

Tetanus, Diphtheria, and Acellular Pertussis and Influenza Vaccinations among Women With a Live Birth, Internet Panel Survey, 2017-2018

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Neil Chandra Murthy^{1,2} , Carla Black¹, Katherine E Kahn^{1,3}, Helen Ding¹, Sarah Ball⁴, Rebecca V Fink⁴, Rebecca Devlin⁴, Denise D'Angelo⁵ and Amy Parker Fiebelkorn¹

¹Immunization Services Division (ISD), National Center for Immunization and Respiratory Diseases (NCIRD), Centers for Disease Control and Prevention (CDC), Atlanta, GA, USA.

²Epidemic Intelligence Service, Centers for Disease Control and Prevention (CDC), Atlanta, GA, USA. ³Leidos, Atlanta, GA, USA. ⁴Abt Associates, Cambridge, MA, USA. ⁵Division of Reproductive Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention (CDC), Atlanta, GA, USA.

ABSTRACT

OBJECTIVES: Pregnant women are at increased risk of complications from influenza, and infants are at increased risk of pertussis. Maternal influenza and Tdap (tetanus, diphtheria, and acellular pertussis) vaccination can reduce risk of these infections and related complications. Our objective was to estimate vaccination coverage with influenza and Tdap vaccines during pregnancy among women with a recent live birth.

METHODS: An opt-in Internet panel survey was conducted from March 28 to April 10, 2018 among pregnant and recently pregnant women. Respondents with a live birth from August 1, 2017 through the date in which the participant completed the survey were included in the analysis. Receipt of influenza vaccination since July 1, 2017 and Tdap vaccination during pregnancy were assessed by sociodemographic characteristics, receipt of a health care provider (HCP) recommendation and/or offer of vaccination, and vaccination-related knowledge, attitudes, and beliefs.

RESULTS: Less than a third (30.3%) of women with a live birth were unvaccinated during their pregnancy with both Tdap and influenza vaccines. Almost a third (32.8%) of the women reported being vaccinated with both vaccines. The majority (73.0%) of women reported receiving an HCP recommendation for both vaccines, and 54.2% of women were offered both vaccines by an HCP. Reasons for nonvaccination included negative attitudes toward influenza vaccine and lack of awareness about Tdap vaccination during pregnancy.

CONCLUSIONS: Maternal Tdap and influenza vaccinations can prevent morbidity and mortality among infants and their mothers, yet many pregnant women are unvaccinated with either Tdap or influenza vaccines. Clinic-based education, along with interventions, such as standing orders and provider reminders, are strategies to increase maternal vaccination.

KEYWORDS: Vaccination, pregnancy, Tdap, influenza, OB/GYN, health care providers

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CORRESPONDING AUTHOR: Neil Chandra Murthy, Immunization Services Division (ISD), National Center for Immunization and Respiratory Diseases (NCIRD), Centers for Disease Control and Prevention (CDC), 2400 Century Center Drive, Mailstop: D92, Atlanta, GA 30345, USA. Email: nmurthy@cdc.gov

Introduction

Pregnant women are at increased risk of complications from influenza, including hospitalizations requiring intensive care and death.^{1,2} In addition, infants aged ≤ 6 months are at high risk of serious influenza illness, but are too young to be vaccinated.¹ Maternal influenza vaccination can reduce the risk of influenza-related illness and hospitalizations in newborn infants and their mothers.^{3–6}

Infants are also at increased risk of pertussis; most cases, hospitalizations, and deaths in the United States occur in infants ≤ 2 months of age.⁷ Maternal vaccination with tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) vaccine can protect infants who are too young to be vaccinated.⁸ Infants whose mothers receive a Tdap vaccination

while pregnant have a lower risk of pertussis and related complications.^{9–11}

The Advisory Committee on Immunization Practices (ACIP) recommends that all women who are or will be pregnant during influenza season receive an influenza vaccination, regardless of trimester of pregnancy.¹ In addition, pregnant women should receive a Tdap vaccination during every pregnancy, optimally at 27 to 36 weeks of gestation.⁸

Recent reports estimate that approximately 50% of pregnant women receive influenza vaccination before or during pregnancy, and approximately 50% receive Tdap vaccination during pregnancy.^{1,12–16} However, there is a paucity of literature describing the reasons for nonvaccination among pregnant women, the sociodemographic characteristics of pregnant women who



remain unvaccinated, and the association between health care provider (HCP) recommendation and offer of vaccine with receipt of vaccination.

To overcome this gap in the literature, the Centers for Disease Control and Prevention (CDC) has used an annual Internet panel survey of pregnant women since the 2010–2011 influenza season to provide timely information on vaccination against influenza in this population; questions about Tdap vaccination during pregnancy have also been included in the survey since 2012. Internet panels typically have greater size, lower cost per interview, and are quicker to conduct compared with mail, telephone, or face-to-face surveys and are considered a useful assessment tool for timely evaluation of influenza and Tdap coverage, as well as in-depth source of information about knowledge, attitudes, behaviors, and barriers related to vaccination among pregnant women.

Our objectives in this analysis were to highlight maternal vaccination data from a 2018 Internet panel survey that have not been previously published, including (1) reporting estimates of maternal vaccination coverage with both Tdap and/or influenza vaccines by demographic characteristics; (2) analyzing provider recommendations and offers for both vaccines; and (3) assessing reasons for nonvaccination among those who were unvaccinated or vaccinated with only 1 vaccine.

Methods

An online survey was conducted from March 28 to April 10, 2018 for the CDC to assess end-of-season influenza vaccination coverage estimates among pregnant women during the 2017–2018 flu season and to assess Tdap vaccination coverage of pregnant women. Women 18 to 49 years of age who were pregnant anytime from August 2017 to April 2018 were recruited from a preexisting, opt-in, general population Internet panel operated by Survey Sampling International.

Analyses were restricted to women who had a live birth to include women who were pregnant during the recommended window for Tdap administration (27–36 weeks' gestation) and to compare Tdap and influenza vaccination coverage in the same sample population. Demographic characteristics of survey respondents including age, race/ethnicity, education level, insurance coverage, poverty status, and presence of high risk medical conditions were ascertained. The number of provider visits since July 2017, the type of provider seen, delivery month, and respondents' knowledge and attitudes about Tdap and influenza vaccinations were also obtained. All data were weighted to reflect the age, race/ethnicity, and geographic distribution of the total US population of pregnant women.

To assess Tdap vaccination coverage, respondents were asked whether they had ever received a Tdap vaccination and, if so, whether they received their most recent Tdap vaccination before, during, or after their most recent pregnancy. Women who reported receiving vaccination during their most recent pregnancy were counted as vaccinated during pregnancy, whereas women who reported never being vaccinated, or being

vaccinated before or after their most recent pregnancy were counted as not vaccinated during pregnancy. Respondents were also asked whether an HCP recommended or offered a Tdap vaccination during their pregnancy. Furthermore, through a multiple choice question, respondents were asked to the best of their knowledge what they thought was the current Tdap vaccination recommendation for pregnant women. Finally, respondents who had not received a Tdap vaccination during their most recent pregnancy were asked about reasons why they were not vaccinated.

To assess influenza vaccination coverage, respondents were asked whether they had received an influenza vaccine since July 1, 2017 (i.e., the start of the most recent influenza season) and whether they received their most recent influenza vaccination before, during, or after their most recent pregnancy. Women who reported receiving influenza vaccination during their most recent pregnancy or before their most recent pregnancy but within the current influenza season (i.e., since July 1, 2017) were counted as vaccinated. Women who reported never being vaccinated or being vaccinated after their most recent pregnancy were counted as not vaccinated. Respondents were also asked whether an HCP recommended or offered an influenza vaccine since July 1, 2017. Furthermore, through a multiple choice question, respondents were asked to the best of their knowledge what they thought was the current influenza vaccination recommendation for pregnant women. Finally, respondents who had not received an influenza vaccination were asked about reasons why they were not vaccinated.

Weighted analyses of Tdap and/or influenza vaccination coverage were calculated using SAS v9.2 (Cary, NC). Because the opt-in Internet panel sample was based on those who initially self-selected for participation in each panel rather than a random probability sample, statistical measures, such as calculation of confidence intervals and tests of differences, were not performed. Human subjects coordinators at CDC determined that this project was nonresearch and was exempt from Institutional Review Board reviews.

Results

Enrollment

A total of 2341 women 18 to 49 years of age who reported being pregnant any time from August 2017 started the online survey, with 2236 completing the survey (95.5%). Of the respondents who completed the survey, 4 respondents were excluded because their survey responses indicated that they were not pregnant during the time period of interest. Of the remaining 2232 respondents, 1417 were pregnant at the time of the survey or did not report a live birth and were excluded from the study. Of the 815 women who reported having a live birth, 115 women were excluded because they did not know whether they had ever received a Tdap vaccination or did not know when they had received their most recent Tdap vaccination.

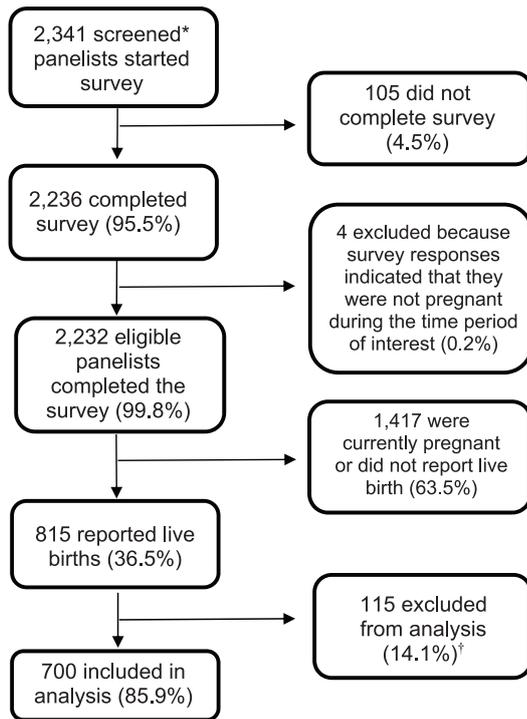


Figure 1. Enrollment and inclusion of survey participants, Internet Panel Survey, March to April 2018.

*Screening criteria: respondents reported they were women, aged 18-49, and pregnant any time since August 1, 2017.

†A total of 115 were excluded because they did not know whether they had ever received a Tdap vaccination or did not know when they received their most recent Tdap vaccination.

We, therefore, had a final analytic sample of 700 respondents (Figure 1).

Vaccination coverage

Overall, 48.1% of women with a live birth reported receipt of influenza vaccination, regardless of Tdap vaccination status, and 54.4% of women reported receipt of Tdap vaccination during pregnancy, regardless of influenza vaccination status (Table 1). Overall, 32.8% of women reported being vaccinated with both Tdap and influenza vaccines, whereas 15.3% were vaccinated with influenza vaccine only, and 21.6% were vaccinated with Tdap vaccine only. Almost a third of the respondents reported that they were not vaccinated with either vaccine. A higher proportion of women 25 to 34 years of age (34.9%), of non-Hispanic other race/ethnicity (39.0%), with greater than a college education (43.2%), at or above the federal poverty line (37.0%), or with private/military health insurance (38.9%) were vaccinated with both vaccines compared with the other groups in each respective category.

Knowledge of ACIP recommendations

Most women reported that they did not know the current medical recommendation for seasonal influenza vaccination of pregnant women (64.7%), whereas approximately half of

respondents reported that they did not know the current medical recommendation for maternal Tdap vaccination during every pregnancy (53.5%) (Table 1). Influenza vaccination coverage was 63.4% among women who reported the correct maternal influenza vaccination recommendation compared with 39.7% among women who did not report the correct recommendation. Tdap vaccination coverage was 77.8% among women who reported the correct maternal Tdap vaccination recommendation compared with 34.1% among women who did not report the correct recommendation.

Provider recommendations for vaccine

An HCP recommendation for both influenza and Tdap vaccines was received by 73.0% of women, whereas 5.8% reported that they were not recommended either vaccine (Table 2). Among those with an HCP recommendation for both vaccines, 44.6% were vaccinated with both vaccines, 12.7% were vaccinated with influenza vaccine only, 24.1% were vaccinated with Tdap vaccine only, and 18.6% were not vaccinated with either vaccine. For those who reported receiving a recommendation for influenza vaccine only (14.9%), none were vaccinated with both influenza and Tdap vaccines, and 40.0% were vaccinated with influenza vaccine only. For those who reported receiving a recommendation for Tdap vaccine only (6.4%), 1.5% were vaccinated with both influenza and Tdap vaccines, and 61.4% were vaccinated with Tdap vaccine only. For women who reported not receiving a recommendation for either Tdap or influenza vaccine (5.8%), 2.2% were vaccinated with both influenza and Tdap vaccines, 1.7% were vaccinated with influenza vaccine only, none were vaccinated with Tdap vaccine only, and 96.1% were not vaccinated with either vaccine.

Provider offers of vaccine

Among respondents, 54.2% reported receiving an HCP offer of both influenza and Tdap, whereas 15.3% reported that they were not offered either vaccine (Table 2). Among those with an HCP offer of both vaccines, 51.4% were vaccinated with both vaccines, 10.7% were vaccinated with influenza vaccine only, 22.4% were vaccinated with Tdap vaccine only, and 15.4% were not vaccinated with either vaccine. For those who were offered influenza vaccine only (17.2%), 6.9% were vaccinated with both influenza and Tdap vaccines, and 37.4% were vaccinated with influenza vaccine only. For those who were offered Tdap vaccine only (13.2%), 13.7% were vaccinated with both influenza and Tdap vaccines, and 57.8% were vaccinated with Tdap vaccine only. For women who reported not receiving an offer for either Tdap or influenza vaccine (15.3%), 12.0% were vaccinated with both influenza and Tdap vaccines, 11.7% were vaccinated with influenza vaccine only, 6.3% were vaccinated with Tdap vaccine only, and 70.0% were not vaccinated with either vaccine.

Table 1. Influenza and Tdap vaccination coverage among women with a live birth during August 2017 to March 2018, by demographic characteristics, Internet panel survey, USA.

CHARACTERISTIC	UNWEIGHTED N	WEIGHTED PERCENT	VACCINATED BOTH ^a (%)	VACCINATED INFLUENZA ONLY ^b (%)	VACCINATED TDAP ONLY ^c (%)	UNVACCINATED ^d (%)
Total	700	100.0	32.8	15.3	21.6	30.3
Age (y)						
18-24	126	24.1	28.2	16.2	20.8	34.8
25-34	444	57.5	34.9	15.8	23.0	26.4
≥35	130	18.4	32.2	12.5	18.4	36.9
Race/ethnicity						
White, non-Hispanic	502	57.3	36.5	11.0	22.8	29.7
Black, non-Hispanic	65	16.6	18.1	16.4	24.8	40.7
Hispanic	78	18.7	32.1	24.9	16.7	26.3
Other, non-Hispanic	55	7.4	39.0	21.7	17.5	21.8
Education						
<College degree	337	50.8	27.1	13.6	23.8	35.6
College degree	274	37.3	37.2	17.8	20.6	24.4
>College degree	89	11.9	43.2	14.6	15.8	26.4
Insurance coverage						
Private/military only	369	50.0	38.9	15.4	19.9	25.8
Any public	314	47.3	27.0	15.1	23.8	34.1
None	<30	— ^e	— ^e	— ^e	— ^e	— ^e
Poverty status ^f						
At or above federal poverty level	538	73.5	37.0	14.9	21.3	26.9
Below federal poverty level	162	26.5	21.2	16.4	22.5	39.9
High risk conditions ^g						
Yes	282	41.2	32.5	15.8	20.7	31.0
No	418	58.8	33	14.9	22.3	29.9
Number of provider visits since July						
None	<30	— ^e	— ^e	— ^e	— ^e	— ^e
1-5	65	9.9	13.4	14.9	31.0	40.7
6-10	243	36.3	27.8	16.5	24.6	31.1
>10	388	53.2	39.6	14.6	18.1	27.7

(Continued)

Table 1. (Continued)

CHARACTERISTIC	UNWEIGHTED N	WEIGHTED PERCENT	VACCINATED BOTH ^a (%)	VACCINATED INFLUENZA ONLY ^b (%)	VACCINATED TDAP ONLY ^c (%)	UNVACCINATED ^d (%)
Type of provider seen most often during pregnancy						
Obstetrician/gynecologist	572	81	33.4	14.8	21.9	29.9
Midwife	73	10.9	25.9	14.5	27	32.6
Other	50	8.1	34.3	22.2	13.2	30.3
Month of delivery						
August to September	159	23.0	10.1	12.2	42.7	34.9
October to January	380	53.8	41.8	12.4	18.0	27.9
February to March	152	23.2	36.8	22.6	8.3	32.3
Correct knowledge of current recommendation for maternal influenza vaccination ^h						
Yes	265	35.3	44.2	19.2	19.8	16.8
No	435	64.7	26.6	13.1	22.6	37.7
Correct knowledge of current recommendation for maternal Tdap vaccination ⁱ						
Yes	344	46.5	47.9	7.4	29.9	14.7
No	356	53.5	19.7	22.1	14.4	43.9

Abbreviation: Tdap, tetanus, diphtheria, and acellular pertussis.

^aWeighted percentage of women who reported receiving influenza vaccination before or during pregnancy since July 1, 2017, and receiving Tdap vaccination during most recent pregnancy.

^bWeighted percentage of women who reported receiving influenza vaccination before or during pregnancy since July 1, 2017, but not receiving Tdap vaccination during most recent pregnancy.

^cWeighted percentage of women who reported receiving Tdap vaccination during most recent pregnancy but not receiving influenza vaccination before or during pregnancy since July 1, 2017.

^dWeighted percentage of women who reported neither receiving influenza vaccination before or during pregnancy since July 1, 2017, nor receiving Tdap vaccination during most recent pregnancy.

^eEstimate not reported because denominator <30.

^fPoverty status was defined based on the reported number of people and children living in the household and annual household income, according to the US Census poverty thresholds (<https://www.census.gov/data/tables/time-series/demo/income-poverty/historical-poverty-thresholds.html>).

^gConditions associated with increased risk for serious medical complications from influenza, including chronic asthma, a lung condition other than asthma, a heart condition, diabetes, a kidney condition, a liver condition, obesity, or a weakened immune system caused by a chronic illness or by medicines taken for a chronic illness.

^hCorrectly answered the question "To the best of your knowledge, what is the current medical recommendation for pregnant women and flu vaccination?" with "Pregnant women SHOULD get the flu vaccination in any trimester."

ⁱCorrectly answered the question "To the best of your knowledge, what is the current medical recommendation for pregnant women and Tdap vaccination?" with "Even if she got a Tdap vaccination when she was younger or with a previous pregnancy, a pregnant woman should get the Tdap vaccination DURING her pregnancy."

Reasons for nonvaccination

Among respondents who reported receiving neither influenza nor Tdap vaccinations, the top 3 reasons for not receiving an influenza vaccination included concern about vaccine effectiveness (28.4%), perceived safety risk to baby (13.7%), and concern about getting influenza illness from the vaccine (13.5%), whereas the top 3 reasons for not receiving a Tdap vaccination included stating that they already received Tdap vaccination during a previous pregnancy or at another time (31.2%), perceived safety risk to baby (16.4%), and not knowing they were supposed to receive a Tdap vaccine (12.9%) (Table 3). Among respondents who received an influenza vaccination only, the top 3 reasons for not receiving a Tdap vaccination included stating that they already received Tdap vaccination during a

previous pregnancy or at another time (32.5%), not knowing they were supposed to receive a Tdap vaccine (14.7%), and a lack of a vaccine recommendation from an HCP (9.2%). Among respondents who received a Tdap vaccination only, the top 3 reasons for not receiving an influenza vaccination included concern about vaccine effectiveness (27.4%), perceived safety risks to self from the vaccine (13.9%), and concern about getting influenza illness from the vaccine (11.7%).

Discussion

Nearly three-quarters of women received a provider recommendation for both influenza and Tdap vaccines, and more than half of women received an offer for both vaccines; however, only 32.8% of pregnant women reported being vaccinated with both maternal vaccines. Although HCP vaccine recommendations

Table 2. Influenza and Tdap vaccination coverage among women with a live birth during August 2017 to March 2018, by health care provider recommendation or offer of vaccination, Internet panel survey, USA.

PROVIDER RECOMMENDATION OR OFFER OF VACCINATION	UNWEIGHTED N	WEIGHTED PERCENT	VACCINATED BOTH ^a (%)	VACCINATED INFLUENZA ONLY ^b (%)	VACCINATED TDAP ONLY ^c (%)	UNVACCINATED ^d (%)
Provider recommendation						
Recommended both vaccines	520	73.0	44.6	12.7	24.1	18.6
Recommended influenza vaccine only	92	14.9	0	40.0	1.4	58.6
Recommended Tdap vaccine only	45	6.4	1.5	0	61.4	37.1
Recommended neither vaccine	40	5.8	2.2	1.7	0	96.1
Provider offer						
Offered both vaccines	394	54.2	51.4	10.7	22.4	15.4
Offered influenza vaccine only	110	17.2	6.9	37.4	5.3	50.4
Offered Tdap vaccine only	94	13.2	13.7	9.6	57.8	18.9
Offered neither vaccine	99	15.3	12.0	11.7	6.3	70.0

Abbreviation: Tdap, tetanus, diphtheria, and acellular pertussis.

^aWeighted percentage of women who reported receiving influenza vaccination before or during pregnancy since July 1, 2017, and receiving Tdap vaccination during most recent pregnancy.

^bWeighted percentage of women who reported receiving influenza vaccination before or during pregnancy since July 1, 2017, but not receiving Tdap vaccination during most recent pregnancy.

^cWeighted percentage of women who reported receiving Tdap vaccination during most recent pregnancy but not receiving influenza vaccination before or during pregnancy since July 1, 2017.

^dWeighted percentage of women who reported neither receiving influenza vaccination before or during pregnancy since July 1, 2017, nor receiving Tdap vaccination during most recent pregnancy.

and/or offers are associated with increased vaccine receipt compared with not receiving a recommendation and/or offer, it is important to note that a recommendation and/or offer alone does not always translate into the patient being vaccinated. HCPs need to understand the specific reasons for nonvaccination to help tailor targeted messages to encourage vaccine uptake among pregnant women. According to a survey of obstetric providers conducted by the American College of Obstetricians and Gynecologists (ACOG), pregnant women may not remember receiving a vaccine recommendation, even when providers believe they are giving a recommendation.¹³ CDC has resources to help providers effectively communicate the importance of vaccination, such as sharing specific reasons why the patient needs a recommended vaccine and highlighting past positive experiences with vaccines.¹⁷

Furthermore, women who received an HCP recommendation and/or offer of both influenza and Tdap vaccines had a higher proportion of receiving both vaccines, whereas those who were recommended and/or offered 1 vaccine but not the other were more likely to receive only the vaccine that was recommended. Other studies in the literature also found a significant association between uptake of Tdap vaccine and/or seasonal influenza vaccine during pregnancy and an HCP recommendation.^{18–23} Vaccine recommendations and offers are

integral components of the National Vaccine Advisory Committee's Standards for Adult Immunization Practice (the "Standards"), which state that all HCPs should assess patients' vaccination status at every visit, strongly recommend needed vaccines, administer vaccines or refer patients for vaccination, and document vaccinations in patients' medical records and immunization information systems, where available.^{24,25}

Overall, 30.3% of respondents were unvaccinated with both vaccines, and 36.9% were "under-vaccinated," only reporting receiving 1 of the 2 ACIP recommended vaccines. Women who are partially vaccinated are presumably amenable to vaccination, and understanding the reasons for partial vaccination can help guide vaccination outreach efforts, particularly the differences by demographic characteristics, can help guide HCPs when counseling patients.¹⁸

We found that reasons for nonvaccination differed by vaccine type, with negative attitudes toward the influenza vaccine as a major driver for not receiving an influenza vaccination, whereas lack of awareness of the Tdap vaccine recommendation was a major driver for not receiving a Tdap vaccination. Our findings align with those from other studies in the literature that found that perceived vaccine safety risks for baby, underestimation of perceived risk of influenza illness, lack of information, and fear of side effects are reasons for not

Table 3. Main reasons reported for nonvaccination with influenza and Tdap vaccines among women with a live birth during August 2017 to March 2018 who were not vaccinated with one or both vaccines, Internet panel survey, USA.

VACCINATION STATUS	TOP 5 REASONS FOR NOT RECEIVING INFLUENZA VACCINE (% REPORTING REASON)	TOP 5 REASONS FOR NOT RECEIVING TDAP VACCINE (% REPORTING REASON)
Received neither vaccine	Don't think vaccine effective (28.4)	Already got Tdap during a previous pregnancy or at another time (31.2)
	Safety risk to baby (13.7)	Safety risk to baby (16.4)
	Get sick when vaccinated (13.5)	Didn't know I was supposed to get Tdap (12.9)
	Safety risk to myself (12.7)	No recommendation from provider (10.9)
	Fear of needles (6.9)	Safety risk to myself (8.0)
Received influenza vaccine only	N/A	Already got Tdap during a previous pregnancy or at another time (32.5)
	N/A	Didn't know I was supposed to get Tdap (14.7)
	N/A	No recommendation from provider (9.2)
	N/A	Provider recommended that I wait (8.1)
	N/A	Safety risk to baby (8.0)
Received Tdap vaccine only	Don't think vaccine effective (27.4)	N/A
	Safety risk to myself (13.9)	N/A
	Get sick when vaccinated (11.7)	N/A
	Do not need the vaccine (10.4)	N/A
	Safety risk to baby (8.8)	N/A

Abbreviation: Tdap, tetanus, diphtheria, and acellular pertussis.

receiving influenza vaccine during pregnancy,^{19,26} and lack of understanding the need for Tdap vaccination during pregnancy and feeling uninformed about Tdap were reasons for not receiving a Tdap vaccination.^{27,28}

Patient education on the importance of maternal vaccination, in combination with other strategies such as patient reminder-recalls and standing orders, are recommended by the Community Preventive Services Task Force to increase vaccine uptake.²⁹ We found that women with knowledge of the ACIP recommendations for maternal vaccination were more likely to be vaccinated than women who did not know the ACIP recommendations, especially for Tdap vaccine. However, because this survey did not assess when the knowledge of the ACIP recommendations was gained, it is not clear whether knowledge drove the decision to vaccinate or whether knowledge is a product of receiving the vaccine. Given this finding, HCPs should educate their patients about the importance of the current ACIP recommendations for maternal vaccination (ie, the benefits of vaccination and risks to mother and infant if unvaccinated) and should set the expectation early on in the course of the pregnancy about the vaccinations that all pregnant women will need.

We found that only slightly more than half of the women in our study reported being offered both influenza and Tdap vaccines. We also noted that vaccination offers were more likely to lead to vaccine receipt than a vaccine recommendation alone (Table 2). Barriers to providers offering vaccines may include challenges providers face related to reimbursement for vaccination services and vaccine storage. A recent study showed that nearly a third of OB/GYNs reported financial barriers related to vaccine reimbursements, as well as logistical barriers associated with storage of vaccines.³⁰ Novel approaches to address these barriers are warranted to ensure that HCPs are able to administer maternal vaccinations during prenatal visits. Although not all providers can stock and offer a vaccine, those who cannot offer vaccines should give a strong recommendation along with a referral for vaccination, and then follow-up with the patient at her next visit to ensure that the vaccination was given.

Limitations

There are several limitations to our findings. Our results are subject to reporting bias, since data were self-reported and not

verified by review of medical records or immunization information systems, and some patients could not recall whether they received Tdap and/or the influenza vaccines. Selection bias can result from an Internet panel as the survey population is self-selected. In addition, women with a live birth who could not recall if they received the recommended vaccine(s) were excluded. As this report was intended to be an exploratory descriptive analysis examining Tdap and influenza vaccination coverage among women with a live birth, we did not attempt to measure estimates of variance in our nonprobability sample.³¹ Furthermore, we used an opt-in convenience sample. Therefore, our results may not be generalizable to the US population of pregnant women. However, although estimates of influenza vaccination from Internet panel surveys have generally been higher than estimates from the population-based National Health Interview Survey, trends in coverage are similar.^{32,33} Furthermore, Tdap coverage estimates from the Internet panel survey have been similar to coverage reported from other sources.^{34,35}

Conclusions

Despite ACIP's recommendations for influenza and Tdap vaccination among pregnant women, vaccination coverage was low in our sample of pregnant women. Nearly a third of pregnant women are unvaccinated with both Tdap and influenza vaccines, and more than a third of pregnant women are "under-vaccinated," receiving only 1 of the 2 recommended vaccines. Strategies to improve uptake of influenza and Tdap vaccinations for pregnant women include increasing knowledge and awareness of the vaccine recommendations and vaccine effectiveness among HCPs and patients, and improving vaccination outreach and communication efforts during routine antenatal care.³⁶ Patient education during clinic visits, along with interventions such as standing orders and provider reminders are strategies to increase maternal vaccination. Further research is warranted to better understand barriers and facilitators of vaccine uptake by pregnant women in the United States.

Authors' Note

The findings and conclusions of this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Author Contributions

NCM was involved with writing the manuscript. CB conceived the study and supervised the design, implementation, and interpretation of the research. RVF, SB, and RD were involved with the design of the Internet Panel Survey. KEK and CB conducted the data analysis. NCM, CB, RVF, SB, RD, KEK, HG, DA, and APF were involved with reviewing the manuscript and providing constructive feedback and edits, and approved the final manuscript.

ORCID iD

Neil Chandra Murthy  <https://orcid.org/0000-0002-6322-7179>

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