



Intentions of public school teachers in British Columbia, Canada to receive a COVID-19 vaccine



C. Sarai Racey^{a,b}, Robine Donken^{a,b,c,1}, Imogen Porter^c, Arianne Albert^b, Julie A. Bettinger^{c,d}, Jennifer Mark^c, Lizl Bonifacio^c, Meena Dawar^{a,e}, Mike Gagel^f, Rakel Kling^f, Silvina Mema^{a,g}, Hana Mitchell^{d,h}, Ian Roeⁱ, Gina Ogilvie^{a,b,i}, Manish Sadarangani^{c,d,*}

^a School of Population and Public Health, University of British Columbia, Vancouver, BC, Canada

^b Women's Health Research Institute, British Columbia Women's Hospital and Health Centre, Vancouver, BC, Canada

^c Vaccine Evaluation Center, BC Children's Hospital Research Institute, Vancouver, BC, Canada

^d Department of Pediatrics, University of British Columbia, Vancouver, BC, Canada

^e Vancouver Coastal Health Authority, Vancouver, BC, Canada

^f Northern Health Authority, Prince George, BC, Canada

^g Interior Health Authority, Kelowna, BC, Canada

^h BC Children's Hospital Research Institute, Vancouver, BC, Canada

ⁱ BC Centre for Disease Control, Vancouver, BC, Canada

ARTICLE INFO

Article history:

Received 1 March 2021

Received in revised form 27 April 2021

Accepted 23 June 2021

Available online 29 June 2021

Keywords:

Vaccines
COVID-19
Public health
Infectious disease
Health policy

ABSTRACT

Background: To control the COVID-19 pandemic high vaccine acceptability and uptake will be needed. Teachers represent a priority population to minimize social disruption and ensure continuity in education, which is vital for the well-being and healthy development of youth during the pandemic. The objective of this analysis was to measure public school teachers' intentions to receive a COVID-19 vaccine in British Columbia (BC), Canada.

Methods: A population-wide cross-sectional online survey from August to November 2020 asked all BC public school teachers with an available email address how likely they were to receive a COVID-19 vaccine. Two multivariable logistic regression models explored separately sociodemographic and vaccine hesitancy predictors for intention to receive a COVID-19 vaccine.

Results: A total of 5,076 teachers participated. The majority, 89.7%, reported they were likely or very likely to accept a COVID-19 vaccine. In multivariable regression, sociodemographic predictors of intention to be vaccinated included being male, having an educational background in science or engineering, and using reliable information sources on vaccination such as public health and health care providers. Teachers who reported lower levels of vaccine hesitancy, higher general vaccine knowledge, and belief that COVID-19 was a serious illness were more likely to intend to receive a COVID-19 vaccine.

Conclusion: A high proportion of public-school teachers in BC intend to receive a COVID-19 vaccine. Continued monitoring of vaccine intentions will be important to inform public health vaccine implementation.

© 2021 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

Deployment of safe and effective vaccines will ultimately be required to control the pandemic. Initial approvals of COVID-19

* Corresponding author at: Vaccine Evaluation Center, BC Children's Hospital Research Institute, 950 West 28th Avenue, Vancouver, British Columbia V5Z 4H4, Canada.

E-mail address: msadarangani@bcchr.ubc.ca (M. Sadarangani).

¹ Current affiliation: Amsterdam UMC, VU University Amsterdam, Department of Epidemiology and Data Science, Amsterdam, the Netherlands.

vaccines were granted by regulatory bodies [1,3] in December 2020, with multiple additional vaccine candidates under evaluation [2]. The impact of vaccination to protect both individuals and communities, and allow social and economic activities to return, will only be possible with a comprehensive vaccine delivery program and high vaccine acceptance. Initial priority for COVID-19 vaccination programs have focused on high-risk populations to minimize mortality and serious illness from COVID-19, with a secondary goal of limiting societal disruption as a result of the pandemic, while ensuring efficient, effective, and equitable allocation of vaccine [4]. The initial phase of COVID-19 vaccine rollout has

focused predominantly on residents and staff of long-term care homes and health-care workers [5]. In BC, the mass general population COVID-19 immunization program will be conducted largely based on age cohorts from oldest to youngest [5].

With the goal of minimizing societal disruption and reducing inequities as a result of the COVID-19 pandemic, educators, specifically teachers, are a distinct population, given the role school structure plays in the well-being of youth and the economy [6]. School closures and the transition to distance learning during the initial wave of the pandemic had significant negative impacts on income, mental health and learning for families and youth [7], disproportionately impacting low-income families, and those requiring essential supports coordinated through the public-school system [6,8,9]. Despite many public schools in Canada remaining open during the second wave of the pandemic, exposure events and quarantine guidelines have continued to be disruptive for teachers, students, and families. High acceptance of a COVID-19 vaccine among teachers will be important to minimizing disruptions to schooling, and ensure the safety of teachers, especially those at high-risk for severe illness due to COVID-19. A focus on the uptake in teachers is also important given that COVID-19 vaccines have not yet been approved for children, and given vaccine roll-out to date, children may be the last to receive a vaccine against COVID-19.

The objective of this analysis was to measure BC teachers' intentions to accept a COVID-19 vaccine, and factors associated with acceptance, to inform COVID-19 vaccination programs.

2. Methods

2.1. Study design and population

All elementary and secondary public school teachers in BC with an available public email address on a school district website from June - July 2020 were invited to participate in an online survey through individual email invitations from August 20th to November 3rd, 2020. Administrative and non-teacher support staff were excluded, based on school website information. Respondents provided informed consent, and were invited to participate in a draw for gift cards. A maximum of two reminder invitations were sent one week apart to non-responders.

2.2. Survey design

Survey items were developed using available literature and previous surveys, in addition to elicitation from experts on vaccine hesitancy and acceptability (MS, GO, JAB, HM). Sociodemographic items included sex, gender, and geographical location based on postal code. Educational training background was assessed based on the selection of one or more broad discipline categories. Indigenous ancestry and visible minority categories were based on the Statistics Canada 2016 census. Vaccine hesitancy was measured using the validated 9-item Vaccine Hesitancy Scale (VHS), which was developed by the WHO's Strategic Advisory Group of Experts (SAGE) Working Group on vaccine hesitancy [10,11]. The VHS is focused on general childhood vaccines and assesses vaccine hesitancy based on two separate factors: lack of confidence in and perceived risks of vaccines. Respondents were asked about past vaccination experience, sources for general vaccine information (e.g. public health, government websites, school district or BC teacher's union, general news sources, social media, friends or colleagues), and general vaccine knowledge was measured using a modified scale [12]. The primary outcome of intention to receive a future COVID-19 vaccine was measured on a 5-point Likert-scale from very unlikely to very likely in response to the question:

"If a safe and effective COVID-19 vaccine were to become available to the public, and recommended for you, how likely are you to receive it?". At the time of survey administration, vaccine product characteristics were not available. Respondents were also asked if they believed COVID-19 was a serious illness. Survey invitation and items included in this analysis appear in [Appendix 1 and 2](#).

The survey was piloted tested with four current public-school teachers and members of the study team for face validity, length, and navigational ease. The survey was administered using the secure web-based software platform REDCap [13]. Ethics approval was received from the University of British Columbia's Research Ethics Board (H20-01820).

2.3. Sample size, response rate, and respondents

A minimum sample size of 2,400 was needed to achieve an 80% power to estimate a population proportion of 0.5 (with 95 %CI) for intent to vaccinate, with a 2% margin of error. We invited all public school teachers in BC with a publicly available email to participate. Completed surveys were those that were submitted as complete by the respondent. Partial surveys were those that initiated the survey but did not submit the survey as complete. Email addresses that were auto-returned as undeliverable, or no longer active, were considered invalid. Response rate (%) was the sum of completed surveys plus partial surveys, divided by the number of invitations sent to respondents with valid email addresses, as per the American Association for Public Opinion Research guidelines [14].

Representativeness of respondents was examined through comparison to the reported distribution of male/female and age cohorts of teachers in BC [15,19], and based on population distribution among the five geographical provincial health authorities [16].

2.4. Statistical analysis

The primary outcome of 'intention to accept a future COVID-19 vaccine' was dichotomized from the 5-point Likert scale to focus on those who intend to vaccinate. Participants responding *likely* and *very likely* to receive a COVID-19 vaccine were categorized as 'yes, intend to accept a COVID-19 vaccine' compared to those who reported *neutral*, *unlikely* and *very unlikely* to accept a COVID-19 vaccine. The dichotomization was done to focus on those with intent to vaccinate, and neutrals were assigned to bias results to the null.

Vaccine hesitancy was calculated as mean scores (range of 1 to 5) for both factors of the VHS, which included the 7-item *lack of confidence in vaccines* factor (reverse scored) and the 2-item *risk of vaccines* factor [10]. Scale item reliability was assessed using Cronbach's α (>0.6 good agreement) for the VHS factors. General vaccine knowledge scale was measured as a grand score to 5-items (true/false, for a range of 0-5) that achieved > 0.6 on the Kuder - Richardson formula (KR20) for reliability. More than one visible minority identity was allowed, and so each visible minority group was summarized separately. A separate dichotomized variable (visible minority yes/no) was included in the analysis, which included anyone who selected one or more visible minorities or identified as Indigenous.

Only surveys submitted as complete were included. Missing data was assessed and complete case analysis was conducted due to less than < 10% missing.

All statistical analyses were completed in R v.4.0.2 [17]. Factors associated with intention to accept a future COVID-19 vaccine were explored using Fisher's Exact Tests for categorical variables and Kruskal-Wallis tests for continuous variables, using case-wise deletion for missing data. Two multivariable logistic regression models explored predictors for intention to accept a COVID-19 vaccine. The first model explored socio-demographic and beha-

vioural predictors of vaccine intention that could be applied in public health practice (*a priori* variables included age, sex, identifying as a visible minority, educational training background, prior vaccine delay or refusal, and the use of reliable sources for vaccine information). The second model explored intention to receive a COVID-19 vaccine based the psychological measures of general vaccine hesitancy, belief COVID-19 was a serious illness, and general vaccine knowledge. For both models, *a priori* variables for predictors of positive vaccine acceptance that reached $p < 0.10$ in bivariable analysis were included.

3. Results

A total of 29,184 email addresses were identified on public school board websites for the estimated 45,000 BC public school teachers [18]. All identified teachers were sent email invitations, of which 1,072 were deemed invalid due to automated undeliverable or inactive accounts. Of the 28,112 teachers with valid email addresses, we received 5,725 responses (20.4%), of which 5,095 (88.9%) submitted a complete survey. Almost all completed surveys (5,076, 99.6%) reported how likely they are to receive COVID-19 vaccine. Respondents were representative of the overall BC teaching population, which were comparable based on the distribution of sex and age to the current workforce [15,19] (Supplementary Table A), and population distribution among the five geographical health regions [16]. Two of the school districts did not display public email address, and we had respondents recorded from 58/60 public school boards across the province.

The majority of respondents, 89.7% (4,551/5,076), reported they were likely or very likely to accept a COVID-19 vaccine (Fig. 1), and 89.2% reported never having delayed or refused any vaccination in the past (Table 1). The majority of respondents reporting seeking general vaccine information from reliable information sources: public health (78.1%), government websites (63.6%), and health care providers (57.3%). 40.7% of respondents reported professional organizations such as school boards or the teacher’s union as a source of vaccine information. Few respondents reported seeking general information about vaccines from social media (4.4%).

In bivariable analysis, factors associated with intent to accept a COVID-19 vaccine included being male; never having personally delayed or refused a vaccine, and having reported an educational background in science or engineering. Those who reported seeking vaccine information from reliable sources such as public health, health care providers, and the school board or teachers’ union, were more likely to intend to accept COVID-19 vaccination. There

was no significant association between vaccine intention and age or visible minority status. Respondents who intended to accept a COVID-19 vaccine had lower scores on the VHS factors (i.e. were less vaccine hesitant), had higher general vaccine knowledge, and were more likely to report COVID-19 being a serious illness (Table 1).

In the multivariable model exploring sociodemographic and behavioral predictors of intention to vaccinate (Table 2), respondents who were male (OR = 1.41, 95% CI 1.07–1.88) and had an educational background in science or engineering (OR = 1.36, 95% CI 1.04–1.79), and sought vaccine information from reliable information sources, including public health (OR = 1.43, 95% CI 1.12–1.83), school boards or teachers’ unions (OR = 1.59, 95% CI 1.27–2.00), and health care providers (OR = 1.51, 95% CI 1.22–1.87) were more likely to intend to receive a COVID-19 vaccine. Those who delayed a previous vaccine were less likely to intend to accept a COVID-19 vaccine (OR = 0.19, 95% CI 0.15–0.24). Age was not predictive of vaccine intentions.

When looking at predictors of intention to accept a COVID-19 vaccine based on the psychological measures (Table 3), for vaccine hesitancy, as the lack of confidence in vaccines increased there was an association with decreased vaccine intention (OR = 0.5, 95% CI 0.44–0.58), which was similar to perceived risk of vaccination, in which an increase in perceived risk of vaccines was associated with a decreased vaccine intention (OR = 0.36, 95% CI 0.31–0.42). Predictors of intent to vaccinate included an increase in general vaccine knowledge (OR = 1.58, 95% CI 1.38–1.80) and belief that COVID-19 was a serious illness (OR = 5.79, 95% CI 4.09–8.19).

4. Discussion

Assessing intention to be vaccinated is a vital step towards ensuring optimal implementation of COVID-19 vaccines. Our analysis found the majority (89.7%) of public school teachers in BC intend to accept a COVID-19 vaccine that is safe, effective, and recommended for them, with 69.5% (95%CI 68.2% – 70.8%) reporting they would be *very likely* to get a COVID-19 vaccine. Vaccine intention in teachers was higher compared to recent national data, which found only 55.5% (95%CI 49.2–61.6%) of the general BC population reported being *very likely* to receive a COVID-19 vaccine [20].

Females comprise approximately 72% of the teaching workforce in BC [15], and despite our finding that females are less likely to accept a COVID-19 vaccine, overall intention for teachers to accept a COVID-19 vaccine remained > 85%. Being male has been previously reported as a positive predictor for COVID-19 vaccine intentions [21,22], where as being female has been identified as a predictor of vaccine hesitancy for the COVID-19 vaccine [23]. Sex differences in vaccine intention may be related to the initial COVID-19 clinical characteristic reports identifying males as more likely to experience severe COVID-19 illness and death [24,25]. In addition, participants who are pregnant, or intend to become pregnant, maybe less likely to accept a COVID-19 vaccine, given the lack of available information at the time of the survey regarding vaccine characterization in pregnancy.

In this highly educated population, having formal education in science or engineering was found to be an independent significant predictor of vaccine intention. In BC, registered teachers are required to have a bachelor in education degree, with many obtaining a prior bachelor degree in another discipline. Those with an educational background in science or engineering were analyzed together compared to those without educational training in a scientific discipline, as globally, science education has been observed to be an important factor for both confidence in vaccines and uptake [26].

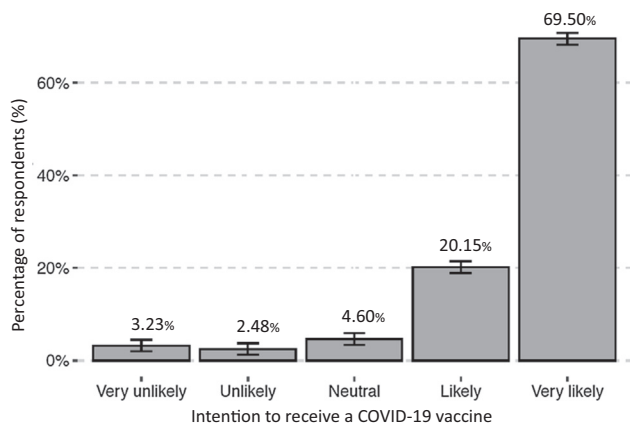


Fig. 1. Distribution of BC Teacher Respondent's Intention of accepting a COVID-19 vaccine (%).

Table 1
Descriptive summary and bivariate analysis of teachers in BC and intention to receive a future COVID-19 vaccine.

	Total N = 5,076	Intention to accept a COVID-19 vaccine		P values
		No, does not intend to vaccinate (n = 525)	Yes, intends to vaccinate (n = 4,551)	
Age				
20–30	494 (9.7%)	57 (10.9%)	437 (9.6%)	0.09
30–40	1,326 (26.1%)	146 (27.8%)	1,180 (26.0%)	
40–50	1,633 (32.2%)	167 (31.8%)	1,466 (32.2%)	
50–60	1,234 (24.3%)	110 (21.0%)	1,124 (24.7%)	
60+	304 (6.0%)	21 (4.0%)	283 (6.2%)	
Missing	85 (1.7%)	24 (4.6%)	61 (1.3%)	
Sex				
Female	3,801 (74.9%)	406 (77.3%)	3,395 (74.6%)	0.0004
Male	1,180 (23.2%)	86 (16.4%)	1,094 (24.0%)	
Prefer not to answer	77 (1.5%)	26 (5.0%)	51 (1.1%)	
Missing	18 (0.4%)	7 (1.3%)	11 (0.2%)	
Gender				
Woman	3,785 (74.6%)	406 (77.3%)	3,379 (74.2%)	<0.0001
Man	1,171 (23.1%)	84 (16.0%)	1,087 (23.9%)	
Non-Binary/genderqueer/S2/other	31 (0.6%)	7 (1.3%)	24 (0.5%)	
Prefer not to answer	76 (1.5%)	24 (4.6%)	52 (1.1%)	
Missing	13 (0.3%)	4 (0.8%)	9 (0.2%)	
White				
White	4,264 (84.0%)	418 (79.6%)	3,846 (84.5%)	0.11
Not White	428 (8.4%)	32 (6.1%)	396 (8.7%)	
Missing	384 (7.6%)	75 (14.3%)	309 (6.8%)	
Black				
Black	25 (0.5%)	6 (1.1%)	19 (0.4%)	0.04
Not Black	4,667 (91.9%)	444 (84.6%)	4,223 (92.8%)	
Missing	384 (7.6%)	75 (14.3%)	309 (6.8%)	
Asian				
Asian	439 (8.6%)	39 (7.4%)	400 (8.8%)	0.59
Not Asian	4,253 (83.8%)	411 (78.3%)	3,842 (84.4%)	
Missing	384 (7.6%)	75 (14.3%)	309 (6.8%)	
South Asian				
South Asian	188 (3.7%)	21 (4%)	167 (3.7%)	0.46
Not South Asian	4,504 (88.7%)	429 (81.7%)	4,075 (89.5%)	
Missing	384 (7.6%)	75 (14.3%)	309 (6.8%)	
Latin American				
Latin American	34 (0.7%)	2 (0.4%)	32 (0.7%)	0.43
Not Latin American	4,658 (91.8%)	448 (85.3%)	4,210 (92.5%)	
Missing	384 (7.6%)	75 (14.3%)	309 (6.8%)	
Indigenous				
Indigenous	150 (3.0%)	15 (2.9%)	135 (3%)	1
Not Indigenous	4,807 (94.7%)	480 (91.4%)	4,327 (95.1%)	
Missing	119 (2.3%)	30 (5.7%)	89 (2%)	
Visible minority				
No	4,023 (79.3%)	385 (73.3%)	3,638 (79.9%)	0.79
Yes	656 (12.9%)	65 (12.4%)	591 (13.0%)	
Missing	397 (7.8%)	75 (14.3%)	322 (7.1%)	
Educational Training Background				
Non-science	3,782 (74.5%)	408 (77.7%)	3,374 (74.1%)	0.002
Science or Engineering	1,194 (23.5%)	92 (17.5%)	1,102 (24.2%)	
Missing	100 (2.0%)	25 (4.8%)	75 (1.6%)	
Ever delayed or refused an immunization				
Yes, delayed/refused	453 (8.9%)	147 (28%)	306 (6.7%)	<0.0001
No	4,526 (89.2%)	350 (66.7%)	4,176 (91.8%)	
No answer	97 (1.9%)	28 (5.3%)	69 (1.5%)	
Source of Information: Public Health				
Yes	3,964 (78.1%)	349 (66.5%)	3,615 (79.4%)	<0.0001
No	986 (19.4%)	133 (25.3%)	853 (18.7%)	
Missing	126 (2.5%)	43 (8.2%)	83 (1.8%)	
Source of Information: Government websites				
Yes	3,229 (63.6%)	305 (58.1%)	2,924 (64.2%)	0.2
No	1,710 (33.7%)	181 (34.5%)	1,529 (33.6%)	
Missing	137 (2.7%)	39 (7.4%)	98 (2.2%)	
Source of Information: School Board or union				
Yes	2,065 (40.7%)	156 (29.7%)	1,909 (41.9%)	<0.0001
No	2,861 (56.4%)	323 (61.5%)	2,538 (55.8%)	
Missing	150 (3.0%)	46 (8.8%)	104 (2.3%)	

Table 1 (continued)

	Total N = 5,076	Intention to accept a COVID-19 vaccine		P values
		No, does not intend to vaccinate (n = 525)	Yes, intends to vaccinate (n = 4,551)	
Source of Information: News				
Yes	1,482 (29.2%)	118 (22.5%)	1,364 (30.0%)	0.003
No	3,460 (68.2%)	368 (70.1%)	3,092 (67.9%)	
Missing	134 (2.6%)	39 (7.4%)	95 (2.1%)	
Source of Information: Social Media				
Yes	221 (4.4%)	37 (7.0%)	184 (4.0%)	0.0009
No	4,697 (92.5%)	441 (84.0%)	4,256 (93.5%)	
Missing	158 (3.1%)	47 (9.0%)	111 (2.4%)	
Source of Information: Health Care Provider				
Yes	2,911 (57.3%)	244 (46.5%)	2,667 (58.6%)	<0.0001
No	2,035 (40.1%)	239 (45.5%)	1,796 (39.4%)	
Missing	130 (2.6%)	42 (8.0%)	88 (1.9%)	
Source of Information: Friends/Co-workers				
Yes	1,106 (21.8%)	116 (22.1%)	990 (21.8%)	0.39
No	3,851 (75.9%)	370 (70.5%)	3,481 (76.5%)	
Missing	119 (2.3%)	39 (7.4%)	80 (1.8%)	
WHO scale: Lack of Confidence in Vaccines*				
Mean (SD)	1.5 (±0.7)	2.4 (±0.9)	1.4 (±0.6)	<0.0001
Missing	83 (1.6%)	9 (1.7%)	74 (1.6%)	
WHO scale: Vaccine Risks**				
Mean (SD)	2.6 (±0.9)	3.6 (±0.8)	2.5 (±0.8)	<0.0001
Missing	31 (0.6%)	5 (1.0%)	26 (0.6%)	
COVID-19 is a serious illness				
No	323 (6.4%)	168 (32.0%)	155 (3.4%)	<0.0001
Yes	4,742 (93.4%)	355 (67.6%)	4,387 (96.4%)	
Missing	11 (0.2%)	2 (0.4%)	9 (0.2%)	
Vaccine knowledge***				
Mean (SD)	4.6 (±0.8)	3.6 (±1.6)	4.8 (±0.5)	<0.0001
Missing	262 (5.2%)	6 (1.1%)	186 (4.1%)	

Notes: * Cronbach's α for VHS Lack of confidence in vaccines, $\alpha = 0.94$; ** Cronbach's α for VHS vaccine risk $\alpha = 0.67$; *** General vaccine knowledge 5-items Kuder - Richardson formula (KR20) = 0.63.

Table 2
Multivariable logistical regression of sociodemographic predictors for intention to accept a COVID-19 vaccine.

Predictors		Adjusted Odds Ratios	95 %CI	p
Age	20–30	Reference		
	30–40	0.77	0.51–1.12	0.184
	40–50	0.82	0.55–1.19	0.304
	50–60	0.99	0.66–1.49	0.98
	60+	1.39	0.77–2.61	0.289
Education	Other	Reference		
	Science/Engineering	1.36	1.04–1.79	0.03
Sex	Female	Reference		
	Male	1.41	1.07–1.88	0.02
Delayed or refused vaccination	No	Reference		
	Yes	0.19	0.15–0.24	<0.001
Reliable Information Source: Public Health	No	Reference		
	Yes	1.43	1.12–1.83	0.004
Reliable Information Source: School Boards or Teachers' Union	No	Reference		
	Yes	1.59	1.27–2.00	<0.001
Reliable Information Source: Health Care provider	No	Reference		
	Yes	1.51	1.22–1.87	<0.001
Observations		4635		
R2 Tjur		0.063		

Using reliable sources of information such as public health, health care providers, and school boards or teachers' union were found to be predictors of vaccine intent. Having a direct recommendation from a health care provider has been previously found to be a key mediator in vaccine acceptance [27,28], and may improve COVID-19 vaccine uptake [29]. Public health and health care providers should be key communicators about COVID-19 vac-

cines, and the risk of COVID-19. However, we also observed information from professional organizations, such as the school board or teachers' union, may be another communication avenue for targeting public health messaging for teachers.

Those who measured as more vaccine hesitant, regarding confidence in vaccines or perceived risks of vaccines, as well as reporting a previous delay or refusal of a vaccine, were less likely to

Table 3

Multivariable logistical regression of perceived vaccine and COVID-19 beliefs as predictors of intention to accept a future COVID-19 vaccine.

Predictors	Adjusted Odds Ratios	CI	p
Vaccine Lack of Confidence Scale	0.5	0.44–0.58	<0.001
Vaccine Risk Scale	0.36	0.31–0.42	<0.001
Vaccine knowledge	1.58	1.38–1.80	<0.001
COVID-19 is a serious illness	5.79	4.09–8.19	<0.001
Observations	4719		
R ² Tjur	0.319		

intend to accept a COVID-19 vaccine. Having an increased perceived risk of vaccines was strongly associated with not intending to receive a COVID-19 vaccine, indicating that communication about COVID-19 vaccines should focus on the safety profile and contextualize vaccine risk. Being transparent about the vaccine development, approval processes and safety monitoring may help address concerns for those individuals that are specifically hesitant towards new vaccines [30]. It is important to note that the VHS has a focus on known childhood vaccines, specifically the factor related to vaccine confidence. Given the COVID-19 vaccine at the time of the study was an unknown and a new vaccine, it is understandable that vaccine intention was more strongly associated with perceived risk of new vaccines.

4.1. Limitations

As with any survey, our findings may be impacted by non-response bias; however, we had over 5000 respondents from a population-wide survey, which exceeded our minimum sample size, and were representative of the BC teaching population based on sex [15], and population distribution between the five geographical health regions in BC [16]. Given the study was conducted by a research institute that promotes the benefits of vaccination, there is the potential that those who refused participation in the study were more vaccine hesitant, or were vaccine deniers. The potential for a selective sample of those who are more supportive of vaccination, may have led to an overestimation of vaccine intention amongst BC teachers, resulting in the predictors of vaccine intention being valid only for those who are more likely to support vaccination. However, ardent vaccine deniers are estimated to be a small minority of the population [31], it is doubtful that non-response from this small sub-population would greatly influence our findings.

Vaccine intention was measured at a single time point before the second wave and prior to vaccine approval or availability of vaccine product information. Intention to vaccinate may change in response to the dynamic nature of the pandemic, and so continued monitoring of vaccine acceptance will be important to ensure vaccination programs are responsive to any changes in vaccine intention [32].

5. Conclusions

This analysis contributes to our understanding of vaccination intention towards a COVID-19 vaccine in teachers, with over 85% of school teachers in BC intending to accept a COVID-19 vaccine. Continuing to communicate about vaccines, vaccine safety, transmission rates and severity of COVID-19, will be important in the planning and continued roll out of vaccine programs, and should include targeted communication through teachers' professional organizations and school districts. Understanding intentions and monitoring of vaccine uptake in the initial phases of vaccine roll-

out, will set the stage and tone for wide-scale vaccination role out as supply meets demand.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: MS is supported via salary awards from the BC Children's Hospital Foundation, the Canadian Child Health Clinician Scientist Program and the Michael Smith Foundation for Health Research. MS has been an investigator on projects funded by GlaxoSmithKline, Merck, Pfizer, Sanofi-Pasteur, Seqirus, Symvivo and VBI Vaccines. All funds have been paid to his institute, and he has not received any personal payments.

All other authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The study was supported by the BC Immunization Committee. We wish to thank Kim Marty and Caitlyn Southey for assistance with study and data management.

CSR is supported by a fellowship from the Michael Smith Foundation for Health Research.

Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jvaxc.2021.100106>.

References

- [1] Health Canada. Regulatory Decision Summary - Pfizer-BioNTech COVID-19 Vaccine - Health Canada. Health Canada; Published 2020. Accessed December 10, 2020. <https://covid-vaccine.canada.ca/info/regulatory-decision-summary-detailTwo.html?linkID=RDS00730>.
- [2] Organization WH. Draft Landscape of COVID-19 Candidate Vaccines; 2020. <https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines%0Ahttps://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines%0D>.
- [3] Polack FP, Thomas SJ, Kitchin N, et al. Safety and Efficacy of the BNT162b2 mRNA Covid-19 Vaccine. *N Engl J Med* 2020;383:2603–15. <https://doi.org/10.1056/NEJMoa2034577>.
- [4] National Advisory Committee on Immunization. Preliminary Guidance on Key Populations for Early COVID-19 Immunization; Published 2020. Accessed June 30, 2021. <https://www.canada.ca/en/public-health/services/immunization/national-advisory-committee-on-immunization-naci/guidance-key-populations-early-covid-19-immunization.html>.
- [5] BC Centre for Disease Control. BC's plan for vaccine distribution. BC's plan for vaccine distribution as of January 25, 2021; Published 2021. Accessed January 25, 2021. <http://www.bccdc.ca/health-info/diseases-conditions/covid-19/covid-19-vaccine/bcs-plan-for-vaccine-distribution>.
- [6] Lee J. Mental health effects of school closures during COVID-19. *Lancet Child Adolesc Heal* 2020;4(6):421. [https://doi.org/10.1016/S2352-4642\(20\)30109-7](https://doi.org/10.1016/S2352-4642(20)30109-7).
- [7] British Columbia Centre for Disease Control and BC Children's Hospital. Impact of School Closures on Learning, Child and Family Well-Being During the COVID-19 Pandemic; Published 2020. Accessed June 30, 2021. http://www.bccdc.ca/Health-Info-Site/Documents/Public_health_COVID-19_reports/Impact_School_Closures_COVID-19.pdf.
- [8] Wong CA, Ming D, Maslow G, Gifford EJ. Mitigating the impacts of the COVID-19 pandemic response on At-risk children. *Pediatrics* 2020;146(1). <https://doi.org/10.1542/peds.2020-0973>.
- [9] Van Lancker W, Parolin Z. COVID-19, school closures, and child poverty: a social crisis in the making. *Lancet Public Heal* 2020;5(5):e243–4. [https://doi.org/10.1016/S2468-2667\(20\)30084-0](https://doi.org/10.1016/S2468-2667(20)30084-0).
- [10] Shapiro GK, Tatar O, Dube E, et al. The vaccine hesitancy scale: Psychometric properties and validation. *Vaccine* 2018;36(5):660–7. <https://doi.org/10.1016/j.vaccine.2017.12.043>.
- [11] Larson HJ, Jarrett C, Schulz WS, et al. Measuring vaccine hesitancy: The development of a survey tool. *Vaccine* 2015;33(34):4165–75. <https://doi.org/10.1016/j.vaccine.2015.04.037>.
- [12] Zingg A, Siegrist M. Measuring people's knowledge about vaccination: Developing a one-dimensional scale. *Vaccine* 2012;30(25):3771–7. <https://doi.org/10.1016/j.vaccine.2012.03.014>.

- [13] Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)-A metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42(2):377–81. <https://doi.org/10.1016/j.jbi.2008.08.010>.
- [14] The American Association for Public Opinion Research. Standard Definitions Final Dispositions of Case Codes and Outcome Rates for Surveys. 9th ed.; 2016. http://dx.doi.10.1207/s15327906mbr2501_2.
- [15] British Columbia Teachers' Federation. BCTF Research Report. Teachers in British Columbia: A feminized workforce; Published 2018. Accessed June 30, 2021. <https://bctf.ca/publications/ResearchReports.aspx?id=52009>.
- [16] Government of British Columbia. British Columbia Population Estimates. BCStats; Published 2020. Accessed December 10, 2020. <https://www2.gov.bc.ca/gov/content/data/statistics/people-population-community/population/population-estimates>.
- [17] R Core Team. The R Project for Statistical Computing: v.4.0.2; Published online 2020. <https://www.r-project.org/>.
- [18] British Columbia Teachers' Federation (BCFT). British Columbia Teachers' Federation. 2021. Accessed June 30, 2021. <https://bctf.ca/AboutUs.aspx>.
- [19] DataBC. British Columbia Public School Teacher Statistics; Published 2018. <https://catalogue.data.gov.bc.ca/dataset/76a16627-90a2-4d94-a8d0-dfe2b7d0a87f>. Accessed April 20, 2021.
- [20] Frank, Kristyn; Arim R. Canadians' willingness to get a COVID-19 vaccine: Group differences and reasons for vaccine hesitancy. *Stat Canada* 2020; (45280001):1-9.
- [21] Dror AA, Eisenbach N, Taiber S, et al. Vaccine hesitancy: the next challenge in the fight against COVID-19. *Eur J Epidemiol* 2020;35(8):775–9. <https://doi.org/10.1007/s10654-020-00671-y>.
- [22] Wang J, Jing R, Lai X, et al. Acceptance of covid-19 vaccination during the covid-19 pandemic in china. *Vaccines* 2020;8(3):1–14. <https://doi.org/10.3390/vaccines8030482>.
- [23] Murphy J, Vallières F, Bentall RP, et al. Psychological characteristics associated with COVID-19 vaccine hesitancy and resistance in Ireland and the United Kingdom. *Nat Commun* 2021;12(1):1–15. <https://doi.org/10.1038/s41467-020-20226-9>.
- [24] Huang C, Wang Y, Li X, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020;395(10223):497–506. [https://doi.org/10.1016/S0140-6736\(20\)30183-5](https://doi.org/10.1016/S0140-6736(20)30183-5).
- [25] Onder G, Rezza G, Brusaferro S. Case-Fatality Rate and Characteristics of Patients Dying in Relation to COVID-19 in Italy. *JAMA - J Am Med Assoc* 2020;323(18):1775–6. <https://doi.org/10.1001/jama.2020.4683>.
- [26] de Figueiredo A, Simas C, Karafillakis E, Paterson P, Larson HJ. Mapping global trends in vaccine confidence and investigating barriers to vaccine uptake: a large-scale retrospective temporal modelling study. *Lancet* 2020;396(10255):898–908. [https://doi.org/10.1016/S0140-6736\(20\)31558-0](https://doi.org/10.1016/S0140-6736(20)31558-0).
- [27] Rahman M, Laz TH, McGrath CJ, Berenson AB. Provider recommendation mediates the relationship between parental human papillomavirus (HPV) vaccine awareness and HPV vaccine initiation and completion among 13- to 17-year-old US adolescent children. *Clin Pediatr (Phila)* 2015;54(4):371–5. <https://doi.org/10.1177/0009922814551135>.
- [28] Ogilvie G, Anderson M, Marra F, et al. A population-based evaluation of a publicly funded, school-based HPV vaccine program in British Columbia, Canada: Parental factors associated with HPV vaccine receipt. *PLoS Med* 2010;7(5). <https://doi.org/10.1371/journal.pmed.1000270>.
- [29] Head KJ, Kasting ML, Sturm LA, Hartsock JA, Zimet GD. A National Survey Assessing SARS-CoV-2 Vaccination Intentions: Implications for Future Public Health Communication Efforts. *Sci Commun* 2020;42(5):698–723. <https://doi.org/10.1177/1075547020960463>.
- [30] Schaffer Deroo S, Pudalov NJ, Fu LY. Planning for a COVID-19 Vaccination Program. *JAMA - J Am Med Assoc* 2020;323(24):2458–9. <https://doi.org/10.1001/jama.2020.8711>.
- [31] Public Health Agency of Canada. Vaccine Coverage in Canadian Children: Results from the 2017 Childhood National Immunization Coverage Survey; Published 2020. Accessed June 30, 2021. <https://www.canada.ca/en/public-health/services/publications/healthy-living/2017-vaccine-uptake-canadian-children-survey.html>.
- [32] Rhodes A, Hoq M, Measey MA, Danchin M. Intention to vaccinate against COVID-19 in Australia. *Lancet Infect Dis* 2020;3099(20):30724. [https://doi.org/10.1016/S1473-3099\(20\)30724-6](https://doi.org/10.1016/S1473-3099(20)30724-6).