Trends and characteristics of Tdap immunization during pregnancy in Ontario, Canada: a retrospective cohort study

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Data sharing statement: The dataset from this current study is held securely in coded form at ICES. Even though data-sharing agreements prohibit ICES from making the data set publicly available, access can be granted to those meeting pre-specified criteria for confidential access, available at https://www.ices. on.ca/DAS. The full data set creation plan and underlying analytic code are available from the authors on request, with the understanding that the computer programs may rely on coding templates or macros that are unique to ICES and, therefore, are inaccessible or may need modification.

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ABSTRACT:

Background: In February 2018, Canada's National Advisory Committee on Immunization recommended tetanus-diphtheria-acellular pertussis (Tdap) vaccination during pregnancy to protect newborns against pertussis infection. We described pre- and post-recommendation trends in Tdap vaccination coverage among pregnant Ontario residents.

Methods: Using linked health administrative databases, we conducted a population-based retrospective cohort study of all pregnant individuals who gave birth in Ontario hospitals between April 2012 and March 2020. We described Tdap vaccination patterns in pregnancy for the entire study period and pre- and post-recommendation. We used log-binomial regression to identify characteristics associated with Tdap receipt during pregnancy.

Results: Among the 991,850 pregnant individuals included, 7.0% received Tdap vaccination during pregnancy. Vaccine coverage increased from 0.4% in 2011-12 to 29.2% in 2019-20. Coverage was highest among individuals who were older, had no previous livebirths, had adequate prenatal care, and received maternity care primarily from a family physician. After adjustment, characteristics associated with lower coverage included younger maternal age, having a multiple birth, residing in a rural location, and higher area material deprivation. More than 70% of those who were vaccinated received Tdap during the optimal gestational window (27-32 weeks). Stratified analyses of the pre-and post-recommendation cohorts yielded findings similar to the main analyses with a few gradient differences after adjustment.

Interpretation: Tdap vaccination coverage during pregnancy increased substantially in Ontario between 2011-12 and 2019-20, with the greatest increase after introduction of recommendations for universal Tdap in pregnancy in Canada.

Key Words (4-6 MeSH Keywords):

Pregnant people, Pregnancy, Maternal immunization, Pertussis vaccine, Tdap vaccine, Whooping cough

INTRODUCTION

Pertussis, a highly infectious vaccine-preventable disease, remains a significant cause of infant morbidity and mortality.[1,2] Despite high levels of childhood coverage with pertussis-containing vaccines, outbreaks continue to occur in Canada and disproportionately affect infants younger than 2 months.[3] Pertussis vaccination during pregnancy, using an acellular pertussis-containing vaccine (Tetanus-diphtheria-acellular pertussis [Tdap]), confers passive protection to infants through transfer of maternal vaccine-derived antibodies before birth.[4] To reduce the burden of pertussis among young infants, the United States (US)[5] and the United Kingdom[6] issued recommendations in 2011-2012 advising all pregnant individuals to receive Tdap immunization during every pregnancy. Canada's National Advisory Committee on Immunization (NACI) released similar guidelines in February 2018, recommending routine pertussis vaccination during pregnancy, ideally at 27-32 weeks' gestation.[7]

Monitoring pertussis vaccination during pregnancy is essential for assessing adoption of these recommendations and can help identify groups with low coverage. Several epidemiological studies have evaluated maternal pertussis vaccine policies by reporting trends and determinants of coverage.[8–13] In Canada, a nationally representative cross-sectional survey estimated maternal pertussis vaccination coverage, by province and territory, among 4,607 pregnant individuals who delivered between September 2018 and March 2019[13]; 43% of respondents nationally, and 40% in Ontario, reported having received Tdap vaccination during pregnancy. The aim of the present study was to examine Tdap vaccination among all pregnant individuals in Ontario over a longer period—from 2012 to 2020.

METHODS

Study design, data sources and study population

We conducted a population-based retrospective cohort study using Ontario health administrative datasets housed at ICES (https://www.ices.on.ca). We identified pregnant individuals aged 12 to 50 years who delivered in an Ontario hospital between April 1, 2012 and March 31, 2020, encompassing six pre-recommendation and two post-recommendation years. We used the MOMBABY database, which contains linked maternal-newborn hospital records, to identify individuals with a livebirth and obtain gestational age, maternal age, and parity. The Canadian Institute for Health Information Discharge Abstract Database, which captures all hospital admissions, was used to

identify individuals with a stillbirth and obtain medical diagnoses and procedures. The Registered Persons Database provided information on neighbourhood income, region of residence, and health care eligibility; the Ontario Health Insurance Plan (OHIP) physician billing claims database was used to identify Tdap vaccinations and prenatal care visits; the Ontario Marginalization Index (ON-Marg) uses census data to quantify the level of marginalization in Ontario; and the ICES Physician Database (IPDB) was used to identify prenatal care provider specialties. **Supplement eTable 1** contains details on each data source.

Datasets were deterministically linked using unique encoded identifiers and analyzed at ICES. Diagnostic and procedural codes were from the Canadian implementation of the International Classification of Diseases, 10th Revision (ICD-10-CA) and the Canadian Classification of Health Interventions (CCI), respectively.

Records were excluded for the following reasons (**Figure 1**): administrative (invalid identifiers, duplicate records, linkage warnings), non-Ontario residents, individuals without continuous OHIP enrolment throughout pregnancy, <12 or >50 years of age, and biologically implausible birthweight/gestational age combinations (according to a Canadian reference standard[14]).

Exposure and outcome measurement

Tdap vaccination, ascertained using billing code G847 in the OHIP database, was classified as occurring during pregnancy if administered 14 days after the estimated date of the last menstrual period (calculated by subtracting gestational age from date of birth) through to 1 day before delivery. We described Tdap vaccination by maternal characteristics (age, parity, pre-existing chronic conditions, neighbourhood income quintile, marginalization indices, region of residence), pregnancy characteristics (multiple gestation, infant sex, prenatal care adequacy index[15] [**eAppendix 1**]), year of conception, and practice specialty of prenatal care provider. **eTable 2** contains definitions and codes for these variables. Regional variation was assessed using groupings of Ontario's Local Health Integration Networks.[16]

Marginalization was based on the four area-based indices within ON-Marg:[17] residential instability (housing instability); material deprivation (poverty and socio-economic status); dependency (high percentage of residents

without employment income); and ethnic concentration (high concentration of recent immigrants or visible minorities). For care provider characteristics, we identified visits to family physicians and obstetricians (defined by specialty variable in the IPDB) with an OHIP fee code related to prenatal care (**eTable 3**). Pregnant individuals were categorized by type of physician (family physician or obstetrician) who provided the "majority" (≥75%) of prenatal care. If neither type provided ≥75% of prenatal care, the category "mix of providers" was assigned. We stratified the exposure groups by pre- and post-recommendation to assess whether there were any differences in maternal characteristics associated with Tdap coverage across these two time periods. Because the NACI recommendation (published February 1st 2018) was for Tdap vaccination between 27 and 32 weeks' gestation, we categorized records as "post-recommendation" if individuals were pregnant but <27 weeks' gestation on February 1, 2018, or conceived after this date. Completed pregnancies or those that ≥27 weeks' gestation on February 1, 2018 were considered "pre-recommendation" (**eTable 2**).

Statistical analysis

Records missing covariate information (<1%) were excluded. We calculated Tdap coverage with 95% confidence intervals (CI) overall and across characteristics, then used log-binomial regression to calculate unadjusted and adjusted rate ratios (RR) and 95% CI. We stratified the study population into pre-and post-recommendation subgroups to investigate whether factors associated with coverage were different in these two time periods. Statistical analyses were conducted using SAS version 9.4.

RESULTS

From April 2012 to March 2020, there were1,059,178 Ontario deliveries ending in a live or stillbirth; among the 991,850 remaining after exclusions, 69,303 (7.0%) had received Tdap vaccine during pregnancy (**Figure 1**). Tdap vaccination among pregnant Ontario residents rose from 0.4% among pregnancies conceived in 2011-12 to 29.2% in 2019-20 (**Table 1**); the increase was sharpest between 2017-18 and 2018-19 (11.7% and 24.9%, respectively; 13.2% increase) after NACI's recommendation. Vaccination was highest among older (30+ years) and nulliparous individuals. Those with pre-existing conditions (asthma, hypertension, diabetes, thyroid disease) had slightly higher coverage than did those without such conditions (8.0% vs. 7.0%). Pregnant individuals in the highest neighbourhood

household income quintile had the highest vaccine coverage (8.0%), but no gradient was observed across other levels. By region, the highest coverage was among residents of the Greater Toronto Area (8.6%), and the lowest, among residents of Northern Ontario (3.6%). There was a gradient by material deprivation, with coverage lowest among the most marginalized areas measured by this dimension. Similarly, higher area dependency corresponded to lower coverage. By contrast, residential instability and ethnic concentration did not demonstrate clear gradients. Number of prenatal care visits was associated with coverage, with the highest rates among those who received adequate (8.2%) or intensive (7.9%) prenatal care. Type of provider was also influential, with coverage highest among individuals who received prenatal care primarily from a family physician (11.0%).

In both unadjusted and adjusted analyses, nulliparity, high area residential instability and ethnic concentration, later year of conception, and receiving prenatal care primarily from a family physician were predictors of Tdap vaccination (**Table 1**). After adjustment, younger maternal age, multiple birth, presence of a pre-existing health condition, rural residence, high area material deprivation, and receiving intermediate or inadequate prenatal care were associated with a reduced likelihood of vaccination. A social gradient in vaccination was not observed among women of varying neighbourhood income quintiles, however some geographic variation in vaccination was noted as residents of Northern Ontario had the lowest likelihood of Tdap receipt (aRR: 0.58, 95% CI: 0.55-0.61).

Tdap coverage rose after the NACI recommendation (from 2.4 to 21.7 per 100) (**eTables 4 and 5**). Residents of Eastern Ontario had the highest likelihood of vaccination in the pre-recommendation period, while residents of the Greater Toronto Area were more likely to receive Tdap in the post-recommendation period. Higher area dependency corresponded with higher likelihood of vaccination in the pre-recommendation period, but not in the post-recommendation period (**eTable 5**). Receiving prenatal care primarily from a family physician was associated with higher coverage in both periods, but the association was stronger in the pre-recommendation period compared to the post-recommendation period (aRR: 3.51, 95% CI: 3.39-3.63 and aRR: 1.72, 95% CI: 1.68-1.75, respectively). Similarly, inadequate prenatal care was associated with a lower likelihood of vaccination in both periods, but the magnitude of the estimate was lower in the pre-recommendation period compared to the post-recommendation period (aRR: 0.30, 95% CI: 0.29-0.32 and aRR: 0.64, 95% CI: 0.62, 0.65, respectively).

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Gestational timing of Tdap vaccination overall and by year of conception is illustrated in **Figure 2**. Overall, 61.8% (42,861/69,303) of immunized pregnant individuals received Tdap within the recommended gestational age range (27-32 weeks), but this percentage increased from 11.7% in 2011-12 to 71.0% in 2019-20 (**Figure 2A**). Among immunized individuals who conceived in 2011-12, 60.0% were vaccinated before 20 weeks' gestation. Median gestational age at vaccination rose from 13 weeks in 2011-12 to almost 30 weeks in 2019-20 (**Figure 2B**).

INTERPRETATION

This study examined eight years of Tdap vaccination data (April 2012 to March 2020), about six of which preceded the recommendation for universal vaccination during pregnancy. We identified 69,303 (7.0%) Ontario residents who were immunized with Tdap while pregnant during this time span. Coverage increased nine-fold from 2.4% (pre-recommendation) to 21.7% (post- recommendation), with the greatest increase occurring after the revised NACI recommendation. Our results show variations in Tdap coverage according to numerous characteristics including age, parity, location of residence, adequacy of prenatal care and practice specialty of prenatal care provider. We identified predictors of Tdap vaccination, even after controlling for potential confounders. Gestational timing of Tdap immunization during pregnancy shifted in response to the NACI recommendation, with coverage during the recommended window of 27-32 weeks surpassing 70% in 2019-20.

Lower vaccination rates among those who were younger, had less than adequate prenatal care, had greater area material deprivation, or lived in lower-income neighbourhoods have been similarly reported in previous studies of pertussis and influenza vaccination among pregnant populations.[12,18–23] Our finding that the number of prenatal care visits was associated with higher vaccine coverage has been demonstrated in other studies[18–20,24,25] and can be attributed to more frequent contact with health care providers creating more opportunities for immunization.

Although vaccine recommendations are important, providing public funding for immunization programs is also needed to increase vaccine access and coverage.[26] Ontario is among the few provinces without a publicly-funded program for repeated Tdap vaccination, including during pregnancy.[13] Although this situation might be related to

low coverage in Ontario,[26] a recent national survey of Tdap coverage during pregnancy reported that fewer than one percent of unvaccinated pregnant individuals mentioned cost as the main reason.[13]

We found that individuals whose prenatal care was provided primarily by a family physician rather than an obstetrician had a greater likelihood of Tdap vaccination. A similar disparity was reported in a study of influenza vaccine coverage during pregnancy during the 2009 H1N1 influenza pandemic in Ontario,[20] and may reflect differences in practice and vaccine recommendation patterns. In a recent Canadian study,[13] reasons for non-immunization with Tdap during pregnancy included not knowing that the vaccine was recommended during pregnancy (60%), not wanting to be vaccinated (16%), and health care provider not offering the vaccine (11%). A US study noted that Tdap vaccination during pregnancy was impeded by factors such as insurance reimbursement, on-site storage issues, and financial concerns.[27] Limited on-site vaccine availability may hinder Tdap administration by obstetricians. A recent multicentre observational study of four vaccine delivery models in Quebec found that coverage was higher when Tdap was offered to pregnant individuals in a family physician's office or an obstetrics clinic, compared with a local community service centre, highlighting the importance of integrating vaccination into prenatal care.[28] Health care provider recommendations and suitable storage and access have an impact on vaccine coverage during pregnancy.[29–33] Training and implementation support should be available to encourage vaccination by all maternity care providers.

We found a shift in the gestational timing of vaccination across the study time-period. The majority of vaccinated individuals who conceived in 2011-12 received Tdap in the first trimester, suggesting vaccination during these earlier years may have been coincidental to pregnancy. An increase in vaccination during the optimal timeframe was also observed, with over 70% of vaccinated individuals being immunized between 27-32 weeks' gestation in 2019-20, compared with approximately 12% in 2011-12. A US study similarly found that Tdap vaccination during the recommended gestational age range rose from 52.5% to 91.8% after release of the 2012 Advisory Committee on Immunization Practices guidelines.[25] Our results indicate early adherence to Canada's current recommendations, as the majority of individuals that conceived in the post-recommendation time period received Tdap within the gestational window conferring the greatest level of infant protection.

Strengths of this study include the use of multiple linked health administrative datasets, which allowed us to assemble a large population of pregnant individuals who were immunized with Tdap during pregnancy, and assess coverage at a population level. The datasets provided information on maternal, pregnancy, and care provider characteristics potentially related to vaccination practices and trends before and slightly after the NACI recommendation. Having the exact immunization date enabled assessment of gestational timing, information that is relevant to policy evaluation.

Limitations

Our analyses depended on accurate fee coding; if Tdap vaccination failed to generate a billing claim, we would have underestimated the true coverage. We had no information on whether unvaccinated individuals had been offered, but had refused, vaccination and their reasons for declining and, therefore, could not assess barriers to Tdap immunization during pregnancy. Provider specialties captured in the physicians database does not include midwives or other health care professionals that might have provided prenatal care outside family physicians and obstetricians. Finally, we restricted our cohort to individuals with uninterrupted OHIP insurance throughout pregnancy to ensure that we could identify Tdap vaccinations administered during pregnancy in the health administrative databases. It is possible that the characteristics of people with discontinuous or no provincial health insurance might be different.

Conclusion

Descriptive information about maternal Tdap vaccination in Ontario is important for establishing baseline evidence about coverage following NACI recommendations for routine Tdap immunization during every pregnancy. Differences in vaccine coverage highlights the value of using local data to identify factors associated with lower coverage that may warrant attention in public health initiatives. Further research is required on barriers faced by health care providers in administering Tdap vaccination to pregnant patients. Future studies should examine whether Tdap coverage continues to increase in Ontario, or whether early gains have been interrupted by the ongoing COVID-19 pandemic.

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Table 1. Vaccine coverage, unadjusted rate ratios and adjusted rate ratios for Tdap vaccination during pregnancy, by socio-demographic and pregnancy characteristics

Characteristic	All births, N (%) [a]	No. vaccinated	Vaccine coverage per 100 (95% CI)	Unadjusted RR (95% CI)	Adjusted RR (95% CI) [b]
Overall	991,850 (100.0)	69,303	7.0 (6.9, 7.0)	-	-
Maternal age (years)					
<20	19,628 (2.0)	622	3.2 (2.9, 3.4)	0.41 (0.38, 0.44)	0.58 (0.53, 0.62)
20–24	99,218 (10.0)	4,298	4.3 (4.2, 4.5)	0.56 (0.54, 0.58)	0.69 (0.67, 0.71)
25–29	262,061 (26.4)	17,283	6.6 (6.5, 6.7)	0.86 (0.84, 0.87)	0.91 (0.90, 0.93)
30–34	369,744 (37.3)	28,518	7.7 (7.6, 7.8)	1.00 (ref)	1.00 (ref)
≥35	241,199 (24.3)	18,582	7.7 (7.6, 7.8)	1.00 (0.98, 1.02)	1.01 (0.99, 1.02)
Fiscal year of conception [c]					
2011	95,494 (9.6)	385	0.4 (0.4, 0.4)	0.097 (0.088, 0.11)	0.099 (0.089, 0.11)
2012	124,712 (12.6)	1,323	1.1 (1.0, 1.1)	0.26 (0.24, 0.27)	0.26 (0.34, 0.27)
2013	124,978 (12.6)	2,043	1.6 (1.6, 1.7)	0.39 (0.37, 0.41)	0.39 (0.37, 0.41)
2014	124,155 (12.5)	2,426	2.0 (1.9, 2.0)	0.47 (0.45, 0.49)	0.47 (0.44, 0.49)
2015	124,215 (12.5)	4,478	3.6 (3.5, 3.7)	0.87 (0.84, 0.90)	0.86 (0.83, 0.89)
2016	123,417 (12.4)	5,122	4.2 (4.0, 4.3)	1.00 (ref)	1.00 (ref)
2017	122,830 (12.4)	14,431	11.7 (11.6, 11.9)	2.83 (2.74, 2.92)	1.41 (1.34, 1.48)
2018	122,322 (12.3)	30,400	24.9 (24.6, 25.1)	5.99 (5.82, 6.16)	2.37 (2.25, 2.49)
2019	29,727 (3.0)	8,695	29.2 (28.7, 29.8)	7.05 (6.83, 7.28)	2.74 (2.60, 2.89)
Parity					
0 (nulliparous)	433,315 (43.7)	35,637	8.2 (8.1, 8.3)	1.36 (1.34, 1.38)	1.38 (1.36, 1.40)
≧1 (multiparous)	558,535 (56.3)	33,666	6.0 (6.0, 6.1)	1.00 (ref)	1.00 (ref)
Multiple birth					
No	973,589 (98.2)	68,364	7.0 (7.0, 7.1)	1.00 (ref)	1.00 (ref)
Yes	18,261 (1.8)	939	5.1 (4.8, 5.5)	0.73 (0.69, 0.78)	0.77 (0.73, 0.82)
Pre-existing maternal medical condition [d]					
Asthma	2,138 (0.2)	127	5.9 (5.0, 7.0)	0.85 (0.72, 1.01)	-
Chronic hypertension	3,947 (0.4)	283	7.2 (6.4, 8.0)	1.03 (0.92, 1.15)	-
Diabetes	8,702 (0.9)	417	4.8 (4.4, 5.3)	0.68 (0.62, 0.75)	-
Heart disease	4,806 (0.5)	294	6.1 (5.5, 6.8)	0.87 (0.78, 0.98)	-
Thyroid disease	13,389 (1.3)	1,466	10.9 (10.4, 11.5)	1.58 (1.50, 1.66)	-
Any pre-existing maternal medical condition [b]					

No	960,721(96.9)	66,825	7.0 (6.9,7.0)	1.00 (ref)	1.00 (ref)
Yes	31,129 (3.1)	2,478	8.0 (7.7,8.3)	1.14 (1.10,1.19)	0.96 (0.93, 1.00)
Neighbourhood median family income quintiles					
1 (Lowest)	210,933 (21.3)	12,713	6.0 (5.9, 6.1)	0.76 (0.74, 0.77)	1.04 (1.01, 1.08)
2	199,725 (20.1)	13,890	7.0 (6.8, 7.1)	0.87 (0.85, 0.89)	1.05 (1.02, 1.08)
3	207,562 (20.9)	14,430	7.0 (6.8, 7.1)	0.87 (0.85, 0.89)	0.96 (0.93, 0.98)
4	208,050 (21.0)	15,080	7.2 (7.1, 7.4)	0.91 (0.89, 0.93)	0.97 (0.95, 0.99)
5 (Highest)	165,580 (16.7)	13,190	8.0 (7.8, 8.1)	1.00 (ref)	1.00 (ref)
Rural residence					
No	899,428 (90.7)	63,968	7.1 (7.1, 7.2)	1.00 (ref)	1.00 (ref)
Yes	92,422 (9.3)	5,335	5.8 (5.6, 5.9)	0.81 (0.79, 0.83)	0.91 (0.88, 0.93)
LHIN Group [e]					
Central	329,495 (33.2)	23,010	7.0 (6.9, 7.1)	0.81 (0.79, 0.83)	0.91 (0.89, 0.93)
East	239,495 (24.2)	19,784	8.3 (8.2, 8.4)	0.96 (0.93, 0.98)	1.07 (1.04, 1.09)
North	50,815 (5.1)	1,853	3.6 (3.5, 3.8)	0.42 (0.40, 0.44)	0.58 (0.55, 0.61)
Toronto	92,261 (9.3)	7,964	8.6 (8.5, 8.8)	1.00 (ref)	1.00 (ref)
West	279,784 (28.2)	16,692	6.0 (5.9, 6.1)	0.69 (0.67, 0.71)	0.84 (0.82, 0.86)
Marginalization Indices [f]					
Residential instability quintile					
1 (least marginalized)	216,203 (21.8)	14,721	6.8 (6.7, 6.9)	1.00 (ref)	1.00 (ref)
2	184,203 (18.6)	13,131	7.1 (7.0, 7.2)	1.05 (1.02, 1.07)	1.02 (1.00, 1.04)
3	180,923 (18.2)	12,764	7.1 (6.9, 7.2)	1.04 (1.01, 1.06)	1.02 (0.99, 1.04)
4	186,076 (18.8)	12,270	6.6 (6.5, 6.7)	0.97 (0.95, 0.99)	1.03 (1.01, 1.06)
5 (most marginalized)	224,445 (22.6)	16,417	7.3 (7.2, 7.4)	1.07 (1.05, 1.10)	1.04 (1.01, 1.07)
Material deprivation quintile					
1 (least marginalized)	201,373 (20.3)	18,272	9.1 (8.9, 9.2)	1.00 (ref)	1.00 (ref)
2	196,248 (19.8)	14,869	7.6 (7.5, 7.7)	0.84 (0.82, 0.85)	0.93 (0.91, 0.94)
3	187,025 (18.9)	12,578	6.7 (6.6, 6.8)	0.74 (0.73, 0.76)	0.85 (0.83, 0.87)
4	186,870 (18.8)	11,977	6.4 (6.3, 6.5)	0.71 (0.69, 0.72)	0.80 (0.78, 0.83)
5 (most marginalized)	220,334 (22.2)	11,607	5.3 (5.2, 5.4)	0.58 (0.57, 0.59)	0.69 (0.67, 0.71)
Dependency quintile					
1 (least marginalized)	335,957 (33.9)	24,105	7.2 (7.1, 7.3)	1.00 (ref)	1.00 (ref)
2	209,933 (21.2)	14,932	7.1 (7.0, 7.2)	0.99 (0.97, 1.01)	1.06 (1.04, 1.07)
3	167,423 (16.9)	11,454	6.8 (6.7, 7.0)	0.95 (0.93, 0.97)	1.05 (1.03, 1.08)
4	149,441 (15.1)	10,371	6.9 (6.8, 7.1)	0.97 (0.95, 0.99)	1.08 (1.06, 1.11)
5 (most marginalized)	129,096 (13.0)	8,441	6.5 (6.4, 6.7)	0.91 (0.89, 0.93)	1.03 (1.01, 1.06)

Ethnic concentration quintile					
1 (least marginalized)	131,891 (13.3)	7,761	5.9 (5.8, 6.0)	1.00 (ref)	1.00 (ref)
2	150,188 (15.1)	10,103	6.7 (6.6, 6.9)	1.14 (1.11, 1.18)	1.06 (1.03, 1.09)
3	169,086 (17.0)	12,385	7.3 (7.2, 7.4)	1.24 (1.21, 1.28)	1.10 (1.07, 1.13)
4	210,064 (21.2)	15,860	7.6 (7.4, 7.7)	1.28 (1.25, 1.32)	1.13 (1.10, 1.17)
5 (most marginalized)	330,621 (33.3)	23,194	7.0 (6.9, 7.1)	1.19 (1.16, 1.22)	1.16 (1.13, 1.20)
Prenatal care [g]					
Intensive	54,690 (5.5)	4,302	7.9 (7.6, 8.1)	0.96 (0.93, 0.99)	1.01 (0.99, 1.04)
Adequate	409,609 (41.3)	33,468	8.2 (8.1, 8.3)	1.00 (ref)	1.00 (ref)
Intermediate	337,279 (34.0)	21,379	6.3 (6.3, 6.4)	0.78 (0.76, 0.79)	0.88 (0.87, 0.90)
Inadequate	134,621 (13.6)	7,875	5.8 (5.7, 6.0)	0.72 (0.70, 0.73)	0.56 (0.55, (0.57) [i]
No care/Missing [b, h]	55,651 (5.6)	2,279	4.1 (3.9, 4.3)	0.50 (0.48, 0.52)	-
Composition of prenatal care visits					
No visits	55,649 (5.6)	2,279	4.1 (3.9, 4.3)	0.68 (0.65, 0.71)	1.12 (1.07, 1.17)
≥ 75% with GP/FP	141,591 (14.3)	15,610	11.0 (10.9, 11.2)	1.82 (1.79, 1.86)	1.97 (1.94, 2.01)
≥ 75% with OBGYN	606,758 (61.2)	36,701	6.0 (6.0, 6.1)	1.00 (ref)	1.00 (ref)
Mix of providers	187,852 (18.9)	14,713	7.8 (7.7, 8.0)	1.29 (1.27, 1.32)	1.31 (1.28, 1.33)

Abbreviations: No., number; RR, rate ratio; CI, confidence interval; GP/FP, general practitioner/family physician; LHIN, Local Health Integration Network; OBGYN, obstetrician-gynecologist

[a] Column percentages

[b] The multivariable model included in all the independent variables listed in this table, except a dichotomous variable for pre-existing medical conditions was added instead of the individual conditions in this variable, and the category for *inadequate* prenatal care was combined with *no care/missing* prenatal care to allow for model convergence.

[c] As the cohort was created using the delivery date on the maternal record (April 1 2012 to March 31 2020), fiscal years 2011 and 2019 are incomplete which explains the lower number of births shown in these two fiscal years.

[d] Sum of each individual condition does not equal number of women with any condition, as categories were not mutually exclusive

[e] Local Health Integration Networks (LHIN) groups were assigned according to the Ontario's Ministry of Health (see eTable 2 in supplement)

[f] Scores corresponding to each of these four dimensions were previously divided into quintiles, where quintile 1 represents the least marginalized areas, and quintile 5, the most marginalized areas. Please see eTable 2 in supplement for complete descriptions of what is captured in each of these four dimensions.

[g] Adequacy of prenatal care characterized using the Revised-Graduated Prenatal Care Utilization Index (R-GINDEX).

[h] Mother did not have any prenatal visits within our definition.

[i] Estimate is for Inadequate and No Care/Missing Care combined

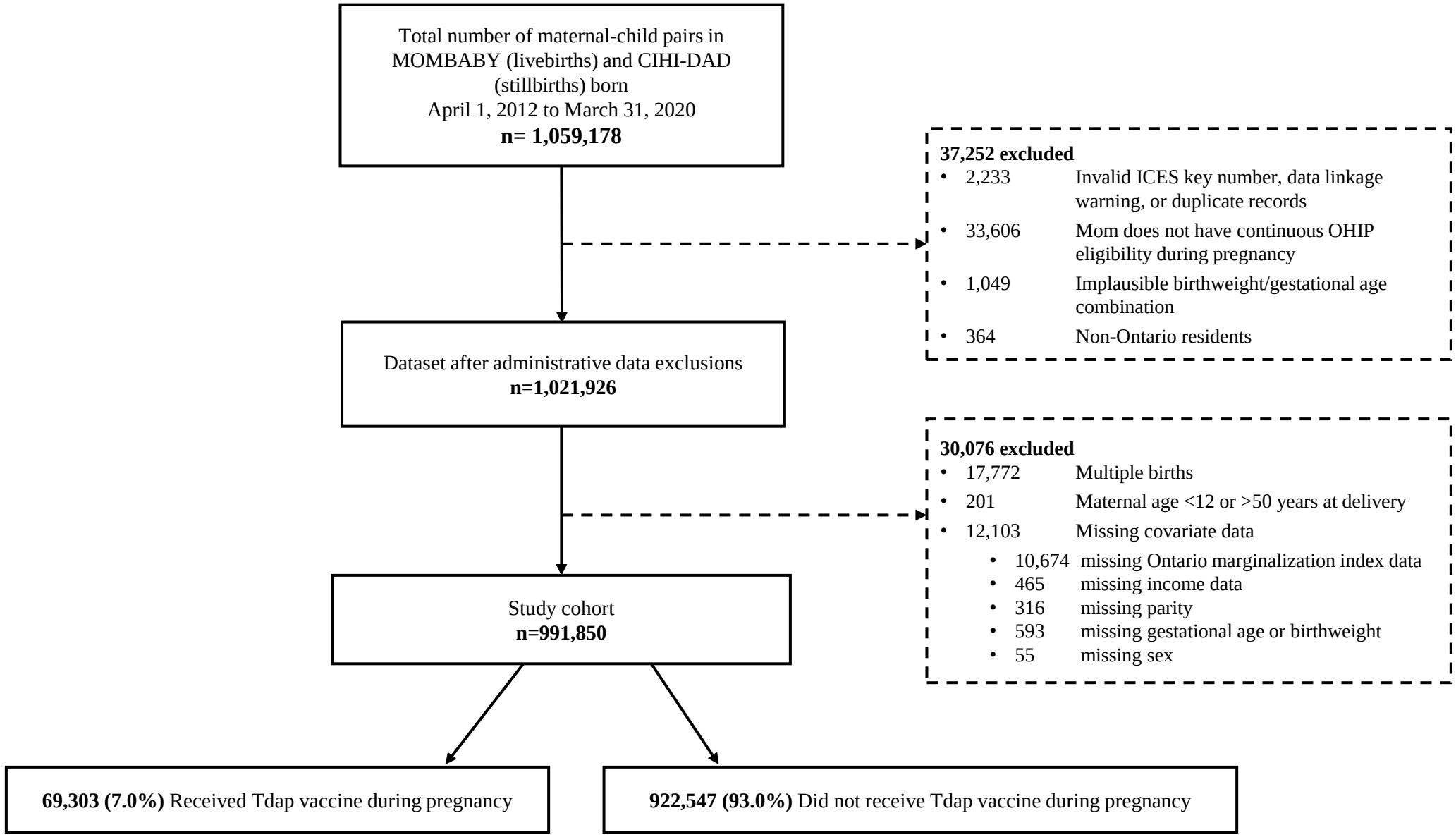
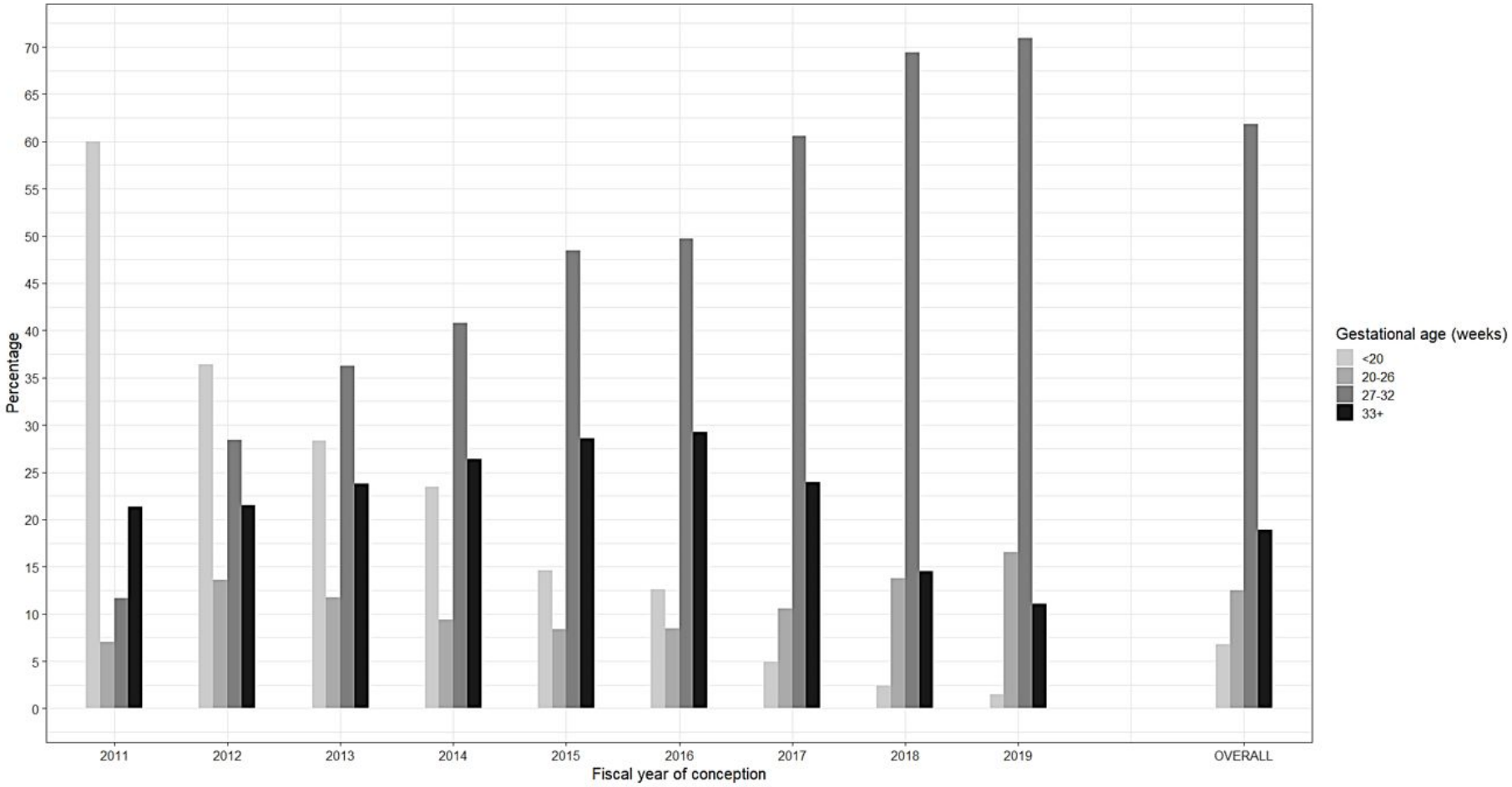


Figure 1. Study flow diagram

Abbreviations: CIHI-DAD, Canadian Institute for Health Information-Discharge Abstract Database; OHIP, Ontario Health Insurance Plan; Tdap, tetanus-diphtheria-acellular pertussis.

A.


Percentage
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
2011
2012
2013
2014
2015
2016
2017
2018
2019
OVERALL
Fiscal year of conception
Gestational age (weeks)
<20
20-26
27-32
33+

B.

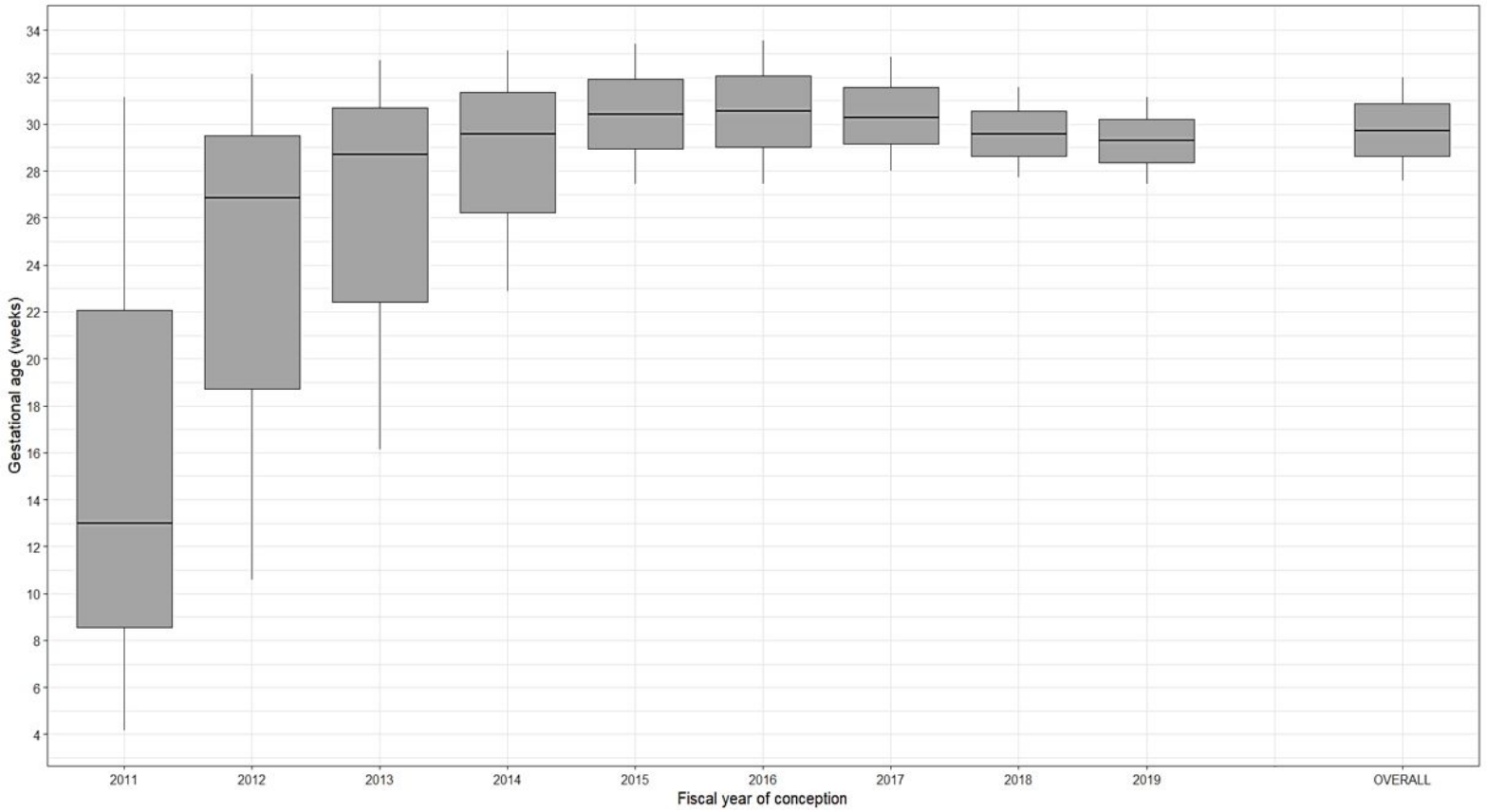


Figure 2. Gestational timing of Tdap vaccination overall and by fiscal year of conception. A) Bar graph presents the distribution of gestational age at which Tdap vaccination was received during pregnancy. B) Box plot presents the median gestational age at which Tdap vaccination was received during pregnancy (horizontal line within each boxplot) and the interquartile range (vertical lines extending above and below each box).

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SUPPLEMENTARY MATERIALS:

eTable 1. Description and purpose of each data source utilized in the study

Database	Description	Information collected
MOMBABY Database	Contains inpatient admission records for delivering mothers and their respective newborns (including stillbirths), linked by a unique matching identifier on each hospitalization record. This administrative dataset, maintained and annually updated at ICES, links approximately 98% of maternal-infant records for in-hospital deliveries in Ontario.	Used to assemble study cohort and to collect maternal and newborn information such as gestational age at birth, maternal age, birth weight, baby's sex, parity, and plurality.
Registered Persons Database (RPDB)	Demographic repository containing information on all Ontario residents eligible for publicly funded health care in the province.	Used to establish how long each participant was eligible for health care services, and to obtain demographic information on neighbourhood income quintile and region of residence.
Ontario Health Insurance Plan (OHIP) Database	Contains health care billing information made by physicians or other health care providers, for service reimbursement. This database includes information on the diagnosis (i.e., reason for the visit), type of service received, and the associated billing code.	Specific OHIP fee codes are used when a vaccine is administered. This provided the information to identify the exposure group.
Canadian Institute for Health Information Discharge Abstract Database (CIHI-DAD)	Captures demographic and clinical information about hospital admissions from all acute care institutions in Canada.	Used to collect information about pre-existing maternal medical conditions, obstetrical complications, and mode of delivery.
Ontario Marginalization Index (ON-Marg)	Data tool that quantifies level of marginalization in Ontario, based on Census data from Statistics Canada. It consists of four dimensions that indicate marginalization: residential instability, material deprivation, dependency, and ethnic concentration. Scores corresponding to each of these four dimensions were previously divided into quintiles, where quintile 1 represents the least marginalized areas, and quintile 5, the most marginalized areas. The ON-Marg user guide can be found here:	Information about the four indices of marginalization.

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	https://www.publichealthontario.ca/-/media/documents/o/2017/on-marg-userguide.pdf	
ICES Physician Database (IPDB)	Contains annual demographic data on all physicians in Ontario, such as specialty training, year of graduation, and whether medical training was completed in Canada.	Used to identify health care provider specialties for prenatal care visits via MAINSPECIALTY variable with values restricted to "GP/FP" and "OBSTETRICS AND GYNECOLOGY"

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eTable 2. Definitions and diagnostic/procedural codes used to define study variables

Study Variable	Record	Definition	Data source, ICD10 diagnostic code, OHIP fee code, and/or CCI procedure code
Stillbirth	Fetal/infant	Fetal death occurring at or after 20 weeks of gestation.	O36.4; Z37.1; Z37.3; Z37.4; Z37.6; Z37.7
Tdap vaccine	Mother	Adult tetanus, diphtheria and acellular pertussis (Tdap) vaccine.	OHIP fee codes: G847
Maternal characteristics			
Maternal age	Mother	Age of the mother at the time of giving birth.	Measured using MOMBABY variable.
Parity	Mother	Total number of previous pregnancies (live births and stillbirths) that reached a viable gestational age.	Measured using MOMBABY variable.
Pre-existing chronic hypertension	Mother	Identified through ICD-10 codes in the DAD on the mother's delivery abstract.	I10, I15, O10.0
Pre-existing asthma	Mother	Identified through ICD-10 codes in the DAD on the mother's delivery abstract.	J45-46
Pre-existing diabetes	Mother	Identified through ICD-10 codes in the DAD on the mother's delivery abstract.	O24.0, O24.1 O24.3, O24.5, O24.6, O24.7, E10, E11, E13, E14
Pre-existing heart disease	Mother	Identified through ICD-10 codes in the DAD on the mother's delivery abstract.	O10.1, I05-I09, I34-I39, I150.0, I20, I25, Q20-26, O99.4
Pre-existing thyroid disease	Mother	Identified through ICD-10 codes in the DAD on the mother's delivery abstract.	E00-E07
Income quintile	Mother	Nearest Census Based Neighbourhood Income Quintile.	Measured using "INCQUINT" variable within RPDB.
Residential instability	Mother	Refers to area-level concentrations of people who experience high rates of family or housing instability.	Measured using "residential instability factor score" variable within the ON-Marg database.
Material deprivation	Mother	Refers to inability for individuals and communities to access and attain basic material	Measured using "material deprivation factor score" variable within the ON-Marg database.

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		needs. This dimension is closely connected to poverty.	
Dependency	Mother	Refers to area-level concentrations of people who don't have income from employment.	Measured using "dependency factor score" variable within the ON-Marg database.
Ethnic concentration	Mother	Refers to high area-level concentrations of recent immigrants and people belonging to a 'visible minority' group.	Measured using "ethnic concentration factor score" variable within the ON-Marg database.
Rural residence	Mother	Rurality determined using second digit of postal code from Canada Post Corporation.	Measured using rural flag variable from postal code conversion file (PCCF).
Local Health Integration Network (LHIN) Group	Mother	Local Health Integration Networks (LHINs) are not-for-profit corporations that are responsible for planning, integrating and funding local health services in 14 different geographic areas of the province. In collaboration with the Ontario Ministry of Health, ICES developed the geographic building blocks for LHINs by defining areas within which residents received most of their hospital care from local hospitals.	Using the LHIN database, the 14 LHIN corporations were grouped into 5 regions according to the Ontario's Ministry of Health website: http://www.health.gov.on.ca/en/news/connectedcare/2019/CC_20191113.aspx
Pregnancy characteristics			
Multiple birth	Mother	Total number of fetuses in the current pregnancy.	Z372, Z373, Z374, Z375, Z376, Z377, Z3790, O31, and O30
Revised Graduated Prenatal Care Index (R-GINDEX)	Mother	Categorizes adequacy of prenatal care into 5 groups: inadequate, intermediate, adequate, intensive, no care/missing.	Derived from a combination of gestational age of the infant at birth (**GEST**), trimester when prenatal care began (**TCPB**), and total number of prenatal care visits (**PCV**). The index is based on work from Alexander and Kotelchuck.[1] The codes associated with prenatal care visits are shown in eTable 3.
Composition of prenatal care visits	Mother	Categorizes proportion of prenatal care visits into 4 groups: no visits, ≥ 75% with GP/FP, ≥ 75% with OBGYN, mix of providers.	Measured using OHIP fee codes associated with prenatal visits to a GP/FP or OBGYN (defined using IPDB MAINSPECIALTY variable with values restricted to "GP/FP" and "OBSTETRICS AND

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			GYNECOLOGY"). The codes associate with prenatal care visits are shown in eTable 3.
Temporal characteristics			
Fiscal year of conception	Mother and infant	Refers to the fiscal year that the infant was conceived.	Estimated by subtracting gestational age from date of birth.
Pre-and post-Tdap policy subgroups			
National Advisory Committee on Immunization (NACI) released updated maternal Tdap recommendations in February 2018 which advised all pregnant women to receive the Tdap vaccine during every pregnancy between 27 and 32 weeks' gestation. For this reason, we chose February 1st, 2018 as the index date to create the two subgroups below. As vaccination is recommended between 27-32 weeks' gestation, we chose to include individuals that were pregnant but not beyond the 27th week of pregnancy by February 1st 2018 in the "post-Tdap policy group".			
Pre-Tdap policy	Mother	Maternal record that either: – Completed pregnancy prior to February 1st 2018 – Pregnancy was beyond the 27th week by Feb 1st, 2018	Date of last menstrual period (LMP), date of delivery
Post-Tdap policy	Mother	Maternal record that either: – Began pregnancy after Feb 1st 2018 – Pregnancy did not surpass the 27th week by Feb 1st 2018	Date of last menstrual period (LMP), date of delivery

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eTable 3. OHIP fee codes associated with prenatal visits

OHIP fee code	Description
A005, A205	Consultation
A006, A206	Re-consultation/Repeat consultation
A204	Partial assessment
A665	Prenatal consult
A920	Medical management of early pregnancy, initial visit
A921	Medical management of early pregnancy, subsequent visit
P002	High risk prenatal assessment
P003	Obs.-prenatal care-general assess - major prenatal visit
P004	Obs.-prenatal care-minor prenatal assess - subsequent prenatal visit
P005	Antenatal health screen
Q606	Prenatal care - gen. Assess - major prenatal visit
Q607	Prenatal care - min. Assess - subsequent prenatal visit

* Prenatal visits will be defined as any OHIP record between LMP and date of delivery (limited to one record per person per type of doctor per day) to a GP/FP or OBGYN (defined using IPDB MAINSPECIALTY with values restricted to “GP/FP” and “OBSTETRICS AND GYNECOLOGY”) with an associated OHIP fee code identified above.

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eAppendix 1. Coding algorithm for Revised Graduated Prenatal Care Utilization Index (R-GINDEX)

The R-GINDEX, first proposed by Alexander and Kotelchuck has 6 categories of prenatal care based on the current ACOG recommendations: inadequate, intermediate, adequate, intensive, no care, and missing. The index calculation relies on three pieces of information: the gestational age of the infant, the trimester during which prenatal care was initiated, and the total number of prenatal care visits during pregnancy. Please see coding algorithm used below:

Key Variables:

GEST = Gestational Age (18-45 weeks based on LMP)
PCV = Number of Prenatal Care Visits (0 = None)
TPCB = Trimester Prenatal Care Began (0 = None, 1-3 trimesters) *
GINDEX = Graduated Prenatal Care Utilization Index

***NOTE:** Trimester 1 = (0-13 weeks or 1-91 days)
Trimester 2 = (14-27 weeks or 92-189 days)
Trimester 3 = (28+ weeks or 190+ days)

INTENSIVE PRENATAL CARE UTILIZATION;

```
IF (TPCB=1) &
      (((18<=GEST<=21) & (11=<PCV))       |   ((22<=GEST<=25) & (13=<PCV))
      | ((26<=GEST<=29) & (14=<PCV))      |   ((30<=GEST<=31) & (15=<PCV))
      | ((32<=GEST<=36) & (16=<PCV))      |   ((37<=GEST<=40) & (17<=PCV))
      | ((41<=GEST<=42) & (18=<PCV))      |   ((43<=GEST<=45) & (19<=PCV)))
THEN GINDEX = 'INTENSIVE (1st Trimester)';
IF (TPCB=2) &
      (((18<=GEST<=21) & (10=<PCV))       |   ((22<=GEST<=25) & (11=<PCV))
      | ((26<=GEST<=31) & (12=<PCV))      |   ((32<=GEST<=35) & (13=<PCV))
      | ((36<=GEST<=37) & (14=<PCV))      |   ((38<=GEST<=40) & (15=<PCV))
      | ((41<=GEST<=42) & (16=<PCV))      |   ((43<=GEST<=45) & (17<=PCV)))
THEN GINDEX = 'INTENSIVE (2nd Trimester)';
IF (TPCB=3) &
      (((GEST=25) & (9=<PCV))           |   ((26<=GEST<=31) & (10=<PCV))
      | ((32<=GEST<=35) & (11=<PCV))      |   ((36<=GEST<=37) & (12=<PCV))
      | ((38<=GEST<=40) & (13=<PCV))      |   ((41<=GEST<=42) & (14=<PCV))
      | ((43<=GEST<=45) & (15=<PCV)))
```


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```
 THEN GINDEX = 'INTENSIVE (3rd Trimester)';

ADEQUATE PRENATAL CARE UTILIZATION CRITERIA;

IF (TPCB=1) &
      (((18<=GEST<=21) & (3=<PCV<=10))     |      ((22<=GEST<=25) & (4=<PCV<=12))
      | ((26<=GEST <=29) & (5=<PCV<= 13))  |      ((30<=GEST<=31) & (6=<PCV<= 14))
      | ((32<=GEST<=33)  & (7=<PCV<=15))   |      ((34<=GEST<=35) & (8=<PCV<=15))
      | ((GEST=36)       & (9=<PCV<=15))   |      ((GEST =37) & (10<=PCV<=16))
      | ((GEST=38)       & (11=<PCV<=16))  |      ((GEST =39) & (12<=PCV<=16))
      | ((GEST=40) & (13=<PCV<=16))        |      ((GEST =41) & (14<=PCV<=17))
      | ((GEST=42) & (15=<PCV<=17))        |      ((43<=GEST<=45) & (16<=PCV<=18)))
THEN GINDEX = 'ADEQUATE (1st Trimester)';

INTERMEDIATE PRENATAL CARE UTILIZATION CRITERIA;

IF (TPCB=1) &
      (((18<=GEST<=21) & (1<=PCV<=2))      |    ((22<=GEST<=25) & (2=<PCV<=3))
      | ((26<=GEST<=29) & (2=<PCV<=4))     |    ((30<=GEST<=31) & (3=<PCV<=5))
      | ((32<=GEST<=33) & (4=<PCV<=6))     |    ((34<=GEST<=35) & (5=<PCV<=7))
      | ((GEST=36) & (5=<PCV<=8))          |    ((GEST=37) & (6=<PCV<=9))
      | ((GEST=38) & (7=<PCV<=10))         |    ((GEST=39) & (7=<PCV<=11))
      | ((GEST=40) & (8=<PCV<=12))         |    ((GEST=41) & (8=<PCV<=13))
      | ((GEST=42) & (9=<PCV<=14))         |    ((43<=GEST<=45) & (9=<PCV<=15)))
THEN GINDEX = 'INTERMEDIATE (1st Trimester)';
IF (TPCB=2) &
      (((18<=GEST<=21) & (1=<PCV<=9))      | ((22<=GEST<=25) & (2=<PCV<=10))
      | ((26<=GEST<=29) & (2=<PCV<=11))    | ((30<=GEST<=31) & (3=<PCV<=11))
      | ((32<=GEST<=33) & (4=<PCV<=12))    | ((34<=GEST<=35) & (5=<PCV<=12))
      | ((36<=GEST<=37) & (6=<PCV<=13))    | ((38<=GEST<=39) & (7=<PCV<=14))
      | ((GEST=40) & (8=<PCV<=14))         | ((GEST =41)    & (8=<PCV<=15))
      | ((GEST=42) & (9=<PCV<=15))         | ((43<=GEST<=45) & (9=<PCV<=16)))
THEN GINDEX = 'INTERMEDIATE (2nd Trimester)';

INADEQUATE PRENATAL CARE UTILIZATION CRITERIA;
```


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```
IF (TPCB=1) &
      (((22<=GEST<=29) & (PCV=1))          |    ((30<=GEST<=31) & (1<=PCV<=2))
      | ((32<=GEST<=33) & (1<=PCV<=3))      |    ((34<=GEST<=36) & (1<=PCV<=4))
      | ((GEST=37) & (1<=PCV<=5))           |    ((38<=GEST<=39) & (1<=PCV<=6))
      | ((40<=GEST<=41) & (1<=PCV<=7))      |    ((42<=GEST<=45) & (1<=PCV<=8)))
THEN GINDEX = 'INADEQUATE (1St Trimester)';
IF (TPCB=2) &
      (((22<=GEST<=29) & (PCV=1))          |     ((30<=GEST<=31) & (1<=PCV<=2))
      | ((32<=GEST<=33) & (1<=PCV<=3))      |     ((34<=GEST<=35) & (1<=PCV<=4))
      | ((36<=GEST<=37) & (1<=PCV<=5))      |     ((38<=GEST<=39) & (1<=PCV<=6))
      | ((40<=GEST<=41) & (1<=PCV<=7))      |     ((42<=GEST<=45) & (1<=PCV<=8)))
THEN GINDEX = 'INADEQUATE (2nd Trimester)';
IF (TPCB=3) &
      (((GEST =25) & (1<=PCV<=8))          |    ((26<=GEST<=31) & (1<=PCV<=9))
      | ((32<=GEST<=35) & (1<=PCV<=10))     |    ((36<=GEST<=37) & (1<=PCV<=11))
      | ((38<=GEST<=40) & (1<=PCV<=12))     |    ((41<=GEST<=42) & (1<=PCV<=13))
      | ((43<=GEST<=45) & (1<=PCV<=14)))
THEN GINDEX = 'INADEQUATE (3rd Trimester)';

MISSING PRENATAL CARE CRITERIA;

IF (((PCV=.) & (TPCB^=0))                 | ((TPCB=3) & (1<=GEST<=24))
|  ((TPCB=2) & (1<=GEST<=11))              | ((GEST=.) & (PCV^=0))
|  ((TPCB=.) & (PCV^=0))                   | (TPCB=0 & (PCV>0)))
THEN GINDEX = 'MISSING';

NO PRENATAL CARE UTILIZATION;

IF (PCV=0)                          |     (TPCB=0 & PCV=.)
THEN GINDEX = 'NOCARE';
```

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eTable 4. Characteristics of pregnant individuals by Tdap vaccination status and Tdap policy eligibility						
Characteristic	**Pre-Tdap policy[a]**			**Post-Tdap policy[a]**		
	No Tdap (n=737,171) % [b]	**Tdap (n=17,989) % [b]**	**Standardized difference**	**No Tdap (n=185,376) % [b]**	**Tdap (n=51,314) % [b]**	**Standardized difference**
Maternal age (years)						
<20	2.2	1.4	0.06	1.5	0.7	0.07
20–24	10.6	6.8	0.13	9.2	6.0	0.12
25–29	26.8	27.4	0.01	25.6	24.1	0.04
30–34	36.9	39.7	0.06	37.5	41.7	0.08
≥35	23.6	24.6	0.02	26.2	27.6	0.03
Fiscal year of conception [c]						
2011	12.9	2.1	0.42	-	-	-
2012	16.7	7.4	0.29	-	-	-
2013	16.7	11.4	0.15	-	-	-
2014	16.5	13.5	0.08	-	-	-
2015	16.2	24.9	0.22	-	-	-
2016	16.0	28.5	0.30	-	-	-
2017	4.9	12.3	0.27	39.1	23.8	0.33
2018	-	-	-	49.6	59.2	0.19
2019	-	-	-	11.3	16.9	0.16
Parity						
0 (nulliparous)	43.8	52.3	0.17	40.5	51.1	0.21
≥1 (multiparous)	56.2	47.7	0.17	59.5	48.9	0.21
Multiple birth						
No	98.1	98.7	0.05	98.1	98.6	0.04
Yes	1.9	1.3	0.05	1.9	1.4	0.04
Pre-existing maternal medical condition [d]						
Asthma	0.2	0.2	0.00	0.2	0.2	0.00
Chronic hypertension	0.4	0.3	0.01	0.4	0.4	0.00
Diabetes	0.8	0.5	0.05	1.2	0.7	0.05
Heart disease	0.5	0.4	0.01	0.5	0.4	0.01
Thyroid disease	1.2	1.8	0.05	1.6	2.2	0.04
Any pre-existing maternal medical condition						
No	97.0	97.0	0.00	96.3	96.2	0.01

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Yes	3.0	3.0	0.00	3.7	3.8	0.01
Neighbourhood median family income quintiles						
1 (Lowest)	21.4	19.5	0.05	21.8	18.0	0.10
2	20.1	21.1	0.02	20.4	19.7	0.02
3	20.8	19.6	0.03	21.5	21.2	0.01
4	21.1	20.7	0.01	20.4	22.1	0.04
5 (Highest)	16.6	19.2	0.07	16.0	19.0	0.08
Rural residence						
No	90.7	91.9	0.05	90.2	92.4	0.08
Yes	9.3	8.1	0.05	9.8	7.6	0.08
LHIN Group [e]						
Central	33.3	31.5	0.04	33.0	33.8	0.02
East	23.8	38.8	0.33	23.8	25.0	0.03
North	5.3	3.4	0.09	5.4	2.4	0.15
Toronto	9.3	11.2	0.07	8.6	11.6	0.10
West	28.4	15.1	0.33	29.2	27.2	0.04
Marginalization Indices [f]						
Residential instability quintile						
1 (least marginalized)	22.1	20.4	0.04	20.6	21.5	0.02
2	18.6	19.7	0.03	18.3	18.7	0.01
3	18.1	17.9	0.00	18.8	18.6	0.01
4	18.8	17.6	0.03	19.1	17.7	0.03
5 (most marginalized)	22.4	24.3	0.04	23.2	23.5	0.01
Material deprivation quintile						
1 (least marginalized)	19.7	25.7	0.14	20.6	26.6	0.14
2	19.6	20.4	0.02	19.7	21.8	0.05
3	18.9	17.8	0.03	18.7	18.3	0.01
4	19.0	18.0	0.03	18.8	17.0	0.05
5 (most marginalized)	22.7	18.1	0.11	22.2	16.3	0.15
Dependency quintile						
1 (least marginalized)	34.1	31.7	0.05	32.8	35.9	0.06
2	21.1	21.0	0.00	21.1	21.7	0.01
3	16.9	17.6	0.02	16.9	16.2	0.02
4	15.0	16.7	0.05	15.4	14.4	0.03
5 (most marginalized)	12.9	13.0	0.00	13.7	11.9	0.05
Ethnic concentration quintile						

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1 (least marginalized)	13.3	12.0	0.04	14.0	10.9	0.09
2	15.1	14.6	0.01	15.6	14.6	0.03
3	17.0	16.9	0.00	17.0	18.2	0.03
4	21.1	21.6	0.01	20.9	23.4	0.06
5 (most marginalized)	33.5	35.0	0.03	32.4	32.9	0.01
Prenatal care [g]						
Intensive	5.6	7.3	0.07	4.8	5.8	0.04
Adequate	41.2	53.6	0.25	38.9	46.4	0.15
Intermediate	34.6	30.4	0.09	32.8	31.0	0.04
Inadequate	13.0	7.0	0.20	16.8	12.9	0.11
No care/Missing [h]	5.5	1.6	0.21	6.7	3.9	0.13
Composition of prenatal care visits						
No visits	5.5	1.6	0.21	6.7	3.9	0.13
≥ 75% with GP/FP	13.9	31.4	0.43	12.7	19.4	0.19
≥ 75% with OBGYN	61.7	50.0	0.24	62.0	54.0	0.16
Mix of providers	18.8	17.0	0.05	18.6	22.7	0.10

Abbreviations: GP/FP, general practitioner/family physician; LHIN, Local Health Integration Network; OBGYN, obstetrician-gynecologist

[a] In February 2018, Canada's National Advisory Committee on Immunization (NACI) released their updated Tdap vaccine recommendation which advised all pregnant women to receive Tdap vaccination during every pregnancy, ideally between 27-32 weeks' gestation. We categorized pregnancies as "post-policy" if they either reached a minimum of 27 weeks' gestation by February 1st 2018 (since NACI's updated policy recommended vaccination between 27-32 weeks' gestation) or began their pregnancy after this index date. Pregnancies that either ended prior to February 1st 2018 or did not reach 27 weeks' gestation by this date were considered "pre-policy" as they were not yet eligible to receive vaccination according to the updated NACI policy.

[b] Percentages shown are column percentages

[c] As the cohort was created using the delivery date on the maternal record (April 1 2012 to March 31 2020), fiscal years 2011 and 2019 are incomplete which explains the lower number of births shown in these two fiscal years.

[d] Sum of each individual condition does not equal number of women with any condition, as categories were not mutually exclusive

[e] Local Health Integration Networks (LHIN) groups were assigned according to the Ontario's Ministry of Health (see eTable 2 in supplement)

[f] Scores corresponding to each of these four dimensions were previously divided into quintiles, where quintile 1 represents the least marginalized areas, and quintile 5, the most marginalized areas. Please see eTable 2 in supplement for complete descriptions of what is captured in each of these four dimensions.

[g] Adequacy of prenatal care characterized using the Revised-Graduated Prenatal Care Utilization Index (R-GINDEX).

[h] Mother did not have any prenatal visits within our definition.

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eTable 5. Vaccine coverage and rate ratios for Tdap vaccination among pregnant women by Tdap vaccination status and Tdap policy eligibility						
Characteristic	**Pre-Tdap policy[a]**			**Post-Tdap policy[a]**		
	Vaccine coverage per 100 (95% CI)	**Unadjusted RR (95% CI)**	**Adjusted RR (95% CI) [b]**	**Vaccine coverage per 100 (95% CI)**	**Unadjusted RR (95% CI)**	**Adjusted RR (95% CI) [b]**
Overall	2.4 (2.3,2.4)	-	-	21.7 (21.5, 21.9)	-	-

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Maternal age (years)						
<20	1.6 (1.4, 1.8)	0.61 (0.54, 0.69)	0.70 (0.62, 0.79)	11.7 (10.6, 12.9)	0.50 (0.45, 0.55)	0.51 (0.46, 0.56)
20–24	1.6 (1.5, 1.6)	0.61 (0.57, 0.64)	0.65 (0.61, 0.69)	15.3 (14.8, 15.8)	0.65 (0.63, 0.67)	0.69 (0.67, 0.72)
25–29	2.4 (2.4, 2.5)	0.95 (0.92, 0.99)	0.95 (0.91, 0.98)	20.6 (20.3, 21.0)	0.88 (0.86, 0.90)	0.89 (0.88, 0.91)
30–34	2.6 (2.5, 2.6)	1.00 (ref)	1.00 (ref)	23.5 (23.2, 23.8)	1.00 (ref)	1.00 (ref)
≥35	2.5 (2.4, 2.6)	0.97 (0.93, 1.00)	1.00 (0.97, 1.04)	22.6 (22.3, 22.9)	0.96 (0.94, 0.98)	1.00 (0.98, 1.02)
Fiscal year of conception [c]						
2011	0.4 (0.4, 0.4)	0.097 (0.088, 0.11)	0.098 (0.088, 0.11)	-	-	-
2012	1.1 (1.0, 1.1)	0.26 (0.24, 0.27)	0.26 (0.24, 0.27)	-	-	-
2013	1.6 (1.6, 1.7)	0.39 (0.37, 0.41)	0.39 (0.37, 0.41)	-	-	-
2014	2.0 (1.9, 2.0)	0.47 (0.45, 0.49)	0.46 (0.44, 0.48)	-	-	-
2015	3.6 (3.5, 3.7)	0.87 (0.84, 0.90)	0.85 (0.82, 0.88)	-	-	-
2016	4.2 (4.0, 4.3)	1.00 (ref)	1.00 (ref)	-	-	-
2017	5.8 (5.6, 6.0)	1.40 (1.33, 1.47)	1.41 (1.35, 1.48)	14.4 (14.2, 14.7)	1.00 (ref)	1.00 (ref)
2018	-	-	-	24.9 (24.6, 25.1)	1.72 (1.69, 1.75)	1.70 (1.67, 1.73)
2019	-	-	-	29.2 (28.7, 29.8)	2.03 (1.98, 2.08)	1.99 (1.95, 2.04)
Parity						
0 (nulliparous)	2.8 (2.8, 2.9)	1.40 (1.36, 1.44)	1.39 (1.35, 1.44)	25.9 (25.6, 26.2)	1.40 (1.38, 1.42)	1.39 (1.37, 1.41)
≥1 (multiparous)	2.0 (2.0, 2.1)	1.00 (ref)	1.00 (ref)	18.5 (18.3, 18.7)	1.00 (ref)	1.00 (ref)
Multiple birth						
No	2.4 (2.4, 2.4)	1.00 (ref)	1.00 (ref)	21.8 (21.6, 21.9)	1.00 (ref)	1.00 (ref)
Yes	1.6 (1.4, 1.9)	0.68 (0.60, 0.78)	0.76 (0.67, 0.86)	16.7 (15.6, 17.9)	0.77 (0.72, 0.82)	0.77 (0.72, 0.82)
Pre-existing maternal medical condition [b]						
No	2.4 (2.3, 2.4)	1.00 (ref)	1.00 (ref)	21.7 (21.5, 21.8)	1.00 (ref)	1.00 (ref)
Yes	2.4 (2.2, 2.6)	1.01 (0.93, 1.10)	0.95 (0.87, 1.03)	22.3 (21.4, 23.1)	1.03 (0.99, 1.07)	0.97 (0.93, 1.01)
Neighbourhood median family income quintiles						
1 (Lowest)	2.2 (2.1, 2.2)	0.79 (0.76, 0.83)	1.04 (0.96, 1.13)	18.6 (18.2, 18.9)	0.75 (0.73, 0.77)	1.05 (1.01, 1.10)
2	2.5 (2.4, 2.6)	0.91 (0.87, 0.96)	1.10 (1.03, 1.17)	21.1 (20.8, 21.5)	0.85 (0.83, 0.88)	1.04 (1.01, 1.08)
3	2.3 (2.2, 2.3)	0.82 (0.79, 0.86)	0.93 (0.88, 0.98)	21.5 (21.1, 21.8)	0.87 (0.85, 0.89)	0.96 (0.94, 0.99)
4	2.3 (2.3, 2.4)	0.86 (0.82, 0.90)	0.93 (0.89, 0.98)	23.1 (22.8, 23.5)	0.94 (0.91, 0.96)	0.98 (0.95, 1.00)
5 (Highest)	2.7 (2.6, 2.8)	1.00 (ref)	1.00 (ref)	24.7 (24.3, 25.1)	1.00 (ref)	1.00 (ref)
Rural residence						
No	2.4 (2.4, 2.5)	1.00 (ref)	1.00 (ref)	22.1 (21.9, 22.3)	1.00 (ref)	1.00 (ref)
Yes	2.1 (2.0, 2.2)	0.85 (0.81, 0.90)	0.83 (0.78, 0.88)	17.6 (17.1, 18.1)	0.80 (0.77, 0.82)	0.92 (0.89, 0.95)
LHIN Group [d]						

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Central	2.3 (2.2, 2.3)	0.79 (0.75, 0.83)	0.86 (0.82, 0.91)	22.1 (21.8, 22.4)	0.82 (0.79, 0.84)	0.90 (0.88, 0.93)
East	3.8 (3.7, 3.9)	1.33 (1.27, 1.40)	1.45 (1.38, 1.53)	22.5 (22.2, 22.8)	0.83 (0.81, 0.85)	0.96 (0.93, 0.99)
North	1.5 (1.4, 1.7)	0.53 (0.49, 0.59)	0.63 (0.58, 0.70)	11.0 (10.5, 11.6)	0.41 (0.39, 0.43)	0.55 (0.52, 0.59)
Toronto	2.9 (2.8, 3.0)	1.00 (ref)	1.00 (ref)	27.1 (26.5, 27.7)	1.00 (ref)	1.00 (ref)
West	1.3 (1.2, 1.3)	0.45 (0.42, 0.47)	0.53 (0.50, 0.56)	20.5 (20.2, 20.9)	0.76 (0.74, 0.78)	0.91 (0.89, 0.94)
Marginalization Indices [e]						
Residential instability quintile						
1 (least marginalized)	2.2 (2.1, 2.3)	1.00 (ref)	1.00 (ref)	22.4 (22.0, 22.8)	1.00 (ref)	1.00 (ref)
2	2.5 (2.4, 2.6)	1.15 (1.10, 1.20)	1.05 (1.01, 1.10)	22.0 (21.6, 22.4)	0.98 (0.96, 1.00)	1.01 (0.99, 1.04)
3	2.4 (2.3, 2.4)	1.07 (1.02, 1.12)	1.00 (0.95, 1.05)	21.5 (21.1, 21.9)	0.96 (0.94, 0.98)	1.02 (1.00, 1.05)
4	2.2 (2.2, 2.3)	1.02 (0.97, 1.07)	1.02 (0.97, 1.08)	20.5 (20.1, 20.9)	0.91 (0.89, 0.94)	1.04 (1.01, 1.07)
5 (most marginalized)	2.6 (2.5, 2.7)	1.17 (1.12, 1.22)	1.08 (1.02, 1.14)	21.9 (21.6, 22.3)	0.98 (0.96, 1.00)	1.03 (1.00, 1.06)
Material deprivation quintile						
1 (least marginalized)	3.1 (3.0, 3.2)	1.00 (ref)	1.00 (ref)	26.4 (26.0, 26.7)	1.00 (ref)	1.00 (ref)
2	2.5 (2.4, 2.6)	0.80 (0.77, 0.84)	0.86 (0.82, 0.90)	23.4 (23.1, 23.8)	0.89 (0.87, 0.91)	0.94 (0.92, 0.96)
3	2.2 (2.2, 2.3)	0.76 (0.69, 0.76)	0.77 (0.73, 0.81)	21.2 (20.9, 21.6)	0.81 (0.79, 0.82)	0.87 (0.85, 0.89)
4	2.3 (2.2, 2.3)	0.73 (0.70, 0.76)	0.75 (0.70, 0.79)	20.1 (19.7, 20.5)	0.76 (0.74, 0.78)	0.81 (0.79, 0.83)
5 (most marginalized)	1.9 (1.8, 2.0)	0.62 (0.59, 0.65)	0.65 (0.61, 0.69)	16.9 (16.6, 17.2)	0.64 (0.62, 0.66)	0.69 (0.66, 0.71)
Dependency quintile						
1 (least marginalized)	2.2 (2.2, 2.3)	1.00 (ref)	1.00 (ref)	23.2 (22.9, 23.5)	1.00 (ref)	1.00 (ref)
2	2.4 (2.3, 2.4)	1.07 (1.02, 1.11)	1.16 (1.12, 1.21)	22.2 (21.8, 22.5)	0.95 (0.93, 0.97)	1.03 (1.01, 1.05)
3	2.5 (2.4, 2.6)	1.12 (1.07, 1.16)	1.27 (1.22, 1.33)	20.9 (20.5, 21.3)	0.90 (0.88, 0.92)	1.00 (0.98, 1.03)
4	2.6 (2.6, 2.7)	1.19 (1.14, 1.25)	1.39 (1.33, 1.46)	20.5 (20.1, 20.9)	0.88 (0.86, 0.90)	1.01 (0.99, 1.04)
5 (most marginalized)	2.4 (2.3, 2.5)	1.08 (1.03, 1.14)	1.25 (1.18, 1.32)	19.3 (18.9, 19.8)	0.83 (0.81, 0.85)	0.98 (0.95, 1.01)
Ethnic concentration quintile						
1 (least marginalized)	2.1 (2.1, 2.2)	1.00 (ref)	1.00 (ref)	17.7 (17.3, 18.2)	1.00 (ref)	1.00 (ref)
2	2.3 (2.2, 2.4)	1.07 (1.01, 1.13)	1.07 (1.01, 1.13)	20.5 (20.1, 20.9)	1.16 (1.12, 1.19)	1.07 (1.03, 1.10)
3	2.4 (2.3, 2.5)	1.10 (1.04, 1.16)	1.10 (1.04, 1.17)	22.8 (22.4, 23.2)	1.29 (1.25, 1.33)	1.11 (1.08, 1.15)
4	2.4 (2.4, 2.5)	1.13 (1.07, 1.19)	1.17 (1.10, 1.25)	23.7 (23.3, 24.0)	1.33 (1.30, 1.37)	1.13 (1.10, 1.17)
5 (most marginalized)	2.5 (2.4, 2.5)	1.16 (1.10, 1.21)	1.29 (1.21, 1.38)	21.9 (21.6, 22.2)	1.24 (1.20, 1.27)	1.14 (1.10, 1.18)
Prenatal care [f]						
Intensive	3.1 (2.9, 3.2)	1.00 (0.95, 1.06)	1.08 (1.02, 1.14)	25.1 (24.3, 25.9)	1.01 (0.98, 1.04)	1.00 (0.97, 1.03)
Adequate	3.1 (3.0, 3.1)	1.00 (ref)	1.00 (ref)	24.8 (24.6, 25.1)	1.00 (ref)	1.00 (ref)
Intermediate	2.1 (2.0, 2.2)	0.68 (0.66, 0.71)	0.80 (0.77, 0.83)	20.8 (20.5, 21.0)	0.84 (0.82, 0.85)	0.90 (0.89, 0.92)

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Inadequate	1.3 (1.2, 1.4)	0.43 (0.40, 0.45)	0.30 (0.29, 0.32) [e]	17.5 (17.1, 17.9)	0.70 (0.69, 0.72)	0.64 (0.62, 0.65) [h]
No care/Missing [g]	0.7 (0.6, 0.8)	0.23 (0.20, 0.25)	-	13.8 (13.2, 14.3)	0.55 (0.53, 0.58)	-
Composition of prenatal care visits						
No visits	0.7 (0.6, 0.8)	0.36 (0.32, 0.40)	1.13 (0.99, 1.29)	13.8 (13.2, 14.3)	0.71 (0.68, 0.74)	1.11 (1.06, 1.17)
≥ 75% with GP/FP	5.2 (5.1, 5.4)	2.69 (2.60, 2.78)	3.51 (3.39, 3.63)	29.8 (29.3, 30.3)	1.53 (1.50, 1.56)	1.72 (1.68, 1.75)
≥ 75% with OBGYN	1.9 (1.9, 2.0)	1.00 (ref)	1.00 (ref)	19.4 (19.2, 19.6)	1.00 (ref)	1.00 (ref)
Mix of providers	2.2 (2.1, 2.2)	1.11 (1.07, 1.16)	1.27 (1.22, 1.32)	25.2 (24.8, 25.6)	1.30 (1.27, 1.32)	1.31 (1.29, 1.34)

Abbreviations: RR, rate ratio; CI, confidence interval; GP/FP, general practitioner/family physician; LHIN, Local Health Integration Network; OBGYN, obstetrician-gynecologist

[a] In February 2018, Canada's National Advisory Committee on Immunization (NACI) released their updated Tdap vaccine recommendation which advised all pregnant women to receive Tdap vaccination during every pregnancy, ideally between 27-32 weeks' gestation. We categorized pregnancies as "post-policy" if they either reached a minimum of 27 weeks' gestation by February 1st 2018 (since NACI's updated policy recommended vaccination between 27-32 weeks' gestation) or began their pregnancy after this index date. Pregnancies that either ended prior to February 1st 2018 or did not reach 27 weeks' gestation by this date were considered "pre-policy" as they were not yet eligible to receive vaccination according to the updated NACI policy.

[b] The multivariable model included in all the independent variables listed in this table, except a dichotomous variable for pre-existing medical conditions was added instead of the individual conditions in this variable, and the category for *inadequate* prenatal care was combined with *no care/missing* prenatal care to allow for model convergence.

[c] As the cohort was created using the delivery date on the maternal record (April 1 2012 to March 31 2020), fiscal years 2011 and 2019 are incomplete which explains the lower number of births shown in these two fiscal years.

[d] Local Health Integration Networks (LHIN) groups were assigned according to the Ontario's Ministry of Health (see eTable 2 in supplement)

[e] Scores corresponding to each of these four dimensions were previously divided into quintiles, where quintile 1 represents the least marginalized areas, and quintile 5, the most marginalized areas. Please see eTable 2 in supplement for complete descriptions of what is captured in each of these four dimensions.

[f] Adequacy of prenatal care characterized using the Revised-Graduated Prenatal Care Utilization Index (R-GINDEX).

[g] Mother did not have any prenatal visits within our definition.

[h] Estimate is for Inadequate and No Care/Missing Care combined