Sexual and Reproductive Health Outcomes Among Adolescent Females During the COVID-19 Pandemic

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abstract

BACKGROUND AND OBJECTIVES: Coronavirus disease 2019 (COVID-19) posed a significant threat to adolescents' sexual and reproductive health. In this study, we examined population-level pregnancy and sexual health-related care utilization among adolescent females in Ontario, Canada during the pandemic and evaluated relationships between these outcomes and key sociodemographic characteristics.

METHODS: This was a population-based, repeated cross-sectional study of >630 000 female adolescents (12–19 years) during the prepandemic (January 1, 2018–February 29, 2020) and COVID-19 pandemic (March 1, 2020–December 31, 2022) periods. Primary outcome was pregnancy; secondary outcomes were contraceptive management visits, contraception prescription uptake, and sexually transmitted infection (STI) management visits. Poisson models with generalized estimating equations for clustered count data were used to model pre-COVID-19 trends and forecast expected rates during the COVID-19 period. Absolute rate differences between observed and expected outcome rates for each pandemic month were calculated overall and by urbanicity, neighborhood income, immigration status, and region.

RESULTS: During the pandemic, lower-than-expected population-level rates of adolescent pregnancy (rate ratio 0.87; 95% confidence interval [CI]:0.85–0.88), and encounters for contraceptive (rate ratio 0.82; 95% CI:0.77–0.88) and STI management (rate ratio 0.52; 95% CI:0.51–0.53) were observed. Encounter rates did not return to pre-pandemic rates by study period end, despite health system reopening. Pregnancy rates among adolescent subpopulations with the highest prepandemic pregnancy rates changed least during the pandemic.

CONCLUSIONS: Population-level rates of adolescent pregnancy and sexual health-related care utilization were lower than expected during the COVID-19 pandemic, and below-expected care utilization rates persist. Pregnancy rates among more structurally vulnerable adolescents demonstrated less decline, suggesting exacerbation of preexisting inequities.

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Dr Vandermorris conceptualized and designed the study, conducted data curation and formal analysis, acquired funding, provided project administration and supervision, and drafted the initial manuscript; Drs Toulany, Brown, and McKinnon conceptualized and designed the study and conducted data curation and formal analysis; Ms Tam contributed to data analysis and coordination of project administration; Drs Harrison, Begun, and Wigle contributed to the conceptualization of the study and data analysis; Ms Guan contributed to the curation of the data set, conducted formal analysis, and provided supervision; Ms Li curated the data set and conducted formal analysis; Ms Wang contributed to the curation of the data set; Mr Fu and Dr Stukel contributed to the methodology of the study; and all authors critically reviewed and revised the manuscript, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

WHAT'S KNOWN ON THIS SUBJECT: A limited number of studies examining small cohorts of adolescents have revealed that the COVID-19 pandemic was associated with decreased access to contraception, decreased sexually transmitted infection testing, higher sexually transmitted infection test positivity, and increased adolescent pregnancy rates.

WHAT THIS STUDY ADDS: This is the first population-level study to examine sexual and reproductive health outcomes and inequities among adolescent females during the COVID-19 pandemic and to investigate adolescent pregnancy rates during the pandemic in a high-income country.

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The coronavirus disease 2019 (COVID-19) pandemic and associated public health restrictions exposed and widened preexisting health inequities, disproportionately affecting structurally marginalized groups.[1–4] Significant pandemic-related implications for sexual and reproductive health (SRH) have been documented in both low-and-middle-income and high-income countries.[4–6] The impact of the pandemic on SRH service access and outcomes among adolescents assigned female at birth ("females") is only beginning to be identified.[7–13]

Globally, the COVID-19 pandemic posed a significant threat to adolescent SRH (ASRH),[14–16] influencing both distal and proximal determinants of this important facet of adolescent health. Distally, it disrupted fundamental aspects of normative adolescent developmental trajectories, resulting in alterations in peer and romantic interactions, differences in parental supervision, changes in risk-taking behavior, and increased potential exposure to relationship abuse.[14,17,18] Proximally, the pandemic reduced opportunities for comprehensive school-based sexual education and altered access to confidential health care, medication, and services.[14,15,19]

An ASRH outcome of particular importance is adolescent pregnancy. Risks for adolescent pregnancy in high-income countries encompass a number of intersecting structural vulnerabilities, including living in poverty, lower education, and other adverse early life experiences.[20,21] Outcomes associated with adolescent pregnancy can further compound these inequities and include elevated risk of substance use, poor educational attainment, exposure to violence, and poverty for both the adolescent parent and their offspring.[20,21]

With this study, we sought to examine changes in population-based rates of pregnancy and sexual health-related care utilization among female adolescents in a high-income country during the COVID-19 pandemic, and to evaluate the relationship of these outcomes with key sociodemographic characteristics, including rurality, neighborhood income quintile, immigration status, and geographic region. Determining trends in these outcomes during the pandemic and identifying potential disparities by key sociodemographic characteristics will be integral to efforts to mitigate the inequitable implications of COVID-19 for structurally vulnerable adolescent populations.[22]

METHODS

Study Design

This population-based, repeated cross-sectional study used deidentified linked health administrative data on all female adolescents (12–19 years) who are eligible for provincial health insurance (ie, a Canadian citizen, permanent resident, or convention refugee) residing in Ontario, Canada during the pre-pandemic period (January 1, 2018–February 29, 2020) and at different phases of the COVID-19 pandemic (March 1, 2020–December 31, 2022), employing a similar design to previous work.[23] Females aged 12 to 19 years as of January 1 of each year were defined as the study population. We excluded non-Ontario residents, those ineligible for the Ontario Health Insurance Plan (OHIP), individuals with invalid birth or death dates (eg, death before the index date) within the study period, and those with missing data on sex. We used health administrative databases housed at ICES, an independent, nonprofit research institute whose legal status under Ontario's health information privacy law allows it to collect and analyze health care and demographic data without consent for health system evaluation and improvement. This study adhered to the Strengthening the Reporting of Observational Studies in Epidemiology checklist for cross-sectional studies.[24]

Data Sources

Demographic information was drawn from the Registered Persons Database, Ontario's provincial health insurance registry, which includes date of birth, sex, and postal code. Using 2016 Canadian Census data, individual postal codes were linked to Census data to derive neighborhood income quintile.[25] Immigration status was obtained from the Ontario portion of Immigration, Refugees and Citizenship Canada's Permanent Resident Database. Rurality was identified by Statistics Canada's definition of residence in a region with <10 000 residents. The OHIP physician billings database was used to ascertain outpatient visits. Emergency department visits were obtained from the National Ambulatory Care Reporting System, hospitalizations from the Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD), and hospitalizations for obstetrical deliveries from the MOMBABY dataset, a linkage of maternal and newborn hospital birth records from the CIHI-DAD.[26] Contraceptive-related prescriptions covered under OHIP+, the provincial prescription drug coverage plan for individuals <24 years of age, were obtained from the Ontario Drug Benefits database.

Outcomes

The primary outcome was adolescent pregnancy, a composite outcome defined by the conception of pregnancies ending in abortion, miscarriage, stillbirth, or livebirth as recorded in health administrative data (International Classification of Diseases, procedural, or OHIP diagnostic or fee codes; Supplemental Table 2) and supplemented by data on health care encounters indicative of pregnancy (ie, prenatal ultrasounds, pregnancy-related outpatient care, pregnancy-related hospitalizations, or emergency department visits) to identify pregnancies without a recorded delivery in health administrative data (eg, miscarriages, abortions at private clinics) (Supplemental Table 3). Therein, conception dates were estimated by using recorded gestational age (based primarily on first-trimester ultrasound) when available or

the median of non-missing values by pregnancy type. Secondary outcomes were health care visits (virtual and in-person) for contraceptive management, uptake of prescription contraception covered by OHIP+, and health care visits (virtual and in-person) for sexually transmitted infection (STI) management (ie, diagnosis and treatment of a newly diagnosed STI; Supplemental Tables 4–6).

Exposure

The exposure was the pre-pandemic (January 1, 2018, to February 29, 2020) and COVID-19 pandemic periods (March 1, 2020 to December 31, 2022). Pregnancies were classified as pandemic-unexposed or -exposed on the basis of whether conception occurred before (January 1, 2018–February 29, 2020) or after the pandemic onset (March 1, 2020–February 28, 2022). Secondary outcomes were classified as pandemic-exposed if they occurred after March 1, 2020. Different phases of the pandemic were examined, with dates based on Ontario's pandemic reopening plan, to determine the potential effect of health and social system reopening. Phase 1 (March 1, 2020–September 30, 2021) began with the pandemic onset and ended with a return to in-person school in September 2021. Phase 2 extended from October 1, 2021 through December 31, 2022.

Covariates

We measured the following sociodemographic characteristics: urbanicity of residence, neighborhood income quintile (low-income: quintiles 1 and 2, vs moderate-/high-income: quintiles 3–5), immigration status (immigrant or refugee vs non-immigrant/non-refugee), and geographic region of residence according to Statistics Canada's aggregate census regions.[27]

Statistical Analysis

We quantified the monthly rates of adolescent pregnancies and all secondary outcomes per 1000 adolescent females from January 2018 to December 2022. Poisson models with generalized estimating equations for clustered count data were used to model the trend of 2-year pre-COVID-19 monthly outcome rates, with an offset of the log of the number of adolescent females. The unit of analysis was the age group-month stratum. The working correlation structure was AR(1) autocorrelation with a lag of 1 to account for correlations in outcome events over time. The pre-COVID-19 model included age group indicators, a continuous linear term of years since January 2018, to estimate the general trend in outcome rates through February 2020 and pre-COVID-19 month indicators to model monthly variations, with April as the reference month using similar methods as Saunders et al.[23] A significant policy change in the provincial prescription drug coverage plan occurred during the study's pre-pandemic period (April 1, 2019), after which those aged <24 years with private insurance coverage were no longer eligible for provincial coverage. We, therefore, added an indicator of policy change to the model on contraceptive uptake. We used the fitted models of pre-COVID-19 time trends to predict the expected outcome rates for each month from March 2020 to December 2022, except expected pregnancy conception rates, which were modeled up to February 2022 to allow for data availability and completeness thereafter to determine pregnancy outcome type.

For the primary analysis, we calculated the absolute rate differences and 95% confidence intervals (CIs) between observed and expected outcome rates for each pandemic month by subtracting observed rates from expected rates. Overall and monthly incidence rate ratios were quantified with 95% CIs, expressed as the ratio of observed to expected rates.

In addition, we examined our primary and secondary outcomes by 4 key sociodemographic characteristics: urbanicity, neighborhood income quintile, immigration status, and geographic region of residence. This involved extracting monthly rates for the outcomes by the strata of each sociodemographic variable and separately calculating the absolute rate differences and incidence rate ratios of observed versus expected rates after the pandemic onset within each stratum. We used the χ^2 test for statistical comparison of heterogeneity of the estimated incidence rate ratios for the entire COVID-19 period across the sociodemographic variables.

Ethics Approval

This study was approved by the Research Ethics Board of the Hospital for Sick Children (REB file #1000076956).

RESULTS

The sociodemographic characteristics of the study population remained consistent throughout the study period (Table 1). The annual population of adolescent females living in Ontario was ~640 000, with a mean age (SD) of 15.5 (2.3) years. The majority (90%) of adolescent females resided in an urban setting, with a relatively equal proportion living in neighborhoods at each income quintile. Approximately 10% were immigrants or refugees. Almost one-quarter resided in a single region (Central West), with only 5% living in the Northern region.

Pregnancy

In the pre-pandemic period, the mean monthly rate of adolescent pregnancies conceived was 0.82 per 1000 adolescent females. The mean monthly rates of live births and abortions were 0.32 per 1000 adolescent females and 0.39 per 1000 adolescent females, respectively. After the pandemic onset, the observed rate of adolescent pregnancies conceived in March 2020 fell below the expected rate (0.66 vs 0.80/1000 adolescent females, rate ratio 0.82; 95% CI:0.81–0.84; Fig 1A). Adolescent pregnancy rates remained lower than expected throughout the pandemic period, with

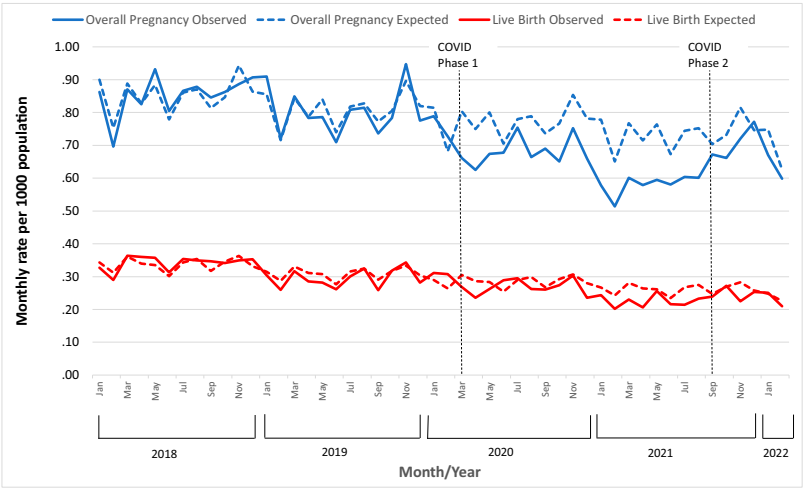
TABLE 1 Baseline Characteristics of Female Adolescents in Ontario, Canada					
Patient Characteristics	**January 1, 2018**	**January 1, 2019**	**January 1, 2020**	**January 1, 2021**	**January 1, 2022**
	n = 635 262	*n* = 638 560	*n* = 636 439	*n* = 644 053	*n* = 647 044
	Total (% of sample)	Total (% of sample)	Total (% of sample)	Total (% of sample)	Total (% of sample)
Age, y					
Mean (SD)	15.55 (2.30)	15.52 (2.30)	15.50 (2.30)	15.48 (2.30)	15.49 (2.28)
Age group, y					
12–15	311 660 (49.1%)	317 027 (49.6%)	318 768 (50.1%)	324 793 (50.4%)	325 600 (50.3%)
16–19	323 602 (50.9%)	321 533 (50.4%)	317 671 (49.9%)	319 260 (49.6%)	321 444 (49.7%)
Urbanicity					
Rural/remote residence	60 836 (9.6%)	60 582 (9.5%)	60 389 (9.5%)	61 421 (9.5%)	61 553 (9.5%)
Urban residence	571 737 (90.0%)	575 465 (90.1%)	573 960 (90.2%)	580 722 (90.2%)	583 388 (90.2%)
Missing	2689 (0.4%)	2513 (0.4%)	2090 (0.3%)	1910 (0.3%)	2103 (0.3%)
Neighborhood income quintile					
Quintile 1 (lowest)	115 902 (18.2%)	115 419 (18.1%)	112 910 (17.7%)	113 784 (17.7%)	113 889 (17.6%)
Quintile 2	113 018 (17.8%)	112 468 (17.6%)	111 213 (17.5%)	111 790 (17.4%)	112 428 (17.4%)
Quintile 3	124 509 (19.6%)	125 681 (19.7%)	126 023 (19.8%)	127 380 (19.8%)	128 416 (19.8%)
Quintile 4	133 530 (21.0%)	135 763 (21.3%)	137 359 (21.6%)	140 402 (21.8%)	141 290 (21.8%)
Quintile 5 (highest)	145 336 (22.9%)	146 454 (22.9%)	146 579 (23.0%)	148 522 (23.1%)	148 663 (23.0%)
Missing	2967 (0.5%)	2775 (0.4%)	2355 (0.4%)	2175 (0.3%)	2358 (0.4%)
Neighborhood income status					
Low income	228 920 (36.0%)	227 887 (35.7%)	224 123 (35.2%)	225 574 (35.0%)	226 317 (35.0%)
Moderate/high income	403 375 (63.5%)	407 898 (63.9%)	409 961 (64.4%)	416 304 (64.6%)	418 369 (64.7%)
Missing	2967 (0.5%)	2775 (0.4%)	2355 (0.4%)	2175 (0.3%)	2358 (0.4%)
Region					
Central East	126 440 (19.9%)	127 385 (19.9%)	128 254 (20.2%)	129 797 (20.2%)	130 023 (20.1%)
Central South	56 438 (8.9%)	56 209 (8.8%)	55 820 (8.8%)	56 684 (8.8%)	56 796 (8.8%)
Central West	147 441 (23.2%)	149 183 (23.4%)	149 088 (23.4%)	150 603 (23.4%)	150 685 (23.3%)
East	80 574 (12.7%)	81 226 (12.7%)	81 208 (12.8%)	82 993 (12.9%)	84 423 (13.0%)
North	36 217 (5.7%)	35 922 (5.6%)	35 622 (5.6%)	36 125 (5.6%)	36 162 (5.6%)
Southwest	74 727 (11.8%)	75 264 (11.8%)	75 080 (11.8%)	76 848 (11.9%)	77 286 (11.9%)
Toronto	111 022 (17.5%)	111 136 (17.4%)	109 525 (17.2%)	109 352 (17.0%)	109 820 (17.0%)
Missing	2403 (0.4%)	2235 (0.4%)	1842 (0.3%)	1651 (0.3%)	1849 (0.3%)
Immigration status					
Nonimmigrants/nonrefugees	561 271 (88.4%)	566 574 (88.7%)	567 641 (89.2%)	578 671 (89.8%)	585 717 (90.5%)
Immigrants	58 890 (9.3%)	56 144 (8.8%)	52 324 (8.2%)	49 009 (7.6%)	45 549 (7.0%)
Refugees	15 101 (2.4%)	15 842 (2.5%)	16 474 (2.6%)	16 373 (2.5%)	15 778 (2.4%)

an overall rate of 0.65/1000 adolescent females (rate ratio 0.87; 95% CI:0.85–0.88). This represents 10 fewer pregnancies than expected per 100 000 (95% CI:9–11), corresponding to a 13% reduction (Fig 1A). Pregnancy rates during phase 1 differed more from expected levels than rates during phase 2 (rate ratio 0.85; 95% CI:0.83–0.86 vs rate ratio 0.93; 95% CI:0.91–0.95). The rates of live births during the pandemic were slightly lower than expected with a rate ratio of 0.91 (95% CI:0.89–0.94; Fig 1A). The rates of abortion were lower than expected for March 2020 conceptions (0.30 vs 0.42/1000 adolescent females, rate ratio 0.73; 95% CI:0.72–0.73) and remained so throughout the pandemic period. Abortions accounted for a smaller than predicted proportion of all adolescent pregnancies during the pandemic (rate ratio 0.91; 95% CI:0.88–0.94; Fig 1B). The rates of pregnancy loss did not differ significantly from the expected rates (0.08/1000 adolescent females, rate ratio 0.97; 95% CI:0.87–1.08) but accounted for a higher-than-predicted proportion of all adolescent pregnancies (rate ratio 1.12; 95% CI: 1.02–1.23; Fig 1B) during the pandemic.

Contraception

The rates of contraceptive management visits dropped significantly after March 2020 (Fig 2). Before the pandemic onset, the mean monthly visit rates were 11.7 per 1000 adolescent females. In April and May 2020, the monthly visit rates were 7.3 per 1000 (rate ratio 0.63; 95% CI:0.62–0.65) and 7.7 per 1000 (rate ratio 0.63; 95% CI:0.61–0.65), respectively. Monthly visit rates rose slightly by June 2020; however, overall rates remained lower than expected throughout the pandemic period (9.2 vs 11.3/1000 adolescent females, rate ratio 0.82; 95% CI:0.77–0.88).

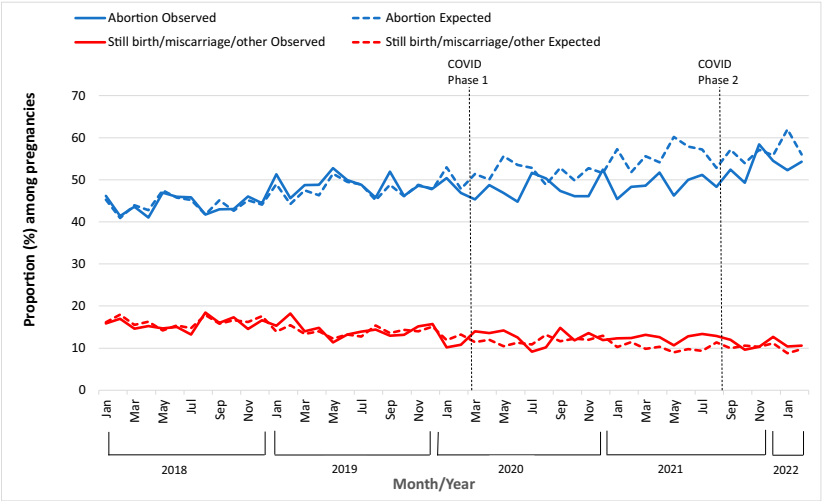
A



Month	Mar-20	May-20	Jul-20	Sep-20	Nov-20	Jan-21	Mar-21	May-21	Jul-21	Sep-21	Nov-21	Jan-22
Pregnancy Overall												
Observed rate	0.66	0.67	0.75	0.69	0.75	0.58	0.60	0.59	0.60	0.67	0.72	0.67
Expected rate	0.80	0.80	0.78	0.74	0.85	0.78	0.77	0.76	0.74	0.70	0.82	0.75
Adjusted Rate Ratio (95% CI)	0.82 (0.81, 0.84)	0.84 (0.84, 0.84)	0.97 (0.95, 0.99)	0.94 (0.94, 0.94)	0.88 (0.87, 0.89)	0.74 (0.74, 0.74)	0.78 (0.76, 0.80)	0.78 (0.78, 0.78)	0.81 (0.79, 0.83)	0.96 (0.95, 0.96)	0.88 (0.87, 0.90)	0.90 (0.89, 0.90)
Absolute Rate Difference (95% CI)	-0.14 (-0.16, -0.13)	-0.13 (-0.13, -0.12)	-0.03 (-0.04, -0.01)	-0.05 (-0.05, -0.05)	-0.10 (-0.11, -0.09)	-0.20 (-0.20, -0.20)	-0.17 (-0.19, -0.15)	-0.17 (-0.17, -0.17)	-0.14 (-0.16, -0.12)	-0.03 (-0.03, -0.03)	-0.09 (-0.11, -0.08)	-0.08 (-0.08, -0.07)

Month	Mar-20	May-20	Jul-20	Sep-20	Nov-20	Jan-21	Mar-21	May-21	Jul-21	Sep-21	Nov-21	Jan-22
Live Birth												
Observed rate	0.27	0.26	0.30	0.26	0.30	0.24	0.23	0.26	0.21	0.24	0.23	0.25
Expected rate	0.30	0.28	0.29	0.27	0.31	0.27	0.28	0.26	0.27	0.25	0.28	0.25
Adjusted Rate Ratio (95% CI)	0.88 (0.86, 0.90)	0.93 (0.91, 0.94)	1.02 (0.98, 1.05)	0.97 (0.96, 0.99)	0.99 (0.96, 1.02)	0.91 (0.91, 0.92)	0.82 (0.79, 0.84)	0.98 (0.97, 0.99)	0.80 (0.77, 0.84)	0.97 (0.94, 0.99)	0.80 (0.78, 0.81)	1.01 (0.99, 1.02)
Absolute Rate Difference (95% CI)	-0.04 (-0.04, -0.03)	-0.02 (-0.03, -0.02)	0.01 (-0.01, 0.02)	-0.01 (-0.01, -0.00)	-0.00 (-0.01, 0.01)	-0.02 (-0.03, -0.02)	-0.05 (-0.06, -0.04)	-0.00 (-0.01, -0.00)	-0.05 (-0.06, -0.04)	-0.01 (-0.01, -0.00)	-0.06 (-0.06, -0.05)	0.00 (-0.00, 0.01)

B

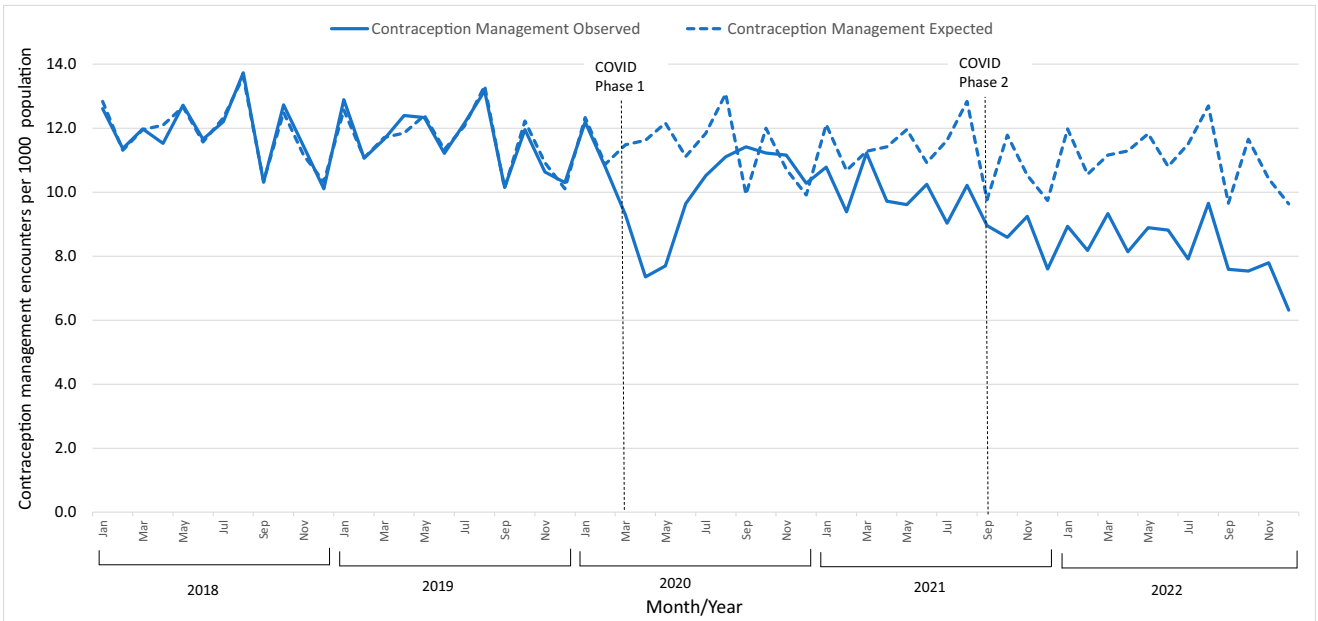


Month	Mar-20	May-20	Jul-20	Sep-20	Nov-20	Jan-21	Mar-21	May-21	Jul-21	Sep-21	Nov-21	Jan-22
Abortion												
Observed proportion	45.37	46.85	51.67	47.38	46.14	45.43	48.58	46.21	51.16	52.42	58.41	52.30
Expected proportion	51.39	55.60	52.85	52.81	52.79	57.30	55.60	60.15	57.19	57.14	57.12	61.97
Adjusted Rate Ratio (95% CI)	0.88 (0.87, 0.89)	0.84 (0.81, 0.88)	0.98 (0.95, 1.00)	0.90 (0.87, 0.93)	0.87 (0.87, 0.88)	0.79 (0.77, 0.82)	0.87 (0.85, 0.90)	0.77 (0.73, 0.81)	0.89 (0.86, 0.93)	0.92 (0.88, 0.96)	1.02 (1.00, 1.04)	0.84 (0.81, 0.88)
Absolute Rate Difference (95% CI)	-6.02 (-6.67, -5.38)	-8.75 (-10.92, -6.65)	-1.19 (-2.61, 0.20)	-5.43 (-7.24, -3.68)	-6.66 (-7.00, -6.31)	-11.87 (-13.62, -10.17)	-7.02 (-8.45, -5.63)	-13.94 (-17.10, -10.94)	-6.03 (-8.33, -3.82)	-4.71 (-7.44, -2.11)	1.29 (0.17, 2.38)	-9.67 (-12.38, -7.07)

Month	Mar-20	May-20	Jul-20	Sep-20	Nov-20	Jan-21	Mar-21	May-21	Jul-21	Sep-21	Nov-21	Jan-22
Stillbirth/miscarriage/other												
Observed proportion	14.01	14.22	9.17	14.81	13.57	12.37	13.18	10.71	13.37	12.01	10.34	10.37
Expected proportion	11.41	10.47	10.89	11.62	11.97	10.27	9.84	9.02	9.38	10.01	10.31	8.79
Adjusted Rate Ratio (95% CI)	1.23 (1.19, 1.26)	1.36 (1.14, 1.62)	0.84 (0.80, 0.88)	1.27 (1.20, 1.36)	1.13 (1.01, 1.28)	1.20 (1.10, 1.31)	1.34 (1.26, 1.43)	1.19 (0.96, 1.46)	1.42 (1.32, 1.54)	1.20 (1.09, 1.32)	1.00 (0.86, 1.17)	1.18 (1.04, 1.33)
Absolute Rate Difference (95% CI)	2.60 (2.26, 2.93)	3.75 (1.78, 5.42)	-1.72 (-2.22, -1.24)	3.19 (2.45, 3.88)	1.60 (0.08, 2.96)	2.10 (1.16, 2.96)	3.34 (2.69, 3.95)	1.69 (-0.40, 3.38)	3.99 (3.20, 4.71)	2.00 (0.99, 2.92)	0.03 (-1.70, 1.51)	1.58 (0.43, 2.59)

FIGURE 1

Observed and expected rates, rate ratios, and absolute rate differences of (A) overall pregnancies and live births per 1000 population and (B) abortions and still births/miscarriages/other per 100 pregnancies among adolescent females in Ontario from March 2020 to February 2022.



Month	Mar-20	Jun-20	Sep-20	Dec-20	Mar-21	Jun-21	Sep-21	Dec-21	Mar-22	Jun-22	Sep-22	Dec-22
Contraception Management												
Observed rate	15.14	22.24	16.29	15.80	14.86	13.71	12.33	12.25	12.45	12.15	10.67	10.18
Expected rate	15.27	15.73	14.20	15.54	15.80	16.27	14.69	16.08	16.46	16.95	15.30	16.74
Adjusted Rate Ratio*	0.99 (0.93,	1.41 (1.30,	1.15 (1.03,	1.02 (0.93,	0.94 (0.85,	0.84 (0.75,	0.84 (0.73,	0.76 (0.68,	0.76 (0.67,	0.72 (0.62,	0.70 (0.59,	0.61 (0.52,
(95% CI)	1.06)	1.54)	1.27)	1.11)	1.04)	0.95)	0.96)	0.86)	0.86)	0.83)	0.82)	0.71)
Absolute Rate Difference	-0.14 (-1.18,	6.51 (5.08,	2.09 (0.53,	0.26 (-1.18,	-0.94 (-2.53,	-2.57 (-4.59,	-2.36 (-4.47,	-3.83 (-5.85,	-4.01 (-6.21,	-4.80 (-7.48,	-4.63 (-7.35,	-6.56 (-9.24,
(95% CI)	0.84)	7.83)	3.50)	1.58)	0.51)	-0.77)	-0.52)	-2.04)	-2.06)	-2.48)	-2.31)	-4.25)

*Adjusted for age, year (linear time trend), and month (indicators for seasonal variation)

FIGURE 2

Observed and expected rates, rate ratios, absolute rate differences of contraception management encounters among adolescent females in Ontario from March 2020 to December 2022.

Contraception uptake rates pre-pandemic declined significantly from March to April 2019, because of a provincial policy change in eligibility criteria for prescription drug coverage (Fig 3). Pre-pandemic trends could, therefore, not be used to model anticipated pandemic rates. Aside from a minor increase in rates of prescription uptake from April to June 2020, no marked change in rates of contraception uptake was observed during the pandemic (Fig 3).

Sexually Transmitted Infections

Figure 4 depicts trends in encounters for STI management. After the onset of the pandemic, there was a steep decline in visit rates to a low of 0.65 per 1000 adolescent females in April 2020 (expected rate 2.1/1000, rate ratio 0.30; 95% CI:0.30–0.31, Fig 4). Monthly visit rates increased over the subsequent months; however, they remained much lower than expected for the duration of the pandemic period (1.2 vs 2.2 per 1000 adolescent females (rate ratio 0.52; 95% CI:0.51–0.53; Fig 4). The rate ratio during the second phase of the pandemic (0.46; 95% CI: 0.45–0.47) was greater than that during phase 1 (0.58; 95% CI: 0.56–0.59), indicating an even greater divergence from expected visit rates.

Sociodemographic Characteristics

Analyses were stratified by 4 key sociodemographic variables (Fig 5). Before the pandemic, the most marked differences in mean monthly pregnancy rates were between adolescents living in rural versus urban settings (1.31 vs 0.77/1000 adolescent females) and between those living in low-income neighborhoods versus moderate-/high-income neighborhoods (1.23 vs 0.59/1000 adolescent females). Nonimmigrant/non-refugee adolescents had higher pre-pandemic pregnancy rates than immigrant/refugee youth (0.83 vs 0.70/1000 adolescent females). Northern Ontario had the highest pre-pandemic pregnancy rate of all regions (1.76/1000 adolescent females; Fig 5A). During the pandemic period, pregnancy rates fell to less than expected for all adolescents. However, this decline was significantly less pronounced among youth in the groups with higher pre-pandemic pregnancy rates across all sociodemographic variables (eg, rate ratio 0.90; 95% CI:0.88–0.93 vs 0.83; 95% CI:0.80–0.86 in low-income vs high-income settings, $P < .001$), other than urbanicity. Of note, the decline in pregnancy rates among urban adolescents was significantly greater than the decline among rural adolescents (rate ratio 0.84; 95% CI 0.82–0.85

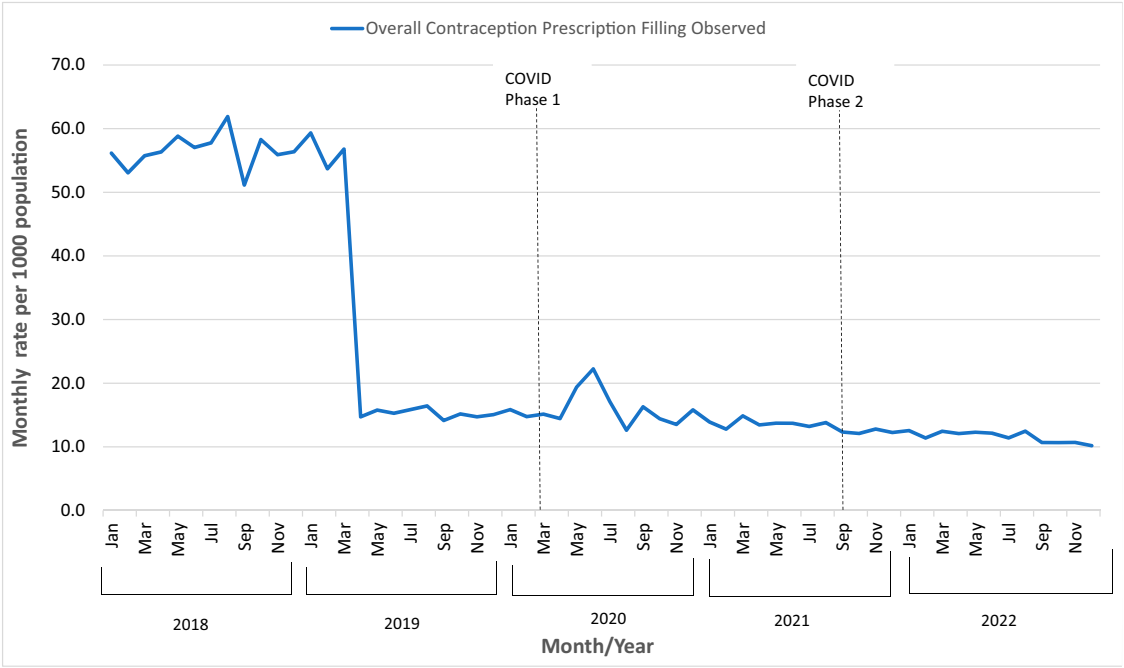


FIGURE 3

Observed rates of contraceptive prescriptions covered by the provincial prescription drug insurance plan and filled by adolescent females in Ontario from January 2018 to December 2022.

vs 0.93; 95% CI 0.85–1.01 urban vs rural, $P = .030$) during phase 1 of the pandemic, but not in phase 2.

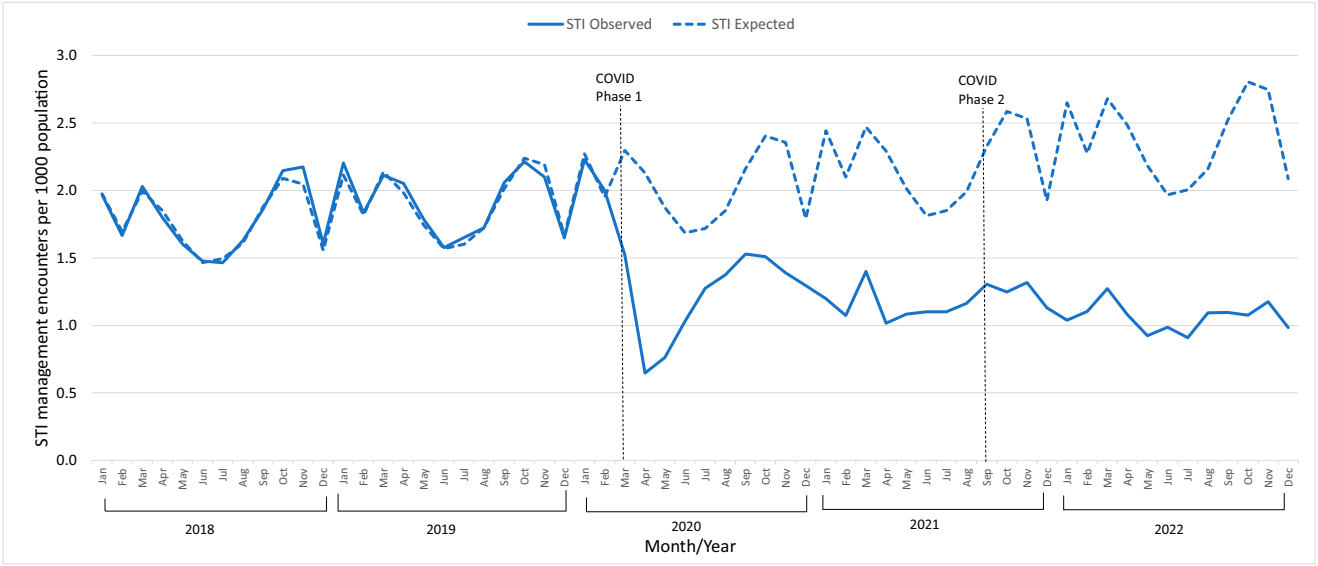
Contraception management visit rates during the pandemic did not differ significantly by any sociodemographic characteristic, although differences between non-immigrantand immigrant/refugee adolescents approached significance (Fig 5B). Visit rates for STI management during the pandemic changed differentially by neighborhood income status and geographic region, but not by urbanicity or immigration status (Fig 5C).

DISCUSSION

This study contributes novel information on trends in population-based ASRH outcomes during the COVID-19 pandemic in a high-income country. We found lower-than-expected rates of adolescent pregnancy and health care encounters for contraceptive and STI management during the COVID-19 pandemic. The rates of pregnancy for adolescents living in contexts associated with higher pre-pandemic pregnancy rates revealed less of a decline, suggesting a further exacerbation of preexisting inequities.

Although the findings of decreased access to sexual health-related services, such as contraception and STI management, are consistent with the anticipated consequences of pandemic-related restrictions,[2,28] the potential implications of the pandemic for adolescent pregnancy were more difficult to predict. Initially, several commentaries raised concerns regarding the potential for significant increases in unplanned pregnancies due to decreased access to both contraception and abortion services.[2,28] However, because adolescents are less likely than adults to cohabitate with their partners, others hypothesized that decreased access to sexual partners during pandemic-associated lockdowns would lead to reduced rates of sexual contact[11,14] and fewer resultant pregnancies.

The single published study on adolescent pregnancy rates during COVID-19 was conducted in Kenya. This study of 910 girls revealed a significant increase in the rate of adolescent pregnancy during the pandemic (10.9% of the COVID-19 cohort vs 5.2% of the pre-COVID-19 cohort). This increased incidence was thought to be associated with increased school disruption and dropout rates among adolescent females during the pandemic.[12] In contrast, our study of adolescent pregnancy trends in Canada indicates a significantly decreased adolescent pregnancy rate. The decreased rate of pregnancy conceptions in our study population, unaccompanied by an associated increase in rates of abortions, may be influenced by a number of factors, including decreased sexual couplings,[11,13] changes in pregnancy intentions wherein adolescents choose to delay a planned pregnancy because of the pandemic,[14] or increased use of contraception, although the latter was not reflected in our data on rates of contraceptive uptake during the pandemic. Importantly, our data also revealed that abortions accounted for a below-expected proportion of pregnancy outcomes during the pandemic, raising concerns about impaired access to this service. Access to medication abortion



Month	Mar-20	Jun-20	Sep-20	Dec-20	Mar-21	Jun-21	Sep-21	Dec-21	Mar-22	Jun-22	Sep-22	Dec-22
STI												
Observed rate	1.52	1.03	1.53	1.29	1.40	1.10	1.30	1.13	1.27	0.99	1.10	0.98
Expected rate	2.30	1.69	2.16	1.79	2.47	1.81	2.32	1.93	2.68	1.97	2.52	2.09
Adjusted Rate Ratio*	0.66 (0.64,	0.61 (0.59,	0.71 (0.70,	0.72 (0.72,	0.57 (0.55,	0.61 (0.59,	0.56 (0.56,	0.59 (0.58,	0.47 (0.46,	0.50 (0.49,	0.43 (0.43,	0.47 (0.47,
(95% CI)	0.69)	0.63)	0.71)	0.73)	0.59)	0.63)	0.56)	0.59)	0.49)	0.52)	0.44)	0.47)
Absolute Rate Difference	-0.77 (-0.85,	-0.65 (-0.71,	-0.63 (-0.65,	-0.50 (-0.50,	-1.08 (-1.16,	-0.71 (-0.77,	-1.02 (-1.04,	-0.79 (-0.81,	-1.41 (-1.51,	-0.98 (-1.03,	-1.43 (-1.44,	-1.10 (-1.12,
(95% CI)	-0.70)	-0.60)	-0.61)	-0.49)	-0.98)	-0.66)	-1.01)	-0.78)	-1.31)	-0.93)	-1.41)	-1.09)

*Adjusted for age, year (linear time trend), and month (indicators for seasonal variation)

FIGURE 4

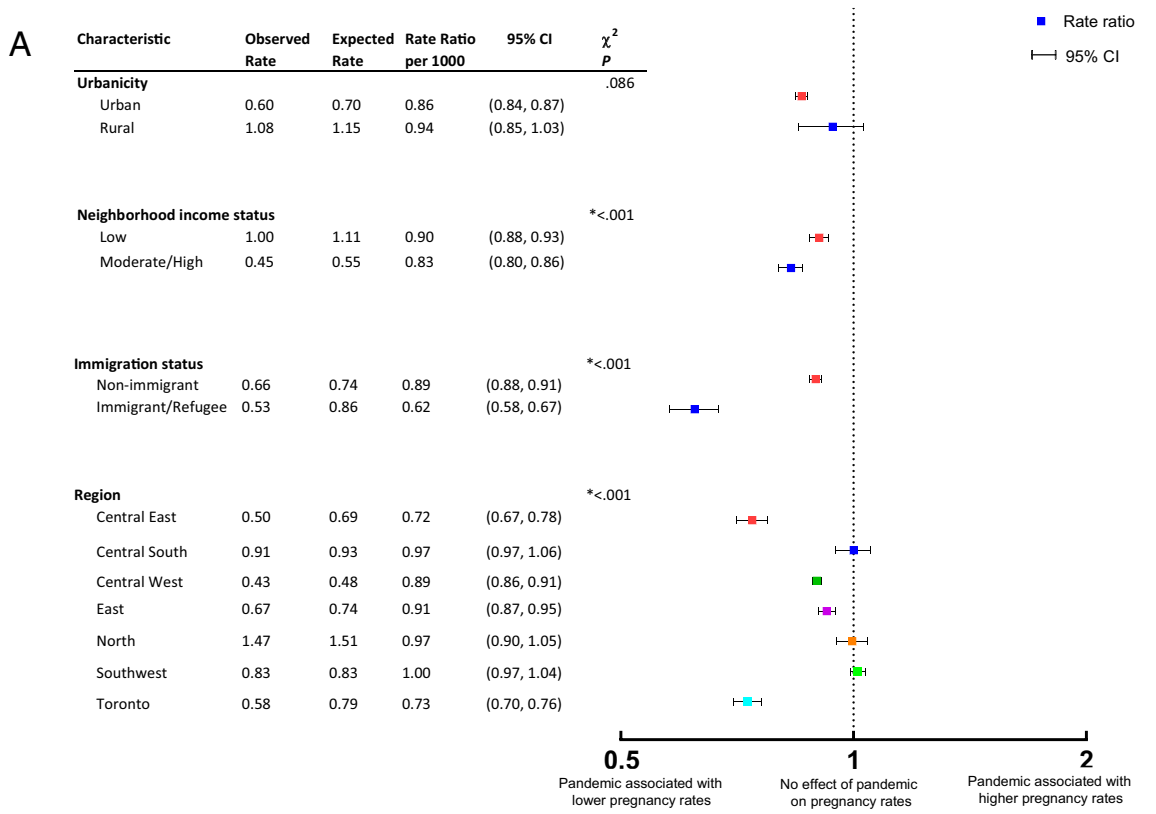
Observed and expected rates, rate ratios, and absolute rate differences of STI management encounters per 1000 population among adolescent females in Ontario from March 2020 to December 2022.

drugs by mail or through online pharmacies is not currently legal in Canada. It should be noted that before the pandemic, 70% of adolescent pregnancies in Canada were unintentional.[21]

During the pandemic, significantly less change in pregnancy rates was observed among subpopulations with higher pre-pandemic rates of pregnancy, such as non-immigrant adolescents, adolescents living in low-income neighborhoods, and adolescents living in northern regions. There are a number of potential explanations for this. It is possible that deeply entrenched structural vulnerabilities, such as reduced access to quality education or long-standing exposure to poverty, are such pervasive drivers of adolescent pregnancy that they predominated over pandemic-associated influences. It is also conceivable that adolescents already confronting multiple social and structural vulnerabilities have developed a resilience to adversity, which made them more able to adapt to pandemic impacts. Finally, adolescents in less populous or lower-income settings may have been less able or less likely to adhere to pandemic-related public health restrictions, such as "stay-at-home" orders, because such restrictions may have had less salience in their communities.[8]

A key study finding is that visits for contraception management had not returned to pre-pandemic levels at the end of the study period. This exposes a potentially concerning gap in coverage, particularly as public health restrictions eased, and sexual behaviors may have shifted back toward pre-pandemic patterns. Our data cannot offer insight into whether this pattern results from decreased desire or need for contraception or decreased access to services. Both factors may contribute, given data from other jurisdictions indicating post-COVID-19 reductions in access to and use of contraceptive care.[29,30] Persistent decreased visit rates for contraception may be, in part, secondary to the health care system's ongoing reliance on virtual care.[31] Virtual care, which was introduced broadly during the pandemic, may present multiple barriers to care-seeking among adolescents, including a lack of access to technology, inadequate internet coverage, and confidentiality and privacy concerns.[8,10,14,27] Virtual care may be particularly difficult among adolescents whose first language is not English and who, therefore, require interpretation services to facilitate access,[3,10] such as immigrant and refugee youth who were disproportionately affected by the pandemic in our study.

Consistent with previous studies,[7,8,10] our study revealed that fewer adolescents have sought care for STI management since the pandemic onset. It is unclear whether this trend represents a decreased need for services, decreased access to services, an increase in care-seeking through alternate access points (eg, clinics that do not bill OHIP), or deferred care-seeking (either for routine asymptomatic screening or



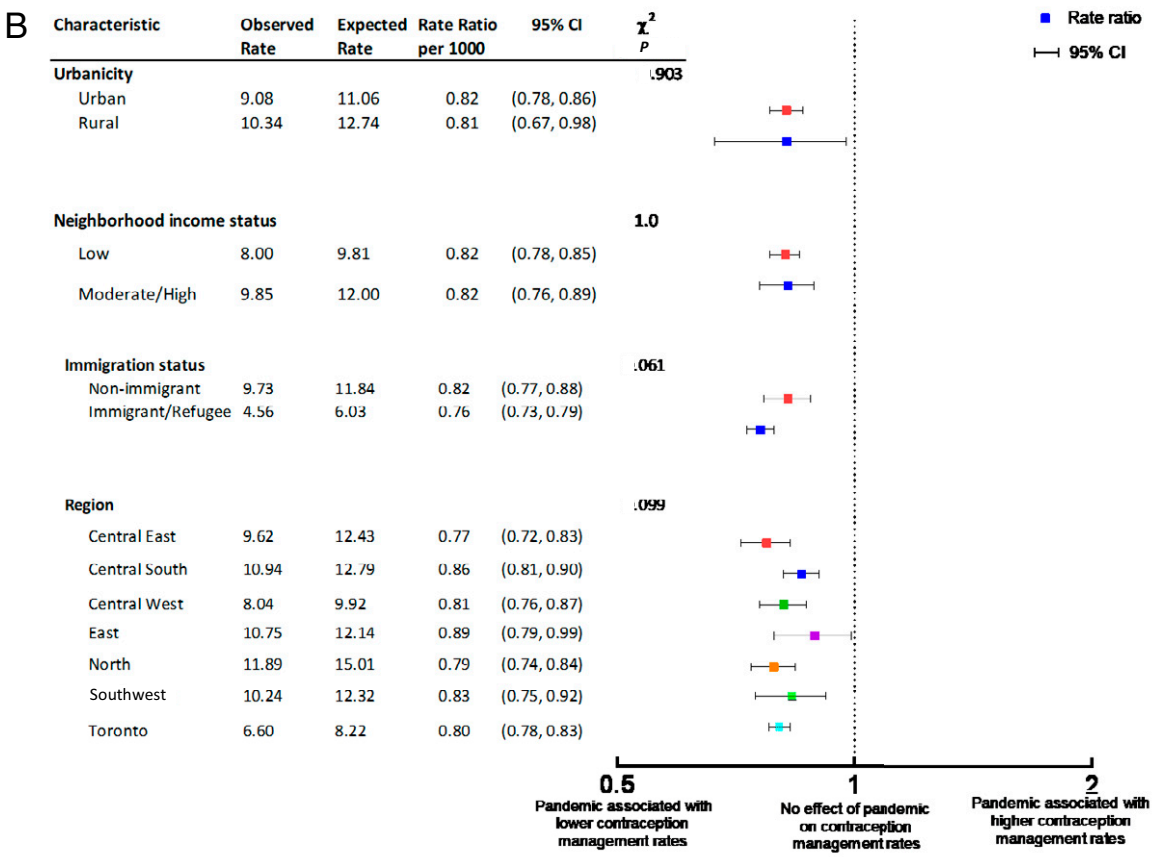
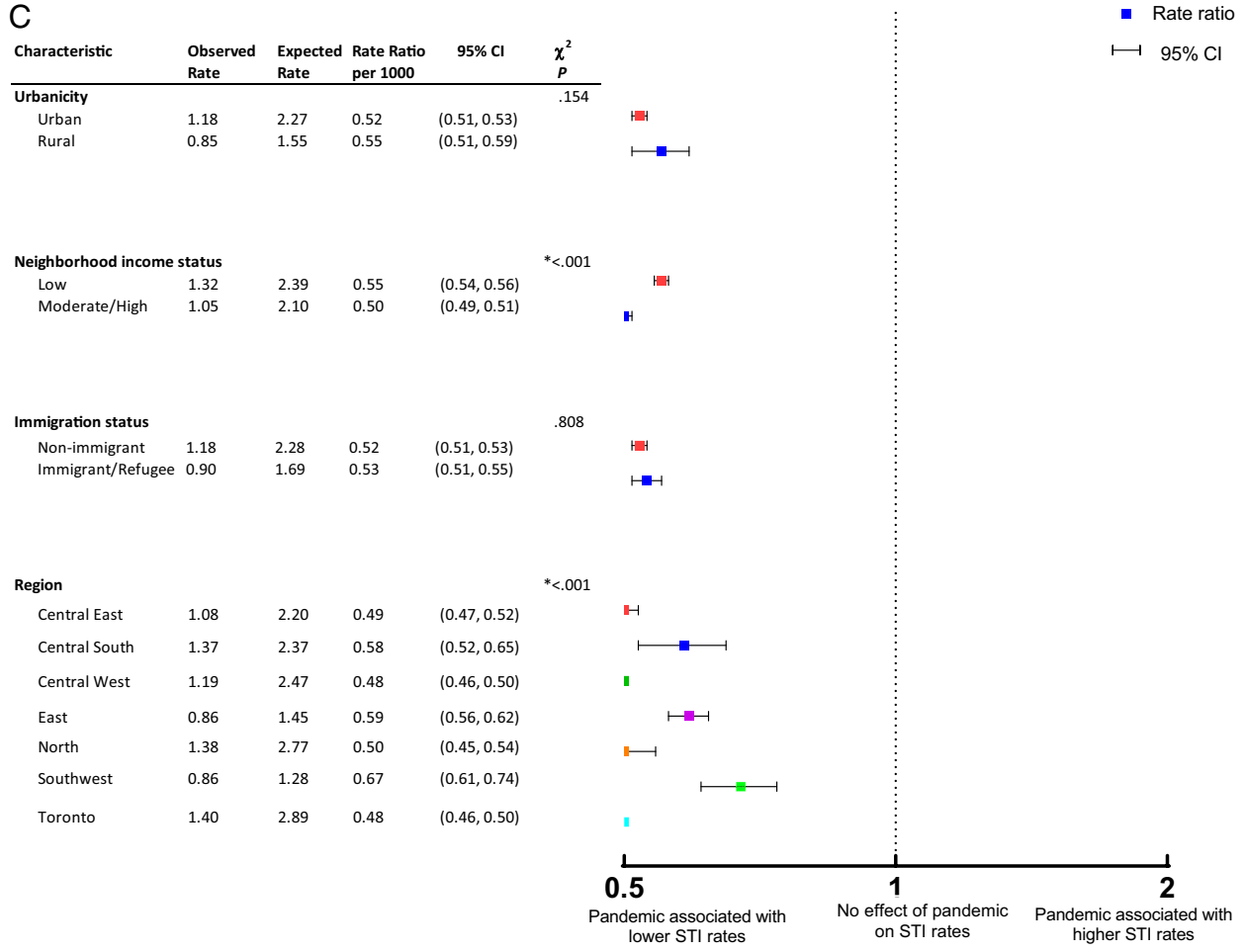


FIGURE 5

Adjusted overall rate ratio of ASRH outcomes, (A) pregnancy, (B) contraception management encounters, and (C) STI management encounters, for the COVID-19 pandemic period compared with the expected rates among adolescent females in Ontario, by urbanicity, neighborhood income level, immigration status, and region of residence.



*Significant at $P < .05$, in which significance indicates rejection of the null hypothesis of homogeneity of the rate ratio.

FIGURE 5
Continued

for the assessment or treatment of symptoms) with an associated increase in unidentified or untreated STIs. It is plausible that all of these factors have contributed to this trend. In one study of STI testing and diagnosis rates among youth 15 to 21 years old in a US pediatric primary care network, testing rates were lower than pre-pandemic rates; however, test positivity rates were higher for both *Chlamydia* and N. gonorrhea.[7] Available population-based data for Ontario on the rates of diagnosis of the two most common bacterial STIs among 15- to 19-year-old females reveals a decrease from 394.6/100 000 in 2019 to 283.2/100 000 in 2020 for *Chlamydia*, and from 134.7/100 000 in 2019 to 110/100 000 in 2020 for gonorrhea.[32] Again, whether this is representative of a true decreased incidence or delayed identification of these STIs remains undetermined.

Study findings are context-specific. Implications of the pandemic may differ among high-income countries with different health care landscapes (eg, private vs publicly financed) or differing pandemic-associated restrictions and in low-and-middle-income countries with different ASRH considerations.[33] In addition, this study did not specifically investigate ARSH outcome rates during the pandemic for a number of subpopulations of adolescents with sociodemographic characteristics not captured by existing databases. Specifically, we did not have details about the racial or ethnic identities of our study population; this is a limitation because we know that structural racism manifests as poorer health outcomes, including poorer SRH outcomes, for racialized adolescents.[20,21,34] Similarly, other structurally marginalized populations, such as 2-spirit, lesbian, gay, bisexual, transgender, queer or questioning, intersex, asexual, and additional sexual and gender identities, justice system-involved, and child welfare system-involved youth may have experienced changing trends in ARSH outcomes during the pandemic that were not identified here. Additional study limitations

include being unable to capture pregnancies not resulting in any public health system interactions (eg, at-home miscarriage), contraception prescriptions not covered by OHIP+, or contraception or STI management encounters at clinics that do not bill OHIP.

CONCLUSIONS

The rates of adolescent pregnancy and visits for contraceptive and STI management decreased in Ontario, Canada during the pandemic, compared with pre-pandemic trends, and preexisting inequities were amplified. Adolescents are early in their reproductive lifecourse, and the pandemic may have SRH implications that have not yet become evident; such impacts must be identified and attended to in a responsive, adolescent-centered, and rights-based manner that promotes optimal outcomes for all.

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ABBREVIATIONS

ASRH: adolescent sexual and reproductive health
CI: confidence interval
CIHI-DAD: Canadian Institute for Health Information Discharge Abstract Database
COVID-19: coronavirus disease 2019
OHIP: Ontario Health Insurance Plan
SRH: sexual and reproductive health
STI: sexually transmitted infection

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