

RESEARCH PAPER

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Knowledge, attitudes, beliefs, and behaviors of pregnant women approached to participate in a Tdap maternal immunization randomized, controlled trial

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ABSTRACT

Immunization with pertussis vaccine during pregnancy is recommended in a number of countries to prevent newborn deaths from whooping cough. In some jurisdictions, vaccine uptake during pregnancy is low. We undertook a survey of the knowledge, attitudes, beliefs, and behaviors of pregnant women who had been approached to participate in a randomized, controlled trial of tetanus-diphtheria-acellular pertussis (Tdap) vaccine during pregnancy. A total of 346 women completed the survey. Knowledge about pertussis and pertussis vaccine was generally low; the mean number of correct answers was 10.65 out of 19 questions. Attitudes toward maternal immunization were generally favorable; 51.7%–94.7% of women had positive responses to 10 attitudinal statements. Substantial uncertainty was shown in responses to a number of the attitudinal statements related to vaccination during pregnancy; 22.3%–45.7% neither agreed nor disagreed with the statements. Importantly, 89% of women reported that they would get immunized with pertussis vaccine during pregnancy if their physician recommended it. We conclude that a national recommendation to be immunized with pertussis vaccine during pregnancy supported by their physicians' recommendation would be well received by Canadian women.

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Introduction

Widespread use of pertussis vaccine led to dramatic decreases in the incidence of pertussis in the mid to late 20th century; however, recently, a resurgence of pertussis has been observed in a number of countries, despite high rates of vaccine coverage.¹ Deaths from pertussis occur mostly in young infants who are too young to have initiated or completed their primary series with pertussis vaccine;^{2,3} infant deaths from pertussis are reported whether or not a resurgence of pertussis is reported in other age groups.⁴ A number of strategies have been proposed to prevent pertussis in infants and the resultant morbidity and mortality. Adding an infant dose of pertussis vaccine (neonatal immunization),⁵ immunizing all close contacts of the young infant (cocooning),⁶ and immunization of women during pregnancy (maternal immunization)⁷ have all been proposed as potential interventions. The immunogenicity of a neonatal dose of pertussis vaccine has been variable, perhaps related to whether the combined diphtheria-tetanus-acellular pertussis vaccine or an acellular pertussis vaccine alone is used.^{8,9} While a cocooning strategy makes sense and there is some evidence for its effectiveness,¹⁰ logistically, it has been difficult to implement on a large scale¹¹ and is expensive.


Maternal immunization has been demonstrated to be the most cost-effective of the currently available strategies and has been implemented in the United States and in the United Kingdom in response to outbreaks of pertussis and increased infant deaths.¹² The effectiveness of the intervention has been demonstrated in several epidemiological and case-control studies in the UK, where high levels of uptake (approximately 70%) were achieved.^{13,14} In the US, uptake of pertussis vaccine during pregnancy has been estimated to be < 5 %, despite being recommended for more than 5 y.¹² In Canada, pertussis immunization during pregnancy is recommended as a response to pertussis outbreaks but is not given routinely in any jurisdiction. In this observational study, we surveyed pregnant women to determine their knowledge, attitudes, beliefs, and behaviors regarding vaccination during pregnancy in general and more specifically about the use of pertussis vaccine during pregnancy.

Results

Demographics

There were 346 respondents to the survey: 171 of 325 participants in the clinical trial completed the survey; 77 women who

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 Supplemental data for this article can be accessed on the publisher's website.

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declined participation in the clinical trial completed the survey (the number of nonparticipants approached was not collected); and 98 women with unknown clinical trial status completed the survey. Most women (72.5%) were between 25 and 35 y of age (Table 1). The respondents to the survey were predominantly white (84.1%), having their first (53.5%) or second (33.8%) baby, and were highly educated (75.4% had a university degree or higher, with 26.9% holding an advanced degree).

Knowledge and awareness

Nearly all (90.2%) participants had heard of pertussis, although only 5.8% reported having had it themselves (Table 1). Most participants knew that pertussis was a greater risk to their infant than to themselves; 68.2% thought that pertussis was a very high or moderately high risk to the newborn, and 67.6%

thought it was a moderate or moderately low risk to adults. The mean number of correct answers to the 19 knowledge questions was 10.65 (95% confidence interval 10.28–11.01).

Attitudes

The majority of participants had attitudes that supported immunization against pertussis during pregnancy (Table 2). Most (89.9%) either disagreed or strongly disagreed that pertussis was rare and that immunization was no longer required. Most participants (84.1%) also disagreed or strongly disagreed that getting the infection was better than being immunized. Although 72.3% of participants agreed or strongly agreed that it was important for children to be immunized against pertussis by 6 months of age, 20.5% neither agreed nor disagreed with this statement. A total of 71.4% of participants agreed or

Table 1. Characteristics of survey respondents.

Characteristic	Category	n	%	95% Confidence Interval
Age (y)	18–24	35	10.1	7.1–13.8
	25–30	119	34.4	29.4–39.7
	31–35	132	38.2	33.0–43.5
	36–40	45	13.0	9.6–17.0
	41–45	15	4.3	2.4–7.0
Ethnicity	White	291	84.1	79.8–87.8
	Black	7	2.0	0.8–4.1
	Asian	33	9.5	6.7–13.1
	First Nations or Inuit	3	0.9	0.2–2.5
	Other	12	3.5	1.8–6.0
Prior deliveries	0	185	53.5	48.1–58.8
	1	117	33.8	28.8–39.1
	2	31	9.0	6.2–12.5
	3	9	2.6	1.2–4.9
	4	1	0.3	0.0–1.6
	5	1	0.3	0.0–1.6
Education	Missing	2	0.6	0.1–2.1
	Some high school	9	2.6	1.2–4.9
	High school diploma	28	8.1	5.4–11.5
	Some postsecondary	48	13.9	10.4–18.0
	Bachelor's degree	168	48.6	43.2–54.0
	Advanced degree	93	26.9	22.3–31.9
Heard about pertussis before receiving study information?	Missing	3	0.9	0.2–2.5
	Yes	312	90.2	86.5–93.1
	No	28	8.1	5.4–11.5
Ever had pertussis	Don't know	3	0.9	0.2–2.5
	Missing	5	1.4	0.5–3.3
	Yes	20	5.8	3.6–8.8
	No	287	82.9	78.6–86.8
How serious a threat do you think pertussis poses to a baby after delivery?	Don't know	34	9.8	6.9–13.5
	Missing	7	2.0	0.8–4.1
	Very high	130	37.6	32.5–42.9
	Moderately high	106	30.6	25.8–35.8
	Moderate	54	15.6	11.9–19.9
	Moderately low	25	7.2	4.7–10.5
How serious a threat do you think pertussis poses to adults?	Very low	6	1.7	0.6–3.7
	Not sure	18	5.2	3.1–8.1
	Missing	6	1.7	0.6–3.7
	Very high	6	1.7	0.6–3.7
	Moderately high	46	13.3	9.9–17.3
	Moderate	136	39.3	34.1–44.7
Were you aware that there is a vaccine to protect adults against pertussis?	Moderately low	98	28.3	23.6–33.4
	Very low	36	10.4	7.4–14.1
	Not sure	18	5.2	3.1–8.1
	Missing	82*	23.7	19.3–28.5
	Yes	139	40.2	35.0–45.5
Mean knowledge score out of 19 questions	No	112	32.4	27.5–37.6
	Don't know	13	3.8	2.0–6.3
		10.65		10.28–11.01

* Note. Most of missing data results from the first 79 participants not being asked the question.

Table 2. Attitudes and beliefs regarding pertussis, pertussis vaccine and vaccination during pregnancy.

Synopsis of Statement	Agreement	n	%	95% Confidence Interval
Pertussis disease is rare and you no longer need to get immunized against it.	Missing	4	1.2	0.3–2.9
	Strongly disagree	144	41.6	36.4–47.0
	Disagree	167	48.3	42.9–53.7
	Neither agree nor disagree	25	7.2	4.7–10.5
	Agree	6	1.7	0.6–3.7
	Strongly agree	0	0	0
It is better to be naturally infected with pertussis disease than to be immunized against pertussis.	Missing	4	1.2	0.3–2.9
	Strongly disagree	164	47.4	42.0–52.8
	Disagree	127	36.7	31.6–42.0
	Neither agree nor disagree	43	12.4	9.1–16.4
	Agree	2	0.6	0.1–2.1
	Strongly agree	6	1.7	0.6–3.7
It is important for children to be fully immunized against pertussis by the time they are 6 months old.	Missing	6	1.7	0.6–3.7
	Strongly disagree	10	2.9	1.4–5.3
	Disagree	9	2.6	1.2–4.9
	Neither agree nor disagree	71	20.5	16.4–25.2
	Agree	148	42.8	37.5–48.2
	Strongly agree	102	29.5	24.7–34.6
Parents and those in close contact to newborns should receive the pertussis vaccine to prevent passing pertussis to their babies.	Missing	5	1.4	0.5–3.3
	Strongly disagree	3	0.9	0.2–2.5
	Disagree	14	4.0	2.2–6.7
	Neither agree nor disagree	77	22.3	18.0–27.0
	Agree	149	43.1	37.8–48.5
	Strongly agree	98	28.3	23.6–33.4
Giving the pertussis vaccine to pregnant women will help protect newborn babies from getting pertussis.	Missing	3	0.9	0.2–2.5
	Strongly disagree	1	0.3	0.0–1.6
	Disagree	3	0.9	0.2–2.5
	Neither agree nor disagree	124	35.8	30.8–41.1
	Agree	156	45.1	39.8–50.5
	Strongly agree	59	17.1	13.2–21.4
Pertussis poses a serious threat to young infants.	Missing	83*	24.0	19.6–28.8
	Strongly disagree	1	0.3	0.0–1.6
	Disagree	1	0.3	0.0–1.6
	Neither agree nor disagree	12	3.5	1.8–6.0
	Agree	121	35.0	29.9–40.3
	Strongly agree	128	37.0	31.9–42.3
The pertussis vaccine is effective in preventing pertussis.	Missing	82*	23.7	19.3–28.5
	Strongly disagree	0	0	0
	Disagree	0	0	0
	Neither agree nor disagree	34	9.8	6.9–13.5
	Agree	154	44.5	39.2–49.9
	Strongly agree	76	22.0	17.7–26.7
It is safe to get the pertussis vaccine during pregnancy.	Missing	83*	24.0	19.6–28.8
	Strongly disagree	0	0	0
	Disagree	5	1.4	0.5–3.3
	Neither agree nor disagree	73	21.1	16.9–25.8
	Agree	134	38.7	33.6–44.1
	Strongly agree	51	14.7	11.2–18.9
It is best to avoid immunizations while pregnant.	Missing	3	0.9	0.2–2.5
	Strongly disagree	45	13.0	9.6–17.0
	Disagree	138	39.9	34.7–45.3
	Neither agree nor disagree	119	34.4	29.4–39.7
	Agree	35	10.1	7.1–13.8
	Strongly agree	6	1.7	0.6–3.7
It is safer to wait until after the first 3 months of pregnancy to receive a vaccine.	Missing	6	1.7	0.6–3.7
	Strongly disagree	8	2.3	1.0–4.5
	Disagree	46	13.3	9.9–17.3
	Neither agree nor disagree	158	45.7	40.3–51.1
	Agree	106	30.6	25.8–35.8
	Strongly agree	22	6.4	4.0–9.5
It is safer to wait until immediately after delivery to receive a vaccine.	Missing	4	1.2	0.3–2.9
	Strongly disagree	23	6.6	4.3–9.8
	Disagree	118	34.1	29.1–39.4
	Neither agree nor disagree	169	48.8	43.5–54.2
	Agree	27	7.8	5.2–11.2
	Strongly agree	5	1.4	0.5–3.3
Being immunized when you are pregnant could cause birth defects.	Missing	4	1.2	0.3–2.9
	Strongly disagree	35	10.1	7.1–13.8

(continued)

Table 2. (Continued)

Synopsis of Statement	Agreement	n	%	95% Confidence Interval
It is better to be immunized in pregnancy than to risk pertussis disease in newborns.	Disagree	128	37.0	31.9–42.3
	Neither agree nor disagree	154	44.5	39.2–49.9
	Agree	23	6.6	4.3–9.8
	Strongly agree	2	0.6	0.1–2.1
	Missing	4	1.2	0.3–2.9
	Strongly disagree	2	0.6	0.1–2.1
	Disagree	12	3.5	1.8–6.0
Vaccines can cause autoimmune diseases such as diabetes and multiple sclerosis.	Neither agree nor disagree	107	30.9	26.1–36.1
	Agree	170	49.1	43.7–54.5
	Strongly agree	51	14.7	11.2–18.9
	Missing	5	1.4	0.5–3.3
	Strongly disagree	72	20.8	16.7–25.5
	Disagree	107	30.9	26.1–36.1
	Neither agree nor disagree	156	45.1	39.8–50.5
	Agree	4	1.2	0.3–2.9
	Strongly agree	2	0.6	0.1–2.1

* Note. Most of missing data results from the first 79 participants not being asked the question.

strongly agreed that close contacts of their infant should be immunized against pertussis but, again, more than one-fifth (22.3%) neither agreed nor disagreed. Nearly all (94.7%) participants who responded to the question agreed or strongly agreed that pertussis poses a serious threat to young infants, and 87.1% who responded to the question agreed or strongly agreed that pertussis vaccine is effective in preventing pertussis.

While attitudes about receiving pertussis vaccine during pregnancy were generally favorable, many women neither agreed nor disagreed with these attitudinal statements (Table 2). The proportion of responses that could be interpreted as being against vaccination during pregnancy was <10% for most of the attitudinal statements. A total of 62.1% of women agreed or strongly agreed that giving pertussis vaccine to pregnant women would protect the infants, although 35.8% neither agreed nor disagreed; 70.3% of women who responded to the question agreed or strongly agreed that it was safe to give pertussis vaccine during pregnancy, although 27.8% of the women who responded to the statement neither agreed nor disagreed. In response to the statement that it is best to avoid vaccines during pregnancy, 52.9% disagreed or strongly disagreed, while 34.4% neither agreed nor disagreed. Only 37.0% of respondents agreed or strongly agreed that it was best to avoid vaccination during the first 3 months of pregnancy, while 45.7% neither agreed nor disagreed. A total of 40.8% of women disagreed or strongly disagreed that it was safer to wait until after delivery to receive a vaccine while 48.8% neither agreed nor disagreed with this statement. The majority of respondents (63.9%) agreed or strongly agreed that it is better to be immunized during pregnancy than to risk pertussis disease in the newborn; 30.9% neither agreed nor disagreed with this statement.

Maternal concerns and response to recommendations

Most of the women who participated in the study were more concerned about the safety and adverse effects of the vaccine for their fetus/infant than for themselves (Fig. 1). A total of 61.6% were concerned about the safety of the vaccine and 58.4% concerned about adverse effects for the baby, compared to only 37.3% and 39%, respectively, for themselves. Only 25.4% were concerned about the risk of not getting the vaccine for themselves, while 42.8% were concerned about the risk of

not getting the vaccine for their infant. Importantly, fully 89% indicated that they would get immunized with pertussis vaccine during pregnancy if it was recommended by their doctor; only 2.9% said they would not, and 8.1% were undecided.

In the univariate analysis, increased knowledge score correlated with increased level of education, having heard of pertussis prior to participating in the study, and being aware of an adult pertussis vaccine (all $p < 0.05$). Respondents who participated in the clinical trial also had higher knowledge scores and differed in their attitudes regarding maternal immunization ($p < 0.05$). Univariate analysis was also undertaken to assess the effect of demographic variables, awareness of pertussis and pertussis vaccine, and knowledge score on uncertainty in response to the attitudinal statements (those who responded “neither agree nor disagree” compared to those who either agreed/strongly agreed and disagreed/strongly disagreed). Lower knowledge scores were significantly correlated with less certainty regarding the attitudinal statements ($p < 0.05$). Uncertainty regarding the attitudinal questions also varied significantly over time; early respondents who completed the survey were more uncertain about the attitudinal statements than those who completed the survey toward the end of the study ($p < 0.05$).

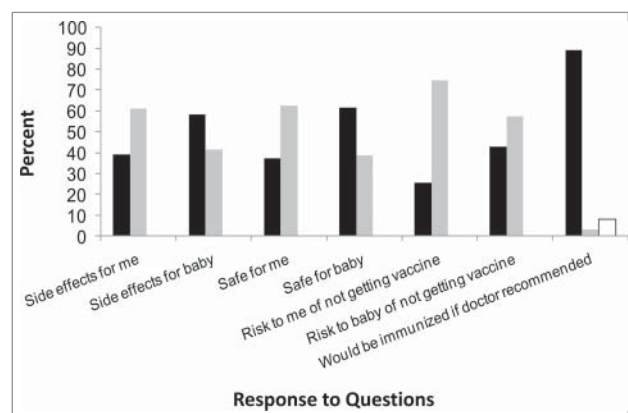


Figure 1. Responses to the questions “To feel more comfortable about receiving the tetanus-diphtheria-acellular pertussis vaccine during pregnancy I need more information about...” and the question “If my doctor recommended it, I would be immunized with pertussis vaccine during pregnancy.” Black bars equal yes, gray bars no, white bar I don't know.

Discussion

Immunizing pregnant women is increasingly being advocated to protect themselves, their fetuses, and their newborns.^{7,15} Influenza vaccine has been recommended for pregnant women since the 1960s and is now the World Health Organization's highest priority for influenza vaccination.¹⁶ Vaccines are being developed specifically for maternal immunization to protect neonates and young infants from group B Streptococcus¹⁷ and Respiratory Syncytial Virus.¹⁸ The combined, adult-formulation tetanus-diphtheria-acellular pertussis vaccine (Tdap) is recommended in the UK in response to an increase in infant deaths from pertussis and is recommended to be given during every pregnancy in the US.¹² Uptake, however, in the US is low.¹²

The reasons for low Tdap utilization in pregnant women are likely multifactorial, but knowledge and attitudes of women regarding vaccination during pregnancy is likely an important factor.¹⁹ As have others,²⁰⁻²⁴ we previously found that knowledge about pertussis and pertussis vaccine is low in the general population,²⁵ similar to what we found in this study in pregnant women who completed our survey. Pregnancy, however, is a time when women have frequent contact with the health-care system so there are numerous opportunities to intervene with education and specific recommendations.

In this study, attitudes toward immunization during pregnancy were most favorable. Only a small proportion of respondents had attitudes that would be categorized as negative; most participants had either favorable attitudes or neutral attitudes ("neither agree nor disagree"). We cannot discern from our data whether participants who chose "neither agree nor disagree" were indifferent to the statement or were undecided. Lack of knowledge regarding the issue might be one reason to take a neutral stance, and lower knowledge scores did correlate with greater proportions neither agreeing nor disagreeing with the attitudinal statements. It is revealing that a remarkable 89% indicated that they would be immunized during pregnancy if their physician recommended it; this suggests that the neutral responses were more a reflection of indecision than indifference. Others have also found that a physician recommendation is the most important predictor of acceptance of Tdap vaccination during pregnancy,^{20,23,24} although the intention to be immunized if their physician recommended it was higher in our study than others have reported.^{21,23} Healthcare providers are more likely to recommend Tdap vaccination during pregnancy if there are strong national recommendations.²²

Our study has a number of strengths and weaknesses. The study was undertaken with a rigorously validated survey instrument and participants were pregnant at the time, making the issues in the survey timely and relevant. Survey responses were collected over 6 y during the clinical trial, and attitudes about maternal immunization changed with time as recommendations for influenza vaccination during pregnancy became more firmly established and pertussis recommendations were implemented in other jurisdictions. This resulted in a change in attitudes over time, with less respondents being uncertain about their attitude toward maternal immunization. In addition, both women who were participating in the clinical trial and those who declined participation were invited to complete the survey. All of the survey respondents had been approached about

participating in the clinical trial of maternal immunization which may have biased the responses toward a more positive attitude, even in those who ultimately decided not to enroll in the clinical trial. Therefore, these results may not be generalized to the entire population of pregnant women. We did detect differences in both knowledge and attitudes depending on whether the respondents were participants in the clinical trial. As well, our participants were predominantly white and highly educated. In Canada, 19.1% of the population self-identifies as a visible minority,²⁶ not very different from the 15.9% of our participants who described themselves as nonwhite. In Canada, 16.5% of the population has completed an undergraduate university degree and 6.7% an advanced degree, substantially lower than the 48.6% and 26.9%, respectively, for our participants.²⁷

In summary, in this survey of pregnant women, immunization with pertussis vaccine during pregnancy was generally well received. Knowledge of pertussis and pertussis vaccine, however, was generally low, suggesting that some of the women who were undecided might be more favorably inclined toward immunization if they were provided with additional information. In keeping with the evidence in the literature relating to the general population, this study provides data specific to pregnant women that a physician recommendation is an important factor in the decision-making process. This suggests that, with strong support from healthcare providers and an appropriately targeted information campaign, maternal immunization with pertussis vaccine could be a successful strategy in Canada.

Methods

Study setting and population

The study took place in Halifax, Nova Scotia; Calgary and Edmonton, Alberta; Montreal, Quebec; Vancouver, British Columbia; and Ottawa, Ontario, between January 2008 and April 2014; during the study period, no outbreaks of pertussis occurred in the study areas. Healthy women with uncomplicated pregnancies who were approached to participate in a randomized, controlled trial of Tdap vaccination during pregnancy were asked to complete the survey. Both women who participated in the clinical trial and those who declined participation were eligible to complete the survey. Women were recruited through family physicians' and obstetricians' offices and in hospital prenatal clinics.

Study design

Surveys were distributed to pregnant women at the time of their physician or clinic visit after they were approached to participate in the randomized, controlled trial of Tdap during pregnancy. Surveys were completed in the waiting rooms and collected prior to leaving or were returned by mail in postage-paid envelopes. Completing and returning the questionnaire denoted informed consent. The study received Research Ethics Board approval at all participating sites.

Survey instrument development

The survey contained 52 questions, including demographics, information and awareness (11 items), knowledge (19 items),

attitudes and beliefs (14 items), and information sources and intentions (8 items). Knowledge questions covered general immunization information as well as immunization information specific to pertussis. Attitudinal statements testing opinions about maternal immunization were structured with a 5-point Likert response scale ranging from “strongly disagree” to “strongly agree.” In the development of the survey instrument, content validity was assessed by presenting the questions to a panel of 5 infectious disease specialists who have a focus in vaccine research. Each question as well as the survey overall was evaluated by the experts using a rating worksheet with a 4-point ordinal rating scale. Items that received a high content rating (3 or 4) were retained; those with low ratings were eliminated or modified and re-evaluated. In addition to this quantitative assessment of content validity, a qualitative assessment was obtained through use of a focus group of 5 target participants to provide feedback on clarity, wording, and relevance of the survey items. Test–retest validity was also assessed by having 3 individuals complete the survey twice at an interval of 1 month. A correlation coefficient > 0.7 was used to denote reasonable consistency over time. Prior to implementation of the survey, the instrument was validated with participants in a clinical trial of the kinetics of the antibody response to Tdap vaccine in women of child-bearing age and further modified and validated with participants in a second study of the kinetics of the antibody response to Tdap in pregnant women.²⁸

Data management and statistical analysis

Paper-based surveys were double-entered by 2 people working independently via Remark Web Survey[®] Professional software (Versions 4 and 5). The data were downloaded, transferred to a secure server and loaded into SAS[®] (versions 8 and 9) datasets. SAS[®] was used to compare the 2 entries and correct data entry errors.

The first level of analysis comprised a review of the descriptive, summative statistics for trends in the data. The second level of analysis involved tests of association. Continuous variables were presented by summary statistics (i.e., mean and standard error) and the categorical variables by frequency distributions (i.e., frequency counts, percentages, and their 2-sided 95% exact binomial confidence intervals). Differences in survey responses were assessed using Fisher’s exact tests or Pearson Chi-square tests. For continuous variables, logistic regression was used. Overall knowledge scores were compared using t-tests. Associations between attitude questions, behavioral responses, and demographics were estimated using ordinal logistic regression or Fisher’s exact tests. P-values < 0.05 were considered statistically significant.

Disclosure of potential conflicts of interest

Drs. Halperin and Langley have served as consultants on ad hoc advisory boards organized by Sanofi Pasteur, which provided funding for this study.

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