

# Predictors of Vaccine Acceptance, Confidence, and Hesitancy in General, and COVID-19 Vaccination Refusal in the Province of Quebec, Canada

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**Introduction:** A surge of COVID-19 variants is a major concern, and literatures that support developing an optimum level of herd immunity are meaningful. This study aimed to examine the factors associated with vaccine acceptance, confidence, and hesitancy in general, and COVID-19 vaccination refusal in the general population of Quebec, Canada.

**Methods:** A web-based cross-sectional survey was conducted in October and November 2020 among French-speaking participants above 18 years of age employing quota sampling technique. The questionnaire included socio-demographic and attitudinal variables towards vaccination. Logistic regression analyses were conducted to examine the association between independent and outcome variables.

**Results:** Of total 1599 participants, 88.9%, 87.5%, 78.5%, and 18.2%, respectively, indicated vaccine acceptance, high level of vaccine confidence, low level of vaccine hesitancy, and COVID-19 vaccination refusals. Participants having higher education, income, and fear of COVID-19 (FCV-19S) were more likely to get vaccinated, while smokers were less likely to get vaccinated. Similarly, age groups (40–59, and ≥60 years), higher education, income, permanent resident in Canada, country of parents from Canada, ever faced acute disease in the family, higher sense of coherence, and FCV-19S scores were predictors of high levels of vaccine confidence. Higher education, income, sense of coherence and FCV-19S scores, and higher health-related quality of life (CORE-6D) produced lower levels of vaccine hesitancy. Conversely, those acting as caretaker, other essential worker, smoker, and those with financial losses were more likely to have higher vaccine hesitancy. Additionally, ≥60 years of age, higher education and income, country of parents from Canada, higher scores of willingness to take risk and FCV-19S were less likely to have high level of COVID-19 vaccination refusal.

**Conclusion:** Over three quarters of the participants indicated positive attitudes toward vaccination. Some socio-demographic and health-related quality of life factors were associated with the outcome variables, and these should be sought while designing interventions to improve COVID-19 vaccination rates.

**Keywords:** COVID-19, behaviour, health determinants, infectious diseases, public health, vaccination

## Introduction

As of April 14, 2022, around 500 million confirmed cases including over 6 million deaths from COVID-19 have been reported worldwide, while Canada has registered 35 million confirmed cases including over 38000 deaths from COVID-19.<sup>1</sup> In response to this major public health crisis, countries around the world have stepped up to manufacturing vaccines to reduce the

morbidity and mortality related to COVID-19. Globally, around 65% of the global population, including 86.9% of Canadians have received at least one vaccine dose, while 59% of global population, including 82.2% of Canadians are fully vaccinated.<sup>2</sup> A vaccine is seen as an effective choice to stop the pandemic, with more than one hundred COVID-19 vaccines in clinical development worldwide, including eight that have now been approved for human testing through clinical trials.<sup>3</sup> For instance, since the onset of the delta variant, the United States' Centers for Disease Control reported that unvaccinated people face 11 times more risk of death from delta variant than vaccinated people based on surveillance data.<sup>4</sup> Although immunisation has historically successfully reduced the global burden of illness and death, public confidence in vaccines can be affected by various concerns. As such, vaccine hesitancy can lead to delays and refusals, and sometimes contribute to disease outbreaks.<sup>5</sup> The approval of the various COVID-19 vaccines sent waves of excitement and relief across the world. However, some people remain hesitant about receiving a vaccine for COVID-19.<sup>6,7</sup> Emerging international evidence on COVID-19 vaccine hesitancy suggests that there is a range of reasons for this reluctance, including doubts about the safety and efficacy of the vaccine, political or pharmaceutical mistrust, belief in natural immunity, and the belief that the virus is mild or not life-threatening.<sup>8,9</sup> Vaccine confidence is an increasingly important global public health issue, with a decrease in confidence leading to well-documented cases of disease outbreaks, setbacks to global polio eradication as well as other immunization goals, and contentious political debates in high- and low-income countries alike.<sup>10,11</sup> Amidst the sudden outbreak of COVID-19 variants which include delta, and omicron variants, a study from New Zealand estimated the threshold of herd immunity to stand at 97% of the population who need to be vaccinated to stop the spread of these new variants.<sup>12</sup>

As of April 14, 2022, the province of Quebec reported 90.2%, 83.01%, and 50.80% of people who, respectively, received their first, second, and third doses of COVID-19 vaccine.<sup>13</sup> This underscores the need to identify the factors which would enable Quebec to increase the vaccine uptake to reach the recommended rate allowing herd immunity. To the best of our knowledge, there is a lack of recent data on the state of vaccine acceptance, confidence, and hesitancy during the pandemics in the province of Quebec. This information and its key drivers are prerequisites to understand the current vaccination situation and facilitate vaccination in a more efficient way. As such, it has the potential to provide evidence on vaccination strategies and to sustain vaccination coverage to an optimum level. Thus, our study aimed to examine the factors associated with vaccine acceptance, confidence, and hesitancy in general, and COVID-19 vaccination refusal in the general population of Quebec, Canada. Our findings would help to develop targeted behavior change strategies, communication interventions, and policy implications to increase the vaccine uptake in Quebec and beyond.

## Methods

### Study Design, Population, and Sampling

A web-based survey was conducted in Quebec, Canada, in October and November 2020 within French-speaking participants using quota sampling techniques according to age, gender and education. Of the total 3615 randomly contacted, 1980 accepted to participate and 1599 completed our survey, giving rise to a response rate of 44.23%. The survey company Dynata Inc. was involved in the recruitment of participants through their dynamic online platform (ie, members are invited to connect on the platform where various surveys are presented to them in an order based on an algorithm using their demographics, preferences, topics of previous surveys completed, etc.). To reach a statistical power of 95% with a first-species risk of 3% (ie, rejecting the null hypothesis when it is true) and a relevant population of 6.5 million, a minimum of 1067 individuals was needed.

### Definition of Variables

The questionnaire included socio-demographic data such as gender, age, education level, household income, attitude towards vaccination including perception, confidence about vaccines, experience with the COVID-19, Fear-of-COVID19 Scale (FCV-19S), Sense of Coherence (SOC-3), and Health-Related Quality of Life (HRQoL) questionnaires. The survey also included a series of hypothetical scenarios describing vaccination strategies and asking people if they would accept to be vaccinated in such a scenario. In each scenario, two hypothetical vaccination strategies and an opt-out (ie, no vaccine program) were proposed. The main outcome variables we used in this study were as follows: vaccine acceptance, confidence, and hesitancy in general in a pandemic context, and refusal of COVID-19 vaccination (ie, corresponding to the hypothetical scenarios). We tested different ways to construct these four variables, using various modalities.

Regarding vaccine acceptance, we asked participants whether they generally accept most/all or some or whether they generally refuse most/all vaccines. Further, these three categories were dichotomized into two as follows: I refuse most or all of the vaccines, and I accept some, most or all of the vaccines. Concerning confidence about vaccine, we asked participants to respond to four questions, where each respondent was asked to choose yes or no, to the three following questions: “Do you consider vaccination to be important for the health of the population? Do you trust Quebec health institutions to recommend an effective and safe vaccine? Do you trust your doctor to recommend a safe and effective vaccine?”. For the fourth question, it was the same as for vaccine acceptance: “About vaccination, which one of the following situations corresponds to you?”. Responses to these four questions were summed, giving a score on a scale from 0 to 5, which were categorized as follows: 0–1 = low confidence, 2–3 = medium confidence, 4–5 = high confidence. Later, these scores were binarized into two groups: 0–2 = low confidence, 3–5 = high confidence. As for vaccine hesitancy, participants responded to eight questions which were summed to give a scale ranging from 0 to 32. Each respondent was asked to rate – on a five-point Likert scale: strongly agree, somewhat agree, do not know, somewhat disagree, strongly disagree – the extent to which they agreed with eight statements pertaining to vaccination: “I feel sufficiently informed about vaccination”, “I feel that there are risks for my health if my vaccination is delayed”, “I have already hesitated to be vaccinated”, “I consider that we receive too many vaccines”, “Overall, I am fearful of vaccines”, “I consider that vaccines are effective in preventing disease”, “I believe that vaccines may weaken my immune system”, “Overall, people around me are in favour of vaccination”. We then grouped hesitancy score into three categories (0–10 = low hesitancy, 11–21 = medium hesitancy, and 22–32 = high hesitancy). Further, these three categories were merged into dichotomous groups (0–16 = low hesitancy and 17–32 = high hesitancy). For COVID-19 vaccine refusal, participants were required to respond to twelve hypothetical scenarios as indicated earlier. A refusal to participate in the vaccination program was coded as 1, yielding a scale ranging from 0 to 12, allowing to create five groups (0 refusal = pro-vaccine, 1–6 = 50% of time or less chose no vaccine, 7–12 = more than 50% of time chose no vaccine, 0–11 = chose at least one time the vaccine program, 12 = anti-vaccine (100% of time chose no vaccine)). These categories were then dichotomized as follows: 0–6 = pro-vaccine, 7–12 = anti-vaccine. It is noteworthy to highlight here that we have tested two ways to construct these outcome variables using two modalities as described above (ie, binary or not). The binary outcome variables were created for the appropriate statistical analytical purposes as the proportion of participants in some category was very small. However, we reported each fragmented category and scores and additional statistical analyses in this regard as [Supplementary Materials \(Tables S1–S6\)](#).

HRQoL was assessed by three questionnaires: Short-form 6-Dimension version 2 (SF-6Dv2), EuroQoL 5-Dimension 5-Level (EQ-5D-5L), and Clinical Outcomes in Routine Evaluation 6-Dimension (CORE-6D). All were designed for calculating Quality-Adjusted Life-Years (QALYs), with a score of 1 for full health and 0 for death. SF-6Dv2 was derived from SF-36v2 and assesses HRQoL on 6 dimensions: Physical Functioning (PF), Role Functioning (RF), Social Functioning (SF), Pain (PA), Mental Health (MH), and Vitality (VT); with 5–6 response levels.<sup>14</sup> The EQ-5D-5L consists of 5 dimensions: Mobility (MO), Self-Care (SC), Usual Activities (UA), Pain/Discomfort (PD), and Anxiety/Depression (AD).<sup>15</sup> A unique health state can be described using a 5-digit vector formed according to the responses to the 5 questions. The CORE-6D is a HRQoL questionnaire dedicated to mental health which consists of 6 items, each with 5 levels of response (ranging from not at all to most or all the time), tapping 2 conceptual domains: 5 emotional items, and a physical symptom item.<sup>16</sup> We assessed the fear of COVID-19 using the French-Canadian version of the FCV-19S, where participants responded to seven questions by choosing “strongly disagree”, “disagree”, “neutral”, “agree”, and “strongly agree”.<sup>17</sup> The SOC-3 Score is based on 3 questions and was grouped into 0–4 and 5–6, as recommended.<sup>18</sup> The other independent variables were socio-demographic variables such as age, gender, education, income, occupation, residential and financial status (ie, loss as a result of COVID-19 situation), willingness to take risk, and other personal attributes.

## Statistical Analysis

Data was collected in Excel and imported into Statistical Package for the Social Sciences version 27 (SPSS). Descriptive statistics were performed to summarize the frequencies and percentages for categorical variables, while mean and standard deviation (SD) for continuous variables. We tested different statistical models. The univariate analysis was conducted employing either non-parametric (Fisher’s exact test, chi-square) and parametric test (one-way analysis of

variance) depending on the types of variables. The multivariable logistic regression analysis was followed to assess the independent associations between independent variables and outcomes of interest. We entered all variables with  $p \leq 0.20$  in univariate analyses into an initial multivariable model with backward selection. The adjusted odds ratio (AOR) with their 95% confidence intervals (95% CI) was reported, along with a  $p$ -value of less than 0.05, which was considered statistically significant. We tested different statistical models, and the additional statistical analyses have been provided in [Supplementary Materials \(Tables S1-S6\)](#). Based on a reviewer comment, considering the number of participant indicating a gender of intersex ( $n = 1$ ), the statistical analysis recorded this participant as a female (ie, biological attribute).

## Ethical Considerations

The procedure and all the questionnaires used in this survey were fully compliant with the indications of the Declaration of Helsinki. Participants' consents, privacy, anonymity and confidentiality were fully maintained throughout the study and beyond. Informed consent was obtained from the study participants prior to the study commencement. The ethical approval was obtained from the ethics committee of the CIUSSS de l'Est de l'île de Montréal, Montreal, QC, Canada.

## Results

### Participants' Characteristics

Results on outcome variables were presented as binary variables ([Table 1](#)). Of the 1599 participants, most reported that they generally accept some, most or all recommended vaccines (88.9%), had high level of vaccine confidence (87.5%), low level of vaccine hesitancy (78.5%), and few indicated COVID-19 vaccination refusal (18.2%).

Most study participants were born in Canada (90.7%), from Canadian parents (87.4%), were Canadian citizen (96.7%), non-smokers (81.1%), non-essential worker during the pandemics (82.3%), and not a health care worker (92.3%). Over 85% of the study participants indicated that themselves, their family or relatives did not suffer from COVID-19 at the time of the survey. Slightly more than half were female (51.3%) and employed (51.1%). Most of them were above 40 years of age (69.3%) (mean  $\pm$  standard deviation (SD),  $50 \pm 16.23$  years), married (59.1%), educated with a college degree or less (64.3%), urban resident (69.7%), living in their own house (62.5%), and were from outside of the Greater Montreal area (55.5%). Nearly half of them (46.6%) had an annual household income of less than CAD \$50,000 (mean  $\pm$  SD, CAD \$ [ $66,857.41 \pm 41,570.27$ ]). Over a quarter of them reported a reduction in quality of life due to physical or mental problems (27.9%). Most of them reported a relatively low sense of coherence (64.8%). Almost half of the study participants (49.2%) indicated that they worked during the COVID-19 crisis, had no financial loss during this crisis (49.6). Mean  $\pm$  SD score of SF-6Dv2, CORE-6D, EQ-5D-5L, and FCV-19S were  $0.72 \pm 0.26$ ,  $0.75 \pm 0.15$ ,  $0.84 \pm 0.14$ , and  $16.45 \pm 16.22$ , respectively. Most of these sociodemographic variables are representative of the general population in the province of Quebec as reported elsewhere<sup>19</sup>

### Factors Associated with Vaccine Acceptance, Confidence, and Hesitancy in General, and COVID-19 Vaccination Refusal

The univariate analysis suggested that the marital status, education, income, smoking, financial loss, and FCV-19S were significantly associated with vaccine acceptance. Regarding vaccine confidence, a number of factors such as gender, age, marital status, occupation, education, income, residence, housing status, country of parents, residence status, smoking, financial loss, SOC-3 and FCV-19S were significantly associated in univariate analysis. Similarly, gender, age, marital status, education, income, housing status, work as other essential worker, caretaker, smoking, financial loss, SOC-3, CORE-6D, SF-6Dv2, FCV-19S, and EQ-5D-5L were significantly associated with vaccine hesitancy in univariate analysis. Likewise, gender, age, education, income, housing status, and perceived risk were significantly associated with vaccine refusal ([Tables 2 and 3](#)).

The final adjusted logistic regression model is presented in [Tables 4 and 5](#). In this model, only four factors (education, income, smoking, and FCV-19S) appeared to be significantly associated with vaccine acceptance. Thus, participants with college degree (OR = 1.58, 95% CI: 1.06–2.33), university degree (OR = 2.21, 95% CI: 1.43–3.40), annual income of CAD \$50,000–\$89,999 (OR = 1.85, 95% CI: 1.21–2.85) and  $\geq$ CAD \$90,000 (OR = 2.49, 95% CI: 1.60–3.88), and high

**Table 1** Personal Characteristics of the Study Participants in the Province of Quebec, Canada, 2020 (N = 1599)

Variable	Number N (%)
<b>Gender</b>	
Male	777 (48.6)
Female	821 (51.3)
Intersex	1 (0.1)
<b>Age</b>	
Mean $\pm$ SD	50 $\pm$ 16.23
18–39	491 (30.7)
40–59	534 (33.4)
$\geq$ 60	574 (35.9)
<b>Marital status</b>	
Single	460 (28.8)
Married	945 (59.1)
Divorced/separated	148 (9.3)
Widowed	46 (2.9)
<b>Occupation</b>	
Employed	817 (51.1)
Retired	516 (32.3)
At home	79 (4.9)
Student	62 (3.9)
Unemployed	77 (4.8)
On leave	48 (3.0)
<b>Education</b>	
Secondary degree or less	568 (35.5)
College degree	461 (28.8)
University degree	570 (35.6)
<b>Income (CAD)</b>	
Mean $\pm$ SD	66,857 $\pm$ 41,570
<\$50,000	745 (46.6)
\$50,000–\$89,999	382 (23.9)
$\geq$ \$90,000	472 (29.5)
<b>Residence</b>	
Rural	485 (30.3)
Urban	1114 (69.7)

(Continued)

**Table 1** (Continued).

<b>Variable</b>	<b>Number N (%)</b>
<b>Housing status</b>	
Owner	1000 (62.5)
Tenant	599 (37.5)
<b>Greater Montreal area</b>	
Outside of Greater Montreal	888 (55.5)
Greater Montreal	711 (44.5)
<b>Country of parents</b>	
Canada	1397 (87.4)
Others <sup>a</sup>	202 (12.6)
<b>Country born</b>	
Canada	1451 (90.7)
Europe	71 (4.4)
Sub-Saharan Africa	20 (1.3)
Middle East and Maghreb	27 (1.7)
Eastern Asia	11 (0.7)
Caribbean	8 (0.5)
America	11 (0.7)
<b>Perceived reduction in their quality of life due to physical or mental problem</b>	
Yes	446 (27.9)
No	1153 (72.1)
<b>Risk</b>	
0	69 (4.4)
1–5	911 (58.0)
6–9	561 (35.1)
10	29 (1.8)
<b>Sense of Coherence-3</b>	
0–4	1036 (64.8)
5–6	563 (35.2)
<b>Residence status</b>	
Temporary resident	20 (1.3)
Permanent resident	33 (2.1)
Canadian citizen	1546 (96.7)

(Continued)

Table 1 (Continued).

Variable	Number N (%)
<b>Continue working during COVID-19 crisis</b>	
Yes	786 (49.2)
No	813 (50.8)
<b>Health care worker</b>	
Yes	123 (7.7)
No	1476 (92.3)
<b>Other essential worker</b>	
Yes	380 (23.7)
No	1219 (76.3)
<b>Non-essential worker</b>	
Yes	283 (17.7)
No	1316 (82.3)
<b>Caretaker</b>	
Yes	115 (7.2)
No	1484 (92.8)
<b>Ever faced acute disease (yourself)</b>	
Yes	364 (22.8)
No	1235 (77.2)
<b>Ever faced acute disease (family)</b>	
Yes	746 (46.7)
No	853 (53.3)
<b>Ever faced acute disease (relative)</b>	
Yes	234 (14.6)
No	1365 (85.4)
<b>Smoking</b>	
Yes	302 (18.9)
No	1297 (81.1)
<b>COVID-19 yourself</b>	
Yes	29 (1.8)
No	1570 (98.2)
<b>COVID-19 family</b>	
Yes	65 (4.1)
No	1534 (95.9)

(Continued)

**Table 1** (Continued).

Variable	Number N (%)
<b>COVID-19 relative</b>	
Yes	172 (10.8)
No	1427 (89.2)
<b>Financial loss due to COVID-19</b>	
No loss	793 (49.6)
Slightly important loss	565 (35.3)
Fairly important loss	203 (12.7)
Very important loss	38 (2.4)
<b>Live with an adult</b>	
Yes	1146 (71.7)
No	453 (28.3)
<b>SF-6Dv2</b> (Mean ± SD)	0.72 ± 0.26
<b>CORE-6D</b> (Mean ± SD)	0.75 ± 0.15
<b>EQ-5D-5L</b> (Mean ± SD)	0.84 ± 0.14
<b>Fear of COVID-19 scale</b> (Mean ± SD)	16.45 ± 16.22
<b>Vaccine acceptance</b>	
I refuse most or all vaccines	177 (11.1)
I accept some, most or all vaccines	1414 (88.9)
<b>Vaccine confidence</b>	
Low	199 (12.5)
High	1392 (87.5)
<b>Vaccine hesitancy</b>	
Low	1247 (78.5)
High	342 (21.5)
<b>Vaccine refusal</b>	
Pro-vaccine (50% or less refusal)	1308 (81.8)
Anti-vaccine (>50% refusal)	291 (18.2)

**Notes:** <sup>a</sup>Europe, sub-Saharan Africa, the Middle East and Maghreb, Eastern Asia, the Caribbean, and America.

**Abbreviations:** SD, standard deviation; SF-6Dv2, Short Form 6-Dimension version 2; CORE-6D, Clinical Outcomes in Routine Evaluation 6-Dimension; EQ-5D-5L, EuroQol 5-Dimension 5-Level.

FCV-19S (OR = 1.11, 95% CI: 1.07–1.14) were more likely, while smokers (OR = 0.58, 95% CI: 0.40–0.86) were less likely to be willing to get vaccinated than their counterparts.

Regarding vaccine confidence, age, education, income, residence status, country of parents, ever faced acute disease in the family, SOC-3, and FCV-19S remained significantly associated with high level of vaccine confidence. Accordingly, age group 40–59 years (OR = 1.48, 95% CI: 1.03–2.13), ≥60 years (OR = 3.30, 95% CI: 2.13–5.13), university degree (OR = 2.14, 95% CI:



**Table 2** Univariate Analysis of Factors Associated with Vaccine Acceptance, and Confidence, in General, in the Province of Quebec, Canada, 2020

Variable	Vaccine Acceptance			Vaccine Confidence		
	I Refuse Most or All Vaccines N (%)	I Accept Most or All Vaccines N (%)	P-value <sup>a</sup>	Low N (%)	High N (%)	P-value <sup>a</sup>
<b>Gender</b>			0.058			0.002
Male	74 (9.6)	698 (90.4)		76 (9.8)	696 (90.2)	
Female	103 (12.6)	716 (87.4)		123 (15.0)	696 (85.0)	
<b>Age</b>			0.84			<0.001
18–39	57 (11.6)	434 (47.0)		94 (19.1)	397 (80.9)	
40–59	60 (11.3)	472 (88.7)		71 (13.4)	459 (86.6)	
≥60	60 (10.8)	510 (89.5)		34 (6.0)	536 (94.0)	
<b>Marital status</b>			<0.001			<0.001
Single	75 (16.3)	384 (83.7)		83 (18.1)	376 (81.9)	
Married	82 (8.7)	857 (91.3)		101 (10.8)	838 (89.2)	
Divorced/separated	16 (10.9)	131 (89.1)		11 (7.5)	136 (92.5)	
Windowed	4 (8.7)	42 (91.3)		4 (8.7)	42 (91.3)	
<b>Occupation</b>			0.28			0.02
Employed	84 (10.3)	732 (89.7)		117 (14.3)	699 (85.7)	
Others (retired, at home, student, on leave, unemployed)	93 (12.0)	682 (88.0)		82 (10.6)	693 (89.4)	
<b>Education</b>			<0.001			0.001
Secondary degree or less	90 (15.9)	477 (84.1)		91 (16.0)	476 (84.0)	
College degree	49 (10.7)	408 (89.3)		60 (13.1)	397 (86.9)	
University degree	38 (6.7)	529 (93.3)		48 (8.5)	519 (91.5)	
<b>Income</b>			<0.001			0.003
<\$50,000	113 (15.2)	628 (84.8)		113 (15.2)	628 (84.8)	
\$50,000–\$89,999	32 (8.4)	349 (91.6)		46 (12.1)	335 (87.9)	
≥\$90,000	32 (6.8)	437 (93.2)		40 (8.5)	429 (91.5)	
<b>Residence</b>			0.22			0.01
Rural	61 (12.6)	423 (87.4)		75 (15.5)	409 (84.5)	
Urban	116 (10.5)	991 (89.5)		124 (11.2)	983 (88.8)	
<b>Housing status</b>			0.14			0.009
Owners	102 (10.2)	895 (89.8)		108 (10.8)	889 (89.2)	
Tenant	75 (12.6)	519 (87.4)		91 (15.3)	503 (84.7)	

(Continued)

Table 2 (Continued).

Variable	Vaccine Acceptance			Vaccine Confidence		
	I Refuse Most or All Vaccines N (%)	I Accept Most or All Vaccines N (%)	P-value <sup>a</sup>	Low N (%)	High N (%)	P-value <sup>a</sup>
<b>Greater Montreal area</b>			0.93			0.38
Outside of Greater Montreal	99 (11.2)	786 (88.8)		105 (11.9)	780 (88.1)	
Greater Montreal	78 (11.0)	628 (89.0)		94 (13.3)	612 (86.7)	
<b>Country born</b>			0.83			0.07
Canada	160 (11.1)	1285 (88.9)		174 (12.0)	1271 (88.0)	
Others	17 (11.6)	129 (84.4)		25 (17.1)	121 (82.9)	
<b>Country of parents</b>			0.97			0.01
Canada	155 (11.1)	1237 (88.9)		163 (11.7)	1229 (88.3)	
Others	22 (11.1)	177 (88.9)		36 (18.1)	163 (81.9)	
<b>Residence status</b>			0.12			0.01
Temporary resident	4 (20.0)	16 (80.0)		6 (30.0)	14 (70.0)	
Permanent resident	1 (3.0)	32 (97.0)		1 (3.0)	32 (97.0)	
Canadian citizen	172 (11.2)	1366 (88.8)		192 (12.5)	1346 (87.5)	
<b>Continue working during COVID-19 crisis</b>			0.14			0.14
Yes	78 (9.9)	707 (90.1)		108(13.8)	677 (86.2)	
No	99 (12.3)	707 (87.7)		91 (11.3)	715 (88.7)	
<b>Health care worker</b>			0.36			0.38
Yes	11(8.7)	116(91.3)		19(15.0)	108(85.0)	
No	166 (11.3)	1298 (88.7)		180 (12.3)	1284 (87.7)	
<b>Other essential worker</b>			0.86			0.63
Yes	43(11.4)	335 (88.6)		50(13.2)	328 (86.8)	
No	134 (11.0)	1079 (89.0)		149(12.3)	1064 (87.7)	
<b>Non-essential worker</b>			0.35			0.23
Yes	27(9.5)	256(90.5)		42(14.8)	241(85.2)	
No	150 (11.5)	1158 (88.5)		157 (12.0)	1151 (88.0)	
<b>Caretaker</b>			0.84			0.55
Yes	18 (16.1)	94 (83.9)		16 (14.3)	96 (85.7)	
No	159 (10.8)	1320 (89.2)		183 (12.4)	1296 (87.6)	
<b>Ever faced acute disease (yourself)</b>			0.67			0.14
Yes	38 (10.5)	324 (89.5)		37 (10.2)	325 (89.8)	

(Continued)

Table 2 (Continued).

Variable	Vaccine Acceptance			Vaccine Confidence		
	I Refuse Most or All Vaccines N (%)	I Accept Most or All Vaccines N (%)	P-value <sup>a</sup>	Low N (%)	High N (%)	P-value <sup>a</sup>
No	139 (11.3)	1090 (88.7)		162 (13.2)	1067 (86.8)	
<b>Ever faced acute disease (family)</b>			0.14			0.40
Yes	73 (9.9)	667 (90.1)		87 (11.8)	653 (88.2)	
No	104 (12.2)	747 (87.8)		112 (13.2)	739 (86.8)	
<b>Ever faced acute disease (caretaker)</b>			0.12			0.13
Yes	19 (8.2)	213 (91.8)		22 (9.5)	210 (90.5)	
No	158 (11.6)	1201(88.4)		177 (13.0)	1182 (87.0)	
<b>Smoking</b>			0.003			0.005
Yes	48 (16.1)	251 (83.9)		52 (17.4)	247 (82.6)	
No	129 (10.0)	1163 (90.0)		147 (11.4)	1145 (88.6)	
<b>COVID-19 (yourself)</b>			0.46			0.44
Yes	2(6.9)	27(93.1)		5(17.2)	24(82.8)	
No	175 (11.2)	1387 (88.8)		194 (12.4)	1368 (87.6)	
<b>COVID-19 (family)</b>			0.93			0.66
Yes	7(10.8)	58(89.2)		7(10.8)	58(89.2)	
No	170 (11.1)	1356 (88.9)		192 (12.6)	1334 (87.4)	
<b>COVID-19 (relative)</b>			0.30			0.92
Yes	15(8.8)	156 (91.2)		21(12.3)	150 (87.7)	
No	162 (11.4)	1258 (88.6)		178 (12.5)	1242 (87.5)	
<b>Perceived reduction in their quality of life due to physical or mental problem</b>			0.24			0.5
Yes	56 (12.6)	388 (87.4)		52 (11.7)	392 (88.3)	
No	121 (10.5)	1026 (89.5)		147 (12.8)	1000 (87.2)	
<b>Financial loss</b>			0.02			0.002
No loss	88 (11.1)	702 (88.9)		87 (11.0)	703 (89.0)	
Slightly important loss	59 (10.5)	502 (89.5)		72 (12.8)	489 (87.2)	
Fairly important loss	20 (9.9)	182 (90.1)		28 (13.9)	174 (86.1)	
Very important loss	10 (26.3)	28 (73.7)		12 (31.6)	26 (68.4)	
<b>Sense of Coherence-3</b>			0.12			<0.001
0–4	124 (12.0)	907 (88.0)		151 (14.6)	880 (85.4)	

(Continued)

Table 2 (Continued).

Variable	Vaccine Acceptance			Vaccine Confidence		
	I Refuse Most or All Vaccines N (%)	I Accept Most or All Vaccines N (%)	P-value <sup>a</sup>	Low N (%)	High N (%)	P-value <sup>a</sup>
5–6	53 (9.5)	507 (90.5%)		48 (8.6)	512 (91.4)	
<b>Risk</b>			0.09			0.09
0	9 (13.2)	59 (86.8)		10 (14.7)	58 (85.3)	
1–5	91 (10.1)	813 (89.9)		101 (11.2)	803 (88.8)	
6–9	65 (11.6)	496 (88.4)		78 (13.9)	483 (86.1)	
10	7 (24.1)	22 (75.9)		7 (24.1)	22 (75.9)	
<b>CORE-6D</b>	0.75	0.75	0.94	0.74	0.75	0.27
<b>SF-6Dv2</b>	0.71	0.72	0.70	0.71	0.72	0.38
<b>EQ-5D-5L</b>	0.84	0.85	0.50	0.84	0.84	0.84
<b>Fear of COVID-19 Scale</b>	13.94	16.78	<0.001	13.9	16.8	<0.001

Notes: <sup>a</sup>The P-values refer to tests between classes using one-way analysis of variance, Bartlett's test for equality of variances, Fisher's exact test, and Chi<sup>2</sup> test of independence based on observations.

Abbreviations: CORE-6D, Clinical Outcomes in Routine Evaluation 6-Dimension; SF-6Dv2, Short Form 6-Dimension version 2; EQ-5D-5L, EuroQol 5-Dimension 5-Level.

Table 3 Univariate Analysis of Factors Associated with Vaccine Hesitancy in General and COVID-19 Vaccination Refusal in the Province of Quebec, Canada, 2020

Variable	Vaccine Hesitancy			Vaccine Refusal		
	Low N (%)	High N (%)	P-value <sup>a</sup>	Pro-Vaccine N (%)	Anti-Vaccine N (%)	P-value <sup>a</sup>
<b>Gender</b>			<0.001			<0.001
Male	639 (82.9)	132 (17.1)		661 (85.1)	116 (14.9)	
Female	607 (74.2)	211 (25.8)		646 (78.6)	175 (21.4)	
<b>Age</b>			0.003			<0.001
18–39	363 (74.1)	127 (25.9)		387 (78.8)	104 (21.2)	
40–59	414 (78.1)	116 (21.9)		423 (79.2)	111 (20.8)	
≥60	470 (82.6)	99 (17.4)		498 (86.8)	76 (13.2)	
<b>Marital status</b>			<0.04			0.34
Single	338 (73.8)	120 (26.1)		364 (79.1)	96 (20.9)	
Married	755 (80.4)	184 (19.6)		784 (83.0)	161 (17.0)	
Divorced/separated	116 (79.5)	30 (20.9)		121 (81.8)	27 (18.2)	
Widowed	38 (82.6)	8 (17.4)		39 (84.8)	7 (15.2)	
<b>Occupation</b>			0.21			0.54
Employed	630 (77.2)	186 (22.8)		673 (82.4)	144 (17.6)	

(Continued)

Table 3 (Continued).

Variable	Vaccine Hesitancy			Vaccine Refusal		
	Low N (%)	High N (%)	P-value <sup>a</sup>	Pro-Vaccine N (%)	Anti-Vaccine N (%)	P-value <sup>a</sup>
Others (retired, at home, student, on leave, unemployed)	617 (79.8)	156 (20.2)		635 (81.2)	147 (18.8)	
<b>Education</b>			<0.001			<0.001
Secondary degree or less	411 (72.5)	156 (27.5)		439 (77.3)	129 (22.7)	
College degree	353 (77.4)	103 (22.6)		371 (80.5)	90 (19.5)	
University degree	483 (85.3)	83 (14.7)		498 (87.4)	72 (12.6)	
<b>Income</b>			<0.001			<0.001
<\$50,000	542 (73.3)	197 (26.7)		579 (77.7)	166 (22.3)	
\$50,000–\$89,999	312 (81.9)	69 (18.1)		313 (81.9)	69 (18.1)	
≥\$90,000	393 (83.8)	76 (16.2)		416 (88.1)	56 (11.9)	
<b>Residence</b>			0.44			0.22
Rural	374 (77.3)	110 (22.7)		388 (80.0)	97 (20.0)	
Urban	873 (79.0)	232 (21.0)		920 (82.6)	194 (17.4)	
<b>Housing status</b>			<0.001			0.003
Owners	814 (81.7)	182 (18.3)		840 (84.0)	160 (16.0)	
Tenant	433 (73.0)	160 (27.0)		468 (78.1)	131 (21.9)	
<b>Greater Montreal area</b>			0.21			0.93
Outside of Greater Montreal	704 (79.6)	180 (20.4)		726 (81.8)	162 (18.2)	
Greater Montreal	543 (77.0)	162 (23.0)		582 (81.9)	129 (18.1)	
<b>Country born</b>			0.31			0.28
Canada	1138 (78.8)	306 (21.2)		1192 (82.2)	259 (17.8)	
Others	109 (75.2)	36 (24.8)		116 (78.4)	32 (21.6)	
<b>Country of parents</b>			0.83			0.13
Canada	1101 (79.2)	290 (20.8)		1149(82.2)	248(17.8)	
Others	146 (73.7)	52 (26.7)		159(78.7)	43(21.3)	
<b>Residence status</b>			0.46			0.93
Temporary resident	14 (70.0)	6 (30.0)		17 (85.0)	3 (15.0)	
Permanent resident	24 (72.7)	9 (27.3)		27 (81.8)	6 (18.2)	
Canadian citizen	1209 (78.7)	327 (21.3)		1264 (81.8)	282 (18.2)	
<b>Continue working during COVID-19 crisis</b>			0.62			0.89
Yes	612 (78.0)	173 (22.0)		644(81.9)	142(18.1)	

(Continued)

Table 3 (Continued).

Variable	Vaccine Hesitancy			Vaccine Refusal		
	Low N (%)	High N (%)	P-value <sup>a</sup>	Pro-Vaccine N (%)	Anti-Vaccine N (%)	P-value <sup>a</sup>
No	635 (79.0)	169 (21.0)		664(81.7)	149(18.3)	
<b>Health care worker</b>			0.09			0.79
Yes	107(84.3)	20(15.7)		105(82.7)	22(17.3)	
No	1140 (78.5)	322 (22.0)		1203(81.7)	269(18.3)	
<b>Other essential worker</b>			0.003			0.53
Yes	276 (73.0)	102(27.0)		306(80.7)	73(19.3)	
No	971 (80.2)	240 (19.8)		1002(82.1)	218(17.9)	
<b>Non-essential worker</b>			0.16			0.93
Yes	231 (81.6)	52 (18.4)		232(82.0)	51(18.0)	
No	1016 (77.8)	290 (22.2)		1076 (81.8)	240 (18.2)	
<b>Caretaker</b>			0.004			0.79
Yes	75 (67.6)	36(32.4)		93 (80.9)	22 (19.1)	
No	1172 (79.3)	306 (20.7)		1215 (81.9)	269 (18.1)	
<b>Ever faced acute disease (yourself)</b>			0.31			0.51
Yes	291 (80.4)	71(19.5)		302(83.0)	62(17.0)	
No	956 (77.9)	271 (22.1)		1006(81.5)	229(18.5)	
<b>Ever faced acute disease (family)</b>			0.54			0.09
Yes	585 (79.2)	154 (20.8)		623(83.5)	123(16.5)	
No	662 (77.9)	188(22.1)		685(80.3)	168(19.7)	
<b>Ever faced acute disease (caretaker)</b>			0.90			0.51
Yes	182 (78.8)	49 (21.2)		195(83.3)	39(16.7)	
No	1065 (78.4)	293 (21.6)		1113(81.5)	252(18.5)	
<b>Smoking</b>			<0.001			0.13
Yes	206 (68.9)	93 (31.1)		238(78.8)	64(21.2)	
No	1041 (80.7)	249 (19.3)		1070(82.5)	227(17.5)	
<b>COVID-19 (yourself)</b>			0.73			0.89
Yes	22(75.9)	7(24.1)		24(82.8)	5(17.2)	
No	1225 (78.5)	335 (21.5)		1284(81.8)	286(18.2)	
<b>COVID-19 (family)</b>			0.54			0.35
Yes	49(75.4)	16(24.6)		56(86.2)	9(13.8)	
No	1198 (78.6)	326 (21.4)		1252(81.6)	282(18.4)	

(Continued)

Table 3 (Continued).

Variable	Vaccine Hesitancy			Vaccine Refusal		
	Low N (%)	High N (%)	P-value <sup>a</sup>	Pro-Vaccine N (%)	Anti-Vaccine N (%)	P-value <sup>a</sup>
<b>COVID-19 (relative)</b>			0.31			0.49
Yes	129 (75.4)	42(24.6)		144(83.7)	28(16.3)	
No	1118 (78.8)	300 (21.2)		1164(81.6)	263(18.4)	
<b>Perceived reduction in their quality of life due to physical or mental problem</b>			0.25			0.25
Yes	340 (76.6)	104(23.4)		357(80.0)	89(20.0)	
No	907 (79.2)	238 (20.8)		951(82.5)	202(17.5)	
<b>Financial loss</b>			<0.001			0.81
No loss	642 (81.5)	146 (18.5)		647 (81.6)	146 (18.4)	
Slightly important loss	430 (76.6)	131 (23.4)		464 (82.1)	101 (17.9)	
Fairly important loss	155 (76.7)	47 23.3)		168 (82.8)	35 (17.2)	
Very important loss	20 (52.6)	18 (47.4)		29 (76.3)	9 (23.7)	
<b>Sense of Coherence-3</b>			<0.001			0.06
0–4	780 (75.7)	250 (24.3)		834(80.5)	202(19.5)	
5–6	467 (83.5)	92 (16.5)		474(84.2)	89(15.8)	
<b>Risk</b>			0.09			0.009
0	52 (76.5)	16 (23.5)		49 (71.0)	20 (29.0)	
1–5	727 (80.5)	176 (19.5)		740 (81.2)	171 (18.8)	
6–9	421 (75.2)	139 (24.8)		475 (84.7)	86 (15.3)	
10	24 (82.8)	5 (17.2)		20 (69.0)	9 (31.0)	
<b>CORE-6D</b>	0.76	0.72	<0.001	0.75	0.7532	0.901
<b>SF-6Dv2</b>	0.73	0.67	<0.001	0.72	0.7202	0.671
<b>EQ-5D-5L</b>	0.85	0.83	0.016	0.84	0.85	0.613
<b>Fear of COVID-19 Scale</b>	16.6	15.8	0.028	16.71	15.29	0.180

Notes: <sup>a</sup>The P-values refer to tests between classes using one-way analysis of variance, Bartlett's test for equality of variances, Fisher's exact test, and Chi<sup>2</sup> test of independence based on observations.

Abbreviations: CORE-6D, Clinical Outcomes in Routine Evaluation 6-Dimension; SF-6Dv2, Short Form 6-Dimension version 2; EQ-5D-5L, EuroQol 5-Dimension 5-Level.

1.40–3.30), annual income  $\geq$ CAD \$90,000 (OR = 2.15, 95% CI: 1.41–3.28), permanent resident in Canada (OR = 10.41, 95% CI: 1.05–102.98), country of parents from Canada (OR = 2.18, 95% CI: 1.35–3.52), ever faced acute disease in the family (OR = 1.41, 95% CI: 1.08–1.97), higher SOC-3 (OR = 1.60, 95% CI: 1.10–2.33), and being afraid of COVID-19 (FCV-19S) (OR = 1.11, 95% CI: 1.07–1.14) were significantly positively associated with high level of vaccine confidence.

Similarly, the final multivariate analysis model also demonstrated several predictors such as education, income, acting as caretaker, other essential worker, smoking, financial loss, SOC-3, FCV-19S, and CORE-6D, for vaccination hesitancy. Study participants educated with university degree (OR = 0.51, 95% CI: 0.37–0.70), annual income of CAD \$50,000–\$89,999 (OR = 0.68, 95% CI: 0.50–0.95) and  $\geq$ CAD \$90,000 (OR = 0.64, 95% CI: 0.46–0.90), higher SOC-3 (OR = 0.69, 95% CI: 0.52–0.92),

**Table 4** Multivariable Logistic Regression Analysis of Factors Associated with Vaccine Acceptance and Confidence, in General, in the Province of Quebec, Canada, 2020

Variables	Vaccine Acceptance AOR (95% CI)	P-value	Vaccine Confidence AOR (95% CI)	P-value
<b>Age</b>				
18–39			REF	-
40–59			1.48 (1.03–2.13)	0.033
≥60			3.30 (2.13–5.13)	<0.001
<b>Education</b>				
Secondary degree or less	REF		REF	
College degree	1.58 (1.06–2.33)	0.023	1.26 (0.86–1.84)	0.230
University degree	2.21 (1.43–3.40)	<0.001	2.14 (1.40–3.30)	0.001
<b>Income</b>				
<\$50,000	REF		REF	
\$50,000–\$89,999	1.85 (1.21–2.85)	0.005	1.26 (0.85–1.88)	0.25
≥\$90,000	2.49 (1.60–3.88)	<0.001	2.15 (1.41–3.28)	<0.001
<b>Residence status</b>				
Temporary resident			REF	
Permanent resident			10.41 (1.05–102.98)	0.04
Canadian citizen			1.51 (0.49–4.63)	0.47
<b>Country of parents</b>				
Canada			2.18 (1.35–3.52)	0.001
Others			REF	
<b>Ever faced acute disease (family)</b>				
Yes	0.73 (0.52–1.02)	0.066	1.41 (1.08–1.97)	0.045
No	REF		-	
<b>Smoking</b>				
Yes	0.58 (0.40–0.86)	0.006	0.69 (0.47–1.01)	0.055
No	REF		REF	
<b>Sense of Coherence-3</b>				
0–4			REF	-
5–6			1.60 (1.10–2.33)	0.013
<b>Fear of COVID-19 scale<sup>a</sup></b>	1.11 (1.07–1.14)	<0.001	1.11 (1.07–1.14)	<0.001

Note: <sup>a</sup>Continuous variable was used.

Abbreviations: AOR, adjusted odds ratio; REF, reference; CORE-6D, Clinical Outcomes in Routine Evaluation 6-Dimension; SF-6Dv2, Short-form 6-Dimension version 2.

FCV-19S (OR = 0.95, 95% CI: 0.93–0.97), and CORE-6D (OR = 0.16, 95% CI: 0.04–0.69), had lower odds of having high level of vaccine hesitancy, while those who were acting as caretaker (OR = 2.05, 95% CI: 1.13–3.21), other essential workers (OR = 1.58, 95% CI: 1.18–2.13), smokers (OR = 1.47, 95% CI: 1.08–2.0) and those having slightly important financial loss (OR =



**Table 5** Multivariable Logistic Regression Analysis of Factors Associated with Vaccine Hesitancy in General and COVID-19 Vaccination Refusal in the Province of Quebec, Canada, 2020

Variables	Vaccine Hesitancy AOR (95% CI)	P-value	Vaccine Refusal AOR (95% CI)	P-value
<b>Age</b>				
18–39			REF	
40–59			1.00 (0.73–1.38)	0.99
≥60			0.52 (0.37–0.74)	<0.001
<b>Education</b>				
Secondary degree or less	REF		REF	
College degree	0.75 (0.55–1.02)	0.06	0.80 (0.59–1.11)	0.191
University degree	0.51 (0.37–0.70)	<0.001	0.52 (0.37–0.74)	<0.001
<b>Income</b>				
<\$50,000	REF		REF	
\$50,000–\$89,999	0.68 (0.50–0.95)	0.02	0.81 (0.58–1.11)	0.196
≥\$90,000	0.64 (0.46–0.90)	0.009	0.44 (0.31–0.63)	<0.001
<b>Country of parents</b>				
Canada			0.64 (0.43–0.95)	0.03
Others			REF	
<b>Caretaker</b>				
Yes	2.05 (1.31–3.21)	0.002		
No	REF			
<b>Other essential worker</b>				
Yes	1.58 (1.84–2.13)	0.002		
No	REF			
<b>Smoking</b>				
Yes	1.47 (1.08–2.0)	0.015		
No	REF			
<b>Financial loss</b>				
No loss	REF			
Slightly important loss	2.70 (1.23–5.89)	0.013		
Fairly important loss	2.56 (1.22–5.56)	0.013		
Very important loss	3.57(1.66–7.14)	0.001		
<b>Sense of Coherence-3</b>				
0–4	REF			
5–6	0.69 (0.52–0.92)	0.013		

(Continued)

Table 5 (Continued).

Variables	Vaccine Hesitancy AOR (95% CI)	P-value	Vaccine Refusal AOR (95% CI)	P-value
<b>Willingness to take a risk</b>				
0	REF		REF	
1–5	0.87 (0.47–1.61)	0.47	0.54 (0.31–0.94)	0.031
6–9	1.28 (0.68–2.41)	0.44	0.42 (0.24–0.76)	0.004
10	0.46 (0.14–1.5)	0.21	0.91 (0.33–2.45)	0.85
<b>Fear of COVID-19 scale<sup>a</sup></b>	0.95 (0.93–0.97)	<0.001	0.95 (0.93–0.97)	<0.001
<b>CORE-6D<sup>a</sup></b>	0.16 (0.04–0.69)	0.01		
<b>SF-6Dv2<sup>a</sup></b>	0.63 (0.38–1.04)	0.069		

Note: <sup>a</sup>Continuous variables were used.

Abbreviations: AOR, adjusted odds ratio; REF, reference; CORE-6D, Clinical Outcomes in Routine Evaluation 6-Dimension; SF-6Dv2, Short-form 6-Dimension version 2.

2.70, 95% CI: 1.23–5.89), fairly important financial loss (OR = 2.56, 95% CI: 1.22–5.56), and very important financial loss (OR = 3.57, 95% CI: 1.66–7.14), had higher odds of having high level of vaccine hesitancy. Likewise, our adjusted multivariate analysis demonstrated a number of associates of COVID-19 vaccine refusal such as age, education, income, country of parents, willingness to take risk about vaccination, and FCV-19S. Study participants of age group  $\geq 60$  years (OR = 0.52, 95% CI: 0.37–0.74), educated with university degree (OR = 0.52, 95% CI: 0.37–0.74), annual income of  $\geq$ CAD \$90,000 (OR = 0.44, 95% CI: 0.31–0.63), country of parents from Canada (OR = 0.64, 95% CI: 0.43–0.95), a score of <sup>1–5</sup> willingness to risk (OR = 0.54, 95% CI: 0.31–0.94) and score of <sup>6–9</sup> willingness to risk (OR = 0.42, 95% CI: 0.24–0.76), and high FCV-19S (OR = 0.95, 95% CI: 0.93–0.97) were less likely to have high level of COVID-19 vaccination refusal. We tested different categorization for the outcomes of interest in order to confirm the above-mentioned results ([Supplementary Materials, Tables S2–S6](#)) and they were not very different from the current results for outcome variables.

## Discussion

In the present study, out of 1599 study participants, 88.9%, 87.5%, 78.5%, and 18.2%, respectively, indicated their acceptance of some, most or all vaccines, had high level of vaccine confidence, low level of vaccine hesitancy in general, and COVID-19 vaccine refusals. Vaccine acceptance rate was almost similar to what was found in another study in Canada (88.9% vs 82%).<sup>20</sup> There could be inter-and-intra country differences in vaccine acceptance rates based on types of vaccines and individual perception of vaccination. It has been reported to have almost 90% (in China) to less than 55% (in Russia) COVID-19 vaccine acceptance rates amidst COVID-19 pandemics.<sup>21</sup> In a recent Canadian study conducted among 9252 Saskatchewan adults ( $\geq 18$  years), 76%, 13% and 11% of the participants, respectively, indicated to be vaccinated or willing to, hesitant and refusal with COVID-19 vaccination<sup>22</sup> which is comparable to our current study findings although we observed higher rates for all three dimensions of vaccine acceptance, hesitancy, and refusals, given that we did not use the same methodology to construct these variables and that their data were collected over a longer period. However, these lower rates of outcome of interest found in Saskatchewan adults may be considered in a perspective where Canadians in central provinces such as Saskatchewan and Alberta have been more protesting against COVID-19 vaccine mandates.<sup>23</sup>

Our study found that higher education attainment and higher income were significantly positively associated with vaccine acceptance, which is consistent with several other previous study findings.<sup>21,24</sup> We also found that having a higher fear of COVID-19 (FCV-19S) was positively associated with willingness to have vaccine acceptance. We assume that increased fear of such emerging disease might have created the participants to be of more health concern. Similar to our study findings, previous studies supported the notion of being afraid of COVID-19 to influence participants to accept vaccination.<sup>25,26</sup> This could be explained in a way that the growing sense of realization about risk of acquiring disease might influence people to adopt preventive strategies. Identification of the risk perception towards specific health intervention is therefore necessary, especially during pandemic situation.<sup>27</sup>

Higher vaccine confidence level could impact vaccination status, and it has been demonstrated a positive association between vaccine confidence and vaccine uptake.<sup>28</sup> However, there are several factors associated with vaccine confidence such as the vaccine safety and effectiveness among many others that are of major concern.<sup>29</sup> We found several sociodemographic factors in the study participants such as an older age group, higher education achievement, and income, being permanent resident in Canada, having parents born in Canada, ever faced acute disease in the family, and FCV-19S, to produce higher odds of having of a high level of vaccine confidence. These findings seem to like what have been found in the literature throughout the COVID-19 pandemic times especially for those studies related to COVID-19 vaccine confidence.<sup>24,29</sup> The possible reasons are obvious as people at this moment are highly concerned with the fatalities associated with COVID-19. Nonetheless, this does not always seem true for vaccination in general, for example, a global study being held in 2016 to assess the general vaccine confidence that included a 67-country survey uncovered that higher educational attainment, good access to health services and socio-economic status had an inverse relation with vaccine confidence.<sup>30</sup> Nonetheless, the vaccine confidence level could be dynamic as it could be determined by many other factors such as the importance of vaccination, vaccine safety concerns and effectiveness.<sup>28,30</sup> Hence, periodic follow-up study should be recommended.

Vaccine hesitancy is a complex issue associated with a variety of context-specific factors. Decreasing vaccine confidence is considered as one of the potential contributors to the reduced vaccine coverage rates.<sup>31</sup> A large-scale global study being conducted among 32,028 subjects from eight different countries around the world reported an overall 27% of the participants who demonstrated vaccine hesitancy with intercountry variation (France, 47.3% vs Brazil, 9.6%) between March 2020 and January 2021.<sup>32</sup> In our study, we observed that more than three fourth of the study participants had low level of vaccine hesitancy. Higher educational achievement and income, as well as higher FCV-19S and HRQoL (CORE-6D) scores, were less likely to have high level of vaccine hesitancy, while those acting as caretakers and other essential workers had higher odds of having high level of vaccine hesitancy. Comparable to our study finding, Muhajarine et al found that not being afraid of COVID-19 were significantly associated with increased likelihood of vaccine hesitancy.<sup>22</sup> In addition, we suppose that the reason behind having lower vaccine hesitancy to those of having higher HRQoL could be due to our study participants being younger who are supposed to have less fatality or to be hospitalized compared to elderly people.<sup>33</sup> Elderly people who have chronic conditions expressed low HRQoL and are at higher risk to get COVID-19 than healthy people, which make them afraid of the virus and subsequently decrease their vaccine hesitancy.<sup>34</sup> It might be possible that the other essential workers (eg, truckers) were more hesitant to COVID-19 vaccine because most of them have low education level which was associated with high vaccine hesitancy in our results.<sup>35</sup> There are also possibly religious and cultural beliefs and personal values (freedom) which opposed the enforcement of vaccine by the government in different countries and subsequently increased their mistrust and less confidence in vaccine.<sup>36</sup> Other studies showed the detrimental effect of socio-economic gradients on higher level of vaccine hesitancy.<sup>37,38</sup> Our study also revealed that those with slightly important financial loss, fairly important financial loss, and very important financial loss were more likely to have high level of vaccine hesitancy indicating the influence of financial losses on incremental vaccine hesitancy. Increasing vaccine uptake strategy should therefore target socio-economically disadvantaged group who are more at risk of having vaccine-preventable diseases.<sup>38</sup>

In addition, more interestingly, our analyses demonstrated that participants having a higher sense of coherence were more likely to have both higher vaccine confidence and lower level of vaccine hesitancy, while smokers were less willing to have vaccine acceptance, and higher vaccine hesitancy. Other studies have highlighted the higher sense of coherence in terms of healthcare and healthcare utilization benefits.<sup>39,40</sup> We presume that the higher sense of coherence in participants might have increased the perceived need and positive attitudes towards vaccine acceptance. In line with our study findings, studies from the UK and the USA also observed that smokers were uncertain and unwilling to be vaccinated for COVID-19.<sup>41,42</sup> This could be argued that smokers do have a negative attitude towards vaccine, were unknown about the future effects of vaccination and/or believed in natural immunity.<sup>41</sup> Smoking cessation interventions would therefore potentially be beneficial to improve vaccine uptake, besides reducing the risk of infection and spread of COVID-19.<sup>43</sup>

Our study more specifically identified the key drivers of COVID-19 vaccine refusals. Study participants of age group  $\geq 60$  years, university degree education, annual income of  $\geq$ CAD \$90,000, country of parents from Canada, a higher score (1–5 and 6–9) for willingness to take a risk, and high fear of COVID-19 were less likely to have a high level of COVID-19

vaccination refusal. Muhajarine et al found that lower education level, being born outside Canada, and not being afraid of COVID-19 were significantly associated with a higher likelihood of vaccine refusal, which is similar to our study findings.<sup>22</sup> The increased vaccine refusal among immigrants may be explained by the fact that most of them have religious and cultural beliefs which are against vaccine uptake.<sup>44</sup> Another cross-sectional study led among women in the UK found that ethnic minority women were twice more likely to reject COVID-19 vaccine when not pregnant, pregnant, and for their babies compared with white ethnic women.<sup>45</sup> Soares et al also reported that vaccine refusal was higher among young people, those who had a loss of income during the pandemic and those having low confidence in the COVID-19 vaccine.<sup>46</sup>

We recommend considering these predictors while initiating interventions to improve the COVID-19 vaccination rates to develop the optimum level of herd immunity in the province of Quebec. This study is meaningful in the context of current COVID-19 pandemic situation with a surge of new variants and has some important strengths to mention about. Firstly, this study involved a representative sample that might allow extrapolation of study outcome in the province of Quebec, Canada, and other similar settings. Secondly, although the study was based on online survey questionnaires, it has a high response rate of 44.23%. Thirdly, we employed validated study instruments in collecting relevant information. Lastly, we conducted robust statistical analyses with various statistical modeling in order to confirm the consistency of the results presented. However, the study should be interpreted in the light of some specific inherent limitations. Indeed, our study participants were only French Speakers and those who could not access the online survey questionnaire because of physical health and other concerns were left behind. This could obviously have external validity threat to use the study outcome beyond French speaker participants and those not reached online. In addition, our study results of vaccine acceptance, confidence and hesitancy might have been influenced by contextual factors since we conducted the study just before the beginning of the COVID-19 vaccination campaign in Quebec (ie, December 2020). Finally, we cannot suggest cause-and-effect relationships as this is a cross-sectional study. However, our study revealed the proportion of participants with COVID-19 vaccination refusal behavior and its associated factors using specific questionnaires. Local area research could provide essential data needed for area-specific interventions. Further studies should focus on the key drivers of low level of vaccine acceptance, confidence, and high level of hesitancy in the context of fulfillment of recommended doses and booster doses for COVID-19 vaccination.

## Conclusions

Our study reported that more than three fourth of the study participants indicated the acceptance of some, most or all vaccines, high level of vaccine confidence, low level of vaccine hesitancy in general, and nearly one in five indicated COVID-19 vaccine refusals in 2020. Since some socio-demographic and health-related quality of life factors were associated with the outcome variables, those factors should be sought while designing interventions to improve COVID-19 vaccination rates to develop the optimum level of herd immunity in the province of Quebec, Canada, and in similar settings. Additional studies should be performed to investigate the key drivers of compliance to recommended doses of COVID-19 vaccination including booster doses.

## Author Contributions

All authors contributed to data analysis, drafting or revising the article, have agreed on the journal to which the article was submitted, gave final approval of the version to be published, and agreed to be accountable for all aspects of the work. Alexis Nizigiyimana and Dilaram Acharya have contributed equally to this work and share first authorship.

## Funding

This study was funded by the Fondation de l'IUSMM and supported by the CIRANO.

## Disclosure

The authors report no conflicts of interest in relation to this work.

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