

Adult tetanus, diphtheria and pertussis immunization: knowledge, beliefs, behavior and anticipated uptake[☆]

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Abstract

Background: Lifetime protection against pertussis has been adopted as a goal of immunization programs in Canada. To anticipate adult coverage with a combined product containing tetanus (T) and diphtheria (d) toxoids and acellular pertussis (aP) vaccine as a booster dose, we conducted a survey of households in British Columbia, Canada.

Methods: In a random telephone survey involving 800 adults, 25 years of age and older, we assessed current behaviors related to adult Td immunization and beliefs regarding pertussis vaccine under various scenarios relevant to adult decision-making.

Results: Forty-five percent of participants reported having received tetanus vaccine within the previous 10 years; this rate was lowest amongst elderly persons 65 years of age or more (28%). On multi-variate analysis, being up-to-date with tetanus immunization was independently associated with belief that an adult should be immunized against tetanus and perception that tetanus is life-threatening and inversely associated with being elderly. At baseline, 59% of respondents indicated willingness to receive pertussis immunization if provided free; this increased to 76% following sequential information about communicability and severity of pertussis illness and safety, efficacy and convenience of vaccine and up to 87% if accompanied by physician or nurse recommendation. Sixty-three percent of adults indicated they would receive the vaccine if required to pay \$40.00 (Cdn) for it.

Conclusions: Personal risk perception, public funding and physician recommendation are important to adults when considering tetanus and pertussis immunization. These factors may be relevant as immunization programs are expanded to include more adults generally.

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1. Introduction

Pertussis is a frequent cause of prolonged cough illness in adolescents and adults [1–4]. In areas where enhanced surveillance has included improved diagnostic methods (polymerase chain reaction or serology), teens and adults have been recognized to be at increased risk and, in some areas, to suffer the highest attack rates by age [5–6]. As such,

adolescents and adults serve as a major reservoir of infection and an important source of transmission to vulnerable infants who remain at highest risk of severe complications from pertussis [7–12]. Pertussis in teens and adults can also lead to complications in up to 28% of affected adults and 16% of affected teens [13–17].

Until recently, whole cell pertussis vaccine in Canada was administered routinely to children at 2, 4, and 6 months of age with booster doses at 18 months and 4–6 years. This whole cell pertussis vaccine could not be administered beyond seven years of age because of side effects considered intolerable by older age groups. Since 1997, acellular pertussis combination vaccines have replaced earlier whole cell versions

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for routine childhood immunization programs across Canada [18].

A combined tetanus (T), diphtheria (d), and acellular pertussis (aP) vaccine (TdaP) for use in adolescents and adults was licensed in Canada in 1999 with a view to offering lifetime protection through booster doses [18–20]. The immunogenicity of the diphtheria and tetanus components is equivalent to that obtained with tetanus and diphtheria (Td) toxoid vaccines. A single dose has been shown to increase pertussis antibody levels in excess of those observed in infants who received three doses of an acellular pertussis-containing vaccine and in whom clinical efficacy was measured at 85%. In a trial comparing adolescents and adults given TdaP or Td, adverse reaction rates were comparable [19].

The National Advisory Committee on Immunization (NACI) recommends routine immunization against tetanus and diphtheria for all persons in Canada with a school-leaving adolescent booster at 14–16 years and adult boosters every 10 years thereafter [18]. These immunization programs are publicly-funded in all provinces. In order to extend protection against pertussis, NACI has recommended that provinces replace the adolescent booster dose of Td with TdaP [18]. In addition, the national goal of the pertussis control strategy for Canada has been revised to address pertussis across the entire lifespan with a view to benefiting adolescents and adults directly and to possibly providing collateral benefit to infants through immunization programs targeting older age groups [20].

To anticipate adult acceptance and uptake of TdaP as a booster dose, we assessed adult behaviors related to Td immunization and attitudes toward pertussis illness and vaccine under various scenarios considered relevant to their decision-making.

2. Methods

2.1. Recruitment and participants

Eligible participants included persons 25 years of age and older, who could understand and respond to a standard questionnaire by telephone interview in English and who lived within a household of British Columbia (BC), Canada, during May 2002. Participants were recruited through random digit dialing to households until an eligible person within one of eight strata was identified and consented to participate. Strata consisted of men or women within one of four age categories: 25–34 years, 35–44 years, 45–64 years or 65 years and older.

The University of British Columbia Clinical Ethics Review Board approved this survey.

2.2. Sample size determination

According to census estimates of the baseline population of BC the total population 25 years or older was 3 million

(51% women) with a range from approximately 300,000 women aged 25 to 34 years [up] to 500,000 women aged 45 to 64 years [21]. Sample size was based on conservative estimate of up-to-date tetanus immunization of 50%. On this basis, 100 participants within each age and sex strata would enable an estimate of tetanus immunization coverage with a 95% confidence interval between 45% to 55% per sex category (99% confidence interval overall), between 43% to 57% per age category and between 40% to 60% per age and sex category.

2.3. Interviews

A standard questionnaire and script were developed by the BC Centre for Disease Control specifically for this study and conducted by trained interviewers of Ipsos-Reid during early May 2002. Survey parameters included baseline characteristics, questions on regular adult immunizations, assessment of knowledge and beliefs related to morbidity from disease using nuisance and severity scores, and questions about tetanus/diphtheria and adult pertussis vaccination. The survey included focused questions about willingness to receive pertussis immunization based on sequential presentation of information using a five-point Likert scale as very likely, likely, unlikely or very unlikely and including a “don’t know” option.

Perceived nuisance of illness was scored based on interference with regular activities such as work or recreation (no interference, interference or prevention of activities for a period of time). Perceived severity was based on requirement for medical intervention (no medical treatment required, medical treatment but no hospitalization required, hospitalization required but not a threat of death or hospitalization required and a threat of death). Both nuisance and severity scores included a “don’t know” option.

2.4. Statistical analysis

Chi-square was used as the test of significance for categorical variables. Logistic regression (forward stepwise) adjusted for independent effects in tests of significance and calculation of odds ratios.

3. Results

3.1. Participation rate

An initial 15,163 random digit dial attempts were made. Of these, 3230 (21%) were to a number no longer in service and 2438 (16%) resulted in no answer. There were 3127 (14%) calls to homes ineligible on the basis of age/sex criteria and 685 (4%) on the basis of language barrier. Of the 5332 successful, eligible phone contacts, there were 4330 refusals (81%) to participate and 201 (4%) early terminations of the interview, resulting in a response rate of 15%.

3.2. Baseline characteristics and general questions about immunization

Baseline characteristics of the study population are shown in detail in Table 1. Most respondents consider recommended vaccinations to be a “good thing” in general (92%); this varied by sex (95% for women versus 90% for men; $P = 0.006$) but not by age. Most respondents (71%) considered themselves up-to-date with recommended adult immunizations (Table 1).

When asked to list, unprompted, as many factors as would increase the likelihood of their receiving or keeping up-to-date with recommended adult immunizations, respondents most often cited perceived personal risk concerns (injury, travel, outbreak, immune compromised state or ill health or a newly emerging pathogen) (38%); this was especially noted amongst women (44%) compared to men (33%; $P = 0.002$). Specific physician or nurse recommendation (18%) was next most frequently cited followed by media promotion (8%), information that the vaccine is important or effective (7%) or safe (5%) and some sort of reminder (6%). Four percent of respondents indicated that no factor could improve their uptake of recommended adult vaccinations because they do not believe in immunization; this perspective was more evident amongst men (5%) than women (2%; $P = 0.04$). Mention of these factors did not vary in frequency by age.

When asked to list their usual source of immunization information for themselves or their family, participants most often cited a health care professional (54%) with women more likely than men to cite this source (60% versus 48%; $P = 0.001$). Newspapers, magazines or books were the next most frequent source of information (27%) followed by TV or radio (20%), work or school (10%) and the internet (6%). Women 65 years and older were less likely (1%) than women 25–44 years (9%) to access the internet for immunization information ($P = 0.01$). This difference in internet access by age category was not significant for older men (5%) compared to younger men aged 25–44 years (10%).

Of the 579 respondents with children (72% of all participants), 84 (14%) indicated they had ever received advice about updating their own immunization during a child’s visit to a doctor or nurse.

3.3. Tetanus and diphtheria immunization

Nearly 80% of men and women in all age categories believe an adult should be immunized against tetanus. Only 64% recall ever having been immunized against tetanus as an adult. This did not vary by age category, but men were more likely than women to report any adult tetanus immunization (68% versus 60%, respectively; $P < 0.05$). Although tetanus immunization in British Columbia is provided only as combined vaccine containing tetanus and diphtheria toxoids, few respondents who had ever received tetanus immunization recognized they had also received diphtheria vaccine (17%).

Women were slightly more aware of this than men (19% versus 15%, respectively; $P < 0.05$).

Amongst 513 respondents vaccinated as an adult against tetanus, 361 (70%) had received tetanus immunization within the previous 10 years. On this basis, 45% of respondents overall would be considered up-to-date with tetanus immunization as recommended by NACI. The most senior age category had the lowest rates of up-to-date tetanus immunization amongst both men (29%) and women (26%) (Table 2). Personal risk and opportunistic factors were most often cited as reason for last tetanus immunization (79% referring to injury or travel) with few citing physician or nurse recommendation as impetus (3%) (Table 2).

Participants were more likely to be up-to-date with tetanus immunization if they considered immunizations to be a “good thing” in general than if they did not (54% versus 46%; $P = 0.03$) and if they believed that an adult should receive tetanus vaccinations compared to if they did not (54% versus 46%; $P < 0.001$).

Being up-to-date with tetanus immunization was not significantly associated with being Caucasian nor with sex, visit at least every two years to a physician or nurse, working or volunteering in health care or travel outside of Canada at least every five years. The likelihood of being up-to-date with tetanus immunization varied by level of education—30% of persons who had not completed high school versus 48% with some post-secondary education were up-to-date ($P = 0.02$). Tetanus immunization status also varied by income level, with more in the middle income category being up-to-date (52%) compared to those in the lowest (42%) or highest (44%) categories ($P = 0.04$). Having children did not increase the likelihood of being up-to-date with tetanus immunization but amongst those with children ($n = 579$), recalling advice about updating their own immunization at a child’s visit to a physician or nurse increased the likelihood of being up-to-date, compared to those who had never received such advice (62% versus 42%; $P < 0.001$).

3.4. Tetanus, diphtheria and pertussis—disease severity

Tetanus was considered to be a life-threatening illness by 31% of participants overall. More who considered tetanus life-threatening were up-to-date with tetanus immunization (55%) compared to those did not know how severe tetanus could be (32%; $P = 0.003$) or who considered tetanus would not require hospitalization (39%; $P < 0.001$) or medical treatment (36%; $P = 0.02$) (Fig. 1a).

Pertussis was described by participants in less severe terms than tetanus or diphtheria (Fig. 1b). Significantly more considered that pertussis in an adult could be treated without hospitalization (56%) compared to tetanus (36%) or diphtheria (30%; $P < 0.001$) and significantly fewer considered that pertussis in an adult would cause death (13% versus 31% and 31%, respectively; $P < 0.001$).

There was no difference in the perception that diphtheria (52%), tetanus (50%) or pertussis (50%) would prevent

Table 1
Baseline and general characteristics of participants

	Men (N = 400)					Women (N = 400)					Total ^b (800)
	Age category (years)					Age category (years)					
	25–34 (100)	35–44 (100)	45–64 (100)	65+ (100)	Total ^a (400)	25–34 (100)	35–44 (100)	45–64 (100)	65+ (100)	Total ^a (400)	
Caucasian (%)	74	87	84	85	82	78	85	86	91	85	84
Highest education level (%)											
<High school	4	7	6	12	7	5	2	6	18	8 ^c	8
High school	23	21	23	22	22	12	21	18	32	21	22
Some post-secondary	72	71	70	63	69	83	75	75	45	69	70
Declined to answer	1	1	1	3	2	0	1	1	5	2	2
Income (family) (%)											
<\$50K	39	32	28	44	36 ^c	51	33	31	66	45 ^c	40 ^c
\$50K–<\$100K	37	39	36	29	35	28	34	29	9	25	30
≥\$100K	9	21	19	2	13	9	13	13	3	10	11
Declined to answer	15	8	17	25	16	12	20	27	22	20	18
Currently works/volunteers in health care ^d (%)	9	8	6	4	7	18	18	18	11	16	12 ^c
Sees MD/nurse at least once every 2 years ^d (%)	82	75	84	91	83 ^e	97	99	99	98	98	91 ^c
Keeps a personal written or electronic vaccination record ^d (%)	35	26	27	26	27	51	60	28	21	40 ^c	33 ^c
Considers self up-to-date with regular vaccinations ^d (%)	68	71 ^f	68 ^f	69	69 ^f	71	72	73	79	74	71
Believes recommended vaccinations to be a “good thing” in general ^d (%)	92	90	87	89	90	96	94	94	95	95	92 ^g

^a Superscripts in these columns refer to tests of significance within sex but across age categories.

^b Superscripts in this column refer to tests of significance comparing men to women.

^c $P \leq 0.001$.

^d $\leq 5\%$ of respondents in any subgroup responded “Don’t Know” unless otherwise indicated.

^e $0.01 < P < 0.05$.

^f $< 10\%$ of respondents in these subgroups responded “Don’t Know”.

^g $0.001 < P \leq 0.01$.

Table 2
Beliefs and behaviors related to adult tetanus and diphtheria and immunization

	Men (N = 400)					Women (N = 400)					Total ^b (800)
	Age category (years)					Age category (years)					
	25–34 (100)	35–44 (100)	45–64 (100)	65+ (100)	Total ^a (400)	25–34 (100)	35–44 (100)	45–64 (100)	65+ (100)	Total ^a (400)	
Ever received tetanus vaccination as an adult ^c (%)	59	70	75	70	68	53	60	68	58	60	64 ^d
Last received tetanus vaccination within 10 years ago ^c (%)	56	56	51	29	48 ^e	48	47	48	26	42 ^f	45
Main reason for last tetanus immunization (N)	59	70	75	70	274	53	60	68	58	239	513
Injury/bite (%)	61	77	79	51	68 ^d	53	62	75	69	65	67
Travel (%)	10	7	4	23	11	17	8	10	16	13	12
Work/school (%)	10	6	1	11	7	13	12	4	0	7	7
Routine schedule (%)	14	4	4	1	6	9	12	4	5	8	6
MD/nurse advice (%)	3	1	4	4	3	4	5	0	3	3	3
Other/do not know (%)	2	4	8	9	6	4	2	6	6	5	5

^a Superscripts in these columns refer to tests of significance within sex but across age categories.
^b Superscripts in this column refer to tests of significance comparing men to women.
^c <5% of respondents in any subgroup responded "Don't Know".
^d 0.01 < P < 0.05.
^e P ≤ 0.001.
^f 0.001 < P ≤ 0.01.

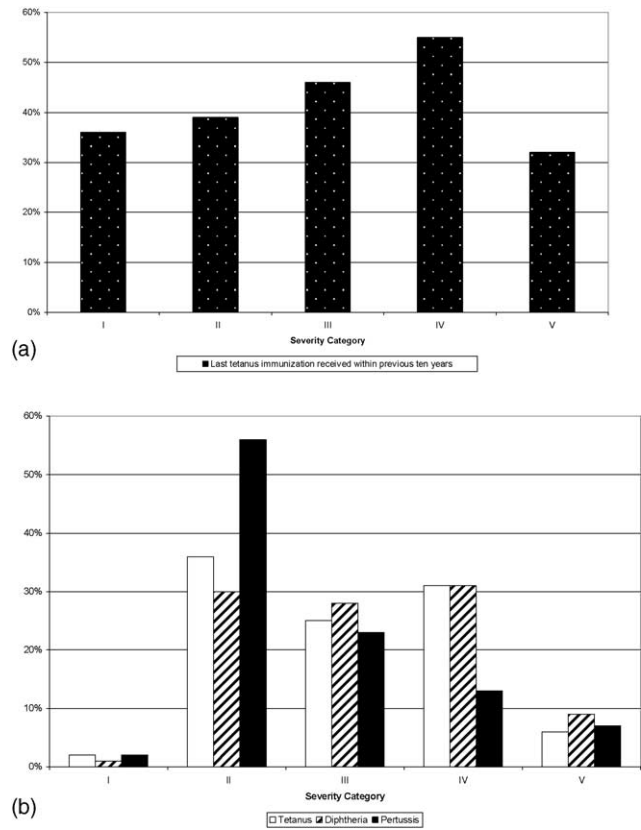


Fig. 1. (a) Proportion up-to-date with tetanus vaccination based on perceived severity of tetanus. (b) Perceived severity of tetanus, diphtheria or pertussis. (I) Would not require medical treatment; (II) would require medical treatment, but no hospitalization; (III) would require hospitalization, but not a threat of death; (IV) would require hospitalization and could kill; (V) do not know.

daily activities such as recreation or work for a period of time. Participants who attributed a higher nuisance score to tetanus were more likely to be up-to-date with immunization, although the strength of that association was less than with perceived severity. Those who believed tetanus would prevent activities were more likely to be up-to-date than those who did not (49% versus 41%; $P = 0.02$).

On multi-variate analysis ($N = 651$, excluding participants with missing information), being up-to-date with tetanus immunization was significantly and independently associated with: belief that an adult should be immunized against tetanus (OR: 6.9; 95% C.I.: 4.1–11.6) and perceived severity of tetanus as life-threatening (OR: 1.6; 95% C.I.: 1.1–2.4) but inversely associated with being a senior (OR: 0.4; 95% C.I.: 0.2–0.5). These associations were found after adjustment for the following variables which were not themselves independently associated with being up-to-date with tetanus immunization: sex, education, income, volunteering or working in health care, travel outside of Canada at least every 5 years, having children, visit to a physician or nurse at least once every 2 years, keeping a personal immunization record, belief that vaccines are a good thing in general, perception

Table 3
Influence of information on attitudes and beliefs toward adult pertussis and immunization

	Men (N = 400)					Women (N = 400)					Total ^b (800)
	Age category (years)					Age category (years)					
	25–34 (100)	35–44 (100)	45–64 (100)	65+ (100)	Total ^a (400)	25–34 (100)	35–44 (100)	45–64 (100)	65+ (100)	Total ^a (400)	
If a vaccine were available free of charge to protect you from whooping cough as an adult, how likely would you be to get it? ^c											
Very likely or likely (%)	75	59	43	45	56 ^d	70	70	62	47	62 ^d	59 ^e
If your doctor or nurse recommended you get this whooping cough vaccine how likely would you be to get it? ^c											
Very likely or likely (%)	90	84	86	81	85	92	86	91	88	89	87, OR: 3.7 (4.8, 6.2) ^f
Given this information [on communicability of pertussis] ^{g,h} , how likely would you be to get this vaccine as an adult if it was available? ^c											
Very likely or likely (%)	78	69	49	55	63 ^d	66	73	74	66	70	66 ⁱ , OR: 1.4 (1.1, 1.7) ^f
Given this information (on severity of pertussis) ^{g,j} in adults, how likely would you be to get a vaccine as an adult to protect you? ^c											
Very likely or likely (%)	76	71	56	54	64 ^k	72	69	72	66	70	67, OR: 1.4 (1.2, 1.8) ^f
If a vaccine could reduce your risk of getting ill from whooping cough as an adult by 85%, how likely would you be to get a vaccine as an adult to protect you?[19] ^{c,g}											
Very likely or likely (%)	82	71	63	66	70 ^d	73	74	74	74	74	72, OR: 1.8 (1.5, 2.2) ^f
If the whooping cough vaccine caused no more side effects than your regular tetanus shot how likely would you be to receive it?[19] ^{c,g}											
Very likely or likely (%)	85	77	59	64	71	76	75	76	71	74	73, OR: 1.9 (1.5, 2.3) ^f
If this vaccine came together with tetanus and diphtheria vaccine at the same time and in the same shot how likely would you be to receive it?[19] ^{c,g}											
Very likely or likely (%)	87	79	70	61	74 ^e	79	76	80	74	77	76, OR: 2.2 (1.8, 2.7) ^f
If you had to pay \$40.00 (Cdn) to receive the whooping cough vaccine yourself how likely would you be to receive it? ^{c,g}											
Very likely or likely (%)	66	56	50	59	58	69	61	73	70	68	63 ^d , OR: 1.2 (0.9, 1.5) ^f

^a Footnotes in these columns refer to tests of significance within sex but across age categories.

^b Superscripts in this column refer to tests of significance comparing men to women.

^c ≤5% of respondents in any subgroup responded “Don’t Know”.

^d $p \leq 0.001$.

^e Referred to as baseline willingness to receive adult pertussis vaccination.

^f Odds ratio and 95% confidence interval relative to baseline willingness to receive adult pertussis vaccination (see footnote e).

^g Statements and questions presented sequentially to participants in the order they appear in this table.

^h Statement read to participants before asking this question: “Whooping cough is caused by a germ that is spread very easily through the air by coughing and sneezing. A vaccine to protect children is given when they are very young and the last dose is given before kindergarten. Protection from the vaccine fades within 10 years [37]. Until recently, there was no vaccine for older children even though pre-teens and teens have the highest rate of whooping cough. About 1 in 5000 adults gets whooping cough during an outbreak [5]. An outbreak happens every 3–4 years in BC [5]”.

ⁱ $0.01 < P < 0.05$.

^j Statement read to participants before asking this question: “Whooping cough causes severe spells of coughing. In adults, this usually lasts about three months. Two thirds of adults cough to the point of vomiting. Adults with whooping cough miss 7 days of work on average and their sleep is interrupted for about two weeks by the coughing. About 5% of adults with whooping cough get pneumonia and 2% have to be hospitalized for several days. Adults rarely die from whooping cough [13]”.

^k $0.001 < P \leq 0.01$.

that tetanus illness would prevent daily activities or being Caucasian.

Amongst respondents with children ($N = 472$, excluding participants with missing information), having received advice about their own immunizations during a child's physician/nurse visit (OR: 2.3; 95% C.I.: 1.3–4.1) also independently increased the likelihood of being up-to-date with tetanus immunization without altering the strength of association of the remaining variables, as already listed above.

3.5. Attitudes toward adult pertussis and immunization

Twelve percent of respondents to this survey had, or knew someone who had, pertussis as an adult; women were more likely to report this than men (15% versus 9%, respectively; $P < 0.01$) (Table 3). This personal or indirect experience with adult pertussis was not associated with increased likelihood of perceiving pertussis as life-threatening (13%) but increased recognition that pertussis would prevent daily activities if acquired as an adult compared to those without this experience (60% versus 49%; $P = 0.04$).

At baseline, 59% of participants indicated they would be willing to receive a vaccine against pertussis as an adult if provided free of charge (Table 3). Baseline willingness to receive adult pertussis immunization varied by age and sex category with lowest rates amongst elderly persons over 65 years of age (Table 3). Sixty-eight percent of respondents said if re-vaccination were then required every 5–10 years to maintain protection, they were likely or very likely to be re-vaccinated.

Previous personal or indirect experience with adult pertussis did not increase the baseline willingness to be vaccinated. Belief that adult pertussis is life-threatening did increase willingness to be vaccinated compared to those who considered pertussis in milder terms (76% versus 56%; $P < 0.001$). Belief that adult pertussis prevents daily activities also increased baseline willingness to be vaccinated compared to those without this belief (64% versus 54%; $P = 0.007$). Health care workers were no more likely than others to perceive pertussis as life-threatening or to prevent activities. They were also no more likely at baseline to be willing to be immunized as an adult against pertussis.

The proportion willing to be vaccinated increased significantly over baseline to 87% (OR: 3.7; 95% C.I.: 4.8–6.2) if a physician or nurse recommended the vaccine (Table 2). Further information about communicability, severity of pertussis in adults, side effects of the vaccine and convenience of vaccine administration also each significantly increased likelihood of receiving the vaccine above baseline, but none so much as physician or nurse recommendation (Table 2).

Adults were also influenced to receive the vaccine if it would protect young children. When given additional information on the severity and complications of pertussis in partially immunized infants less than 6 months of age, 75% of respondents overall indicated they would be willing to receive the vaccine themselves in order to protect these infants; this

was as high as 86% amongst those who had regular contact with infants less than 6 months of age ($P \leq 0.01$).

4. Discussion

This survey characterizes adult willingness to be vaccinated against pertussis based on socio-demographic factors, knowledge, beliefs and behaviors related to immunization already offered to adults and the potential influence of targeted information. Although it cannot precisely predict adult pertussis vaccine uptake, it reasonably anticipates the upper and lower bounds of vaccine acceptance.

When this survey was undertaken in May 2002, only Newfoundland and Nunavut in Canada had implemented the switch from Td to Tdap for the adolescent booster dose. By the spring of 2004, 10 of 13 provinces or territories, including BC, had announced publicly funded Tdap programs for adolescents. No province has yet incorporated periodic adult pertussis booster dose into its routine publicly funded immunization program. We were therefore able to assess the determinants and deterrants of adult pertussis immunization uptake in the absence of population-based promotional campaigns targeting older age groups.

Response rate to this survey was low (15%), introducing the potential for non-response bias. This is a recognized concern of random-digit dialing (RDD) survey methods [22]. In previous comparisons of RDD-elicited samples with household surveys and census data, RDD samples, despite low response rates, have been found representative on most population characteristics, particularly when questions pertaining to sensitive issues (such as socially stigmatized behaviors) are avoided. Misrepresentation, when it occurs, has involved certain age groups (the young or the elderly) and socio-economic classes (respondents are more often employed or have higher education [23–27]). In our study, a stratum-based quota sampling method was used to ensure adequate sample size within each age and sex group. With 100 adults per strata, our sample represented the age distribution of the BC population, with only minor mismatch. In comparison with the most recent census data, our sample represented the BC population on key socio-demographic factors, including education and income [21]. Overall, a slightly higher proportion of the BC population is comprised of visible minorities (22%) compared to self-report by our sample (16%). [21] We present relevant baseline characteristics of this sample to enable informed extrapolation to other populations. Significant trends related to immunization acceptance in association with these characteristics should apply beyond the study population.

In our survey, about 70% of participants considered themselves up-to-date with recommended adult immunizations but less than 50% acknowledged receipt of tetanus vaccine within the previous 10 years. Only a minority knew they had also received diphtheria vaccine at the same time. Similar findings have been identified in other surveys of tetanus/diphtheria immunization in Canada and other devel-

oped countries [28–31]. In our survey, belief that one should be immunized against tetanus as an adult was strongly associated with the likelihood that one was. Improving knowledge about recommended vaccines, their components and their required periodicity may prove worthwhile in improving uptake. Understanding what is being given during an immunization visit is also an important component of informed consent.

At baseline, 59% of respondents indicated they would be willing to receive pertussis immunization as an adult if it were provided free. This is consistent with acknowledged behavior related to any adult tetanus immunization (64%; $P = 0.03$)—also provided free. Perception of the severity of tetanus illness was significantly associated with the likelihood of being up-to-date with tetanus immunization and participants cited their own personal risk most often as the key motivation for being immunized. On multi-variate analysis, perceived severity of pertussis was significantly linked to willingness to receive pertussis immunization. Overall, participants characterized pertussis as less severe than tetanus. On this basis, it is unlikely that adult pertussis immunization will exceed 55–65%. Recognizing that reported perceptions and willingness may not ultimately reflect actual uptake of vaccine, coverage may yet be even lower than this unless concerted efforts are made to promote the vaccine and address perceived risk.

As in other surveys, older participants cited the lowest rates of tetanus immunization (28%) [28–31]. Although the risk of complications from pertussis illness increases with age, elderly persons also expressed the least willingness to be vaccinated against pertussis (46%) [13]. In our survey, the extent to which pertussis was perceived as disruptive to regular activities was associated with willingness to be vaccinated and adults were particularly poised to accept vaccine in order to protect vulnerable infants. Social marketing campaigns should address these issues in a way that is personally relevant to adults—capitalizing on disease severity in older persons, perceived interference with regular activities in young adults and the protection of infants among new parents or infant caretakers.

Coupling information with clear physician or nurse recommendation is likely to be most influential in determining adult pertussis immunization—whether offered to all adults or in targeted campaigns for new parents or the elderly. Health care professionals were cited as the usual source of immunization information for most participants and recommendation from a physician or nurse was the next most frequently cited factor believed to increase likelihood of being vaccinated. Information on communicability and severity of pertussis illness combined with information on safety, efficacy and convenience of the vaccine marginally improved likelihood of receiving the vaccine but these cumulative effects were virtually negated by the requirement to pay and none achieved the significance of physician or nurse recommendation. Other immunization surveys have also emphasized the role of the health care provider and the influence afforded his or her advice in immunization decision-making [29,32–36].

Although, opportunistic immunization related to injury was most often cited as the reason for last receiving tetanus vaccine, other opportunities also exist for updating adult immunization. More than 90% of adults in this survey indicated they see a physician or nurse at least every 2 years; this proportion was highest amongst women compared to men (98% versus 83%). Paradoxically, women were less likely to report ever having been immunized as an adult against tetanus; this has also been found in other surveys of tetanus coverage [29,30]. Amongst participants with children, less than 15% recalled ever having been advised about their own immunization during a child's visit but those who had been were twice as likely to report being up-to-date with tetanus immunization.

Lifetime protection against pertussis is an explicit goal of pertussis immunization programs in Canada; other countries contemplating a similar goal will also benefit from consideration of our results. Current pertussis vaccine formulations do not provide lifelong protection and adult booster doses will be necessary to meet such a goal [37]. Our survey results emphasize the importance of public funding, personal risk perception and physician or nurse recommendation to adults when considering tetanus or pertussis immunization. Other vaccine-preventable diseases, such as influenza also require repeat immunization [29]. Understanding the determinants and deterrants of immunization uptake by adults is important if vaccination programs in general are to include more adults on a routine basis.

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