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Trends in Tdap Vaccination among Privately Insured Pregnant Women in the United States, 2009–2016

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Abstract

Background: Infants younger than 6 months are at increased risk of complications and mortality from pertussis infection. In October 2012, the Advisory Committee on Immunization Practices revised its recommendation to include a Tdap dose during each pregnancy, ideally between 27–36 weeks gestation.

Objective: Assess trends in Tdap vaccination coverage among privately insured pregnant women from 2009–2016 including timing of Tdap vaccination (before, during, or after pregnancy), trimester of vaccination for women vaccinated during pregnancy, and missed vaccination opportunities for unvaccinated women. Identify factors associated with vaccination during the optimal period of 27–36 weeks gestation.

Study Design: Retrospective analysis of privately insured women 15–49 years who delivered live births during 2009–2016 conducted using 2009–2016 MarketScan data. Tdap vaccination coverage and the timing of Tdap vaccine administration were assessed for women continuously enrolled from 6 months before pregnancy to 1 month after delivery. Multivariable logistic regression was performed to identify factors independently associated with receipt of Tdap vaccine at 27–36 weeks gestation.

Results: Tdap vaccination coverage during pregnancy increased from 0.4% in 2009 to 6.2% in 2012 and to 53.2% in 2016. The proportion of vaccinated women receiving Tdap at 27–36 weeks gestation increased from <10% in 2009 to nearly 90% in 2016, with most vaccination occurring at 27–32 weeks gestation. Women of older age, residing in a metropolitan statistical area, residing outside the South, and having a capitated health insurance plan were more likely to receive Tdap at 27–36 weeks gestation than their counterparts. Among women not vaccinated during pregnancy, 77.7% had a pregnancy-related medical claim between 27 and 36 weeks gestation.

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Conclusion: Tdap vaccination coverage during pregnancy increased significantly from 2009–2016, with the greatest increase occurring after the revised Advisory Committee on Immunization Practices recommendation. Most women who did not receive Tdap vaccine had a missed vaccination opportunity during pregnancy, indicating potential for much higher vaccination coverage and consequent infant protection against pertussis.

Keywords

MarketScan data; pregnant women; tetanus; diphtheria and acellular pertussis vaccine (Tdap); vaccination coverage

Introduction

Infants are at increased risk for severe disease and associated complications from pertussis infection. Up to 90% of pediatric pertussis hospitalizations occur in infants < 6 months of age.[1] Despite ongoing efforts to reduce pertussis, the number of reported pertussis infections in the United States remains substantial. In 2012, the United States reached 4,994 pertussis cases and 16 deaths – 80% of all pertussis deaths recorded in 2012 – reported among infants <12 months.[2]

Vaccination of pregnant women with tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis vaccine (Tdap) is the most effective strategy for protecting both mothers and their infants from pertussis.[3–9] Maternal vaccination is especially important for young infants who are not old enough to receive pertussis-containing vaccines themselves, as the primary vaccine series is given at two, four, and six months of age. In 2005, the Advisory Committee on Immunization Practices (ACIP) recommended Tdap vaccination for unvaccinated postpartum mothers and family members to surround newborn infants with a protective “cocoon” of pertussis immunity. Implementation challenges and suboptimal vaccination coverage from cocooning programs led ACIP to revisit its Tdap recommendations.[10] In October 2011, ACIP recommended Tdap vaccination for pregnant women who previously had not received Tdap.[10] However, recent studies suggest maternal antibodies may wane quickly.[11–13] Therefore, Tdap vaccination in a previous pregnancy might not provide adequate protection in subsequent pregnancies. To optimize vaccination strategies and provide protection of newborns from pertussis infection in early life, in October 2012, ACIP recommended one dose of Tdap during every pregnancy.[14] Preferably, Tdap vaccination should be administered between 27 and 36 weeks gestation to provide the highest level of maternal antibodies that could be transferred to infants for optimal protection.[11] More recent data suggest vaccination earlier in the third trimester (i.e. 27–32 weeks) may provide better infant protection.[15]

While several recent studies have assessed Tdap vaccination coverage during pregnancy,[16–20] robust data on coverage after the 2012 changes to ACIP’s recommendations are limited. The objective of this study was assess trends in Tdap vaccination coverage from 2009 through 2016, including timing of administration (before, during, or after pregnancy), trimester of vaccination for women vaccinated during pregnancy, and missed vaccination

opportunities for unvaccinated women among pregnant women enrolled in private insurance plans, the largest insured segment of the U.S. population.[21]

Materials and Methods

Tdap vaccination coverage was assessed using the MarketScan 2009–2016 Commercial Claims and Encounters (CCAE) databases from Truven Health Analytics.[22] MarketScan data come from a selection of large employers, health plans, and government and public organizations, and represent one of the largest collections of paid health insurance claims data for the private sector in the United States. These data are collected from more than 300 contributing employers and 25 different health plans and cover approximately 180 million unique de-identified patients since 1995.

All enrolled women aged 15–49 years who delivered a live infant from January 2009 through December 2016 were included. Women with a live birth were identified using an International Classification of Clinical Diseases, 9th and 10th Revision, Clinical Modification codes: 650, V27.0, V27.2, V27.3, V27.5, V27.6, O80, Z370, Z372, Z373, Z375, Z376, and Z379.[20] Due to the lack of gestational age information in claims data, delivery date was used to approximate the beginning of pregnancy. Specifically, the beginning of pregnancy was defined as 280 days (40 weeks) prior to the delivery date. We conducted a sensitivity analysis assuming pregnancy began 37, 38, 39, and 41 weeks prior to the delivery date; 90% of births from 2010–2016 were delivered between 37 and 41 weeks gestation.[23] The direction and magnitude of changes in estimates of vaccination timing were assessed, with differences of ≥5 percentage points considered notable. The pre-pregnancy period was defined as 6 months (180 days) before the beginning of pregnancy. The postpartum period was defined as 1 month (30 days) after the delivery date. In order to fully capture immunization utilization prior to and during the entire pregnancy, we limited our sample to those who had continuous enrollment from 6 months prior to pregnancy to 1 month postpartum. Enrollees with missing enrollment or delivery information were excluded from the analyses. The final study population was approximately 50% of the MarketScan CCAE female population with live births. Demographic and insurance characteristics among excluded women were similar to those among women included in the study population.

The CCAE provides financial information as well as demographic and clinical information such as age (which we categorized into three age groups to distinguish pregnancies among adolescents and women of advanced maternal age: 15–18 years, 19–34 years, 35–49 years), gender (male, female), region (Northeast, North Central, South, West), residence in a metropolitan statistical area (yes, no), service date, diagnostic codes, procedure codes, and insurance plan type (capitated, not capitated).The Current Procedural Terminology (CPT) code 90715 from either inpatient or outpatient service claims files was used to identify Tdap vaccination given from 6 months before pregnancy through 1 month postpartum. The timing of Tdap vaccination was reported in three categories: (1) before pregnancy, (2) during pregnancy, and (3) postpartum. For women who received Tdap during pregnancy, the timing of pregnancy was also classified into first trimester (Tdap vaccination from 0–13 weeks gestation), second trimester (Tdap vaccination from 14–26 weeks gestation), and third trimester (Tdap vaccination from 27–40 weeks gestation). To assess timing of vaccination in

accordance with ACIP recommendations, Tdap vaccination in the third trimester was further divided into three periods: receipt at 27 through 32 weeks (i.e. early in the recommended period), 33 through 36 weeks (later in the recommended period), and 37 through 40 weeks gestation (outside the recommended period).

SAS 9.3 statistical software (SAS Institute Inc.) was used to calculate point estimates of vaccination coverage. The MarketScan Commercial Insurance Weights were used in our analyses. Weights were constructed using the Household Component of the Medical Expenditures Panel Survey and American Community Survey,[22] and reflect the distribution of the privately insured U.S. population by age, sex, geographic region, residence in a metropolitan statistical area, and insurance policy holder status (policy holder or spouse/dependent). The most recent MarketScan data (data year 2016) available at the time of the analysis were used in a multivariable logistic regression model to identify factors independently associated with Tdap vaccination during the ACIP-recommended period of 27–36 weeks gestation among privately insured pregnant women. In addition, claims including codes for two tests commonly administered in the third trimester of pregnancy (glucose screening test and Group B streptococcal [GBS] screening) were examined among unvaccinated women in 2016 to assess missed opportunities for vaccination and among vaccinated women to assess co-administration of Tdap with these tests. Finally, Tdap vaccinations given from September-December 2016 were examined to determine prevalence of Tdap co-administration with influenza vaccine. As a secondary analysis of de-identified data, this study did not require Institutional Review Board approval.

Results

On average, 137,396 pregnant women in the MarketScan databases met the study inclusion criteria each year, ranging from 113,956 in 2009 to 175,648 in 2012 (Table 1). Table 1 presents the demographic characteristics of the study population. Most women who delivered a live birth were 19–34 years of age (76.8–78.7%), lived in a metropolitan statistical area (85.4–89.4%), and were enrolled in non-capitated insurance plans (84.7–89.8%).

Tdap vaccination coverage

Tdap vaccination coverage during pregnancy among women in the study sample increased from 0.4% in the 2009 cohort to 53.2% in the 2016 cohort, with an increase of 47 percentage points between 2012 and 2016 (Table 2). In 2016, Tdap vaccination coverage during pregnancy in women 19–34 years and 35–49 years was 53.1% and 54.0%, respectively, higher than women 15–18 years (39.3%). Those who lived in a metropolitan statistical area were more likely to receive Tdap vaccination during pregnancy (54.0%) compared with women not living in a metropolitan statistical area (45.3%). Women living in the South had the lowest Tdap vaccination coverage during pregnancy (44.7%) compared with women living in the Northeast (54.0%), North Central (61.8%), and West (56.1%) regions. Women with a partially or fully capitated insurance plan were more likely to be vaccinated during pregnancy compared with their counterparts (Table 2). Findings were mostly similar in

2009–2015, although some variation was obscured by low overall vaccination coverage prior to 2012.

Age older than 18 years, residency in a metropolitan statistical area, residency in a region other than the South, and enrollment in a capitated health insurance plan remained associated with an increased likelihood of Tdap vaccination at 27–36 weeks gestation in 2016 after adjustment in multivariable analysis (Table 3). Findings were similar when examining vaccination at 27–32 weeks.

Timing of Tdap vaccination

Among vaccinated women, 97.7% received their Tdap vaccination during pregnancy in 2016 compared with 63.9% in 2012 (Table 4). The proportion of vaccinated women who received Tdap in the 1-month postpartum period decreased from 35.3% in 2010 to 1.1% in 2016. For women vaccinated during pregnancy, the percentage who received Tdap between 27–36 weeks increased from 33.7% in 2011 to 89.5% in 2016. From 2012–2016, the largest proportion of vaccinated women received Tdap in the earlier part of the third trimester (at 27 through 32 weeks); this proportion increased from 32.1% in 2012 to 63.2% in 2016. The proportion vaccinated at 33 through 36 weeks was similar in both years (25.1% in 2012 and 26.2% in 2016) (Table 4).

In sensitivity analysis, overall proportions of women who received Tdap before, during, and after pregnancy were unchanged (Appendix A). Assuming shorter duration of pregnancy generally resulted in similar or lower vaccination coverage estimates during the first and late third trimester, and similar or higher estimates of vaccination during the second and early third trimesters. Assuming a longer duration of pregnancy had less effect on the estimates with the primary change observed being a shift in vaccination from the beginning to the end of the third trimester. In the four years following ACIP's revised recommendations, the largest proportion of women vaccinated during pregnancy were observed to have received Tdap in their early third trimester (27 weeks-32 weeks 6 days), regardless of assumed duration of pregnancy.

In 2016, 24.3% of Tdap vaccinations administered to pregnant women in this sample were given at the same visit as a glucose or GBS test, and 18.7% of Tdap vaccinations were given at the same visit as an influenza vaccine. Among the 46.9% of pregnant women in 2016 who did not receive Tdap vaccine during pregnancy, 77.7% had a claim at 27 through 36 weeks for glucose or GBS testing, or both, representing a medical encounter at which Tdap vaccine could have been administered; 91.5% had a claim for a glucose or GBS test at any point during pregnancy.

Discussion

This study assessed Tdap vaccination coverage and timing of vaccination among a large sample of privately insured pregnant women over a period before and after the 2012 ACIP Tdap recommendation. We found a substantial increase in Tdap vaccination during pregnancy from 2009 to 2016 among privately insured pregnant women, with the greatest increases occurring after the revised ACIP recommendation in 2012. We also found that

timing of Tdap vaccination shifted quickly in response to ACIP's revised recommendation, with 89.4% of vaccinated women in 2016 receiving Tdap vaccine between 27–36 weeks gestation, compared with 33.7% in 2011. Despite increased Tdap vaccination uptake over time among pregnant women, vaccination coverage in this group is still suboptimal.

Assessing the timing of Tdap vaccination is important for optimizing vaccination strategy to maximize protection of infants early in life.[11,24] We found a clear shift to receipt of Tdap vaccination during pregnancy since 2012. From 2009–2011, a small proportion of women were vaccinated during pregnancy and many of those were vaccinated during the first trimester; this may in part represent inadvertent vaccine receipt by women who did not know they were pregnant. Among all pregnant women, Tdap coverage during pregnancy increased from 6.2% in 2012 to 53.2% in 2016, and among vaccinated women, the proportion who received Tdap vaccine during pregnancy increased from 63.9% in 2012 to 97.7 % in 2016. In addition, we observed an increase in the proportion of Tdap administration in the third trimester among those who were vaccinated during pregnancy. This increase is consistent with ACIP's October 2012 recommendation identifying 27–36 weeks gestation as the optimal time for Tdap vaccination, although vaccine may be given at any point during pregnancy.[14] More recently, some studies have suggested that vaccination in the earlier part of the third trimester, or even before the third trimester, may provide equal or better protection against pertussis to infants.[15,25–27] Beginning in 2012, we found that the largest proportion of vaccinated women received Tdap vaccine in the first part of the third trimester, from 27 through 32 weeks gestation. In 2016, nearly two-thirds of vaccinated pregnant women received Tdap vaccine during this time period. This suggests the recent preferential recommendation for Tdap early in the third trimester will be feasible to implement.[28]

We found 78% of unvaccinated pregnant women in 2016 received a glucose or GBS screening test during their third trimester, representing substantial missed opportunities for vaccination during the optimal 27–36 week timeframe. About one-quarter of Tdap vaccines administered to pregnant women in our 2016 cohort were given in conjunction with one of these tests, indicating willingness by providers and patients to combine multiple preventive services in the same obstetric visit. In general, there is a low awareness of Tdap vaccines among the adult population[29,30] and barriers to provider recommendation of Tdap vaccine, most notably the cost of the vaccine.[31,32] However, the majority of ob-gyns in a recent study reported assessing Tdap vaccination status and administering Tdap vaccine to their pregnant patients.[32] It is unknown whether women with missed opportunities were offered Tdap vaccine during these visits and declined, or whether providers neglected to offer the vaccine. Direct observation of clinician-patient encounters during pregnancy may be useful to identify reasons for non-receipt of Tdap vaccine.

Several factors were associated with increased Tdap vaccination among pregnant women in 2016. Women ≥19 years were more likely to receive Tdap than younger women (≤18 years), which is consistent with previous studies.[16,17] Women living in metropolitan statistical areas were more likely to receive Tdap vaccination, as were women living in regions outside of the South. While urbanicity has not been previously reported as a risk factor for maternal vaccination, it may be a proxy for factors that we could not measure in this study, such as race/ethnicity, income, and access to care, which have previously been associated with Tdap

and influenza vaccination among pregnant women and Tdap vaccination in women of childbearing age.[18,33,34]

A similar recent study by Butler and colleagues using the Marketscan database found that prenatal Tdap vaccination increased from 9.8% among women who delivered in October 2012 to 44.4% among women who delivered in December 2014.[20] Our study provides a more complete examination of the impact of ACIP's revised Tdap recommendations, including two additional years of data in the post-2012 period and more detailed breakdowns of vaccination prior to 27 weeks gestation. We showed that prenatal Tdap vaccination coverage continued to increase, reaching 53.2% among privately insured women who delivered from January-December 2016, similar to recent national estimates of influenza vaccination coverage among pregnant women[35] for which there has been a longstanding ACIP recommendation. We further extended prior work by identifying missed vaccination opportunities for pregnant women, suggesting that provider or patient attitudes rather than healthcare utilization behaviors account for suboptimal vaccination coverage in this population.

Our study is subject to several limitations. First, study data represented a convenience sample of paid insurance claims reported for reimbursement purposes, and might not be representative of the U.S. privately insured population of pregnant women. Our findings showed a continuing decrease in adolescent pregnancy rates that is consistent with national vital statistics data, suggesting our data are acceptably representative.[36] Second, gestational age was estimated based on date of delivery, so the true timing of vaccine receipt might differ from our estimates for women delivering before or after 40 weeks. However, our sensitivity analysis suggested our findings are robust across a range of assumed delivery dates and supported our conclusions that most vaccinated women received Tdap during the recommended time period of 27–36 weeks gestation following ACIP's revised recommendations, and that most of these were vaccinated in their early third trimester (before 33 weeks). Third, Tdap vaccination uptake might be underestimated if a claim was not submitted, not successfully submitted using a vaccination-specific code, or not reimbursed by the insurance plan. Our estimates for Tdap coverage during pregnancy in prior years were lower than those reported from other studies using different data sources and methods to examine the same time period.[15–19] Fourth, we examined only women who delivered a live birth and had at least 16 months continuous enrollment in their insurance plan, resulting in the exclusion of approximately half of all women in the sample with a live birth. While included and excluded women were similar when examining information available in Marketscan, it is unknown if they differed on sociodemographic or other characteristics not captured in Marketscan data. Finally, uptake of Tdap vaccination in our study population might have differed from the general population. For example, a previous study reported that Tdap vaccination coverage among adults with public health insurance was lower compared with privately insured adults.[37] People enrolled in private insurance are also less likely to be low-income or nonwhite than those enrolled in public health insurance, factors that are independently associated with vaccination uptake.[38] Further study is needed to examine Tdap vaccination coverage among pregnant women with public health insurance following the updated 2012 Tdap recommendation.

Vaccinating pregnant women with Tdap is the best strategy to protect both women and their newborns from pertussis. While Tdap vaccination coverage during pregnancy has increased over the past several years, coverage among pregnant women is still suboptimal. Improving Tdap uptake during pregnancy is an important public health priority. Evidence-based strategies to improve vaccination coverage, such as clinic-based education on the benefits, safety and timing of Tdap vaccination coupled with provider reminders and standing orders[39] are needed to ensure adequate vaccination among pregnant women during each pregnancy to maximize infant protection against pertussis. Adherence to the National Vaccine Advisory Committee's standards for adult immunization practice, which state that all providers should routinely assess the immunization status of patients, recommend needed vaccines, administer needed vaccines or refer patients to an immunizing provider, and document receipt of vaccination,[40] is important for prenatal care providers (including internists, family physicians, pediatricians, obstetricians, and nurse midwives) to support improved Tdap vaccination of pregnant women.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Characteristics of pregnant women 15–49 years —Marketscan, 2009–2016

	2009		2010		2011		2012		2013		2014		2015		2016	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Total	113,956	100.0	114,579	100.0	144,788	100.0	175,648	100.0	143,736	100.0	156,244	100.0	120,086	100.0	130,129	100.0
Age (years)																
15–18	3,380	3.0	2,990	2.6	3,380	2.3	3,781	2.2	2,528	1.8	2,282	1.5	1,476	1.2	1,357	1.0
19–34	88,649	77.8	89,492	78.1	112,801	77.9	138,125	78.6	113,095	78.7	122,385	78.3	93,836	78.1	9,921	76.8
35–49	21,927	19.2	22,097	19.3	28,607	19.8	33,742	19.2	28,113	19.6	31,577	20.2	24,774	20.6	28,851	22.2
Residence in Metropolitan Statistical Area																
No	16,428	14.4	14,854	13.0	20,892	14.4	25,728	14.6	20,181	14.0	20,626	13.2	13,135	10.9	13,851	10.6
Yes	97,528	85.6	99,725	87.0	123,896	85.6	149,920	85.4	123,555	86.0	135,618	86.8	106,951	89.1	116,278	89.4
Region of policyholder residence																
Northeast	9,326	8.2	14,610	12.8	22,307	15.4	31,136	17.7	24,563	17.1	28,936	18.5	21,365	17.8	21,201	16.3
North Central	30,173	26.5	30,073	26.2	36,782	25.4	43,737	24.9	32,976	22.9	35,522	22.7	24,059	20.0	26,794	20.6
South	57,168	50.2	51,137	44.6	55,085	38.0	64,411	36.7	48,915	34.0	55,264	35.4	53,013	44.1	59,586	45.8
West	17,106	15.0	18,649	16.3	26,810	18.5	32,314	18.4	33,652	23.4	32,115	20.6	21,245	17.7	22,459	17.3
Unknown	183	0.2	110	0.1	3,804	2.6	4,050	2.3	3,630	2.5	4,407	2.8	404	0.3	89	0.1
Partially/fully capitated insurance plan																
No	96,574	84.7	98,448	85.9	124,478	86.0	154,992	88.2	124,257	86.4	138,808	88.8	106,834	89.0	116,821	89.8
Yes	17,382	15.3	16,131	14.1	20,310	14.0	20,656	11.8	19,479	13.6	17,436	11.2	13,252	11.0	13,308	10.2

Table 2.

Tdap vaccination coverage during pregnancy among pregnant women 15–49 years by demographic and insurance characteristics, Marketscan, 2009–2016

	2009 %	2010 %	2011 %	2012 %	2013 %	2014 %	2015 %	2016 %
Overall	0.4	0.9	2.1	6.2	21.9	37.8	48.4	53.2
Age								
15–18 years	0.6	1.0	2.3	4.0	16.6	26.3	33.9	39.3
19–34 years	0.4	0.9	2.0	6.3	22.2	38.5	48.2	53.1
35–49 years	0.5	1.1	2.5	6.6	22.4	38.1	50.0	54.0
Residence in Metropolitan Statistical Area								
No	0.2	0.5	1.0	4.3	18.9	33.3	40.5	45.3
Yes	0.5	1.0	2.3	6.5	22.3	38.4	49.2	54.0
Region of policyholder residence								
Northeast	0.5	0.5	0.9	4.1	20.7	36.4	48.2	54.0
North Central	0.5	0.7	1.6	6.5	26.0	45.7	57.1	61.8
South	0.4	0.5	1.0	5.3	18.5	31.4	41.6	44.7
West	0.5	2.4	5.5	9.4	23.6	39.9	50.7	56.1
Partially/fully capitated insurance plan								
No	0.4	0.8	1.8	6.2	22.0	37.6	47.9	53.0
Yes	0.5	1.7	4.1	6.3	21.2	39.8	53.2	55.0

Tdap: Tetanus toxoid, diphtheria toxoid, and acellular pertussis vaccine.

Table 3.

Logistic regression analyses of factors associated with Tdap vaccination at 27–36 weeks and 27–32 weeks gestation among pregnant women, MarketScan 2016

	Vaccinated at 27–36 weeks		Vaccinated at 27–32 weeks	
	Unadjusted Odds Ratio (95% CI)	**Adjusted Odds Ratio (95% CI)**	**Unadjusted Odds Ratio (95% CI)**	**Adjusted Odds Ratio (95% CI)**
Age				
15–18 years	Referent	Referent	Referent	Referent
19–34 years	1.73 (1.65–1.82)	1.73 (1.65–1.82)	1.71 (1.61–1.80)	1.72 (1.63–1.82)
35–49 years	1.81 (1.73–1.91)	1.78 (1.69–1.87)	1.66 (1.57–1.76)	1.67 (1.57–1.76)
Residence in Metropolitan Statistical Area				
No	Referent	Referent	Referent	Referent
Yes	1.41 (1.39–1.43)	1.38 (1.36–1.40)	1.30 (1.28–1.33)	1.32 (1.29–1.34)
Region of policyholder residence				
Northeast	1.43 (1.41–1.45)	1.39 (1.37–1.41)	1.26 (1.24–1.28)	1.23 (1.22–1.25)
North Central	2.00 (1.97–2.02)	2.01 (1.98–2.03)	1.85 (1.83–1.88)	1.86 (1.83–1.88)
South	Referent	Referent	Referent	Referent
West	1.55 (1.53–1.57)	1.51 (1.49–1.53)	1.32 (1.30–1.34)	1.30 (1.28–1.31)
Partially or fully capitated insurance plan				
No	Referent	Referent	Referent	Referent
Yes	1.08 (1.07–1.10)	1.06 (1.05–1.08)	1.04 (1.02–1.06)	1.03 (1.01–1.04)

*Odds ratios adjusted for all other covariates shown.

Table 4.

Timing of Tdap vaccination among pregnant women aged 15–49 years, Marketscan 2009–2016

Year	Received before pregnancy (%)	Received during pregnancy (%)	Received postpartum (%)	Received at any point during pregnancy*				
				Received during 1st trimester* (%)	Received during 2nd trimester* (%)	Received during 3rd trimester* (%)		
						27 weeks-32 weeks 6 days	33 weeks-36 weeks 6 days	37 weeks-40 weeks
2009	1.4	0.4	0.6	63.1	13.2	5.3	2.9	15.5
2010	1.6	0.9	1.4	34.8	11.6	13.6	17.6	22.3
2011	2.0	2.1	1.7	26.1	21.2	17.4	16.3	19.0
2012	2.0	6.2	1.5	8.3	15.6	32.1	25.1	19.0
2013	1.7	21.9	1.2	2.4	9.7	47.1	27.3	13.5
2014	1.1	37.8	0.8	0.9	4.4	56.9	27.8	10.0
2015	0.8	48.4	0.6	0.5	3.4	61.2	26.7	8.2
2016	0.7	53.2	0.6	0.4	2.8	63.2	26.2	7.4

*Data in these columns represent the proportion of women vaccinated at any point during pregnancy who received Tdap vaccine during the time period specified. First trimester: 0 weeks through 13 weeks 6 days gestation; second trimester: 14 weeks through 26 weeks 6 days gestation; third trimester: 27 weeks through 40 weeks gestation.