

RESEARCH PAPER

Tdap vaccine attitudes and utilization among pregnant women from a high-risk population

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ABSTRACT

Infants infected with *Bordatella pertussis* experience high morbidity and significant mortality. Vaccinating pregnant mothers with the tetanus-diphtheria-acellular pertussis (Tdap) vaccine is a recommended strategy for preventing infant pertussis. This is especially important for mothers living in poverty and from racial and ethnic minority populations as these groups are at increased risk of having a pertussis-affected infant. Using the Health Belief Model as a framework, we surveyed a convenience sample of pregnant mothers representing these high-risk populations to understand factors associated with Tdap vaccine uptake during their pregnancy. Among the 316 mothers surveyed, 82% had gotten or planned to get Tdap that same day even though 63% of the sample had concerns about the safety of the vaccine during pregnancy. Perceived benefits and norms were the Health Belief Model constructs most consistently associated with Tdap vaccination. Although 32% of women reported prior Tdap vaccine receipt, this factor was not associated with Tdap vaccination during the current pregnancy, contrasting studies of vaccination done in non-pregnant populations. Important variations in attitudes were apparent, with Spanish-speaking women significantly more likely to have concerns about the vaccine's safety and efficacy than English-speaking women. This study indicates that among this high-risk population acceptance of Tdap vaccine during pregnancy is high. However, our results suggest that it may be important to modify information conveyed about the safety and importance of Tdap during pregnancy based on individual level factors such as language or acculturation.

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Introduction

Bordatella pertussis infection is endemic both in the U.S. and abroad. In 2014 alone, more than 28,000 cases were reported.¹ Young infants infected with pertussis experience the highest morbidity and mortality from this infection. Recent estimates suggest that approximately 50% of infected infants require hospitalization and of these, nearly 2% die.²

The majority of infants infected with pertussis acquire it from their immediate family members.^{3–5} Vaccination of these family members and other close contacts against pertussis using the tetanus-diphtheria-acellular pertussis (Tdap) vaccine, a strategy called cocooning, is recommended for protecting newborns and infants too young to receive the vaccine series themselves.^{6,7} Within this framework, recommendations for Tdap vaccination of *mothers* specifically have evolved significantly over the last several years. In 2006, Tdap vaccine was recommended in the immediate post-partum period for all mothers who had not received the vaccine previously.⁸ Recognizing potential benefit from transplacental transfer of antibodies, in 2011 this recommendation was changed to target women prenatally, with vaccination recommended at 20+ weeks gestation among women not previously vaccinated.⁹ The most recent recommendation from 2012 is even more robust, with Tdap recommended during *each* pregnancy, preferably

between 27 and 36 weeks, regardless of prior immunization history.¹⁰

Significant socioeconomic and racial disparities exist for both infant pertussis infection and maternal Tdap vaccination. In terms of infection, epidemiologic studies suggest that compared to white infants, Hispanic and black infants are at significantly greater risk of disease,^{11–13} and pertussis cases tend to cluster in areas of poverty.¹⁴ Disparities with prenatal Tdap vaccination have also been found with regard to race, with Black women generally less likely to have received Tdap during pregnancy than white women.^{15–17} However, disparities between white and Hispanic women in prenatal Tdap vaccination have not been identified.^{15,16,18} Moreover, a few studies from other countries have reported lower Tdap vaccination during pregnancy among non-English speakers compared to native English speakers.^{19,20}

While several studies have examined recently-delivered mothers' acceptance of Tdap during pregnancy or the postpartum period,^{19,21–25} there is a paucity of research on attitudes about Tdap vaccination among women who are *currently* pregnant. Such research is important as it has ramifications for the use of Tdap vaccines as they are currently recommended, particularly among subpopulations such as racial and ethnic

minorities and those living in poverty who are at high risk for pertussis-affected infants. To address this knowledge gap we conducted a study of Tdap vaccine attitudes and acceptability among a population of currently pregnant women receiving care at a safety-net institution whose patients represent a demographic population at high risk for infant pertussis infection.

Results

During the recruitment period a convenience sample of 316 women were enrolled in the study. As shown in Table 1, 26% were Spanish-speaking and 32% reported prior Tdap vaccination. Ethnicity data was not collected, but the majority (>65%) of patients served by the clinics where the study was implemented are Hispanic. When queried about whether or not they had received or intended to receive Tdap at that day's visit, 82% (n = 259) indicated they did or would get Tdap that day, 3% (n = 9) did not intend to get the vaccine that day but did intend to get it after the baby was born, and 2% (n=7) were undecided or decided against getting the vaccine (missing data was 13%, n = 41).

As shown in Table 2, attitudes about Tdap vaccination were generally positive, and there was good correlation between items within the Health Belief Model constructs. However, it was notable that 63% of women in the sample overall worried about the safety of the Tdap vaccine, and 48% had concerns that the vaccine would not be effective in protecting their baby from pertussis.

When assessed as individual items, several attitudinal statements within the Health Belief Model constructs of Perceived Benefits, Norms, and Perceived Susceptibility were associated with the outcome of getting or intending to get the Tdap vaccine at that day's visit, as shown in Table 3. However, when the multi-item constructs were assessed as a scale measures, only Perceived Benefits (median score in vaccine acceptors 1.0 vs. non-acceptors 1.8, $p = 0.008$) and norms (median score in vaccine acceptors 1.3 vs. non-acceptors 2.0, $p = 0.006$) remained significantly associated with getting or intending to get Tdap at that day's visit. None of the demographic characteristics assessed (language, clinic site, age, and prior Tdap vaccination) were associated with this outcome.

Table 1. Study sample characteristics (n = 316).

Characteristic	27.8 (10.0) % (n) ^b
Mean Age, ^a yrs (IQR)	
Language	
English	74% (233)
Spanish	26% (83)
Clinic Location	
Site A	46% (146)
Site B	18% (56)
Site C	36% (113)
Missing	0.3% (1)
Ever had a Tdap Vaccine in the Past	
No	31% (98)
Yes	30% (94)
Don't know/Not sure	31% (98)
Missing	8% (26)

^aDefined as (year of survey) – (year of birth)

^bPercentages may not add to 100% due to rounding

We examined in exploratory analyses whether language, age or prior Tdap vaccination was associated with differences in vaccination attitudes. While age, and prior Tdap vaccination showed no association with any of the attitudinal statements, language did show an association with specific items (Table 4), and with the corresponding construct scale measures (data not shown). Specifically, Spanish speakers were more concerned about the efficacy and safety of Tdap than English speakers, and were also more concerned about their baby's susceptibility to whooping cough.

Discussion

In this population of Spanish and English-speaking women representing populations at high risk for infant pertussis, there was significant support and acceptance of Tdap vaccination during routine prenatal visits. Despite nearly half of the women having concerns about the efficacy of the Tdap vaccine, and 62% with concerns about its safety, a majority of women indicated they had gotten or intended to get Tdap vaccination on the day they were surveyed. Within the framework of the Health Belief Model, perceived benefits and norms were the constructs most consistently associated with vaccine acceptance.

To our knowledge, there are only 2 prior studies that have examined Tdap vaccination among *currently* pregnant women. Chamberlain et al.²⁶ examined influenza and Tdap vaccine acceptability among a convenience sample of 325 women from Georgia who had not received these vaccines during their current pregnancy. The study population was approximately half white and half black; only 6% were Hispanic. This study found significantly lower Tdap vaccine intentions among black women than white. No differences in this outcome between Hispanic and non-Hispanic women were found, though the analysis was limited by the small number of Hispanic women in the study (n = 20). In contrast to the high Tdap vaccine acceptability in our study, only 44% of women in the Chamberlain study reported they were likely to receive Tdap during their current pregnancy, though in this study the vaccine was not offered at the time of the survey. Similarly, Chamberlain demonstrated that stronger perceptions about infant pertussis severity were associated with higher Tdap vaccination intentions, which also differs from our study where our single item of perceived severity was not associated with Tdap receipt or intention. However, consistent with our study's finding that 63% of women were concerned about the safety of Tdap vaccine, Chamberlain also found that a substantial proportion (26%) of women in their study were "worried or had concerns" about the safety of receiving vaccines during pregnancy. Concern about the safety of prenatal vaccination more broadly has been demonstrated in several other studies representing diverse populations.²⁷⁻³⁰

A second study by Laenen et al. examined factors associated with Tdap (and influenza) vaccination among 250 pregnant Belgian women attending a routine prenatal ultrasound visit.²⁰ In this study 39% of women had medical record documentation of Tdap during the current pregnancy, which is considerably lower than that found in our study, though our study used self-report which may differ inaccuracy from the medical record.

Table 2. Tdap vaccination attitudes and internal consistency of proposed constructs (n = 313).

Statement ^a	% (n) Strongly Agree/Agree	Cronbach's Alpha
Perceived Benefits		
The Tdap (whooping cough) vaccine is a good way to protect the health of newborn babies.	97% (303)	0.76
Getting myself vaccinated with the Tdap (whooping cough) vaccine will help keep my baby from getting whooping cough.	96% (299)	
Perceived Barriers		
I worry about the safety of Tdap (whooping cough) vaccine.	62% (190)	0.80
I worry that my getting the Tdap (whooping cough) vaccine will not protect my baby from getting whooping cough.	48% (145)	
Norms		
My family would probably think getting a Tdap (whooping cough) vaccine is a good idea.	94% (291)	0.73
Pregnant women should get the Tdap (whooping cough) vaccine.	97% (303)	
My friends would probably think getting a Tdap (whooping cough) vaccine is a good idea.	94% (290)	
I get all recommended vaccines when I am not pregnant.	85% (258)	
Perceived Severity		
It would be really bad if my baby got whooping cough.	96% (293)	N/A
Perceived Susceptibility		
I worry that I could give whooping cough to my baby.	87% (267)	0.74
Pregnant women should be concerned about the possibility of whooping cough in their babies.	97% (202)	
I worry that someone besides me will give my baby whooping cough.	87% (270)	
Self - efficacy		
I felt that I had enough information about the Tdap (whooping cough) vaccine to decide about receiving it.	94% (291)	N/A

^aMissing data varied from 3%–5% and were dropped from the analysis, thus denominator varied by statement.

Moreover, in contrast to our study and that of Chamberlin, relatively few women in the Laenen study (3%) appeared to have concerns about vaccination safety as a reason for not getting vaccinated. Instead, lack of a vaccination recommendation from their provider was a main reason cited for not having gotten vaccinated (12% of unvaccinated women). The Laenen study did not examine the relationship between race and vaccination status. Although the results between our study and that of Laenen are fairly divergent, differences between the Belgian and U.S. medical care systems make it difficult to evaluate the relevance of the Belgian study to a U.S. population.

Past research has shown that a significant predictor of vaccine acceptance is prior vaccination behavior.^{26,28,31} Indeed, in the Chamberlain study one of the strongest predictors of intending to receive Tdap during the current pregnancy was the number of times a woman had received influenza vaccine in the past (prior Tdap vaccination was not assessed). Similarly, in the Laenen study, women who had previously received the influenza vaccine had a “higher vaccination rate” (vaccine not specified) during the current pregnancy than women who had not received the influenza vaccine previously, though these results were not statistically significant (62.2% vs. 37.8%, $p=0.1$). Studies of post-partum women also support the relations between past vaccination behavior and current vaccine acceptability.¹⁶ In our sample nearly one-third of women indicated they had received Tdap in the past. However, in our analyses, prior Tdap vaccination was *not* associated with same-day Tdap vaccine acceptance. One potential reason for this lack of association could be that because vaccine acceptance was high in our sample, we had significantly limited statistical power for uncovering differences between subgroups. However, another hypothesis is that women vaccinated with Tdap in the past likely received the vaccine outside of pregnancy, which may

have been more acceptable to these women than vaccination during pregnancy, as is supported by the high degree of reported concern among our study population about the safety of Tdap during pregnancy. Related to this, because the our study population was relatively young, it is quite possible that some of these women may have actually received Tdap during adolescence, which could reflect these individuals’ parents’ opinions about the vaccine rather more so than their own opinions.

Although language was not associated with our primary outcome of same-day Tdap vaccine acceptance, language *was* associated with specific attitudes about the vaccine. In our study Spanish speakers were notably more concerned than English-speakers about the vaccine’s efficacy and safety, and about their baby’s susceptibility to pertussis. This could possibly be due to cultural differences in expressing concerns and worries, and not a true difference in attitude given that language was not associated with vaccine acceptance, and that our Spanish version of the survey was vetted by 2 native Spanish-speakers to ensure understandability. There is relatively little published data available on the association between language and acceptability of vaccines among pregnant women. A study by Wong et al.¹⁹ of 297 pregnant Australian women demonstrated being non-English speaking was a significant predictor of failing to get Tdap and influenza vaccines as recommended. Language is sometimes a proxy measure for acculturation, and in a second study of pregnant Belgian women by Laenen et al.²⁰ being “foreign-born” was strongly associated with a lower likelihood of both Tdap and influenza vaccination (language was not directly assessed). Studies of other vaccines and other populations^{32–36} support the notion that language and/or acculturation may be important mediators of vaccine acceptability. Thus, understanding cultural differences in vaccination attitudes among

Table 3. Associations between Tdap vaccination attitudes and getting Tdap at “today’s visit”.

Attitude Statement	% Strongly Agree/Agree (n)			p-value
	Sample Overall ^a (n = 275)	“Did or will get Tdap at today’s visit” (n = 259)	All other responses (n = 16)	
Perceived Benefits				
The Tdap (whooping cough) vaccine is a good way to protect the health of newborn babies.	98% (265)	98% (251)	88% (14)	0.043 ^b
Getting myself vaccinated with the Tdap (whooping cough) vaccine will help keep by baby from getting whooping cough.	96% (261)	98% (251)	63% (10)	<0.001 ^b
Perceived Barriers				
I worry about the safety of Tdap (whooping cough) vaccine.	63% (166)	62% (154)	75% (12)	0.29
I worry that my getting the Tdap (whooping cough) vaccine will not protect my baby from getting whooping cough.	48% (127)	48% (119)	50% (8)	0.85
Norms				
My family would probably think getting a Tdap (whooping cough) vaccine is a good idea.	94% (253)	96% (243)	63% (10)	<0.001 ^b
Pregnant women should get the Tdap (whooping cough) vaccine.	97% (265)	99% (254)	69% (11)	<0.001 ^b
My friends would probably think getting a Tdap (whooping cough) vaccine is a good idea.	94% (253)	96% (242)	73% (11)	0.006 ^b
I get all recommended vaccines when I am not pregnant.	84% (223)	84% (212)	69% (11)	0.15 ^b
Perceived Severity				
It would be really bad if my baby got whooping cough.	97% (259)	97% (244)	94% (15)	0.39 ^b
Perceived Susceptibility				
I worry that I could give whooping cough to my baby.	89% (237)	90% (227)	63% (10)	0.004 ^b
Pregnant women should be concerned about the possibility of whooping cough in their babies.	98% (267)	99% (254)	81% (13)	0.002 ^b
I worry that someone besides me will give my baby whooping cough.	86% (235)	88% (224)	69% (11)	0.05 ^b
Self - efficacy				
I felt that I had enough information about the Tdap (whooping cough) vaccine to decide about receiving it.	94% (255)	95% (242)	81% (13)	0.06 ^b

^aMissing values ranged from 13–16% and were dropped from the analysis

^bFisher’s Exact Chi-square test Bolded p-value highlight statistical significance

pregnant women, particularly those from high-risk populations, may be important for optimizing educational materials about the safety, efficacy and importance of vaccination with Tdap and other vaccines during pregnancy. However, an alternate hypothesis that also should be considered is that the Spanish-speaking women in our study may have generally lower literacy levels than English speakers which could have impacted their understanding of the survey materials and their responses.

Our study should be interpreted in light of several additional important limitations. First, our study population consisted of a convenience sample, which may have introduced bias into our results such that women more (or less) in favor of Tdap vaccination were more interested in participating in the study. Also, because this was a convenience sample we were not able to determine characteristics of patients choosing not to participate in the study, nor could we calculate an “acceptance rate” for

Table 4. Belief statements significantly associated with language, among subjects that received or intended to receive Tdap.

Attitude Statement ^a	% Strongly Agree/Agree (n)			p-value
	Sample Overall (n = 259)	English (n = 200)	Spanish (n = 59)	
Perceived Benefits				
Perceived Barriers				
I worry about the safety of Tdap (whooping cough) vaccine.	62% (154)	52% (100)	95% (54)	<0.001
I worry that my getting the Tdap (whooping cough) vaccine will not protect my baby from getting whooping cough.	48% (119)	38% (73)	81% (46)	<0.001
Perceived Susceptibility				
I worry that I could give whooping cough to my baby.	90% (227)	88% (171)	100% (56)	0.006
I worry that someone besides me will give my baby whooping cough.	88% (224)	85% (167)	97% (57)	0.016

^aStatements had 0%–4% missing values and were dropped from the analysis, thus the denominator varied for each statement.

Tdap vaccination among those eligible for Tdap attending the clinics during the study. Mitigating both of these limitations somewhat is clinical data from the health system involved in the study showing consistently high Tdap up-to-date rates within the Ob-Gyn patient population (that includes our study's clinical sites plus others) ranging from 75%-85% during the same time period. A third limitation is that our study population came from a specific geographic area and may not be generalizable to high-risk populations in other geographic regions. Our results would need to be confirmed among larger, more geographically diverse samples. Finally, it should be recognized this is a survey reporting attitudes and intent and Tdap vaccine receipt during the visit or in the past was not verified by clinical data.

Conclusions

Tdap vaccine acceptance was high among Spanish- and English-speaking pregnant women at a safety-net institution representing patients with increased risk for having an infant affected by pertussis. Perceived benefits and societal norms were the most consistently associated factors of Tdap vaccine acceptance. There appeared to be important variations in attitudes about the Tdap vaccine by primary language. These latter results may indicate that women from different cultural backgrounds need different types of information to feel confident in their decision to get vaccinated with Tdap and other recommended vaccines during their pregnancy.

Patients and methods

Study population

The study population consisted of a convenience sample of women receiving prenatal care at one of 3 outpatient ob-gyn clinics within a large integrated public health care system in central Colorado between January and May of 2014. Women were eligible for the study if they were eligible to receive the Tdap vaccine on the day of their clinic visit where the survey was administered, and could complete the survey in English or Spanish. No data were collected on women who chose not to participate in the study. All study activities were approved by the Colorado Multiple Institutional Review Board.

Instrument development

A paper-based survey of 13 questions based on the Health Belief Model³⁷ was developed by the research team. This model is an organizational framework for understanding and predicting acceptance of health and medical care recommendations, particularly preventative services. This model has been used to successfully predict vaccination behavior in several prior studies on vaccination, including those of pregnant women.^{27,30,38} Attitudes about Tdap vaccination were assessed with the following dimensions from the Health Belief Model: perceived susceptibility (3 items) and perceived severity (1 item), which together make up perceived threat of disease, perceived barriers (2 items), perceived norms (4 items) and perceived benefits (2-items). Self-efficacy for receiving vaccines (1 item) was

included as an additional construct. Surveys were pilot tested in English among a sample of representative participants and revised to improve understandability and content before being translated into Spanish by a native Spanish speaker also fluent in English. Spanish translations were read by a second bi-lingual team member to ensure understandability and correctness of translation.

Outcome measures

In keeping with the Health Belief Model which proposes that "intention" for a health behavior is the immediate upstream proxy measure for actually performing that health behavior, we assessed as the primary study outcome self-reported receipt or intentions to receive the Tdap vaccine at the visit where the survey was administered. This outcome was defined as participants choosing that they "got or will get the vaccine at today's visit" in response to the question "Did you or will you get the Tdap vaccine at today's visit?" Other response choices included that they "do not plan on getting the vaccine," "do plan on getting the vaccine after the baby is born" or are "undecided about whether or not [they] will get the vaccine."

Items corresponding to the various Health Belief Model constructs were assessed using a 4-point Likert scale (strongly agree to strongly disagree). Demographic characteristics assessed included age and language (defined by whether they chose to self-administer the survey in English or in Spanish). Clinical information collected included self-reported Tdap vaccination history prior to pregnancy and the location of the prenatal care visit at which they enrolled in the study.

Study procedures

As part of routine care at the 3 clinics in the study, all participants were offered the Tdap vaccine under a standing order during a routine prenatal care visits. Regardless of whether or not a Tdap vaccine was provided, medical assistants in the clinics were instructed to then give the survey (paper-based) to all eligible women. An incentive was provided to medical assistants for agreeing to offer the survey to every Tdap-eligible patient, regardless of the patient's decision to receive the vaccine. However, no incentives were provided for the patients themselves for completing the survey.

Data analysis

Descriptive statistics were generated for all survey questions. Internal reliability for multi-item scale constructs from the Health Belief Model was measured by Cronbach's α , with a value of ≥ 0.6 defined as acceptable. For constructs with multiple items, scale measures were calculated by averaging the score across all statements related to the measure (range of possible values = 1-4). The association between "got or will get the vaccine at today's visit" and each individual belief item, each scale construct, and each demographic variable, was assessed using median, Chi-square, logistic regression or exact tests, computed as appropriate. Because few women in the study chose not to get the vaccine at the visit, analyses were limited to univariable associations with possible predictor variables. Based on

previous research^{19,20} suggesting vaccine acceptability varies based on language (which is likely a proxy measure for acculturation), an exploratory analysis on the association between language and attitude items comprising the Health Belief Model constructs was also undertaken. All analyses were performed in SAS 9.3(Cary, NC). A p-value of ≤ 0.05 was considered statistically significant.

Disclosure of potential conflicts of interest

Amanda Dempsey serves on advisory boards for Merck and Pfizer. She does not receive research funding from either company, nor did either company play any role in this research.

Author contributions

AFD designed the study, analyzed the data and wrote the first draft of the manuscript.

SEB and JP assisted with the study design, collected data, assisted with analysis and wrote sections of the manuscript.

CS analyzed the data, assisted with manuscript drafts.

SM assisted with the study design and collected data.

STO designed the study, analyzed the data and edited the manuscript.

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