 admission. Given the novel nature of the COVID-19 pandemic, not all information
313 regarding the virus, disease presentation, or disease progression are known and
314 misclassification remains possible. This study spans a timeframe of April and May 2020,
315 a period of rapid dissemination of infection across Chicago[7] and a time when school

316 closures were common. Thus, these data may not necessarily be transposable to earlier or
317 later epochs of the pandemic or in areas where other public health strategies were
318 implemented.
319
320 *Research Implications*

321 The identified association between having living children and SARS-CoV2 infection
322 augments growing concern that asymptomatic or mildly symptomatic children may
323 contribute to disease spread. As pregnant women are a population with a disproportionate
324 exposure to young children at home, future research should corroborate this association
325 and evaluate interventions targeted for multiparous women, such as augmented public
326 health messaging about hand-washing and the utilization of masks to prevent airborne
327 transmission.

328 *Conclusions*

329 This study reinforces the significant racial and ethnic disparities that exist in SARS-CoV2
330 infections among pregnant women and the critical need for public health interventions to
331 combat them. Currently, Chicago's Racial Equity Rapid Response Team (RERRT)
332 strives to address COVID-19 related disparities with targeted interventions[30]. RERRT
333 aims to increase testing in Southside Chicago, host virtual town halls in underserved
334 neighborhoods, and overall lessen the burden that this unprecedented public health crisis
335 has created for Chicago's racial and ethnic minority groups. Similar community efforts
336 focused on health equity will be important to attempt to mitigate the observed disparities.

337 In addition to recognizing the racial and ethnic disparities in identified SARS-CoV2

infections, obstetric clinicians must consider how changes in obstetric care delivery for women diagnosed with SARS-CoV2 may disproportionately affect socially vulnerable or disadvantaged women[31]. Awareness of the epidemiologic factors associated with SARS-CoV2 infection in pregnancy and the corresponding disparities that exist is the requisite first step to improving health equity. The onus is on us to ensure it is not the only step.

References

1. World Health Organization. *COVID-19 Situation Report - 183*.; 2020. Accessed July 22, 2020. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports

2. CDC. Coronavirus Disease 2019 (COVID-19) in the U.S. Centers for Disease Control and Prevention. Published 2020. Accessed July 22, 2020. https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/cases-in-us.html

3. Arons M, Hatfield K, Reddy S, Kimball A. Presymptomatic SARS-CoV-2 Infections and Transmission in a Skilled Nursing Facility. *N Engl J Med*. Published online April 24, 2020. Accessed May 14, 2020. https://www-nejm-org.ezproxy.galter.northwestern.edu/doi/full/10.1056/NEJMoa2008457

4. Office of Governor Andrew M. Cuomo. Amid Ongoing COVID-19 Pandemic, Governor Cuomo Announces Results of Completed Antibody Testing Study of 15,000 People Showing 12.3 Percent of Population Has COVID-19 Antibodies [Press Release]. Published online May 2, 2020. Accessed May 14, 2020. https://www.governor.ny.gov/news/amid-ongoing-covid-19-pandemic-governor-cuomo-announces-results-completed-antibody-testing

5. Di Mascio D, Khalil A, Saccone G, et al. Outcome of coronavirus spectrum infections (SARS, MERS, COVID-19) during pregnancy: a systematic review and meta-analysis. *Am J Obstet Gynecol MFM*. Published online March 25, 2020:100107. doi:10.1016/j.ajogmf.2020.100107

6. APM Research Lab Staff. *The Color of Coronavirus: COVID-19 Deaths by Race and Ethnicity in the U.S.* APM Research Lab; 2020. Accessed May 14, 2020. https://www.apmresearchlab.org/covid/deaths-by-race

7. Illinois Department of Public Health. *COVID-19 Statistics*. IDPH; 2020. Accessed May 14, 2020. https://www.dph.illinois.gov/covid19/covid19-statistics

8. American College of Obstetricians and Gynecologists. Position Statement: Addressing Health Equity During the COVID-19 Pandemic. Published online May 11, 2020. Accessed May 14, 2020. https://www.acog.org/en/Clinical Information/Policy and Position Statements/Position Statements/2020/Addressing Health Equity During the COVID-19 Pandemic

9. Ferguson NM, Cummings DAT, Fraser C, Cajka JC, Cooley PC, Burke DS. Strategies for mitigating an influenza pandemic. *Nature*. 2006;442(7101):448-452. doi:10.1038/nature04795

10. Dong Y, Mo X, Hu Y, et al. Epidemiology of COVID-19 Among Children in China. *Pediatrics*. Published online March 31, 2020. doi:10.1542/peds.2020-0702

11. Di Nardo M, van Leeuwen G, Loreti A, et al. A literature review of 2019 novel coronavirus (SARS-CoV2) infection in neonates and children. *Pediatr Res*. Published online July 17, 2020:1-12. doi:10.1038/s41390-020-1065-5

12. Xu Y, Li X, Zhu B, et al. Characteristics of pediatric SARS-CoV-2 infection and potential evidence for persistent fecal viral shedding. *Nat Med*. 2020;26(4):502-505. doi:10.1038/s41591-020-0817-4

13. Cai X, Ma Y, Li S, Chen Y, Rong Z, Li W. Clinical Characteristics of 5 COVID-19 Cases With Non-respiratory Symptoms as the First Manifestation in Children. *Front Pediatr*. 2020;8. doi:10.3389/fped.2020.00258

14. She J, Liu L, Liu W. COVID-19 epidemic: Disease characteristics in children. *J Med Virol*. Published online March 31, 2020:1-8. doi:10.1002/jmv.25807

15. Park YJ, Choe YJ, Park O, et al. Contact Tracing during Coronavirus Disease Outbreak, South Korea, 2020 (Early Release). *Emerg Infect Dis*. 2020;26(10). doi:10.3201/eid2610.201315

16. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research Electronic Data Capture (REDCap) - A metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377-381. doi:10.1016/j.jbi.2008.08.010

17. Laurencin CT, McClinton A. The COVID-19 Pandemic: a Call to Action to Identify and Address Racial and Ethnic Disparities. *J Racial Ethn Health Disparities*. Published online April 18, 2020:1-5. doi:10.1007/s40615-020-00756-0

18. Chan JF-W, Yuan S, Kok K-H, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: a study of a family cluster. *The Lancet*. 2020;395(10223):514-523. doi:10.1016/S0140-6736(20)30154-9

19. Centers for Disease Control. COVID-19 in Racial and Ethnic Minority Groups. *Cent Dis Control Prev*. Published online April 22, 2020. Accessed May 14, 2020.

https://www.cdc.gov/coronavirus/2019-ncov/need-extra-precautions/racial-ethnic-minorities.html

20. Grantz KH, Rane MS, Salje H, Glass GE, Schachterle SE, Cummings DAT. Disparities in influenza mortality and transmission related to sociodemographic factors within Chicago in the pandemic of 1918. *Proc Natl Acad Sci U S A*. 2016;113(48):13839-13844. doi:10.1073/pnas.1612838113

21. Centers for Disease Control and Prevention. 2009 Pandemic Influenza A (H1N1) Virus Infections --- Chicago, Illinois, April--July 2009. *Morb Mortal Wkly Rep*. 2009;58(33). Accessed May 14, 2020. https://www.cdc.gov/mmwr/preview/mmwrhtml/mm5833a1.htm

22. U.S. Bureau of Labor Statistics. Labor force characteristics by race and ethnicity, 2018. Published October 2019. Accessed May 14, 2020. https://www.bls.gov/opub/reports/race-and-ethnicity/2018/home.htm

23. Heymann J, Raub A, Waisath W, et al. Protecting health during COVID-19 and beyond: A global examination of paid sick leave design in 193 countries. *Glob Public Health*. Published online May 12, 2020:1-10. doi:10.1080/17441692.2020.1764076

24. Kumar S, Grefenstette JJ, Galloway D, Albert SM, Burke DS. Policies to Reduce Influenza in the Workplace: Impact Assessments Using an Agent-Based Model. *Am J Public Health*. 2013;103(8):1406-1411. doi:10.2105/AJPH.2013.301269

25. Miller ES, Grobman WA, Sakowicz A, Rosati J, Peaceman AM. Clinical Implications of Universal Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) Testing in Pregnancy. *Obstet Gynecol*. 2020;Publish Ahead of Print. doi:10.1097/AOG.0000000000003983

26. Lokken EM, Walker CL, Delaney S, et al. Clinical Characteristics of 46 Pregnant Women with a SARS-CoV-2 Infection in Washington State. *Am J Obstet Gynecol*. Published online May 2020:S0002937820305585. doi:10.1016/j.ajog.2020.05.031

27. Kelly JC, Dombrowksi M, O'neil-Callahan M, Kernberg AS, Frolova AI, Stout MJ. False-Negative COVID-19 Testing: Considerations in Obstetrical Care. *Am J Obstet Gynecol MFM*. Published online April 28, 2020:100130. doi:10.1016/j.ajogmf.2020.100130

28. Long C, Xu H, Shen Q, et al. Diagnosis of the Coronavirus disease (COVID-19): rRT-PCR or CT? *Eur J Radiol*. 2020;126:108961. doi:10.1016/j.ejrad.2020.108961

29. Li Y, Yao L, Li J, et al. Stability issues of RT-PCR testing of SARS-CoV-2 for hospitalized patients clinically diagnosed with COVID-19. *J Med Virol*. Published online March 26, 2020. doi:10.1002/jmv.25786

30. Office of Mayor Lori E. Lightfoot. Mayor Lightfoot and the Racial Equity Rapid Response Team Announce Latest Efforts to Address Racial and Health Disparities Among Minority Communities. Published online April 20, 2020. Accessed May 14, 2020.

https://www.chicago.gov/content/city/en/depts/mayor/press_room/press_releases/2020/april/RERRTUpdate.html

31. Onwuzurike C, Meadows AR, Nour NM. Examining Inequities Associated With Changes in Obstetric and Gynecologic Care Delivery During the Coronavirus Disease 2019 (COVID-19) Pandemic. *Obstet Gynecol*. Published online April 30, 2020. doi:10.1097/AOG.0000000000003933

457 **Table 1: Maternal Characteristics Stratified by SARS-CoV2 Infection Status**

Maternal Characteristic	SARS-CoV2 Status		p-value
	SARS-CoV2 negative n=1317	SARS-CoV2 positive n=101	
Maternal age (y)	33.7 (30.9-36.3)	30.6 (26.2-33.3)	<0.001
Public insurance (n=1408)	218 (16.7%)	62 (62.0%)	<0.001
Race (n=1417)			<0.001
Asian	104 (7.9%)	3 (3.0%)	
Black or African American	141 (10.7%)	28 (28.0%)	
White	772 (58.6%)	23 (23.0%)	
Other/unknown	300 (22.8%)	46 (46.0%)	
Latina ethnicity (n=1341)	244 (19.7%)	53 (53.5%)	<0.001
Married	1027 (78.0%)	40 (39.6%)	<0.001
BMI at delivery (kg/m2) (n=1307)	29.8 (26.9-33.3)	32.3 (28.9-34.6)	0.002
Obesity (n=1307)	603 (48.0%)	35 (70.0%)	0.002
Tobacco use (n=1413)			
Never	1181 (89.8%)	89 (90.8%)	0.50
Past	119 (9.1%)	7 (7.1%)	
Current	15 (1.1%)	2 (2.0%)	
Any maternal chronic disease (n=1412)	452 (34.3%)	42 (44.2%)	0.051
Pre-existing diabetes	20 (1.5%)	1 (1.0%)	1.00
Hypertension	56 (4.3%)	7 (6.9%)	0.21
Pulmonary disease	179 (13.6%)	22 (21.8%)	0.023
Gestational diabetes (n=1314)	87 (6.9%)	6 (12.8%)	0.12
Nulliparous (n=1415)	677 (51.5%)	30 (30.0%)	<0.001
Any living children (n=1415)	622 (47.3%)	70 (70.0%)	<0.001
Number of living children	0 (0-1)	1 (0-1)	<0.001

458 BMI=body mass index

459 Data presented as median (interquartile range) or n (%)

460

461 **Table 2: Multivariable Analyses for the Outcome of SARS-CoV2 Infection Status**

Maternal Characteristic	Odds Ratio	95% CI	Adjusted Odds Ratio*	95% CI
Maternal age (y)	0.89	0.84-0.94	0.94	0.88-1.01
Public insurance	8.15	5.31-12.53	4.38	2.03-9.48
Race				
Asian	0.96	0.29-3.28	---	---
Black or African American	6.67	3.73-11.91	---	---
White	ref	ref	---	---
Other/unknown	5.15	3.07-8.64	---	---
Latina ethnicity	4.71	3.10-7.17	---	---
Married	0.18	0.12-0.28	---	---
Obesity	2.53	1.36-4.68	1.65	0.82-3.31
Pulmonary disease	1.77	1.08-2.91	1.58	0.78-3.23
Any living children	2.60	1.67-4.04	2.33	1.13-4.78

462 *Model includes maternal age, insurance, obesity, pulmonary disease, and living children

463 **Table 3: Maternal Characteristics by Symptom Presentation**

Maternal Characteristic	Symptoms Present		p-value
	Asymptomatic n=24	Symptomatic n=77	
Maternal age (y)	31.0 (26.2-33.3)	30.4 (25.9-35.6)	0.84
Public insurance	17 (70.8%)	45 (59.2%)	0.31
Nulliparous	6 (25.0%)	24 (31.6%)	0.54
Any living children	18 (75.0%)	52 (68.4%)	0.54
Number of living children	1 (1-2)	1 (0-1)	0.41
Race			0.15
Asian	0 (0.0)	3 (4.0%)	
Black or African American	11 (45.8%)	17 (22.4%)	
White	5 (20.8%)	18 (23.7%)	
Other/unknown	8 (33.3%)	38 (50.0%)	
Latina ethnicity	10 (41.7%)	43 (57.3%)	0.18
Married	6 (25.0%)	34 (44.2%)	0.09
BMI at delivery (kg/m2) (n=50)	31.2 (28.6-36.5)	32.7 (28.9-34.5)	0.96
Obesity (n=50)	16 (70.0%)	19 (70.4%)	0.95
Tobacco use (n=98)			0.81
Never	21 (91.3%)	68 (90.7%)	
Past	2 (8.7%)	5 (6.7%)	
Current	0 (0.0%)	2 (2.7%)	
Any maternal chronic disease (n=95)	11 (47.8%)	31 (43.1%)	0.69
Pre-existing diabetes	1 (4.2%)	0 (0.0%)	0.24
Hypertension	0 (0.0%)	7 (9.1%)	0.19
Pulmonary disease	5 (20.8%)	17 (22.1%)	0.90
Gestational diabetes (n=47)	2 (8.7%)	4 (16.7%)	0.67

464 BMI=body mass index

465 Data presented as median (interquartile range) or n (%)

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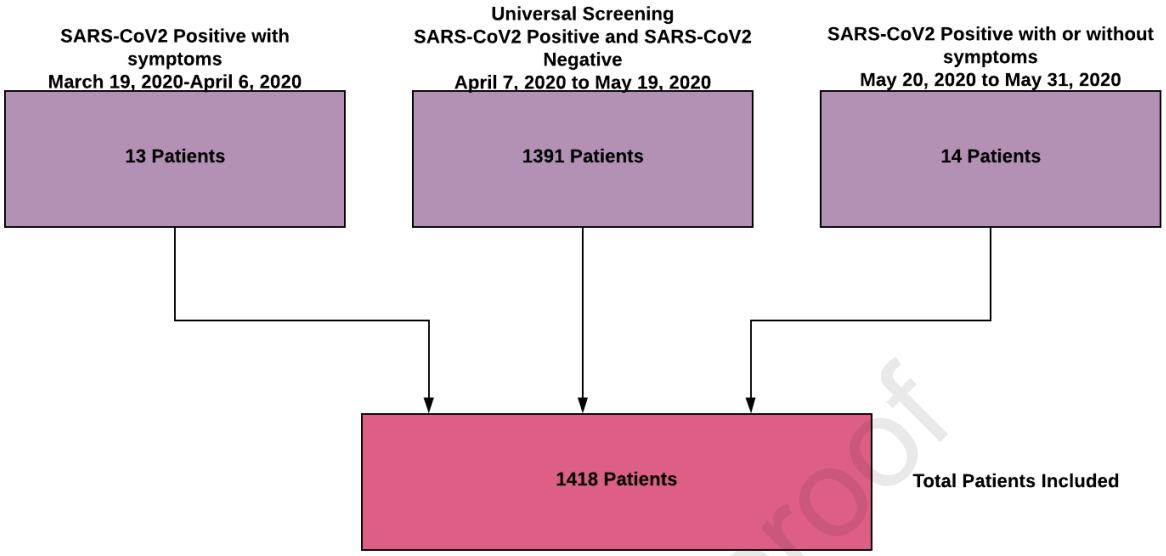
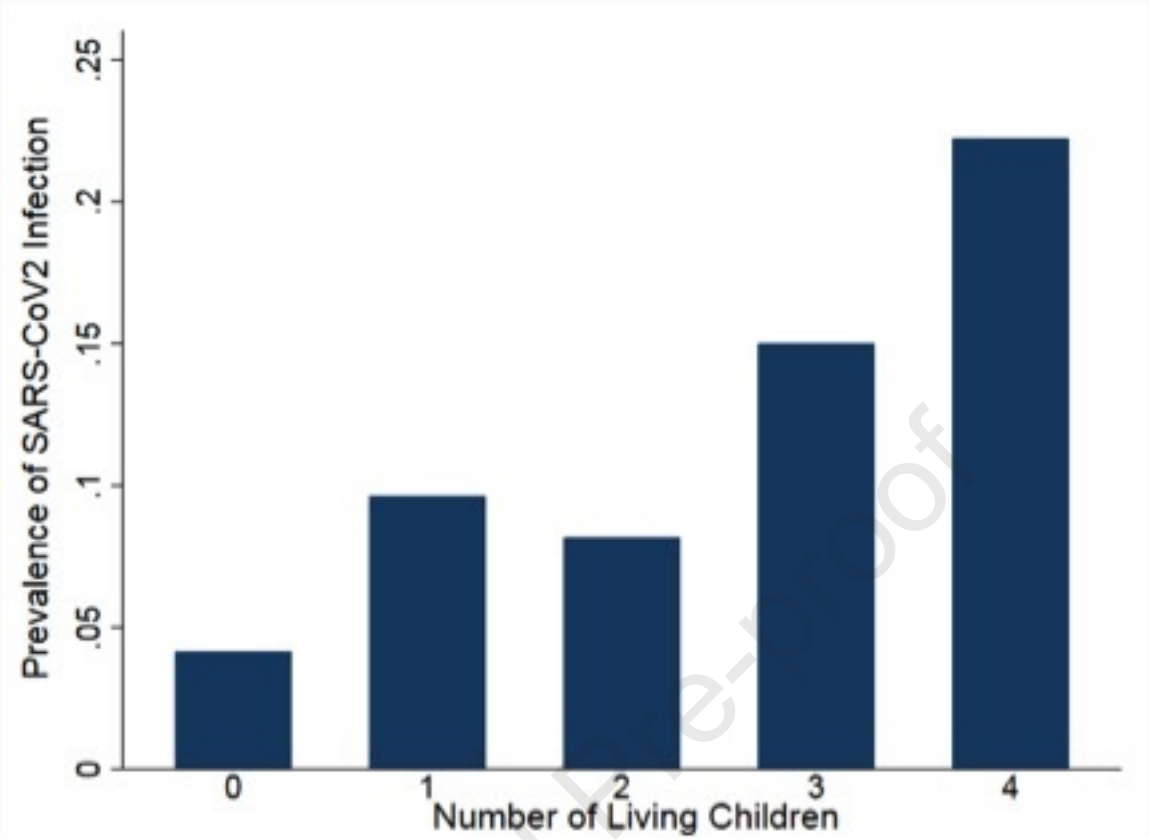
Figure 1: Prevalence of SARS-CoV2 infection stratified by the number of living children

474 **Figure 2: Timeline of study recruitment**
475





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Corresponding author: Allie Sakowicz

Authors may either sign the same form or submit individually

I am an author on this submission, have adhered to all editorial policies for submission as described in the Information for Authors, attest to having met all authorship criteria, and all potential conflicts of interest / financial disclosures appears on the title page of the submission.

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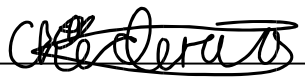
Signature: 

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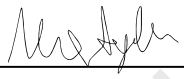
Signature: 

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