COVID-19 Vaccine Hesitancy Among Young Adults in Canada

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Abstract

Objectives: Vaccine hesitancy is a multifaceted decision process that encompasses various factors for which an individual may choose to get vaccinated or not. We aimed to identify the relationship between COVID-19 conspiracy theories, general attitudes towards vaccines, current COVID-19 vaccine factors and COVID-19 vaccine hesitancy.

Methods: The present research is a multi-province cross-sectional study design. Survey data was collected in May and June 2021 (n=4905) in the Canadian provinces of Alberta, Ontario, and Quebec. Multivariate ordinal regression models were used to assess the association between vaccine hesitant profiles and COVID-19 conspiracy theories, general attitudes towards vaccines, and specific factors pertaining to COVID-19 vaccines.

Results: Participants were aged 18 to 40 years and 59% were women. Individuals with low income, low educational attainment, and/or who are unemployed were more likely to be vaccine hesitant. COVID-19 conspiracy theory beliefs and general attitudes towards vaccines are significantly associated with greater hesitancy for the COVID-19 vaccine. Vaccine factors including pro-vaccine actions and opinions of friends and family and trust in scientists and government are associated with less vaccine hesitancy.

Conclusion: Conspiracy theories are distinct from criticism and concerns regarding the vaccine. Nevertheless, poverty, low level of education and distrust are associated with higher odds of being vaccine hesitant. Results suggest it is imperative to deliver transparent and nuanced health communications to address legitimate distrust towards political and scientific actors and address the societal gap regarding general attitudes towards vaccines as opposed to focusing solely on COVID-19.

Introduction

Vaccine hesitancy is part of the complex decision-making process underlying an individual's decision for vaccination. It includes a continuum of attitudes ranging from total acceptance of all vaccines, acceptance of some vaccines, to complete refusal of all vaccines (Dubé et al. 2013). It may apply to vaccines in general or to specific vaccines and may be a “default” position or a “reactive” one, i.e., related to localised, one-time events such as the introduction of new vaccines (Dubé et al. 2013). Frameworks such as the WHO SAGE working group's 3Cs model of vaccine hesitancy as well as the 5C psychological antecedents of vaccination models offer sound measures for many factors of vaccine hesitancy, such as Confidence, Complacency, Constraints, Calculation, and Collective response (Betsch et al. 2018), but do not fully capture the complexity and interaction of factors, particularly in urgent contexts such as COVID-19 pandemic, during which new knowledge has emerged at an unprecedented pace (Silva et al., 2020) and during which social and political tensions are exacerbated. Vaccine hesitancy is often discussed as a barrier to achieving optimal vaccination rates; the conversation has been refuelled as widespread acceptance of COVID-19 vaccines is anticipated to reduce COVID-19 morbidity as well as the need for further restrictive measures.

Research on vaccine hesitancy in Canada is limited but data on COVID-19 vaccine hesitancy among Canadians is emerging, the first studies having been conducted before COVID-19 vaccines were made available to the general public. A study analysing Canadian tweets about COVID-19 vaccine hesitancy from December 2020, around the time where the first vaccines were administered in Canada, identified the following contributing themes: concerns over safety, suspicion about political or economic forces driving the COVID-19 pandemic or vaccine development, a lack of knowledge about the vaccine, anti-vaccine or confusing messages from authority figures, and lack of legal liability from vaccine companies (Griffith et al. 2021). A survey given to a sample of Saskatchewan adults between May 2020 and April 2021 associated vaccine hesitancy with lower education level, financial instability, identifying as Indigenous, not being concerned about spreading the coronavirus, and low threat perception (Muhajarine et al. 2021). These results are consistent with the literature on demographic determinants of general vaccine hesitancy, which points toward lower income and educational attainment, risk aversion, lower health literacy, rurality, parental status, mistrust in authority, and younger age (Hudson & Montelpare 2021).

Conspiracy beliefs surrounding COVID-19, its origin, and the intentions of entities at different levels of power, have also emerged and taken up space in the public discourse. Conspiracy beliefs have in the past been associated with reluctance to engage in health-protective behaviours (Dunn et al. 2017). Amidst the COVID-19 pandemic, a parallel infodemic has unravelled with massive exchange of information on social media platforms, facilitating and accelerating the spread of false information. Trust in different platforms such as TV, WHO, and other credible sources were associated with higher intentions to get the COVID-19 vaccine as opposed to sources including Facebook and WhatsApp where individuals were exposed to more fake news were associated with lower intentions for the COVID-19 vaccine (Ghaddar et al. 2022). Similar associations have been found with COVID-19 vaccination, such that individuals who adhere to one or more conspiracy theories have lower vaccine intent (Earnshaw et al. 2020).

General attitudes towards vaccines such as trust in pharmaceutical companies and fear of side effects also mediate the relationship individuals have with all vaccines, including COVID-19 (Paul et al. 2021). Exploring general attitudes towards vaccines may help understand the underlying factors of COVID-19 vaccine hesitancy among individuals, and can potentially inform public health communications for the current pandemic, as well as in efforts to strengthen immunisation program outcomes in society.

Other factors have contributed to the decision-making process, such as political climate, public health measures, and lived experiences. These COVID-19-specific vaccine factors, measured in this study, include topics related to current politics, trust in the government and in scientists, opinions of loved ones, and the research, development, and manufacturing of COVID-19 vaccines. Little is known about COVID-19 vaccine hesitancy after vaccines were made widely available and limited research has been done to understand vaccine hesitancy in younger adults, where despite the vaccines being available to the general public, those aged 18 to 40 had consistently lower COVID-19 vaccination rates in Canada (PHAC 2021).

At the time of the present study, regulatory approvals regarding COVID-19 vaccines at the provincial and federal levels were rapidly changing and concerns surrounding certain vaccines were growing. Across the three provinces, the number of COVID-19 cases plummeted over the duration of data collection as vaccine intake rapidly increased (CIHI 2021). In Quebec, vaccines were made available to those over the age of 12 by May 25, leading to the province approaching a 70% one-dose vaccine coverage milestone by mid-June (CIHI 2021; PHAC 2021). In May, both the Quebec government and the Alberta government launched large ad campaigns pushing for mass vaccination against COVID-19 so the population can return to normal life (The Canadian Press 2021; Franklin 2021). By June, Alberta had announced its Open for Summer Plan to ease restrictions and two weeks later had entered two of the three stages put forth by the plan as the one-dose vaccine coverage for the general population (all ages) approached 60% (CIHI 2021; PHAC 2021). Ontario started administering COVID-19 vaccines to the general adult population on May 18 and to youth aged 12 and over on May 23, enabling it to reach a vaccine coverage of almost 65% among adults by the end of the data collection period, when the province entered stage 1 of its reopening plan (CIHI 2021; PHAC 2021).

This study aimed to answer the research question: are conspiracy theory beliefs, general attitudes towards vaccines, and other vaccine factors associated with COVID-19 vaccine hesitancy in the Canadian context? We hypothesised that endorsing conspiracy theories, and negative attitudes towards vaccines in general, would be associated with greater COVID-19 vaccine hesitancy, and ultimately a decrease in vaccine intent. We also hypothesised that COVID-19 vaccine factors would be associated with less vaccine hesitancy, encouraging vaccine intent.

Methods

Data and Sample

This is a multi-provincial cross-sectional study design. An online survey was conducted among Canadians 18 to 40 years old in the context of the early stages of the vaccination campaign during the COVID-19 pandemic. Data was collected between May 21st and June 14th, 2021 (n=5,007) in the province of Alberta, Ontario, and Quebec using the Leger360 pool of registered members, accessing 500,000 Canadian professionals and consumers. Participants were randomly selected by the Leger panel and could respond in English or French and took approximately 12 minutes to complete the survey. Exclusion criteria were individuals aged under 18 or above 40, with cognitive deficits or other disabilities rendering informed consent not possible, and not speaking the language in which the survey was translated to.

Measures

Vaccine Hesitancy

The primary outcome, vaccine hesitancy, was measured by responses to two questions focused on current vaccination status and COVID-19 vaccine intent (C4R Investigators 2020). Participants were

grouped into three outcome categories inspired by the vaccine hesitancy spectrum (Dubé 2013): 1. “non-hesitant” if they had already been vaccinated against COVID-19 or if they intended on getting the vaccine as soon as possible; 2. “hesitant” if they intended to wait to see how it affects others in the community before getting it or not intending to get it soon, but might sometime in the future; and 3. “does not intend on getting vaccinated” if they did not intend on ever getting the vaccine.

General attitudes towards vaccines

The Vaccination Attitudes Examination (VAX) Scale was used to assess general attitudes towards vaccines (Martin & Petrie 2017). The scale constitutes 12 items on a 7-point Likert scale grouped into four subscales, including *trust/mistrust of vaccine benefit* (reverse coded) ($\alpha = .877$), *worries over unforeseen future effects* ($\alpha = .819$), *Concerns about commercial profiteering* ($\alpha = .847$), and *Preference for natural immunity* ($\alpha = .868$).

COVID-19 Conspiracy Theory Beliefs

Participants were asked to respond to which extent they agreed with four statements around COVID-19 conspiracy theory beliefs on a Likert scale ranging from 1 = do not agree to 5 = agree completely. The statements were adapted from Freeman et al., to the following: “*The government is misleading the public about the cause of the Coronavirus*”, “*The spread of the Coronavirus is a deliberate attempt by a group of powerful people to gain control*”, “*Coronavirus is a bioweapon developed by China to destroy the West*”, and “*The mainstream media is deliberately feeding us misinformation about the Coronavirus and lockdown*” (Freeman et al. 2020).

Vaccine Factors

Participants were asked what factors contribute to their attitudes about a COVID-19 vaccine. They were asked to rate their opinion on a Likert scale from 1 = strongly disagree to 7 = strongly agree. Factors included the eight following statements from the C4R Investigators (2020) C4R Questionnaire: the current politics, the rushed/fast-tracked research and development timeline, the frequently changing science of COVID-19, actions and opinions of my friends and family regarding the vaccine, my trust in scientists, my own reading and research on COVID-19 vaccines, the country in which a vaccine is manufactured, and the potential cost of a coronavirus (COVID-19) vaccine. Additional to the factors stated, participants were asked to respond to which extent they agreed with the following statement, “*Most of the time, we can trust people in the provincial government to do the right thing*” on a Likert scale ranging from 1 = do not agree to 5 = agree completely (adapted from Franzen & Vogl 2013).

Sociodemographic characteristics

Sociodemographic variables collected included age, gender (man, woman, other), province (Alberta, Ontario, and Quebec), marital status (never married, divorced/separated/widowed, or married/living together as a couple), household income ($\leq \$19,999$, \$20,000-\$39,999, \$40,000-\$59,999, \$60,000-\$79,999, \$80,000-\$99,999, and $\geq \$100,000$) education (None/Less than high school, High

school graduate, any year of apprenticeship or technical institute or trade or vocational school, any year of College or CEGEP or other non-university certificate or diploma, any year of University certificate or diploma or degree), employment (not employed, employed - essential, employed non-essential), generation (first, second, third or more). Age, gender, marital status, and variables pertaining to socioeconomic status (i.e., household income, education, and employment) were chosen for their frequent association to vaccine hesitancy in the literature (Hudson & Montelpare 2021; McFadden et al. 2021). Inclusion of immigration generation stems from emerging reports of access and vaccine hesitancy consideration among refugees, immigrants, and people without status in the United States (Thomas et al 2021).

Data Analysis

Cases with missing outcome variables were omitted from further analyses (n=102), leaving 4,905 participants. Missing values were imputed with multiple imputations by chained equations (*MICE*) package (n=20) for continuous and categorical data (Burren 2019). A sensitivity analysis was conducted, and imputed variables maintained integrity of results. Variables were assessed for collinearity using *lsr* package, variables returned low correlations (refer to Online Resource 1; Navarro 2015).

We used bivariate ordinal regression analyses to assess the association between sociodemographic characteristics and vaccine hesitancy profiles (Not hesitant, Hesitant, and Does not intend on getting vaccinated). Ordinal regression analyses used R-package *MASS* (Venables & Ripley 2002). Next, we built multivariate ordinal regression models to assess the association between vaccine attitudes, COVID-19 conspiracy theories, COVID vaccine factors and COVID vaccine hesitancy, controlling for sociodemographic characteristics using the following approach. First, we built separate multivariate ordinal regression models to assess the association between COVID-19 conspiracy theories and vaccine hesitancy. Second, analogous analyses were run to identify the relationship between the four subscales for general attitudes towards vaccines and vaccine hesitant profiles. Third, we conducted analogous analyses to identify the relationship between COVID-19 vaccine factors and vaccine hesitant profiles. Finally, we ran a model combining significant variables (at $p = 0.05$) including conspiracy theory statements, general attitudes towards vaccines, and societal dynamic factors to analyse their independent association with the outcome. (Table 3). All statistical analyses were conducted using RStudio Version 1.4.1717 (R Foundation for Statistical Computing, Vienna, Austria; see <https://www.R-project.org/>).

Table 3

Results from ordinal regression final model with COVID-19 vaccine hesitancy as dependent variable

Model 4	
Variable	Proportional OR (95% CI)
Gender	
<i>Woman</i>	1
<i>Man</i>	0.929(0.756,1.142)
<i>Other</i>	2.119(0.559,8.037)
Age, years	
<i>36-40(ref)</i>	1
<i>18-25</i>	0.94(0.665,1.328)
<i>26-30</i>	1.049(0.76,1.447)
<i>31-35</i>	1.242(0.903,1.709)
Province	
<i>Alberta(ref)</i>	1
<i>Ontario</i>	0.912(0.711,1.168)
<i>Quebec</i>	0.797(0.602,1.055)
Marital Status	
<i>Never Married(ref)</i>	1
<i>Divorced/separated/widowed</i>	1.109(0.639,1.924)
<i>Married/living together as a couple</i>	1.357***(1.091,1.688)
Immigrant Generation	
<i>First generation(ref)</i>	1
<i>Second generation</i>	1.283(0.952,1.728)
<i>Third generation or more</i>	1.128(0.868,1.465)
Household income	
<i>\$19,999 or less(ref)</i>	1
<i>\$20,000-\$39,999</i>	0.692*(0.475,1.009)

	Model 4
<i>\$40,000-\$59,999</i>	0.633**(0.43,0.932)
<i>\$60,000-\$79,999</i>	0.591**(0.395,0.885)
<i>\$80,000-\$99,999</i>	0.575*** (0.381,0.867)
<i>\$100,000 or more</i>	0.579*** (0.388,0.865)
Education	
<i>None/Less than high school(ref)</i>	1
<i>High school graduate</i>	0.696(0.402,1.203)
<i>Apprenticeship, technical institute, trade or vocational school (any year)</i>	0.883(0.484,1.608)
<i>College, CEGEP or other non-university certificate or diploma (any year)</i>	0.575*(0.33,1.002)
<i>University certificate, diploma or degree (any year)</i>	0.405*** (0.233,0.706)
Employment	
<i>Not employed(ref)</i>	1
<i>Employed – essential</i>	0.517*** (0.401,0.666)
<i>Employed - nonessential</i>	0.629*** (0.484,0.815)
Conspiracy Theory Q1	1.094 (0.98,1.221)
Conspiracy Theory Q2	1.184*** (1.05,1.336)
Conspiracy Theory Q3	0.891** (0.796,0.998)
Conspiracy Theory Q4	1.093*(0.985,1.214)
Trust/mistrust of vaccine benefit	1.225*** (1.192,1.259)
Worries over unforeseen future effects	1.109*** (1.074,1.145)
Concerns about commercial profiteering	1.064*** (1.029,1.1)
Preference for natural immunity	1.078*** (1.045,1.113)
Vaccine Factor 1	1.079** (1.01,1.154)
Vaccine Factor 2	1.242*** (1.15,1.341)
Vaccine Factor 3	1.142*** (1.051,1.242)
Vaccine Factor 4	0.862*** (0.807,0.921)
Vaccine Factor 5	0.803*** (0.748,0.861)
Vaccine Factor 6	0.85*** (0.793,0.91)

	Model 4
Vaccine Factor 7	0.857*** (0.776, 0.946)
<i>Note. Conspiracy theory (CT) Q1 - The government is misleading the public about the cause of the Coronavirus; CT Q2 - The spread of the Coronavirus is a deliberate attempt by a group of powerful people to gain control; CTQ3 - Coronavirus is a bioweapon developed by China to destroy the West; CTQ4- The mainstream media is deliberately feeding us misinformation about the Coronavirus and lockdown. Vaccine Factor (VF1) - The current politics; VF2 - The rushed/fast-tracked research and development timeline; VF3 - The frequently changing science of COVID-19; VF4 - Actions and opinions of my friends and family regarding the vaccine; VF5 - My trust in scientists; VF6 - The country in which a vaccine is manufactured; VF7 - Trust in the Government - Most of the time, we can trust people in the provincial government to do the right thing.</i>	
<i>Model 4 looks at the relationship between vaccine hesitancy, conspiracy theory beliefs; general attitudes towards vaccines and different societal dynamics. Sociodemographic variables are controlled for. OR : *p<0.05; **p<0.01; ***p<0.001.</i>	

Ethics

Institutional ethics approval was obtained by X (blinded for review).

Results

A total of 5,007 participants responded to the online questionnaire, of which 59% identified as women. Participants were aged 18 to 40 years old and residing in Alberta (23%), Ontario (41%), and Québec (36%). This sample was highly educated and reported higher household income, with 74% holding a post-secondary degree or currently engaged in higher education, and 7% with a household income of $\leq \$19,999$ and 26% $\geq \$100,000$. See Table 1 for sociodemographic characteristics of each vaccine hesitancy group; the majority of study participants ($n=4,030$) were not hesitant regarding the COVID-19 vaccine, having been vaccinated or going to be vaccinated as soon as they were eligible. A total of 609 were hesitant and 266 participants did not intend on getting vaccinated. Lower household income, lower level of education, and unemployment were significantly associated with more vaccine hesitancy, as did being married or living together as a couple.

Table 1
Characteristics of the study participants

		Total Sample (n=4,905) n (%)	Not hesitant (n=4,030) n (%)	Hesitant (n=609) n (%)
Gender				
<i>Woman</i>	2,898 (59%)	2,333 (58%)	403 (66%)	162 (61%)
<i>Man</i>	1,972 (40%)	1,671 (41%)	202 (33%)	99 (37%)
<i>Other</i>	22 (0%)	18 (0%)	3 (0%)	1 (0%)
<i>Missing</i>	13 (0%)	8 (0%)	1 (0%)	4 (2%)
Age, years				
<i>18-25</i>	1,394 (28%)	1,158 (29%)	164 (27%)	72 (27%)
<i>26-30</i>	1,565 (32%)	1,289 (32%)	195 (32%)	81 (30%)
<i>31-35</i>	1,373 (28%)	1,119 (28%)	179 (29%)	75 (28%)
<i>36-40</i>	573 (12%)	464 (12%)	71 (12%)	38 (14%)
Province				
<i>Alberta</i>	1,104 (23%)	865 (21%)	164 (27%)	75 (28%)
<i>Ontario</i>	2,021 (41%)	1,658 (41%)	275 (45%)	88 (33%)
<i>Quebec</i>	1,780 (36%)	1,507 (37%)	170 (28%)	103 (39%)
Marital Status				
<i>Never Married</i>	2,548 (52%)	2,127 (53%)	285 (47%)	136 (51%)
<i>Divorced/separated/widowed</i>	123 (3%)	97 (2%)	20 (3%)	6 (2%)

Note: Nature of employment (essential or non-essential) was self-reported by study participants

		Total Sample (n=4,905) n (%)	Not hesitant (n=4,030) n (%)	Hesitant (n=609) n (%)
<i>Married/living together as a couple</i>	2,186 (45%)	1,767 (44%)	300 (49%)	119 (45%)
<i>Missing</i>	48 (1%)	39 (1%)	4 (1%)	5 (2%)
Immigrant Generation				
<i>First</i>	897 (18%)	741 (18%)	125 (21%)	31 (12%)
<i>Second</i>	1,059 (22%)	864 (21%)	144 (24%)	51 (19%)
<i>Third or more</i>	2,922 (60%)	2,401 (60%)	339 (56%)	182 (68%)
<i>Missing</i>	27 (1%)	24 (1%)	1 (0%)	2 (1%)
Household Income				
<i>\$19,999 or less</i>	357 (7%)	244 (6%)	74 (12%)	39 (15%)
<i>\$20,000-\$39,999</i>	629 (13%)	479 (12%)	107 (18%)	43 (16%)
<i>\$40,000-\$59,999</i>	728 (15%)	588 (15%)	105 (17%)	35 (13%)
<i>\$60,000-\$79,999</i>	755 (15%)	618 (15%)	95 (16%)	42 (16%)
<i>\$80,000-\$99,999</i>	689 (14%)	589 (15%)	66 (11%)	34 (13%)
<i>\$100,000 or more</i>	1,269 (26%)	1,120 (28%)	105 (17%)	44 (17%)
<i>Missing</i>	478 (10%)	392 (10%)	57 (9%)	29 (11%)
Education Level				
<i>None/Less than high school</i>	98 (2%)	54 (1%)	29 (5%)	15 (6%)
<i>High school graduate</i>	858 (17%)	614 (15%)	162 (27%)	82 (31%)

Note: Nature of employment (essential or non-essential) was self-reported by study participants

		Total Sample (n=4,905) n (%)	Not hesitant (n=4,030) n (%)	Hesitant (n=609) n (%)
<i>Apprenticeship, technical institute, trade or vocational school (any year)</i>	298 (6%)	208 (5%)	57 (9%)	33 (12%)
<i>College, CEGEP or other non-university certificate or diploma (any year)</i>	1,083 (22%)	865 (21%)	140 (23%)	78 (29%)
<i>University certificate, diploma or degree (any year)</i>	2,530 (52%)	2,255 (56%)	218 (36%)	57 (21%)
<i>Missing</i>	38 (1%)	34 (1%)	3 (0%)	1 (0%)
Employment				
<i>Not employed</i>	991 (20%)	709 (18%)	185 (30%)	97 (36%)
<i>Employed - essential</i>	2,032 (41%)	1,707 (42%)	221 (36%)	104 (39%)
<i>Employed - non essential</i>	1,771 (36%)	1,529 (38%)	185 (30%)	57 (21%)
<i>Missing</i>	111 (2%)	85 (2%)	18 (3%)	8 (3%)
Trust/mistrust of vaccine benefit (range 3 – 21)				
Mean (SD)	22 (8%)	7 ($\pm$ 3)	11 ($\pm$ 4)	16 ($\pm$ 4)
Missing	151 (3%)	71 (2%)	58 (10%)	43 (16%)
Worries over unforeseen future effects (range 3 – 21)				
Mean (SD)	13 ($\pm$ 5)	12 ($\pm$ 4)	16 ($\pm$ 3)	18 ($\pm$ 4)
Missing	227 (5%)	182 (5%)	28 (5%)	17 (6%)
Concerns about commercial profiteering (range 3 – 21)				
Mean (SD)	9 ($\pm$ 5)	8 ($\pm$ 4)	12 ($\pm$ 4)	17 ($\pm$ 4)
Missing	228 (5%)	161 (4%)	45 (7%)	22 (8%)
Preference for natural immunity (range 3 – 21)				

Note: Nature of employment (essential or non-essential) was self-reported by study participants

		Total Sample (n=4,905) n (%)	Not hesitant (n=4,030) n (%)	Hesitant (n=609) n (%)
Mean (SD)	10 (± 5)	9 (± 4)	13 (± 4)	17 (± 4)
Missing	343 (7%)	266 (7%)	55 (9%)	22 (8%)
Conspiracy Theory 1: The government is misleading the public about the cause of the Coronavirus (range 1 – 5)				
Mean (SD)	2 (± 1)	2 (± 1)	3 (± 1)	4 (± 1)
Missing	218 (4%)	161 (4%)	39 (6%)	18 (7%)
Mean (SD)	2 (± 1)	1 (± 1)	2 (± 1)	3 (± 1)
Missing	222 (5%)	156 (4%)	46 (8%)	20 (8%)
Conspiracy Theory 2: The spread of the Coronavirus is a deliberate attempt by a group of powerful people to gain control (range 1 – 5)				
Mean (SD)	2 (± 1)	1 (± 1)	2 (± 1)	3 (± 1)
Missing	222 (5%)	156 (4%)	46 (8%)	20 (8%)
Conspiracy Theory 3: Coronavirus is a bioweapon developed by China to destroy the West (range 1 – 5)				
Mean (SD)	2 (± 1)	2 (± 1)	2 (± 1)	3 (± 2)
Missing	325 (7%)	224 (6%)	67 (11%)	34 (13%)
Conspiracy Theory 4: The mainstream media is deliberately feeding us misinformation about the Coronavirus and lockdown (range 1 – 5)				
Mean (SD)	2 (± 1)	2 (± 1)	3 (± 1)	4 (± 1)
Missing	172 (4%)	122 (3%)	35 (6%)	15 (6%)
Vaccine Factor 1: The current politics (range 1-7)				
Mean (SD)	4 (± 2)	4 (± 2)	4 (± 2)	5 (± 2)
Missing	127 (3%)	93 (2%)	18 (3%)	16 (6%)
<i>Note: Nature of employment (essential or non-essential) was self-reported by study participants</i>				

		Total Sample (n=4,905) n (%)	Not hesitant (n=4,030) n (%)	Hesitant (n=609) n (%)
Vaccine Factor 2: The rushed/fast-tracked research and development timeline (range 1 – 7)				
Mean (SD)	4 (±2)	4 (±2)	5 (±2)	5 (±2)
Missing	111 (2%)	89 (2%)	11 (2%)	11 (4%)
Vaccine Factor 3: The frequently changing science of COVID-19 (range 1 – 7)				
Mean (SD)	5 (±2)	5 (±2)	5 (±2)	5 (±2)
Missing	110 (2%)	86 (2%)	12 (2%)	12 (5%)
Vaccine Factor 4: My trust in scientists (range 1 – 7)				
Mean (SD)	5 (±2)	6 (±1)	5 (±1)	4 (±2)
Missing	78 (2%)	57 (1%)	11 (2%)	10 (4%)
Vaccine Factor 5: My own reading and research on COVID-19 vaccines				
Mean (SD)	5 (±2)	5 (±2)	5 (±1)	5 (±2)
Missing	119 (2%)	88 (2%)	16 (3%)	15 (6%)
Vaccine Factor 6: The country in which a vaccine is manufactured (range 1 – 7)				
Mean (SD)	4 (±2)	4 (±2)	4 (±2)	4 (±2)
Missing	97 (2%)	69 (2%)	14 (2%)	14 (5%)
Vaccine Factor 7: Trust in the Government - Most of the time, we can trust people in the provincial government to do the right thing (range 1 – 5)				
Mean (SD)	3 (±1)	3 (±1)	2 (±1)	2 (±1)
Missing	93 (2%)	70 (2%)	17 (3%)	6 (2%)
<i>Note: Nature of employment (essential or non-essential) was self-reported by study participants</i>				

In multivariate analyses adjusted for sociodemographic characteristics, all VAX subscales, COVID-19 conspiracy beliefs, and COVID-19 vaccine factors were associated with vaccine hesitancy at the $p < 0.001$ level (see Table 2). The VAX subscale for which the association with the outcome had the largest magnitude was the subscale focused on overall trust/mistrust of the benefit of vaccines (odds ratio (OR)= 1.325, 95% CI = [1.288,1.362], p -value<0.01). For the COVID-19 conspiracy theory beliefs, the

magnitude of the relationship with the outcome was greatest for endorsement of the conspiracy theory “The government is misleading the public about the cause of the Coronavirus” (OR=1.492, 95% CI= [1.357,1.641], p-value <0.01)). Finally, for COVID-19 vaccine factors, the statements regarding current politics, the research and development timeline, and the frequently changing science of COVID-19 were associated with greater hesitancy, with ORs ranging from 1.175 to 1.474, all statistically significant at the $p<.001$ level. In contrast, statements related to actions and opinions of friends and family regarding the vaccine, trust in scientists and government, as well as the vaccine manufacturing country are associated with less hesitancy and higher levels of vaccine intent (ORs ranging from 0.596 to 0.919, please refer to Table 2 for specifics).

Table 2

Results from ordinal regression model building with COVID-19 vaccine hesitancy as dependent variable

	Model 1	Model 2	Model 3
Variable	Proportional OR(95% CI)	Proportional OR(95% CI)	Proportional OR(95% CI)
Gender			
<i>Woman</i>	1	1	1
<i>Man</i>	0.743** (0.619,0.892)	0.933(0.763,1.14)	0.826** (0.688,0.992)
<i>Other</i>	1.221(0.373,3.994)	4.366** (1.126,16.931)	0.703(0.218,2.268)
Age, years			
<i>36-40(ref)</i>	1	1	1
<i>18-25</i>	0.892(0.657,1.213)	0.945(0.672,1.329)	0.756* (0.555,1.028)
<i>26-30</i>	1.097(0.822,1.464)	0.992(0.722,1.364)	0.961(0.721,1.282)
<i>31-35</i>	1.196(0.898,1.593)	1.117(0.813,1.534)	1.105(0.831,1.469)
Province			
<i>Alberta(ref)</i>	1	1	1
<i>Ontario</i>	0.85(0.686,1.053)	0.838(0.658,1.069)	0.987(0.793,1.228)
<i>Quebec</i>	0.7*** (0.553,0.887)	0.665*** (0.511,0.867)	1.225(0.954,1.573)
Marital Status			
<i>Never Married(ref)</i>	1	1	1
<i>Divorced/separated/widowed</i>	1.009(0.601,1.693)	1.274(0.73,2.223)	1.102(0.665,1.826)
<i>Married/living together as a couple</i>	1.422*** (1.167,1.732)	1.409*** (1.13,1.758)	1.388*** (1.136,1.697)
Immigrant Generation			
<i>First generation</i>	1	1	1
<i>Second generation</i>	1.308* (0.999,1.711)	1.459** (1.087,1.958)	1.01(0.773,1.321)
<i>Third generation or more</i>	1.074(0.848,1.359)	1.319** (1.02,1.706)	0.943(0.746,1.192)

	Model 1	Model 2	Model 3
Household income			
<i>\$19,999 or less(ref)</i>	1	1	1
<i>\$20,000-\$39,999</i>	0.77(0.55,1.078)	0.735(0.498,1.086)	0.734* (0.522,1.032)
<i>\$40,000-\$59,999</i>	0.634*** (0.453,0.887)	0.61** (0.417,0.904)	0.555*** (0.391,0.788)
<i>\$60,000-\$79,999</i>	0.614*** (0.436,0.867)	0.632** (0.423,0.943)	0.58*** (0.409,0.823)
<i>\$80,000-\$99,999</i>	0.549*** (0.382,0.789)	0.566** (0.374,0.856)	0.505*** (0.349,0.732)
<i>\$100,000 or more</i>	0.509*** (0.36,0.719)	0.608** (0.406,0.909)	0.439*** (0.306,0.629)
Education			
<i>None/Less than high school(ref)</i>	1	1	1
<i>High school graduate</i>	0.627* (0.388,1.014)	1.088(0.63,1.878)	0.533**(0.33,0.86)
<i>Apprenticeship, technical institute, trade or vocational school (any year)</i>	0.722(0.423,1.232)	1.281(0.701,2.34)	0.698(0.411,1.188)
<i>College, CEGEP or other non-university certificate or diploma (any year)</i>	0.455*** (0.28,0.739)	0.906(0.52,1.58)	0.397*** (0.245,0.642)
<i>University certificate, diploma or degree (any year)</i>	0.273*** (0.168,0.443)	0.627* (0.359,1.093)	0.219*** (0.136,0.354)
Employment			
<i>Not employed(ref)</i>	1	1	1
<i>Employed – essential</i>	0.577*** (0.462,0.72)	0.53*** (0.41,0.684)	0.634*** (0.506,0.796)
<i>Employed - non essential</i>	0.626*** (0.497,0.788)	0.64*** (0.494,0.83)	0.659*** (0.522,0.833)
Conspiracy Theory Q1	1.492*** (1.357,1.641)		
Conspiracy Theory Q2	1.483*** (1.344,1.637)		
Conspiracy Theory Q3	0.844*** (0.767,0.928)		

	Model 1	Model 2	Model 3
Conspiracy Theory Q4	1.386*** (1.271,1.511)		
Trust/mistrust of vaccine benefit		1.325*** (1.288,1.362)	
Worries over unforeseen future effects		1.167*** (1.129,1.206)	
Concerns about commercial profiteering		1.066*** (1.03,1.104)	
Preference for natural immunity		1.095*** (1.06,1.131)	
Vaccine Factor 1			1.175*** (1.1,1.246)
Vaccine Factor 2			1.474*** (1.378,1.578)
Vaccine Factor 3			1.246*** (1.158,1.338)
Vaccine Factor 4			0.912*** (0.862,0.965)
Vaccine Factor 5			0.632*** (0.594,0.669)
Vaccine Factor 6			0.919*** (0.868,0.974)
Vaccine Factor 7			0.596*** (0.545,0.649)
<i>Note. Conspiracy theory (CT) Q1 - The government is misleading the public about the cause of the Coronavirus; CT Q2 - The spread of the Coronavirus is a deliberate attempt by a group of powerful people to gain control; CTQ3 - Coronavirus is a bioweapon developed by China to destroy the West; CTQ4- The mainstream media is deliberately feeding us misinformation about the Coronavirus and lockdown. Vaccine Factor (VF1) - The current politics; VF2 - The rushed/fast-tracked research and development timeline; VF3 - The frequently changing science of COVID-19; VF4 - Actions and opinions of my friends and family regarding the vaccine; VF5 - My trust in scientists; VF6 - The country in which a vaccine is manufactured; VF7 - Trust in the Government - Most of the time, we can trust people in the provincial government to do the right thing.</i>			
<i>Model 1 looks at the relationship between vaccine hesitancy and conspiracy theory beliefs; Model 2 looks at the relationship between vaccine hesitancy and general attitudes towards vaccines; Model 3 looks at the relationship between vaccine hesitancy and different societal dynamics. All models control for sociodemographic variables. OR : odds ratio; *p<0.05; **p<0.01; ***p<0.001.</i>			

Finally, a multivariate model combining all the exposures shows that all VAX subscale items, two of the COVID-19 conspiracy beliefs, and all COVID-19 vaccine factors remain statistically significant when assessed simultaneously. The conspiracy theory statement “*The spread of the Coronavirus is a deliberate*

attempt by a group of powerful people to gain control" ($OR = 1.184$, $95\% CI = [1.05, 1.336]$, $p\text{-value} < 0.01$) remains significantly associated with the greater vaccine hesitancy, while *"Coronavirus is a bioweapon developed by China to destroy the West"* ($OR = 0.891$, $95\% CI = [0.796, 0.998]$, $p\text{-value} < 0.05$) remains significantly associated with less vaccine hesitancy. The current politics, the rushed/fast-tracked research and development timeline, and the frequently changing science of COVID-19 are significantly associated with greater vaccine hesitancy (either being hesitant, or not intending on getting vaccinated) for the COVID-19. Actions and opinions of friends and family regarding the vaccine, trust in scientists and government, as well as the country in which a vaccine is manufactured is associated with lower levels of vaccine hesitancy and higher levels of vaccine intent. Odds ratios for each vaccine factor can be found in table 4.

Discussion

To date, our study is one of the few to investigate COVID-19 vaccine hesitancy among young Canadians, representing the age groups with the lowest vaccination rates among eligible adults (PHAC 2021). As hypothesised, results show that negative attitudes towards vaccines in general are associated with greater COVID-19 vaccine hesitancy. All four vaccine attitude items in the survey (mistrust in vaccine benefits, worries over unforeseen future effects, concerns about commercial profiteering, and preference over natural immunity) were significantly associated with greater vaccine hesitancy. However, while we anticipated that adherence to conspiracy theories would be associated with vaccine hesitancy, we found a decrease in magnitude of association when all variables were analysed together. A significant association with higher vaccine hesitancy for only one of the conspiracy theory items remained while there was a slight association with lower vaccine hesitancy for one other item. Finally, we found that two of the COVID-19 vaccine factor items (reliance on the current politics and on the fast-tracked research and development timeline) were positively associated with vaccine hesitancy while all other items were associated with lower vaccine hesitancy and higher levels of vaccine intent (opinions of friends and family, trust in scientist, country of manufacturing, and trust in government).

It is imperative to distinguish adherence to conspiracy theory beliefs, criticism or distrust in the political or institutional systems, and concerns regarding the vaccine from one another as they each have different implications; those who are vaccinated and/or "non-hesitant" may still be critical of the government or have fears and concerns regarding the vaccine, and individuals may hold a critical view of the vaccine or the government but not adhere to conspiracy theories. In fact, this study points out that conspiracy theory beliefs may be much less relevant to COVID-19 vaccine hesitancy than overall attitudes towards vaccines in general, a finding which proposes an important counterpoint to the public and media discourses implicitly presupposing a causal association between conspiracy theory and vaccine hesitancy. Similar findings have identified that negative attitudes towards vaccines in general are associated with a lower intent to get vaccinated for the COVID-19 virus (Paul et al. 2021). It is worthy to note that the heterogeneity in vaccine hesitancy outcomes across conspiracy theory items may suggest that conspiracy theories should not be treated the same. In fact, the idea of conspiracy culture as a monolithic whole has been dispelled, despite similarities in distrust towards institutions (Harambam & Aupers 2017).

Conspiracy theories exist in larger complex and multilayered contexts; individuals who hold conspiratorial beliefs cannot all be painted with the same brush and dismissed in vaccine campaign strategies.

This study also veers away from a monolithic perception of vaccine hesitancy and offers a portrait of vaccine hesitancy that is more nuanced: the results demonstrate a heterogeneity across the vaccine hesitancy spectrum, pointing out the risk of over-simplification of the perceived “not intending on getting vaccinated”, “hesitant”, and “non-hesitant” groups. The heterogeneity of reasons supporting vaccine hesitancy suggests that the amalgamation of vaccine hesitancy with anti-vaccination discourses that is often proposed should be avoided (Larson & Broniatowski 2021). Persisting with the current discourse may further divide the population and increase stigmatisation, frustration, and subsequent resentment among the hesitant group.

It should be noted that this is a cross-sectional study executed during a period where government guidelines and information were rapidly changing. The study reflects the participants’ sentiments over only a few weeks and cannot capture the way vaccine behaviour may change with the emergence of different policies and communications over time. The sample also may not be fully representative of the general population as it was of a high socioeconomic status, with high rates of employment, education, and income. Certain hesitancies may have been explained by other concerns regarding the vaccine that were not asked in the survey.

We suggest delivering transparent and nuanced health communications using clear positive language to address distrust towards political and scientific actors, in line with COVID-19-related communication recommendations that have been put forth using evidence from multiple sources (Habersaat et al. 2020). Such communication must recognize the limits of current knowledge in justifying institutional choices in terms of vaccination and health measures and offer a rationale to foster mechanisms of intrinsic motivation (Habersaat et al. 2020). While any one message or policy may not change public trust at the current time, steps can be taken to gain the populations’ overall confidence in vaccines. General attitudes towards vaccines could be leveraged as they are the more salient aspect in the results of this study. A non-paternalistic empowerment approach may be adopted to foster trust and secure access to care and health-seeking behaviour (Thiede 2005). A safe and respectful environment for discussions for all needs to be encouraged and should emphasise the legitimacy of individual choice, while recalling our obligations towards collective well-being and the fact that this involves delicate negotiations.

Moving forward, it is important to look past COVID-19 factors and address the larger societal interactions at play. As our results demonstrate, general attitudes towards vaccines are the strongest predictors for hesitancy levels towards the COVID-19 vaccine, followed by vaccine factors between individuals and the government. Findings on vaccine hesitancy in Canada may show misleading associations with other factors such as conspiracy theory beliefs if we fail to include general attitudes towards vaccines and key vaccine factors. Vaccine education, tailored knowledge translation, as well as transparent and nuanced political discourse are recommended to improve not only COVID-19 vaccine intent but future

immunisation programs. With third dose vaccines having been made available, these strategies may prove useful in retaining full vaccination rates.

Contributions To Knowledge

- What does this study add to existing knowledge?

This study offers a portrait of vaccine hesitancy in the age group with the lowest COVID-19 vaccination rates in Canada, adding to a limited pool of knowledge regarding vaccine intent and attitudes among young Canadians. While it validates certain associations found in the literature, the study highlights that default positions on vaccines are more strongly associated with COVID-19 vaccine hesitancy than sociodemographic variables and adherence to conspiracy theories.

- What are the key implications for public health interventions, practice or policy?

The results of the study imply a need for communications strategies around COVID-19 vaccination be adapted to the literacy level of the group and prioritise social media and local means of outreach which they may use. Onwards, there is a critical need to continue developing populational knowledge on vaccines and their role as a public health intervention, all the while equipping health professionals with the tools to support individuals through the decision-making process of getting vaccinated.

Declarations

Author contributions: All authors contributed to the study conception and design. Tara Santavicca and Cindy Ngov equally contributed to data cleaning, analysis and the first draft of the manuscript. All authors commented on previous versions of the manuscript, read, and approved the final manuscript.

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Consent for publication Not applicable.

Acknowledgements:

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