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SPECIAL SECTION ON COVID-19: QUANTITATIVE RESEARCH

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 were 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, with 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 as well as the country in which a vaccine is manufactured 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 towards the government 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.

Résumé

Objectifs L'hésitation vaccinale est un processus de décision multidimensionnel qui englobe divers facteurs qui contribuent au choix individuel de se faire vacciner ou non. Cet article étudie la relation entre les théories du complot autour de la COVID-19, les attitudes générales envers les vaccins, les facteurs spécifiques aux vaccins contre la COVID-19 et l'hésitation vaccinale dans le contexte de la COVID-19.

Méthodes La présente recherche est une étude transversale multi-provinces. Les données de l'enquête ont été recueillies en mai et en juin 2021 (n=4905) en Alberta, en Ontario et au Québec. Des modèles de régression ordinale multivariés ont été utilisés pour évaluer l'association entre l'hésitation à se faire vacciner et les théories du complot autour de la COVID-19, les attitudes générales envers les vaccins et des facteurs spécifiques relatifs aux vaccins contre la COVID-19.

Résultats Les répondants sont âgés de 18 à 40 ans et 59 % s'identifient comme étant des femmes. Les personnes ayant un faible revenu, ayant un faible niveau d'éducation et/ou sans emploi étaient plus susceptibles d'hésiter à se faire vacciner. L'adhésion à la théorie du complot du COVID-19 et les attitudes générales envers les vaccins sont significativement associées à plus d'hésitation

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à se faire vacciner contre la COVID-19. Les facteurs liés aux vaccins, y compris les actions pro-vaccins et les opinions des amis et de la famille, et la confiance envers les scientifiques et le gouvernement ainsi que le pays de fabrication du vaccin sont associés à moins d'hésitation vaccinale.

Conclusion Les théories du complot sont distinctes des préoccupations concernant le vaccin. La pauvreté, le faible niveau d'éducation et la méfiance envers le gouvernement sont associés à des niveaux plus élevés d'hésitation vaccinale. Les résultats suggèrent que les communications en santé devraient être transparentes et nuancées sur la santé de façon à diminuer la méfiance envers les acteurs politiques et scientifiques et à combler le fossé sociétal concernant les attitudes générales envers les vaccins plutôt que de se cibler uniquement la COVID-19.

Keywords Vaccine hesitancy · Conspiracy theory · Health communication · COVID-19 vaccines · Determinants of health

Mots-clés Hésitation vaccinale · théories du complot · communications en santé · vaccins contre la COVID-19 · déterminants de la santé

Introduction

Vaccine hesitancy (VH) is part of the complex decision-making process underlying an individual's decision for vaccination. VH comprises a continuum of attitudes that range from total acceptance of all, to acceptance of some, 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 localized, one-time events such as the introduction of new vaccines (Dubé et al., 2013). VH 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 hospitalizations and complications and morbidity as well as the need for further restrictive measures.

Exploring general attitudes towards vaccines may help with understanding the underlying factors of COVID-19 VH among individuals and can potentially inform public health communications for the current pandemic, as well as in efforts to strengthen immunization program outcomes in society. General attitudes towards vaccines such as trust in pharmaceutical companies and fear of side effects have been found to mediate the relationship individuals have with all vaccines, including COVID-19 (Paul et al., 2021). Other factors contribute to the decision-making process, including political climate, public health measures, and lived experiences. In the United States, Canada, and Italy, negative opinions towards government response, transparency, and communication efforts have been associated with increased VH (Savoia et al., 2022). Young adults were also likely to be more vaccine hesitant (Savoia et al., 2022). Little is known about COVID-19 VH after vaccines were made widely available and limited research has been done to understand VH in younger adults, where despite the vaccines being available to the public, those aged 18 to 40 had consistently lower COVID-19 vaccination rates in Canada (PHAC, 2021).

Frameworks such as the WHO SAGE working group's 3Cs model of VH as well as the 5C psychological antecedents of vaccination models offer sound measures for many factors of VH, 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 the 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. Thus, it is imperative that research on COVID-19 VH goes beyond identifying more traditional sociodemographic determinants of VH and explores other factors that may influence VH.

One such factor that has thus far received more limited attention is conspiracy theories related to COVID-19. Conspiracy beliefs surrounding COVID-19 have been linked to vaccine hesitancy and found to be negatively associated with vaccine intent (van Mulukom et al., 2022). In the US context, beliefs in conspiracies have, in the past, been associated with reluctance to engage in health-protective behaviours (Dunn et al., 2017), and more recently with lower COVID-19 vaccination intentions (Earnshaw et al., 2020). Amid the COVID-19 pandemic, trust in information sources such as the WHO, the study country's Ministry of Public Health, and television/radio was associated with higher intentions to get the COVID-19 vaccine as opposed to sources including Facebook and WhatsApp where individuals who were exposed to more unverified news were associated with lower intentions for the COVID-19 vaccine (Ghaddar et al., 2022). Vaccine conspiracy beliefs were found to be the greatest predictor of COVID-19 VH (Rosenthal & Cummings, 2021); however, due to the novelty of COVID-19 vaccines, individuals may base risk perception (and decision to vaccinate) on general attitudes towards vaccines (van Mulukom et al., 2022). As such, it is important to explore the importance of conspiracy theories as compared to more general attitudes towards vaccines and their relationship with COVID-19 VH. This has important implications for public health

messaging and communication campaigns related to COVID-19 vaccine uptake.

Research on COVID-19 VH among Canadians is slowly emerging. One survey found VH was associated with lower education level, financial instability, identifying as Indigenous, limited concern about spreading COVID, and low threat perception (Muhajarine et al., 2021). These results are consistent with the literature on demographic determinants of general VH, which points towards lower income and educational attainment, risk aversion, lower health literacy, rurality, parental status, mistrust in authority, and younger age (Hudson & Montelpare, 2021). Other factors shaping VH were identified in Canadian tweets beginning in December 2020, including concerns over safety, suspicion about political or economic forces driving the COVID-19 pandemic or vaccine development, 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).

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, 2021, leading to a 70% one-dose vaccine coverage milestone by mid-June (CIHI, 2021; PHAC, 2021). In May 2021, both the Quebec and Albertan governments launched large ad campaigns pushing for mass vaccination against COVID-19 so the population can return to normality (The Canadian Press, 2021; Franklin, 2021). By June 2021, Alberta had announced its plan to ease restrictions and 2 weeks later had entered two of the three stages put forth by the plan as the one-dose vaccine coverage (for all ages) approached 60% (CIHI, 2021; PHAC, 2021). Ontario started administering COVID-19 vaccines to the general adult population on May 18, 2021, and to youth aged 12 and over on May 23, 2021, enabling it to reach a vaccine coverage of almost 65% among adults by the end of the data collection period (May 21–June 14, 2021), 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 VH in the Canadian context? We hypothesized that endorsing conspiracy theories, and negative attitudes towards vaccines in general, would be associated with greater COVID-19 VH, and ultimately a decrease in vaccine intent. We also hypothesized that COVID-19 vaccine factors would be associated with less VH, encouraging vaccine intent.

Methods

Data and sample

This is a 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 were collected between May 21 and June 14, 2021 (n=5007), in the provinces of Alberta, Ontario, and Quebec using the Leger360 pool of registered members, accessing 500,000 Canadian professionals and consumers (Leger360, 2022). A total of 50,845 participants were randomly selected by Leger Marketing and received an invitation via email with a private link where they could respond to the survey in English or French, taking approximately 12 min to complete. Exclusion criteria were individuals aged under 18 or above 40, with cognitive deficits or other disabilities rendering informed consent not possible. Refer to Online Resource 1 for detailed methods.

Measures

Vaccine hesitancy

The primary outcome, VH, was measured by responses to two questions focused on current vaccination status and COVID-19 vaccine intent (C4 Investigators, 2020). Participants were grouped into three outcome categories inspired by the VH spectrum (Dubé et al., 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) (α = .877), *worries over unforeseen future effects* (α = .819), *concerns about commercial profiteering* (α = .847), and *preference for natural immunity* (α = .868).

COVID-19 conspiracy theory beliefs

Participants were asked to respond to what 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 C4 Investigators (2020) C4 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 what 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, Quebec), marital status (never married, divorced/separated/widowed, married/living together as a couple), household income (≤$19,999, $20,000–$39,999, $40,000–$59,999, $60,000–$79,999, $80,000–$99,999, ≥$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), and generation (first, second, third or more). Age, gender, marital status, and variables pertaining to socioeconomic status (i.e., household income, education, employment) were chosen for their frequent association to VH in the literature (Hudson & Montelpare, 2021; McFadden et al., 2021). Inclusion of immigration generation stems from emerging reports of access and VH consideration among refugees, immigrants, and people without status in the USA (Thomas et al., 2021).

Data analysis

Cases with missing outcome variables were omitted from further analyses (n=102), leaving 4905 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, and variables returned low correlations (refer to Online Resource 2; Navarro, 2015).

We used bivariate ordinal regression analyses to assess the association between sociodemographic characteristics and VH 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 VH, 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 VH (Table 2, model 1). Second, analogous analyses were run to identify the relationship between the four subscales for general attitudes towards vaccines and vaccine hesitant profiles (Table 2, model 2). Third, we conducted analogous analyses to identify the relationship between COVID-19 vaccine factors and vaccine hesitant profiles (Table 2, model 3). 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 analyze their independent association with the outcome (Table 3, model 4). All statistical analyses were conducted using RStudio Version 1.4.1717 (RStudio, 2022).

Ethics

Ethics approval was obtained from the McGill Faculty of Medicine Institutional Review Board (Approval no. A04-B38-21A).

Results

A total of 5007 participants responded to the survey, of whom 59% identified as women. Participants were aged 18 to 40 years old and residing in Alberta (23%), Ontario (41%), and Quebec (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 ≤$19,999 and 26% ≥$100,000. See Table 1 for sociodemographic characteristics of each VH group; the majority of study participants (n=4030) were not hesitant regarding the COVID-19 vaccine, having been

Table 1 Characteristics of the study participants

	Total sample (*n*=4905) *n* (%)	Not hesitant (*n*=4030) *n* (%)	Hesitant (*n*=609) *n* (%)	Does not intend on getting vaccinated (*n*=266) *n* (%)
Gender				
Woman	2898 (59%)	2333 (58%)	403 (66%)	162 (61%)
Man	1972 (40%)	1671 (41%)	202 (33%)	99 (37%)
Other	22 (0%)	18 (0%)	3 (0%)	1 (0%)
Missing	13 (0%)	8 (0%)	1 (0%)	4 (2%)
Age, years				
18–25	1394 (28%)	1158 (29%)	164 (27%)	72 (27%)
26–30	1565 (32%)	1289 (32%)	195 (32%)	81 (30%)
31–35	1373 (28%)	1119 (28%)	179 (29%)	75 (28%)
36–40	573 (12%)	464 (12%)	71 (12%)	38 (14%)
Province				
Alberta	1104 (23%)	865 (21%)	164 (27%)	75 (28%)
Ontario	2021 (41%)	1658 (41%)	275 (45%)	88 (33%)
Quebec	1780 (36%)	1507 (37%)	170 (28%)	103 (39%)
Marital status				
Never married	2548 (52%)	2127 (53%)	285 (47%)	136 (51%)
Divorced/separated/widowed	123 (3%)	97 (2%)	20 (3%)	6 (2%)
Married/living together as a couple	2186 (45%)	1767 (44%)	300 (49%)	119 (45%)
Missing	48 (1%)	39 (1%)	4 (1%)	5 (2%)
Immigrant generation				
First	897 (18%)	741 (18%)	125 (21%)	31 (12%)
Second	1059 (22%)	864 (21%)	144 (24%)	51 (19%)
Third or more	2922 (60%)	2401 (60%)	339 (56%)	182 (68%)
Missing	27 (1%)	24 (1%)	1 (0%)	2 (1%)
Household income				
$19,999 or less	357 (7%)	244 (6%)	74 (12%)	39 (15%)
$20,000–$39,999	629 (13%)	479 (12%)	107 (18%)	43 (16%)
$40,000–$59,999	728 (15%)	588 (15%)	105 (17%)	35 (13%)
$60,000–$79,999	755 (15%)	618 (15%)	95 (16%)	42 (16%)
$80,000–$99,999	689 (14%)	589 (15%)	66 (11%)	34 (13%)
$100,000 or more	1269 (26%)	1120 (28%)	105 (17%)	44 (17%)
Missing	478 (10%)	392 (10%)	57 (9%)	29 (11%)
Education level				
None/Less than high school	98 (2%)	54 (1%)	29 (5%)	15 (6%)
High school graduate	858 (17%)	614 (15%)	162 (27%)	82 (31%)
Apprenticeship, technical institute, trade or vocational school (any year)	298 (6%)	208 (5%)	57 (9%)	33 (12%)
College, CEGEP, or other non-university certificate or diploma (any year)	1083 (22%)	865 (21%)	140 (23%)	78 (29%)
University certificate, diploma or degree (any year)	2530 (52%)	2255 (56%)	218 (36%)	57 (21%)
Missing	38 (1%)	34 (1%)	3 (0%)	1 (0%)
Employment				
Not employed	991 (20%)	709 (18%)	185 (30%)	97 (36%)
Employed — essential	2032 (41%)	1707 (42%)	221 (36%)	104 (39%)
Employed — non essential	1771 (36%)	1529 (38%)	185 (30%)	57 (21%)
Missing	111 (2%)	85 (2%)	18 (3%)	8 (3%)
Trust/mistrust of vaccine benefit (range 3–21)				
Mean (SD)	22 (8%)	7 (±3)	11 (±4)	16 (±4)
Missing	151 (3%)	71 (2%)	58 (10%)	43 (16%)
Worries over unforeseen future effects (range 3–21)				
Mean (SD)	13 (±5)	12 (±4)	16 (±3)	18 (±4)
Missing	227 (5%)	182 (5%)	28 (5%)	17 (6%)
Concerns about commercial profiteering (range 3–21)				
Mean (SD)	9 (±5)	8 (±4)	12 (±4)	17 (±4)
Missing	228 (5%)	161 (4%)	45 (7%)	22 (8%)
Preference for natural immunity (range 3–21)				
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%)

Table 1 (continued)

	Total sample (*n*=4905) *n* (%)	Not hesitant (*n*=4030) *n* (%)	Hesitant (*n*=609) *n* (%)	Does not intend on getting vaccinated (*n*=266) *n* (%)
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%)
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%)

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

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 VH, as were being married or living together as a couple (Table 3, model 4).

In multivariate analyses adjusted for sociodemographic characteristics, all VAX subscales, COVID-19 conspiracy beliefs, and COVID-19 vaccine factors were associated with VH at the $p<0.001$ level (see Table 2, models 1–3). 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) (Table 2, model 2). For COVID-19 conspiracy theory beliefs, the magnitude of the relationship with the outcome was greatest for endorsement of the conspiracy theories "The government is misleading the public about the cause of the Coronavirus" (CT1) (OR = 1.492, 95% CI = 1.357, 1.641; $p<0.01$) and "The spread of the Coronavirus is a deliberate attempt by a group of powerful people to gain control" (CT2) (OR = 1.483, 95% CI = 1.344, 1.637; $p<0.01$) (Table 2, model 1). Finally, for COVID-19 vaccine factors, statements regarding the current politics, the rushed/fast-tracked 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 $p<0.001$ level (Table 2, model 3). In contrast, statements related to actions and opinions of friends and family regarding the vaccine and trust in scientists and government as well as the country in which a vaccine is manufactured are associated with less hesitancy and higher levels of vaccine intent (Table 2, model 3).

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 (Table 3, model 4). The conspiracy theory statement, CT2

Table 2 Results from ordinal regression model building with COVID-19 vaccine hesitancy as dependent variable

Variable	Model 1 Proportional OR (95% CI)	Model 2 Proportional OR (95% CI)	Model 3 Proportional OR (95% CI)
Gender			
Woman	1	1	1
Man	0.743** (0.619, 0.892)	0.933 (0.763, 1.14)	0.826** (0.688, 0.992)
Other	1.221 (0.373, 3.994)	4.366** (1.126, 16.931)	0.703 (0.218, 2.268)
Age, years			
36–40 (ref)	1	1	1
18–25	0.892 (0.657, 1.213)	0.945 (0.672, 1.329)	0.756* (0.555, 1.028)
26–30	1.097 (0.822, 1.464)	0.992 (0.722, 1.364)	0.961 (0.721, 1.282)
31–35	1.196 (0.898, 1.593)	1.117 (0.813, 1.534)	1.105 (0.831, 1.469)
Province			
Alberta (ref)	1	1	1
Ontario	0.85 (0.686, 1.053)	0.838 (0.658, 1.069)	0.987 (0.793, 1.228)
Quebec	0.7*** (0.553, 0.887)	0.665*** (0.511, 0.867)	1.225 (0.954, 1.573)
Marital status			
Never married (ref)	1	1	1
Divorced/separated/widowed	1.009 (0.601, 1.693)	1.274 (0.73, 2.223)	1.102 (0.665, 1.826)
Married/living together as a couple	1.422*** (1.167, 1.732)	1.409*** (1.13, 1.758)	1.388*** (1.136, 1.697)
Immigrant generation			
First generation	1	1	1
Second generation	1.308* (0.999, 1.711)	1.459** (1.087, 1.958)	1.01 (0.773, 1.321)
Third generation or more	1.074 (0.848, 1.359)	1.319** (1.02, 1.706)	0.943 (0.746, 1.192)
Household income			
$19,999 or less (ref)	1	1	1
$20,000–$39,999	0.77 (0.55, 1.078)	0.735 (0.498, 1.086)	0.734* (0.522, 1.032)
$40,000–$59,999	0.634*** (0.453, 0.887)	0.61** (0.417, 0.904)	0.555*** (0.391, 0.788)
$60,000–$79,999	0.614*** (0.436, 0.867)	0.632** (0.423, 0.943)	0.58*** (0.409, 0.823)
$80,000–$99,999	0.549*** (0.382, 0.789)	0.566** (0.374, 0.856)	0.505*** (0.349, 0.732)
$100,000 or more	0.509*** (0.36, 0.719)	0.608** (0.406, 0.909)	0.439*** (0.306, 0.629)
Education			
None/less than high school (ref)	1	1	1
High school graduate	0.627* (0.388, 1.014)	1.088 (0.63, 1.878)	0.533** (0.33, 0.86)
Apprenticeship, technical institute, trade or vocational school (any year)	0.722 (0.423, 1.232)	1.281 (0.701, 2.34)	0.698 (0.411, 1.188)
College, CEGEP, or other non-university certificate or diploma (any year)	0.455*** (0.28, 0.739)	0.906 (0.52, 1.58)	0.397*** (0.245, 0.642)
University certificate, diploma or degree (any year)	0.273*** (0.168, 0.443)	0.627* (0.359, 1.093)	0.219*** (0.136, 0.354)
Employment			
Not employed (ref)	1	1	1
Employed — essential	0.577*** (0.462, 0.72)	0.53*** (0.41, 0.684)	0.634*** (0.506, 0.796)
Employed — non essential	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)		
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)	

Table 2 (continued)

Variable	Model 1 Proportional OR (95% CI)	Model 2 Proportional OR (95% CI)	Model 3 Proportional OR (95% CI)
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)

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; CT Q3 — Coronavirus is a bioweapon developed by China to destroy the West; CT Q4 — 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

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; $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

(OR = 1.184, 95% CI = 1.05, 1.336; $p<0.01$), remains significantly associated with the greater VH, while "Coronavirus is a bioweapon developed by China to destroy the West" (CT3) (OR = 0.891, 95% CI = 0.796, 0.998; $p<0.05$) remains significantly associated with less VH. The current politics, the rushed/fast-tracked research and development timeline, and the frequently changing science of COVID-19 are significantly associated with greater VH (either being hesitant or not intending on getting vaccinated) towards the COVID-19 vaccine. Actions and opinions of friends and family regarding the vaccine and trust in scientists and government as well as the country in which a vaccine is manufactured are associated with lower levels of VH and higher levels of vaccine intent. Odds ratios for each vaccine factor can be found in Table 3, model 4.

Discussion

To date, our study is one of the few to investigate COVID-19 VH among young Canadians, representing the age groups with the lowest vaccination rates among eligible adults (PHAC, 2021). As hypothesized, results show that negative attitudes towards vaccines in general are associated with greater COVID-19 VH. All four VAX subscale items were significantly associated with greater VH. However, while we anticipated that adherence to conspiracy theories would be associated with VH, we found a decrease in magnitude of association when all variables were analyzed together. A significant association with higher VH for only one of the conspiracy theory items (CT Q2) remained while there was a slight association with lower VH for one other item (CT Q3). Finally, we found that two of the COVID-19 vaccine factor items (the current politics and the rushed/fast-tracked research and development timeline) were positively associated with VH while all other items were associated with lower VH and higher levels of vaccine intent.

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. This study points out that conspiracy theory beliefs may be much less relevant to COVID-19 VH 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 VH. 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 VH 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 multi-layered 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 VH and offers a portrait of VH that is more nuanced: the results demonstrate a heterogeneity in attitudes across the VH spectrum, pointing out the risk of over-simplification of the perceived "not intending on getting vaccinated",

Table 3 Results from ordinal regression final model with COVID-19 vaccine hesitancy as dependent variable

Variable	Model 4 Proportional OR (95% CI)
Gender	
Woman	1
Man	0.929 (0.756, 1.142)
Other	2.119 (0.559, 8.037)
Age, years	
36–40 (ref)	1
18–25	0.94 (0.665, 1.328)
26–30	1.049 (0.76, 1.447)
31–35	1.242 (0.903, 1.709)
Province	
Alberta (ref)	1
Ontario	0.912 (0.711, 1.168)
Quebec	0.797 (0.602, 1.055)
Marital status	
Never married (ref)	1
Divorced/separated/widowed	1.109 (0.639, 1.924)
Married/living together as a couple	1.357*** (1.091, 1.688)
Immigrant generation	
First generation (ref)	1
Second generation	1.283 (0.952, 1.728)
Third generation or more	1.128 (0.868, 1.465)
Household income	
$19,999 or less (ref)	1
$20,000–$39,999	0.692* (0.475, 1.009)
$40,000–$59,999	0.633** (0.43, 0.932)
$60,000–$79,999	0.591** (0.395, 0.885)
$80,000–$99,999	0.575*** (0.381, 0.867)
$100,000 or more	0.579*** (0.388, 0.865)
Education	
None/less than high school (ref)	1
High school graduate	0.696 (0.402, 1.203)
Apprenticeship, technical institute, trade or vocational school (any year)	0.883 (0.484, 1.608)
College, CEGEP, or other non-university certificate or diploma (any year)	0.575* (0.33, 1.002)
University certificate, diploma or degree (any year)	0.405*** (0.233, 0.706)
Employment	
Not employed (ref)	1
Employed — essential	0.517*** (0.401, 0.666)
Employed — non-essential	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)

Table 3 (continued)

Variable	Model 4 Proportional OR (95% CI)
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)
Vaccine factor 7	0.857*** (0.776, 0.946)

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; CT Q3 — Coronavirus is a bioweapon developed by China to destroy the West; CT Q4 — 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

Model 4 looks at the relationship between vaccine hesitancy and conspiracy theory beliefs; general attitudes towards vaccines; and different societal dynamics. Sociodemographic variables are controlled for. OR: $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$

"hesitant", and "non-hesitant" groups. The heterogeneity of reasons supporting VH suggests that the amalgamation of VH 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 stigmatization, frustration, and subsequent resentment among the hesitant group.

Study limitations include this being 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 may not be representative of the general population for two reasons: (1) it was of a high socioeconomic status, with high rates of employment, education, and income, and (2) the sample was extracted from a panel of Canadian internet users. In addition, certain hesitancies may have been explained by other concerns regarding the vaccine that were not asked in the survey. Future studies should aim to include psychometric scales that have been validated within the COVID-19 context.

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 emphasize 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 VH 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 and tailored knowledge translation as well as transparent and nuanced political discourse are recommended to improve not only COVID-19 vaccine intent but also future immunization programs. With booster 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 to be adapted to the literacy level of the group and to prioritize 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.

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Declarations

Ethics approval This study received approval by McGill University Faculty of Medicine IRB (A04-B38-21A).

Consent to participate Consent was obtained by the Leger survey company, in agreement with McGill Research and Ethics Board approval of the research protocol.

Consent for publication Not applicable.

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