



## Using Best-Worst Scaling to investigate younger adult Canadians' preferences for COVID-19 vaccination and public health measures: An observational study

Ovidiu Tatar<sup>a,b,\*</sup>, Ben Haward<sup>a</sup>, Patricia Zhu<sup>a,c</sup>, Gabrielle Griffin-Mathieu<sup>a</sup>, Samara Perez<sup>a,d</sup>, Gregory Zimet<sup>e</sup>, Zeev Rosberger<sup>a,f</sup>

<sup>a</sup> Lady Davis Institute for Medical Research (LDI), Jewish General Hospital, Montreal, QC, Canada

<sup>b</sup> Research Center, Centre Hospitalier de l'Université de Montréal (CRCHUM), Montreal, QC, Canada

<sup>c</sup> Department of Psychiatry, McGill University, Montreal, QC, Canada

<sup>d</sup> McGill University Health Center (MUHC), Montreal, QC, Canada

<sup>e</sup> Indiana University School of Medicine, IN, USA

<sup>f</sup> Departments of Psychology, Psychiatry and Oncology, McGill University, Montreal, QC, Canada

### ARTICLE INFO

#### Keywords:

COVID-19  
Vaccination  
Public health measures  
Preferences  
Best-Worst Scaling  
Vaccine acceptability  
Younger adults

### ABSTRACT

Containing the COVID-19 pandemic is dependent on compliance with public health recommendations and mandates which is lower in younger compared to older adults. Furthermore, younger adults have demonstrated lower uptake of COVID-19 vaccines. The aim of this study was to assess preferences for COVID-19 related preventive health measures and vaccination and to explore their association with COVID-19 vaccine acceptability. Canadians aged 18–39 years were invited to participate in a web-based survey in August 2021. We used the Best-Worst-Scaling (BWS) methodology to collect and analyze preference data and multivariable binary logistic regression to estimate associations with vaccine acceptability. Based on 266 complete responses, we found strong preferences for physical distancing and wearing face masks, as compared to general hygiene and respiratory etiquette. High vaccine accessibility independent of the location, receiving successive doses of the same vaccine brand and higher vaccine uptake of people in younger adults' social circle were highly preferred. Higher preferences for mandates requiring proof of vaccination and altruistic motives focused on protecting others by getting vaccinated were associated with vaccine acceptability. As the COVID-19 pandemic waxes and wanes, studies using larger, nationally representative samples are needed to replicate and validate these results to assess preferences for health behaviors corresponding to the latest recommendations. The use of this methodology could provide public health authorities with a unique opportunity to develop targeted, preference-based messaging that aligns with the latest guidelines to effectively encourage compliance and COVID-19 vaccine uptake.

### 1. Introduction

The COVID-19 pandemic is one of the greatest public health challenges of recent times. Canada alone has reported over 1.69 million cases and 28,500 deaths at the time of writing, and mitigation strategies have had far-reaching effects on our social and economic landscape (Government of Canada, 2021). Non-pharmaceutical measures, such as mask wearing, physical distancing, and restrictions on schools and businesses, remain essential tools to contain the COVID-19 pandemic and reduce the strain on healthcare systems. The introduction of

vaccines has further bolstered our ability to combat the pandemic and has likely saved countless lives. However, vaccine refusal and non-compliance to recommended public health measures pose significant barriers to containing and ultimately halting the pandemic, particularly in light of the unpredictable emergence of new variants such as Omicron.

Younger adults have been identified as a population of concern during this pandemic because they have a greater number of social contacts, are more likely to experience mild or asymptomatic infection (Sah et al., 2021), and are less likely to be aware of infection and isolate

\* Corresponding author.

E-mail address: [ovidiu.tatar@mail.mcgill.ca](mailto:ovidiu.tatar@mail.mcgill.ca) (O. Tatar).

<https://doi.org/10.1016/j.pmedr.2022.101755>

Received 22 November 2021; Received in revised form 27 February 2022; Accepted 6 March 2022

Available online 8 March 2022

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from others [Boehmer et al. \(2020\)](#). Numerous population-based studies have identified an association between younger age and public health measure non-compliance ([Valenti and Faraci, 2021](#); [Coroiu et al., 2020](#)). Despite COVID-19 vaccines (including booster shots) now being widely available in Canada, younger adults aged 18–39 have a lower rate of full vaccination (about 85%; only 35% with booster shots) than older adults, aged 60+ (90–95%; over 75% with booster shots) in Canada ([Government of Canada, 2022](#)), reflecting previous findings suggesting younger age is associated with greater COVID-19 vaccine hesitancy ([Affifi et al., 2021](#); [Ogilvie et al., 2021](#)).

Attitudes and beliefs towards COVID-19 public health measures and vaccination vary across age groups, suggesting that the acceptability of, and compliance with, measures and recommendations will also vary with age ([Ogilvie et al., 2021](#); [Lang et al., 2021](#)). Few studies have examined individual preferences for COVID-19 preventive health measures including vaccines as a way to understand the public response to mitigation measures ([Eshun-Wilson et al., 2021](#); [Manipis et al., 2021](#); [Chorus et al., 2020](#); [Reed et al., 2020](#)), and none in younger Canadian adults. In the last decade, the Best-Worst Scaling (BWS) methodology (grounded in the microeconomic theory) has gained traction in evaluating preferences for interventions in healthcare ([Cheung et al., 2016](#); [Muhlbacher et al., 2016](#)) but it has yet to be used in the context of the COVID-19 pandemic. Compared to using conventional multiple choice questions in which preferred attributes are selected only once, BWS offers a more in-depth, nuanced understanding of preferences based on the concept of utility trade-off ([Finn and Louviere, 1992](#); [Szeinbach et al., 1999](#)).

Using more advanced evaluation methods of public preferences could assist public health authorities in modifying and aligning guidelines, and in turn build trust, ensure acceptability, and increase compliance with mitigating strategies to address the COVID-19 pandemic. The objectives of this study were to advance our understanding of the preferences of Canadian younger adults (aged 18–39) for COVID-19 public health measures and vaccination; and to explore the associations between these preferences and COVID-19 vaccine acceptability.

## 2. Methods

### 2.1. Study design

In August 2021, we used a cross-sectional design and a web-based survey to collect data from Canadian adults. We provided the study details according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) recommendations ([Vandenbroucke et al., 2007](#)). Ethical approval was obtained from the Research Ethics Board of the CIUSSS West-Central Montreal (Project ID 2022-2877).

### 2.2. Setting and participants

Canadian residents aged 18–39 years independent of their COVID-19 vaccination status were invited to complete the questionnaire in English. At the time of data collection COVID-19 vaccines were available for Canadians 12 years and older in all jurisdictions and the national uptake rate in the population of interest was about 70% ([Government of Canada, 2021](#)). Data collection was facilitated by Dynata, an international survey company that used different platforms (e.g., direct email, smartphone app notifications, their own website) to invite participants to complete a survey about “health and wellness”. Dynata participants are recruited through a “By-Invitation-Only” method, in which participants’ identities are validated by other partnered businesses to ensure response quality. We used quotas for sex and province of residence (according to national census data) to ensure a balanced sample. After providing electronic consent, participants completed the questionnaire on smartphones or computers and were compensated according to Dynata’s rewards and points system (e.g., Amazon, Starbucks).

### 2.3. Variables

Sociodemographics included continuous (i.e., age) and categorical variables [gender province or territory; ethnicity; self-perceived visible minority (yes/no); influence of religion on health decisions (yes/no); language spoken at home (English, French, Other); post-secondary education attainment (yes/no); and income (twenty thousand dollars increments)]. Variables with small cell count for some categories were re-categorized. Thus, province or territory was re-categorized into Western, Central, or Atlantic Canada. The nine categories used by Statistics Canada to measure self-reported ethnic origins ([Statistics Canada, 2016](#)) were re-categorized into North American (e.g., Canadian; American; Ontarian, Quebecois, North American Aboriginal origins), European, Asian, or Other (i.e., Caribbean, Latin, Central and South American, African). We used multiple validated categories ([National LGBT Health Education Center, 2016](#)) to measure gender identity that captures men and women’s socially constructed roles, identities and behaviors and retained for analyses three categories: male, female and gender diverse. For self-reported yearly family income in the year preceding the pandemic, we created three categories using 40- and 80-thousand-dollar cut-offs.

Informed by the literature search conducted by our team, we included measures that were associated with COVID-19 vaccine acceptability. We used the following dichotomous (yes/no) variables: healthcare professional status; caregiver of an elderly person; receipt of the flu vaccine in the last 12 months; history of testing positive for COVID-19 for oneself and friends/family. The validated 6-point-item (excellent to very poor) measure of self-perceived health status ([Bowling, 2005](#)) was dichotomized into “excellent or very good” and “good or less”. Smoking history was captured by three categories: never; former; and current smoker.

We used the Precaution Adoption Process Model (PAPM) ([Weinstein et al., 2008](#)) to measure COVID-19 vaccine acceptability and participants selected one of the five nominal intention stages: *unengaged*; *undecided*; *decided not*; *decided to vaccinate*; and *vaccinated*. The outcome was dichotomized into vaccine acceptors (stages *decided to* and *vaccinated*) and vaccine hesitant/rejectors (*unengaged*, *undecided* and *decided not*).

Preferences for preventive public health measures and COVID-19 vaccination were measured using the case 2 BWS methodology ([Cheung et al., 2016](#); [Muhlbacher et al., 2016](#)). Two domains of preferences were determined for preventive public health measures (A – preventive health behaviors; B – government mandates) and two for vaccination (C – immunization specific; D – motives for vaccination). For each domain, we defined attributes that reflect high-order preferences within a domain and within each attribute we used attribute-levels to measure preferences for an attribute. We selected attributes and attribute-levels for each domain based on public health measures and COVID-19 vaccination recommendations available on the website of the Government of Canada and government mandates (e.g., curfew, travelling limitations) ([Government of Canada, 2021](#)) at the time of study conception (April–June 2021). Additionally, preferences (e.g., altruistic vaccination motives, self-interested motives) were chosen based on relevant literature ([Hershey et al., 1994](#); [Cucciniello et al., 2022](#)) and concepts included in media campaigns designed to improve vaccine uptake. To measure preferences, a total of 57 questions were answered, 16 questions in each of the domains A, B and D and 9 questions in domain C ([Table 1](#), sample questions).

We created a separate set of questions for each domain in two phases. First, we defined the attributes and their corresponding attribute-levels, and second, we used the orthogonal main effect design methodology recommended by [Aizaki and Fogarty \(2019\)](#) and the R software packages “DoE.base” ([Groemping, 2017](#)) and “support.BWS2” ([Aizaki, 2019](#)) to generate the full set of questions for each of the four domains. For each domain, participants answered a distinct set of questions (generated in R using the functions “oa.design” and “bws2.questionnaire”) that

**Table 1**  
Sample questions for domain A (preventive health behaviours) and D (vaccination motives).

I could prevent the spread of the virus by		
LEAST preferred	Options	MOST preferred
	...frequently washing my hands for at least 20 s with soap and water or using hand sanitizers	
	...avoiding exposure to closed or crowded spaces	
	...wearing a face mask when using public transportation or shopping	
I would get the COVID-19 vaccine to		
LEAST preferred	Options	MOST preferred
	...protect my family	
	...allow others to go back to school	
	...allow myself to socialize at restaurants, bars, etc.	

account for the number of attributes and their corresponding attribute-levels. The domains A, B, and D measured three attributes with four attribute-levels each and domain C measured four attributes with three attribute-levels each. Each question within a domain consisted of an equal number of randomly allocated attribute-levels and participants selected the best or the worst preferred attribute-level. To mitigate the possibility of response bias, the order of questions within a domain and the order of domains within the questionnaire were randomized for each participant.

2.4. Statistical analysis

To analyze BWS preference data, we used the counting and the modelling approaches described by Aizaki et al. (2019) to assess preferences (Aizaki and Fogarty, 2019). In line with the counting approach, within each domain we calculated the best-minus-worst (BW) total score for each attribute and attribute level. For each observation, the BW score (BWs) is calculated by subtracting the number of times an attribute-level (or attribute) X is selected as the worst from the number of times an attribute-level (or attribute) X is selected as the best among all the questions in a domain. The total BWs is obtained by summing the scores for all observations and higher scores reflect higher preference. We calculated scores using the function “bws2.count” from the package “support.BWS2” in R.

For the modelling approach, we used conditional logistic regression to model preferences as a function of the sum of the utility of attributes and attribute-levels (Aizaki and Fogarty, 2019). We used the marginal model based on the assumption that respondents evaluated all attribute-levels both when choosing the best and the worst attribute-level in each question. In each of the four models (corresponding to domains A to D), one attribute and one attribute-level (per attribute) that had the lowest total BWs were omitted from the utility function and treated as reference categories. We estimated the odds ratios (OR) and 95% confidence intervals (CI) using the “clogit” function which is part of the “survival” package in R (Therneau, 2021).

To explore the correlates of COVID-19 vaccine acceptability we used binary logistic regression and reported OR and their 95% CI. Socio-demographics and other health related behaviors that were significantly associated with vaccine acceptability in bivariate analyses were included in the multivariable model. All variables corresponding to attributes with a positive total BWs from all the four domains were simultaneously included in the model. The logistic regression diagnostic model criteria and results are provided in the note of Table 7.

The sample size was calculated based on the work of Peduzzi et al.

(1995) who recommended a minimum of 10 observations per variable to adequately power binary logistic regression models (Peduzzi et al., 1995). At the time of study conception, we estimated 60% vaccine uptake and calculated that a sample of 250 participants would be required based on the formula  $N = 10 \cdot k/p$  where  $N =$  minimum number of observations needed,  $k =$  number of predictor variables and  $p =$  smallest of the proportion in the binary model (i.e.,  $N = 10 \cdot 10/0.4$ ). Based on the data provided by Cheung et al. (2016) in their systematic review, we calculated that studies using the case 2 BWS methodology in healthcare recruited an average of 316 participants with a median of 162 and range 16 to 1296 participants. Therefore, we estimated that a sample of about 250 would be adequate to conduct both BWS and multivariable logistic regression analyses.

We conducted all analyses using RStudio and the R software v. 4.0.5. (R Development Core Team, 2015).

3. Results

Between August 6–18, 2021, 308 participants enrolled in the survey, 26 (8.4%) abandoned and 16 (6%) were terminated during completion of the survey by Dynata’s internal mechanisms to identify inattentive responders. The final dataset consisted of 266 observations with no missing data as questions could not be skipped. Vaccine hesitant participants ( $n = 68$ ; 25.6%) were in the PAPM decision stages *unengaged* ( $n = 20$ ; 7.5%); *undecided* ( $n = 30$ ; 11.3%) or *decided not* ( $n = 18$ ; 6.8%) while vaccine acceptors ( $n = 198$ ; 74.4%) included stages *decided to* ( $n = 20$ ; 7.5%) and *vaccinated* ( $n = 178$ ; 66.9%).

3.1. Preferences for preventive public health measures

At the attribute level, the most preferred preventive health behavior was physical distancing (BWs = 124) followed by wearing face masks (BWs = 32) and the least preferred was respecting general hygiene and respiratory etiquette (BWs = -156). Physical distancing (OR = 1.10) and wearing face masks (OR = 1.07) were preferred over respecting general hygiene and respiratory etiquette. As shown by the descending order of all attribute-level BWs in domain A (preventive health behaviours), the most preferred behavior was “avoiding exposure to closed or crowded spaces” (BWs = 88) and the least preferred was “wearing a face mask in open spaces such as the park or on the street” (BWs = -133). With respect to physical distancing, the most preferred behavior was avoiding exposure to closed or crowded spaces (OR = 1.13). Participants preferred wearing face masks when using public transportation or shopping (OR = 1.15) and when two metres distancing cannot be kept (OR = 1.13) over wearing masks in open spaces. To prevent the spread of the virus, participants preferred adequate hand washing (OR = 1.10) compared to respecting the recommended sneezing etiquette. (See Table 2).

The most preferred government mandates attribute was the request to provide proof of health (BWs = 960) followed by imposing travelling limitations (BWs = 199) and the least preferred were measures to reduce the exposure to the virus (BWs = -1159). Preferences for the first two attributes were significantly higher than for the last one (OR = 2.18 and OR = 1.65 respectively). Among all attribute-levels studied in domain B (government mandates), the most preferred was the request to provide vaccination proof when entering Canada (BWs = 358) and the least preferred were evening or overnight stay at home orders (BWs = -415). While requiring proof of vaccination for entering Canada was more popular (OR = 1.31) than regular proof of a negative COVID test to attend work or school, the reverse was true for mandatory proof of vaccination to return to work or school (OR = 0.90). Participants preferred mandatory testing measures (OR = 1.41) and quarantine after arriving in Canada (OR = 1.10) and disliked restrictions on travel within provinces (OR = 0.81) compared to restriction on travel between provinces. Compared to curfew, preferences were higher for mandatory remote work or online classes (OR = 1.47) and lower for reduced hours

**Table 2**  
Preferences for attributes and attribute levels corresponding to domain A (preventive health behaviours).

I could prevent the spread of the virus by...			
Attributes	BWs	OR	95% CI
Physical distancing	124	<b>1.10</b>	<b>1.05; 1.16</b>
Wearing face masks	32	<b>1.07</b>	<b>1.01; 1.13</b>
General hygiene and respiratory etiquette	-156		ref
<b>Levels for attribute: physical distancing</b>			
...avoiding exposure to closed or crowded spaces	88	<b>1.13</b>	<b>1.04; 1.22</b>
...limiting contact with those at higher risk such as the elderly and those with a weaker immune system	66	1.08	1.00; 1.17
...maintaining a physical distance of 2 m from people outside of my household	33	1.00	0.93; 1.09
...avoiding non-essential travel outside of Canada	-63		ref
<b>Levels for attribute: wearing face masks</b>			
...wearing a face mask when using public transportation or shopping	75	<b>1.15</b>	<b>1.07; 1.25</b>
...wearing a face mask in situations when I cannot keep a 2-meter distance from others	65	<b>1.13</b>	<b>1.04; 1.22</b>
...wearing a face mask at work or at school	25	1.04	0.96; 1.12
...wearing a face mask in open spaces such as at the park or on the street	-133		ref
<b>Levels for attribute: general hygiene and respiratory etiquette</b>			
...frequently washing my hands for at least 20 s with soap and water or using hand sanitizers	6	<b>1.10</b>	<b>1.02; 1.19</b>
...regularly disinfecting surfaces I frequently touch with my hands	-33	1.01	0.94; 1.10
...avoiding touching my eyes, nose, or mouth with unwashed hands	-59	0.96	0.89; 1.04
...coughing and sneezing into a tissue or the bend of my arm, not my hand	-70		ref

**Note:** in bold significant 95% confidence interval (CI) of odds ratios (OR); ref = the reference category for levels and attributes; BWs = best-worst score.

for non-essential businesses (OR = 0.84). (See Table 3).

### 3.2. Preferences for COVID-19 vaccination

The most preferred immunization specific attribute was vaccine accessibility (BW = 231) followed by the vaccination status of other people (BW = 92) and vaccine dosing (BW = 9) and the least preferred was the pairing of flu vaccination (BW = -332) with the COVID-19 vaccine. Higher preferences were expressed for the first three attributes compared to the last (OR = 1.61; OR = 1.43 and OR = 1.33 respectively). Among all attribute-levels in domain C (immunization specific), both the most (receiving 2 doses of the same vaccine, BW = 133) and the least preferred (receiving two doses of two different brands, BW = -123) were captured by the vaccine dosing attribute. Possible drivers of vaccine acceptability were high vaccine uptake amongst close others (85% vs. 40%, OR = 1.15) and the availability of the same vaccine brand for the second dose compared to different brands (OR = 1.55) (See Table 4).

We found that interpersonal altruism motives (BW = 1641) were of higher importance than receiving the vaccine for societal altruism motives (BW = -535) or self-interested motives (BW = -1106). Both interpersonal altruism motives (OR = 2.79) and societal altruism motives (OR = 1.24) were preferred over self-interested motives. Among all attribute-level motives in domain D (motives for vaccination), protecting one's family (BW = 490) was the most and going to the gym (BW = -395) the least important motive. Among interpersonal altruism motives, protecting one's family was more important (OR = 1.22) than protecting friends, classmates or coworkers while protecting the whole community was less important (OR = 0.90). At a societal level, reducing the burden on the healthcare system was preferred (OR = 1.50) over facilitating large social gatherings. Among self-interested motives, travelling without restrictions (OR = 1.14) and socializing at bars, restaurants (OR = 1.11) were of higher importance than going to the gym. (See Table 5).

**Table 3**  
Preferences for attributes and attribute levels corresponding to domain B (government mandates).

The government requires...			
Attributes	BWs	OR	95% CI
Requiring proof of health	960	<b>2.18</b>	<b>2.06; 2.30</b>
Traveling limitations	199	<b>1.65</b>	<b>1.56; 1.74</b>
Reducing exposure to the virus	-1159		ref
<b>Levels for attribute: requiring proof of health</b>			
...proof of vaccination for entering Canada	358	<b>1.31</b>	<b>1.21; 1.42</b>
...proof of vaccination to attend large gatherings such as sports, music, and religious events	244	1.00	0.93; 1.09
... proof of vaccination to return to work or school	195	<b>0.90</b>	<b>0.83; 0.98</b>
...regular proof of negative COVID tests to attend work or school	163		ref
<b>Levels for attribute: traveling limitations</b>			
... mandatory COVID test for any air travel	206	<b>1.41</b>	<b>1.30; 1.53</b>
... mandatory quarantine after arriving in Canada	93	<b>1.10</b>	<b>1.01; 1.19</b>
... restrictions on travel within provinces	-47	<b>0.81</b>	<b>0.75; 0.88</b>
... restrictions on travel between provinces	-53		ref
<b>Levels for attribute: reducing exposure to the virus</b>			
... mandatory remote work for non-essential workers or online classes for students	-119	<b>1.47</b>	<b>1.36; 1.59</b>
... limitations on the number of people that can meet for socializing or leisure purposes	-258	1.08	1.00; 1.17
... reduced hours for non-essential businesses	-367	<b>0.84</b>	<b>0.77; 0.91</b>
... Evening or overnight stay at home orders (curfew)	-415		ref

**Note:** in bold significant 95% confidence interval (CI) of odds ratios (OR); ref = the reference category for levels and attributes; BWs = best-worst score.

**Table 4**  
Preferences for attributes and attribute levels corresponding to domain C (immunization specific).

I would receive a COVID-19 vaccine if...			
Attributes	BWs	OR	95% CI
Vaccine accessibility	231	<b>1.61</b>	<b>1.49; 1.75</b>
Vaccination status of other people	92	<b>1.43</b>	<b>1.32; 1.55</b>
Vaccine dosing	9	<b>1.33</b>	<b>1.23; 1.45</b>
Comparison vaccines	-332		ref
<b>Levels for attribute: vaccine accessibility</b>			
...I could get vaccinated at a doctor's office/clinic	85	1.03	0.94; 1.13
...I could get vaccinated at a pharmacy	83	1.02	0.93; 1.12
...I could get vaccinated at a vaccination site	63		ref
<b>Levels for attribute: vaccination status of other people</b>			
...85% of my family, friends and acquaintances were already vaccinated	71	<b>1.15</b>	<b>1.05; 1.26</b>
...60% of my family, friends and acquaintances were already vaccinated	31	1.00	0.91; 1.10
...40% of my family, friends and acquaintances were already vaccinated	-10		ref
<b>Levels for attribute: vaccine dosing</b>			
...I could get vaccinated with 2 doses of the same vaccine	133	<b>1.55</b>	<b>1.42; 1.71</b>
...I could get vaccinated with only one dose of a vaccine	-1	0.99	0.90; 1.08
...I could get vaccinated with 2 doses of two different vaccine brands	-123		ref
<b>Levels for attribute: integration with flu vaccination</b>			
...I were to receive both the COVID-19 vaccine and the flu vaccine at the same time	-99	1.04	0.95; 1.14
...I were to receive the COVID-19 vaccine and the flu vaccine but NOT at the same time	-116	0.98	0.89; 1.08
... I were to only receive the COVID-19 vaccine and not the flu vaccine	-117		ref

Note: in bold significant 95% confidence interval (CI) of odds ratios (OR); ref = the reference category for levels and attributes; BWs = best-worst score.

### 3.3. Correlates of vaccine acceptability

In bivariate analyses, age (OR = 1.08) and Asian ethnicity (OR = 3.50) were associated with higher odds of vaccine acceptability. Influence of religion on health decisions (OR = 0.47), being a healthcare professional (OR = 0.34) or a caregiver of an elderly person (OR = 0.43) or having tested positive for COVID (OR = 0.43) were associated with lower vaccine acceptability (Table 6). In multivariable analysis, the association of age (AOR = 1.12) and Asian ethnicity (AOR = 8.37) remained unchanged. Higher preferences for mandates related to providing proof of health (e.g., vaccination) or interpersonal altruism motives (e.g., protecting one's family) were associated with higher odds of vaccine acceptability (AOR = 1.16 and AOR = 1.06 respectively) (Table 7).

**Table 5**  
Preferences for attributes and attribute levels corresponding to domain D Motives for vaccination).

I would get the COVID-19 vaccine to...			
Attributes	BWs	OR	95% CI
Interpersonal altruism motives	1641	<b>2.79</b>	<b>2.63; 2.95</b>
Societal altruism motives	-535	<b>1.24</b>	<b>1.17; 1.31</b>
Self-interested motives (leisure)	-1106		ref
<b>Levels for attribute: interpersonal altruism motives</b>			
...protect my family	490	<b>1.22</b>	<b>1.12; 1.33</b>
...protect vulnerable persons such as children, the elderly, and the chronically ill	419	1.02	0.94; 1.11
...protect everyone in my community	367	<b>0.90</b>	<b>0.83; 0.98</b>
...protect my friends, classmates, or coworkers	365		ref
<b>Levels for attribute: societal altruism motives</b>			
...help reduce the burden on the healthcare system	47	<b>1.50</b>	<b>1.38; 1.62</b>
... allow others to go back to school	-152	0.96	0.89; 1.04
...allow others to go back to work	-170	0.92	0.85; 1.00
...allow others to attend large gatherings such as sports, music, and religious events	-260		ref
<b>Levels for attribute: self-interested motives (leisure)</b>			
...allow myself to travel without restrictions	-221	<b>1.14</b>	<b>1.05; 1.24</b>
... allow myself to socialize at restaurants, bars, etc.	-232	<b>1.11</b>	<b>1.02; 1.20</b>
...allow myself to attend large gatherings such as sports, music, and religious events	-258	1.05	0.96; 1.14
...allow myself to go to the gym	-395		ref

Note: in bold significant 95% confidence interval (CI) of odds ratios (OR); ref = the reference category for levels and attributes; BWs = best-worst score.

### 4. Discussion

To better understand compliance to preventive health behaviour recommendations in younger adults we investigated their preferences for various public health measures and vaccination options and explored their association with COVID-19 vaccine acceptability.

Physical distancing, and in particular "avoiding exposure to closed or crowded spaces", was preferred. This was surprising as other studies investigating younger adults' attitudes and beliefs towards and compliance with physical distancing show this population to be less compliant with such measures (Valenti and Faraci, 2021; Coroiu et al., 2020; Lang et al., 2021). Unlike these studies, our methodology required participants to consider the utility trade-offs of multiple attributes when evaluating a preventive health measure. Our results could posit that compared to evaluating attribute levels using conventional multiple-choice questions, younger adults may be more likely to endorse physical distancing when repeatedly assessing its value amongst attribute

**Table 6**  
Sociodemographics and health behaviors. Bivariate associations with vaccine acceptability (n = 266).

	N(%) or Mean (SD)	OR (95% CI)
<b>Age</b> (one -year increase)	30.2 (5.5)	<b>1.08 (1.03; 1.14)</b>
<b>Gender</b>		
Male	122 (45.9)	ref
Female	139 (52.3)	1.46 (0.84; 2.55)
Gender diverse	5 (1.8)	1.67 (0.18; 15.5)
<b>Canadian region</b>		
Western	96 (36.1)	0.82 (0.46; 1.47)
Atlantic	16 (6)	0.51 (0.17; 1.50)
Central	154 (57.9)	ref
<b>Ethnicity</b>		
North American	100 (37.6)	ref
European	64 (24.1)	1.48 (0.73; 2.98)
Asian	73 (27.4)	<b>3.50 (1.55; 7.90)</b>
Other	29 (10.9)	0.94 (0.39; 2.24)
<b>Self-perceived visible minority</b>		
Yes	101 (38.0)	0.65 (0.37; 1.14)
No	165 (62.0)	ref
<b>Influence of religion on health decisions</b>		
Yes	80 (30.1)	<b>0.47 (0.26; 0.83)</b>
No	186 (69.9)	ref
<b>Language spoken at home</b>		
English	240 (90.2)	ref
French	16 (6.0)	1.04 (0.32; 3.36)
Other	10 (3.8)	1.39 (0.29; 6.74)
<b>Education (any post secondary)</b>		
Yes	206 (77.4)	ref
No	60 (22.6)	1.32 (0.66; 2.62)
<b>Income</b>		
<40 K	61 (22.9)	0.79 (0.39; 1.59)
40 K–80 K	96 (36.1)	1.05 (0.55; 1.98)
>80 K	109 (41.0)	ref
<b>Healthcare professional</b>		
Yes	42 (15.8)	<b>0.34 (0.17; 0.67)</b>
No	224 (84.2)	ref
<b>Caregiver of an elderly person</b>		
Yes	56 (21.1)	<b>0.43 (0.23; 0.81)</b>
No	210 (78.9)	ref
<b>Smoking status</b>		
Never	128 (48.1)	ref
Former smoker	70 (26.3)	0.77 (0.40; 1.48)
Current	68 (25.6)	0.85 (0.43; 1.67)
<b>Self-perceived health status</b>		
Excellent or very good	141 (53.0)	ref
Good or less	125 (47.0)	1.62 (0.92; 2.84)
<b>Received flu vaccine in the last 12 months</b>		
Yes	96 (36.1)	0.96 (0.54; 1.70)
No	170 (63.9)	ref
<b>Ever tested positive for COVID-19</b>		
Yes	39 (14.7)	<b>0.43 (0.21; 0.87)</b>
No	227 (85.3)	ref
<b>Friends/family ever tested positive for COVID-19</b>		
Yes	104 (39.1)	0.76 (0.43; 1.32)
No	162 (60.9)	ref

Note: for age we report the effect for one-year increase; In bold significant ORs and 95% CIs

levels. Considering that adequate respiratory etiquette and hand hygiene are effective in reducing the incidence of respiratory tract infections (Aiello et al., 2008), it is concerning that we observed relative lower preference for these behaviours in our sample, although this finding is consistent with other research showing that younger age is associated with reduced handwashing (Czeisler et al., 2020).

Regarding government mandates, younger adults showed a strong preference for requiring proof of health through vaccination or negative COVID-19 test. Importantly, multivariable analyses also demonstrated that this preference was associated with a greater likelihood of vaccine acceptance. In bivariate analyses, it is somewhat surprising that being a healthcare professional or caretaker for the elderly was a correlate of vaccine hesitancy, although consistent with the results published by Head et al. (2020). This may be related to issues faced in Canada and the United States, where mandated vaccination for healthcare professionals has caused considerable controversy. Despite this, our results suggest

that for the most part, younger adult Canadians are willing to provide proof of health through vaccination or testing, and that backlash to these policies will most likely emanate from those who are unvaccinated. Additionally, aversion to mandatory limitations to gathering, in-person school and work, and non-essential businesses, might further suggest that most younger adults prefer mandates that require vaccination or other proof of health if they can continue their usual activities. Public health messaging might benefit from using messages based on the most highly endorsed preferences within each domain. For example, emphasizing that while vaccine passports are a relatively minor inconvenience, they facilitate travel to and from Canada.

We found no significant difference in preference for vaccination at a doctor's office, pharmacy, or vaccination site. This might suggest that tailored vaccine administration models for younger adults should focus less on which sites are optimal, and rather prioritize flexibility by having the vaccine available in many different settings. Participants preferred

**Table 7**  
Results of multivariable logistic regression (n = 266).

	AOR (95% CI)
<b>Age</b>	<b>1.12 (1.05; 1.21)</b>
<b>Ethnicity</b>	
North American	ref
European	1.50 (0.62; 3.67)
Asian	<b>8.37 (2.88; 24.32)</b>
Caribbean, Latin, Central and South American, African	2.13 (0.71; 6.38)
<b>Influence of religion on health decisions</b>	
Yes	0.80 (0.35; 1.79)
No	ref
<b>Healthcare professional</b>	
Yes	0.55 (0.19; 1.58)
No	ref
<b>Caregiver of an elderly person</b>	
Yes	0.79 (0.30; 2.09)
No	ref
<b>Ever tested positive for COVID-19</b>	
Yes	1.38 (0.45; 4.27)
No	ref
<b>BWS Attributes</b>	
Physical distancing	0.94 (0.87; 1.02)
Wearing face masks	0.95 (0.89; 1.01)
Vaccination status of other people	1.07 (0.94; 1.22)
Vaccine accessibility	1.13 (0.97; 1.31)
Vaccine dosing	0.94 (0.80; 1.11)
Requiring proof of health	<b>1.16 (1.09; 1.25)</b>
Traveling limitations	1.00 (0.92; 1.08)
Interpersonal altruism	<b>1.06 (1.02; 1.11)</b>

Note: for age we report the effect for one-year increase; for BWS attributes we report the effect for one unit increase in the BW score. In bold are significant ORs and 95% CIs.

We used the following logistic regression model diagnostic criteria: 1) Rank Discrimination Index C whereby higher C values indicated better model ability to classify individuals correctly into groups according to their outcome, 2) Cessie-van Houwelingen goodness-of-fit test whereby  $p > 0.05$  suggests no evidence to reject a good fit, and 3) Variation Inflation Factor (VIF) with a cutoff value of  $< 10$  for ruling out collinearity issues. Rank Discrimination Index C = 0.85; Cessie-van Houwelingen goodness-of-fit test  $p = 0.22$ ; VIF range: 1.17–2.70.

being vaccinated with two doses of the same vaccine over receiving only a single dose or two doses of different vaccine brands. As evidence emerges that “mix-and-match” booster shot strategies could be effective in providing sustained protection against COVID-19 (Atmar et al., 2021), acceptance of this strategy might be lower in younger adults. While the joint administration of COVID-19 and influenza vaccination may be a promising solution to increase coverage for both vaccines (Wise, 2021), our results suggest it would not motivate younger adults to take a COVID-19 vaccine. Similar to the results of Leng et al. (2021) who found that increased vaccine uptake was associated with acceptability in unvaccinated individuals, we found that younger adults were more likely to prefer receiving a COVID-19 vaccine if 85% of their family, friends, and acquaintances had already received it. While social influence can be an important, positive determinant of vaccine acceptability, this finding could reflect “free riding” which occurs when an individual waits to view the consequences of others’ behaviour before acting, while taking advantage of the externalities produced by those actions, e.g., herd-immunity (Ibuka et al., 2014).

Consistent with other studies (Rieger, 2020; Burke et al., 2021), we found a strong association between interpersonal altruism motives and vaccine acceptance, particularly when targeted towards the protection of one’s family. Furthermore, altruistic motives emphasizing the benefits of vaccination to society were preferred over self-interested motives, suggesting that messages promoting external benefits of vaccination (e.g., reducing the burden on the healthcare system) may be more effective in this age group. The strong relationship between Asian ethnicity and vaccine acceptance could reflect collectivistic values, a factor that has been positively associated with COVID-19 vaccine intentions (Tatar et al., 2019). Similarly, the significant positive association of age with vaccine uptake in the multivariable model might reflect evolving community and family-oriented concerns in older members of the studied age group (aged 18–39).

#### 4.1. Limitations

Studies using BWS in larger, representative samples are needed to confirm our results and to examine differences in subgroups (e.g., HCPs). A larger sample would allow for specific PAM stage of analysis as each stage may have unique correlates and associated attitudes (Cucciniello et al., 2022). While we tried to anticipate emerging public health measures and recommendations, The COVID-19 pandemic is a rapidly evolving situation, and new challenges have emerged since the inception of our study (e.g., the highly transmissible Omicron variant).

#### 5. Conclusions

Using Best-Worst-Scaling methodology in a younger adult population (aged 18–39), our findings provide a fine-tuned insight into the preferences of this age group whose adherence to public health recommendations and uptake of vaccines is critical to contain the pandemic. Our findings could inform public health authorities in aligning evidence-based guidelines with public preferences, to promote compliance with preventive measures and increase COVID-19 vaccination rates, including for possible upcoming booster shots.

#### Credit author statement

All authors had substantial contribution in study conceptualization and design. OT and BH completed data analysis and wrote the first draft of the manuscript. OT, BH, PZ, GGM, SP, GZ and ZR critically reviewed, contributed to data interpretation, edited the manuscript, and approved the final manuscript. ZR supervised all stages of the project.

#### Funding

This study was supported by the McGill Interdisciplinary Initiative in

Infection and Immunity (MI4). OT is supported by the Canadian Institutes of Health Research (CIHR)-Frederick Banting and Charles Best Doctoral award (Award No. FBD-170837) outside the submitted work.

## Declaration of Competing Interest

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

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