



Intention to Receive a COVID-19 Vaccine by HIV Status Among a Population-Based Sample of Women and Gender Diverse Individuals in British Columbia, Canada

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Abstract

COVID-19 vaccination is recommended for people living with HIV (PLWH), among whom social inequities and co-morbidities may drive risks of COVID-19 infection and outcome severity. Among a provincial (British Columbia) sample, we determined the prevalence of COVID-19 vaccine intention by HIV status and assessed socio-demographic, vaccine hesitancy, and psychological predictors of vaccine intention. Individuals (25–69 years) recruited from province-wide research cohorts and the general public completed an online survey examining COVID-19 impacts (August/2020–March/2021). In an analysis restricted to women and gender diverse participants (n = 5588), we compared intention to receive a recommended COVID-19 vaccine (Very likely/Likely vs Neutral/Unlikely/Very Unlikely) by self-reported HIV status. Logistic regression models assessed the independent effect of HIV status and other factors on COVID-19 vaccine intention. Of 5588 participants, 69 (1.2%) were living with HIV, of whom 79.7% were on antiretroviral therapy. In bivariate analyses, intention to vaccinate was significantly lower among PLWH compared to participants not living with HIV (65.2% vs 79.6%; OR 0.44; 95%CI 0.32–0.60). However, this association was not statistically significant after adjustment for ethnicity, income, education, and essential worker status (aOR 0.85; 95%CI 0.48–1.55). Among PLWH, those with greater vaccine confidence, positive attitudes towards the COVID-19 vaccine, and more strongly influenced by direct and indirect social norms to vaccinate had significantly higher odds of vaccine intention. Tailored messaging is needed to build vaccine confidence, address questions about vaccine benefits, and support informed vaccination decision-making to promote COVID-19 vaccine uptake among women and gender diverse people living with HIV.

Keywords HIV · Women · Intention to vaccinate · Social determinants of health · Gender diverse populations · COVID-19 vaccine · Vaccine hesitancy

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Introduction

The COVID-19 pandemic and the associated public health response has significantly disrupted lives and livelihoods in Canada and around the world. As of July 26th 2021 in Canada, 1,427,342 COVID-19 cases and 26,553 related deaths have been reported. Sex-disaggregated data reveal that 50.3% of COVID-19 cases and 49.8% of deaths are among females [1], with disproportionate impacts among individuals and communities confronting socio-structural inequities, including poverty, racism, and gender inequity [2–4].

Early in the pandemic, the US Centres for Disease Control and Prevention flagged that people living with HIV (PLWH) may be at heightened risk of severe COVID-19 illness [5]. Emerging data suggest, however, that HIV infection itself does not confer higher susceptibility to COVID-19, [6–8] rather, HIV-accompanying social disparities and co-morbidities may drive observed increases in the risk of infection and outcome severity among PLWH [9, 10]. This distinction is important as it informs government and public health officials on how best to act to reduce inequities.

The National Advisory Committee on Immunization (NACI) in Canada considered such social disparities and co-morbidities, alongside considerations of risks for SARS-CoV-2 infection and severe illness, to identify priority populations for the first phase of COVID-19 vaccination [11]. Early recommendations prioritized COVID-19 vaccination for the following key populations: those at high risk of severe illness and death from COVID-19 (advanced age and/or living with other high-risk conditions), those most likely to transmit COVID-19 to those at high risk and workers essential to maintaining the COVID-19 response (e.g., healthcare workers, caregivers at long-term care facilities), other essential workers outside of healthcare (e.g., police, firefighters, grocery store workers), and those living or working conditions put them at elevated risk or consequence of COVID-19 infection, including Indigenous communities [11]. People living with HIV were not prioritized for early vaccination, unless individuals met other priority population criteria. Canada launched its COVID-19 vaccine roll-out in December 2020 for adults, with eligibility expanding to include all individuals 12+ years of age (without contraindications) by June 2021 [12].

Although relatively few PLWH participated in COVID-19 vaccine trials, available data indicate that the vaccines are effective and that there are no unusual safety concerns among people with well-controlled HIV, including those with undetectable viral loads and CD4 cell counts above 200 cells/mm³ [13, 14]. As such, the NACI strongly

recommended that immunosuppressed and immunocompromised individuals (including PLWH) be offered a complete COVID-19 vaccine series [11]. In tandem, the British Columbia Centre for Excellence in HIV/AIDS (BCCfE) Committee for Drug Evaluation and Therapy similarly advised that “*People living with HIV (PLWH) aged 18 years or older should be vaccinated for COVID-19 if they meet current public health criteria for priority groups and if they have no contraindications... regardless of CD4 count*”, and recommended receipt of any of the COVID-19 vaccines currently approved in Canada (i.e., Pfizer-BioNTech, Moderna, AstraZeneca, and Janssen vaccines) [15].

Adherence to these recommendations and the ultimate success of the national COVID-19 vaccine roll-out is contingent on vaccine intention and vaccine uptake. Vaccine hesitancy (a concept defined as the refusal or delay in accepting vaccination despite the availability of vaccination services [16, 17]), vaccine misinformation, and medical mistrust may limit vaccine uptake and contribute to further perpetuating COVID-19 inequities [18–20]. There are currently few data regarding intention to receive the COVID-19 vaccine among PLWH [18, 21], and, to our knowledge, no data from women or gender diverse individuals living with HIV. Moreover, there is a paucity of data examining vaccine hesitancy or the attitudes, social norms, and perceived behavioral controls that predict COVID-19 vaccine intention among PLWH, and whether these differ from patterns in the general population. In Canada, such data are particularly pertinent since women living with HIV (WLWH) experience significant socio-structural inequities and co-morbidities relative to both men living with HIV and HIV-negative women. For instance, among WLWH, 79% are Indigenous, Black, or other women of colour, including 36% who are of Indigenous ancestry [22]; 70% live below the poverty line (defined as \$20 K CAD per year) [23]; and 75% live with one or more co-morbidities in addition to HIV, including cardiovascular disease, cancers, osteoporosis, chronic kidney or liver disease, chronic depression, anxiety and other mental health illnesses [24, 25]. WLWH also have poorer HIV clinical outcomes across the HIV care cascade including lower prevalence of antiretroviral therapy (ART) initiation and HIV viral suppression compared with men [26]; all factors known to increase risk and consequence of SARS-CoV-2 infection.

Using population-based survey data from a provincial sample of women and gender diverse individuals in British Columbia (BC), Canada, the objectives of this study were (1) to estimate and compare intention to receive the COVID-19 vaccine by HIV status; (2) to measure and compare the prevalence of vaccine hesitancy [17, 27] by HIV status; (3) to measure and compare the prevalence of four COVID-19 vaccine-specific psychological constructs grounded in the Theory of Planned Behavior [28] by HIV status, including

vaccine attitudes, perceived behavioral control to receive the COVID-19 vaccine if desired, and the influence of direct and indirect social norms; and (4) among those living with HIV, to examine whether vaccine hesitancy and psychological constructs predict COVID-19 vaccine intention.

These analyses are aimed at guiding public health programming and recommendations for COVID-19 vaccination for women and gender diverse individuals living with HIV to optimize COVID-19 vaccine uptake in this population.

Methods

Study Design and Participants

We used cross-sectional survey data from participants enrolled in the **Rapid Evidence Study of a Provincial Population Based COhort for GeNder and SEx (RESPONSE)** study, which assessed the impacts of COVID-19 and the associated public health control measures on people across the Canadian province of BC [29].

Individuals (aged 25–69 years, BC residents) enrolled in existing, large provincially-representative community and hospital-based cohort studies who had consented to be contacted for future research were invited to complete an online survey examining impacts of COVID-19 (August 20–March 1, 2021) and receive an at-home SARS-CoV-2 research antibody test (results to be reported elsewhere). Two existing cohorts (the Canadian HIV Women’s Sexual and Reproductive Health cohort study (CHIWOS) [30] and the Children and Women: AntiRetroviral Therapy and Markers of Aging (CARMA) study [24] specifically enrolled WLWH while other cohorts enrolled members of the general population, inclusive to all people living with HIV.

All eligible individuals were sent an email invitation to participate in an online survey. To increase sex and gender diversity of the study, upon completing the survey, participants were asked to provide the email address of an adult household member who identified as another gender. These individuals were then invited to participate. All prospective participants who did not complete the survey after the initial invitation were sent up to two email reminders, each seven days apart. Participants who did not complete the survey within 21 days after the initial invitation were considered as having declined participation.

For power considerations, we aimed to enroll a total of $n = 750$ participants per each 5-year age-strata [20]. After recruiting from the existing cohorts, we pursued public recruitment via social media, websites, listservs, and word-of-mouth to fill the target quota for individuals aged 25–40 and 65–69 years. We employed additional targeted recruitment strategies to enhance study participation among WLWH (of all eligible ages), who are consistently

under-represented in research [31, 32]. Learning from community-based research principles [33, 34], we hired and trained three experienced Peer Research Associates (WLWH trained in quantitative research methods) [35] to support recruitment of WLWH, who may not have had a working email address, reliable access to computers, internet access, or other infrastructure required to complete an online survey. We also pursued recruitment of WLWH via researchers, HIV clinics, and community-based organizations who support PLWH in BC.

Ethical Considerations

All participants provided voluntary informed consent at enrollment. After completing the survey, participants were entered into a lottery to receive a \$100 gift card. Ethical approval was received from The University of British Columbia Research Ethics Board (H20-01421).

Inclusion and Exclusion Criteria

Analyses were restricted to self-identified women (inclusive to cis and trans women) and gender diverse participants either living with or not living with HIV. Gender diverse individuals comprised 1.2% of the overall sample [20], however, given a high proportion of gender diverse individuals living with HIV who identified a biological sex of female, we chose to include this group in the analysis to enable consideration of this priority and underserved group living with HIV.

Study Procedures

Participants completed a structured online questionnaire (supported by Research Electronic Data Capture (REDCap)) software [36]. The questionnaire was developed by experts in sex-and-gender based analysis, vaccine intention, Theory of Planned Behavior, social determinants of health, economics, mental health, and sexual and reproductive health, using validated scales when available. The questionnaire was assessed for face validity and comprehension, pilot tested, revised, and the final version was implemented using REDCap. Questionnaires were available in English and took a median of 31 min [Interquartile range [IQR] 23–47] to complete.

Measures

The primary outcome was ‘intention to vaccinate’, considered as the most proximate measure to actual vaccine uptake, and assessed via a 5-point Likert scale to the question “*If a COVID-19 vaccine were to become available to the public, and recommended for you, how likely are you to receive it?*”

The question was phrased theoretically given that a large majority of participants completed the survey before the COVID-19 vaccine was widely available in BC. Consistent with a RESPPONSE study analysis of overall vaccine intentions in BC, responses were dichotomized as follows: Participants who reported “Very Likely” or “Somewhat Likely” were considered as having an intention to vaccinate while those who reported “Neutral”, “Unlikely”, or “Very Unlikely” were considered as not intending to vaccinate [20].

Potential socio-demographic correlates of vaccine intention were considered a priori, including: age, sex, gender (woman or gender diverse, which referred to individuals who identify as, but not limited to, gender non-binary, GenderQueer, Two-Spirit, agender, gender fluid, gender non-conforming, or other gender identity), Indigenous ancestry, ethnicity [37], education, annual household income, existing chronic health conditions (excluding HIV), and employment as an essential worker including both healthcare and non-healthcare essential workers (defined as those working in retail, transportation, social services, and other services deemed essential), [38] all assessed by self-report.

Among PLWH, we measured median time living with HIV (median [IQR]), the proportion on ART, with an undetectable HIV viral load (<50 copies/mL), receipt of HIV medical care since the COVID-19 restrictions were implemented in mid-March 2020, and how much their HIV status affected their fear of acquiring COVID-19 (more/much more fearful vs no difference vs less/much less fearful).

WHO Vaccine Hesitancy Scales and Psychological Constructs Within the Theory of Planned Behavior

The questionnaire assessed several psychological constructs as potential correlates of vaccine intention, including (1) a modified **WHO Vaccine Hesitancy Scale** [17, 27], which included two factors: **Lack of Vaccine Confidence** (7-item 5-point Likert scale from Strongly Agree to Strongly Disagree, with higher agreement corresponding with higher lack of general vaccine confidence) and **Vaccine Risk** (2-item 5-point Likert scale from Strongly Agree to Strongly Disagree, with higher agreement corresponding with higher concerns about vaccine risks); and grounded in the Theory of Planned Behavior [28], items developed and previously used to measure key factors shown to influence COVID-19 vaccine intention [20] including (2) **Attitudes towards the COVID-19 vaccine** (8 item 5-point Likert scale from Strongly Agree to Strongly Disagree, with higher agreement corresponding with more positive attitudes towards the COVID-19 vaccine); (3) **Perceived Behavioral Control** to receive a COVID-19 vaccine (4 item 5-point Likert scale from Strongly Agree to Strongly Disagree, with higher agreement corresponding with higher self-perception

of being able to receive the COVID-19 vaccine if desired); (4) the influence of **Direct Social Norms** (4-item 5-point Likert scale from Strongly Agree to Strongly Disagree, with higher agreement corresponding with being more likely to be influenced by direct social norms to receive the COVID-19 vaccine); and (5) the influence of **Indirect Social Norms** (8 item 5-point Likert scale assessing both whether various influencers would Strongly Approve to Strongly Disapprove of the participant receiving the COVID-19 vaccine and how much the participant Strongly Agrees to Strongly Disagrees that what the influencer thinks is important to them, with higher scores indicating a greater influence of indirect social norms). All scale items are shown in Table 4.

Data Analyses

Descriptive statistics (mean (Standard Deviation (\pm SD)) or median [IQR] for continuous variables and n (%) for categorical variables) were used to characterize baseline distributions of study variables, stratified by HIV status. Baseline differences were compared using Wilcoxon rank sum test for continuous variables and Fisher’s exact test for categorical variables.

Descriptive statistics were also used to report the prevalence of intention to vaccinate by HIV status. Bivariable analyses examined the relationship between intention to vaccinate and socio-demographic variables. An exploratory multivariable logistic regression model was used to examine the crude and adjusted odds ratios (with 95% confidence intervals) between HIV status and vaccine intention controlling for potential socio-demographic confounders. After assessing collinearity, a priori possible predictors of vaccine intention with $p < 0.1$ in bivariable analyses were considered in the multivariable model. Multivariable analyses included only non-missing data.

For each of the items in the WHO Vaccine Hesitancy Scale and the psychological constructs, the proportion of participants reporting Strongly Agree/Agree (vs Neutral/Disagree/Strongly Disagree) were reported and compared by HIV status, with differences compared using Pearson χ^2 or Fisher’s exact test. We also computed the mean (\pm SD) total score of each scale and compared means by HIV status using Wilcoxon rank sum tests.

Among PLWH, we used logistic regression to examine associations between socio-demographic characteristics, the WHO Vaccine Hesitancy Scale, and the psychological constructs with COVID-19 vaccine intention.

All p-values were two-sided and considered statistically significant at $p < 0.05$. Analyses were conducted in R v.4.0.2 [39].

Results

Between August 20th, 2020 and March 1st, 2021, 6518 individuals completed the online survey, of whom 5588 (85.7%) identified as women or gender diverse individuals and were included in this analysis. Of these, 69 (1.23%) were living with HIV (LWH) whereas 5519 (98.8%) were not LWH.

Baseline Characteristics

Age was similar among participants LWH (mean \pm SD: 49.9 ± 11.4 years) and not LWH (48.1 ± 12.1 years) and a majority reported being assigned female sex at birth (99.6%). Participants LWH reported significantly greater gender, ethno-racial, and socio-economic diversity. Compared to those not LWH, individuals LWH were significantly more likely to identify as gender diverse (8.7% vs 1.2%; $X^2 = 23.62$; $p = 0.0003$), of Indigenous ancestry (29% vs 3%; $X^2 = 266.69$; $p < 0.001$), African Caribbean or Black (8.7% vs 0.3%; $X^2 = 266.69$; $p < 0.0001$), report a household income below \$20,000/year (17.4% vs 2.3%; $X^2 = 266.69$; $p < 0.0001$), and a highschool education or less (34.8% vs

12.2%; $X^2 = 29.54$; $p < 0.0001$). There were no differences by essential worker employment (27.5% vs 32.9%; $X^2 = 2.47$; $p = 0.30$) (Table 1).

A higher proportion of participants LWH reported living with ≥ 1 chronic health condition (excluding HIV) (82.6% vs 49.6%; $X^2 = 45.38$; $p < 0.0001$) and were significantly more likely to report living with chronic obstructive pulmonary disease (COPD) or emphysema, chronic lung disease, heart disease, liver disease and liver cirrhosis, and renal problems compared with those not LWH.

Characteristics of Participants Living with HIV

Median years living with HIV was 20.5 [IQR 14–17], 79.7% were currently on ART for a median of 14.0 years [10–23 years], and 73.9% reported being virally undetectable (< 50 copies/mL). Overall, 62.3% reported receiving any HIV medical care since the COVID-19 restrictions were implemented and 58.6% reported that their HIV-positive status made them more fearful of acquiring COVID-19 (3.4% reported less fearful, 37.9% reported that it makes no difference) (Table 2).

Table 1 Baseline characteristics of study sample overall and by HIV status, column % (n = 5588)

	Total n = 5588	HIV status		Test statistic	p value
		Not living with HIV (n=5519)	Living with HIV (n=69)		
Age Mean (SD)	48.2 (± 12.1)	48.1 (± 12.1)	49.9 (± 11.4)	W = 176592	0.30
<i>Sex</i>					
Female	5565 (99.6%)	5499 (99.6%)	66 (95.7%)	$X^2 = 25.34$	0.001
Male	17 (0.3%)	14 (0.3%)	3 (4.3%)		
<i>Gender</i>					
Woman	5,514 (98.7%)	5,451 (98.8%)	63 (91.3%)	$X^2 = 23.62$	0.0003
Gender diverse (non-binary, GenderQueer, agender, Two-spirit, gender fluid, or other gender identity)	74 (1.3%)	68 (1.2%)	6 (8.7%)		
<i>Ethnicity</i>				$X^2 = 266.69$	< 0.0001
Indigenous	186 (3.3%)	166 (3.0%)	20 (29.0%)		
African/Caribbean/Black	21 (0.4%)	15 (0.3%)	6 (8.7%)		
White	4,441 (79.5%)	4,402 (79.8%)	39 (56.5%)		
Other or mixed ethnicity	775 (13.9%)	771 (14.0%)	4 (5.8%)		
<i>Education</i> More than high school	4,879 (87.3%)	4,834 (87.6%)	45 (65.2%)	$X^2 = 29.54$	< 0.0001
<i>Household income</i> $< \$20K/year$	138 (2.5%)	126 (2.3%)	12 (17.4%)	$X^2 = 266.69$	< 0.0001
<i>Chronic health conditions (excluding HIV)</i>					
None	2792 (50.0%)	2780 (50.4%)	12 (17.4%)	$X^2 = 45.38$	< 0.0001
1	1538 (27.5%)	1518 (27.5%)	20 (29.0%)		
2+	1249 (22.4%)	1212 (22.0%)	37 (53.6%)		
<i>Essential worker</i>					
No	3752 (67.1%)	3702 (67.1%)	50 (72.5%)	$X^2 = 2.47$	0.30
Yes, health worker	865 (15.5%)	859 (15.6%)	6 (8.7%)		
Yes, other essential worker	967 (17.3%)	954 (17.3%)	13 (18.8%)		

Table 2 Baseline characteristics of people living with HIV enrolled in the RESPPONSE study (n=69)

Characteristic	n or Median	% or IQR
Median years living with HIV	20.5	14.0–17.0
Currently on antiretroviral therapy (ART)	55	79.7%
Median years on ART	14.0	10.0–23.0
Undetectable HIV viral load (<50 copies/mL)	51	73.9%
Received any HIV medical care since COVID-19 restrictions	43	62.3%
<i>How much does your HIV status affect your fear of acquiring COVID-19? (n=58)</i>		
More/much more fearful	34	58.6%
It makes no difference	22	37.9%
Less/much less fearful	2	3.4%

Intention to Receive a COVID-19 Vaccine by HIV Status and Socio-demographic Characteristics

In the overall sample, 79.7% reported being “very or somewhat likely” to receive a COVID-19 vaccine if it were to become available to the public and recommended for them. Intention to vaccinate was significantly lower among participants LWH compared with those not LWH (65.2% vs 79.6%; $LRT=6.87$; $p=0.009$. OR 0.49; 95%CI 0.30–0.83) (Table 3).

In the full sample, intention to vaccinate was also lower among racialized individuals, including people of Indigenous ancestry (65.1%; OR 0.44; 95% CI 0.32–0.60), African/Caribbean/and Black people (57.1%; OR 0.32; 95% CI 0.13–0.78), and people of other or mixed ethnicities (77.8%; OR 0.83; 95% CI 0.69–1.00) relative to white participants (80.9%). Participants residing in lower income households, with less education, or essential workers not in the health sector were also significantly less likely to report an intention to vaccinate. There were no significant differences by age, gender, or the presence of chronic health conditions.

In the multivariable model, living with HIV was no longer significantly associated with intention to vaccinate (adjusted OR 0.85; 95%CI 0.48–1.55). The observed effect in unadjusted analyses was attenuated by differences in the distribution of ethnicity, household income, education, and essential worker status between groups. Compared to white participants, people of Indigenous ancestry (aOR 0.49; 95% CI 0.35–0.70) and people of other or mixed ethnicities (aOR 0.76; 95% CI 0.62–0.94) had significantly lower adjusted odds of reporting an intention to vaccinate. There was no significant difference among African/Caribbean/and Black participants, although the sample was small (OR 0.49; 95% CI 0.19–1.38). Participants residing in lower income households (<\$40 K per year aOR 0.53; 95% CI 0.42–0.67 and \$40 K to <\$80 K per year aOR 0.77; 95% CI 0.64–0.92 compared with those with household incomes of \geq \$80 K per year), with a high school education or less (aOR 0.65; 95% CI 0.53–0.79), or who were essential workers not in

the health sector (aOR 0.69; 95% CI 0.57–0.83) had significantly lower adjusted odds of reporting an intention to vaccinate.

WHO Vaccine Hesitancy Scale and Psychological Constructs by HIV Status

All scales demonstrated good to strong agreement (Cronbach’s alpha ranging from a low of 0.63 for the Perceived Behavioral Control scale to a high of 0.95 for the WHO Lack of Vaccine Confidence Scale) (Table 4).

Lack of vaccine confidence was low overall, however, participants LWH expressed significantly higher lack of vaccine confidence (or higher vaccine hesitancy) across each of the 7 scale items. Among those LWH, mean Lack of Vaccine Confidence score was 1.6 (SD = 1.1) compared with 1.3 (SD = 0.6) among those not LWH ($W=151,584$; $p=0.005$).

Perceptions of vaccine risks were high overall (45% reported being “concerned about potential serious adverse effects of vaccines”), however, there were no significant differences by HIV status. Among respondents LWH, the mean Vaccine Risk score was 3.0 (SD = 1.1), similar to that among those not LWH (3.0 (SD = 1.1) ($W=186,332$; $p=0.82$).

Attitudes towards the COVID-19 vaccine were positive with at least 75% Strongly Agreeing/Agreeing with most scale items, with the exception of three items where a lower proportion of participants agreed that a COVID-19 vaccine would be effective at preventing COVID-19, would be safe, or should be mandatory. Participants LWH expressed significantly less positive attitudes towards the COVID-19 vaccine across each of the 8 scale items, with the exception of “COVID-19 is a serious illness” where agreement was similar (81.1% vs 84.2%; $p=0.86$). Among participants LWH, the mean Attitudes towards the COVID-19 vaccine score was 32.5 (SD = 6.6) compared with 34.5 (SD = 5.8) among those not LWH ($W=168,099$; $p=0.004$).

Approximately two-thirds of participants reported *perceiving that they had high behavioral control* over whether or not they could receive the COVID-19 vaccine if they

Table 3 Unadjusted and adjusted odds ratios (and 95% confidence intervals) of vaccine intention by HIV status and socio-demographic variables, row %

	Intention to receive the COVID-19 vaccine				Unadjusted odds ratio (OR)			Adjusted odds ratio (aOR)				
	Total n = 5568	No n = 1129		Yes n = 4439	Test Statistic [§]	p value	Crude OR	95%CI	p value	Adjusted OR	95% CI	p value
<i>HIV status</i>												
Not living with HIV	5500 (98.8%)	1106 (20.0%)	4394 (79.6%)	6.87	0.009	Ref	Ref	Ref	0.006	Ref	Ref	0.576
Living with HIV	68 (1.2%)	23 (33.3%)	45 (65.2%)			0.49	0.30–0.83	0.85		0.48–1.55		
<i>Age (years)</i>												
Mean (±SD)	48.2 (±12.1)	48.1 (±11.0)	48.2 (±12.3)	0.03	0.86	1.00	1.00–1.01	1.00	0.863	0.99–1.01		0.763
<i>Gender</i>												
Woman	5494 (98.7%)	1118 (20.3%)	4376 (79.7%)	1.46	0.31	Ref	Ref	Not included	0.25	Not included		
Gender diverse	74 (1.3%)	11 (14.9%)	63 (85.1%)			1.46	0.80–2.94					
<i>Ethnicity</i>												
White	4427 (79.5%)	847 (19.1%)	3580 (80.9%)	32.39	< 0.0001	Ref	Ref	Ref	Ref	Ref	Ref	
Other or mixed	770 (13.8%)	171 (22.2%)	599 (77.8%)			0.83	0.69–1.00	0.76	0.047	0.62–0.94		0.01
Indigenous	186 (3.3%)	65 (34.9%)	121 (65.1%)			0.44	0.32–0.60	0.49	< 0.001	0.35–0.70		< 0.001
African/Caribbean/Black	21 (0.4%)	9 (42.9%)	12 (57.1%)			0.32	0.13–0.78	0.49	0.009	0.19–1.38		0.153
Missing	164 (2.9%)	37 (22.6%)	127 (77.4%)									
<i>Education</i>												
More than high school	4864 (87.4%)	926 (19.0%)	3938 (81.0%)	35.23	< 0.0001	Ref	Ref	Ref	< 0.001	Ref	Ref	< 0.001
High school or less	694 (12.5%)	202 (29.1%)	492 (70.9%)			0.57	0.48–0.69	0.65		0.53–0.79		
Missing	10 (0.2%)	1 (10.0%)	9 (90.0%)									
<i>Household income (annual)</i>												
\$80K+	3049 (54.8%)	516 (16.9%)	2533 (83.1%)	58.54	< 0.0001	Ref	Ref	Ref	Ref	Ref	Ref	
0 to <\$40K	424 (7.6%)	131 (30.9%)	293 (69.1%)			0.46	0.36–0.57	0.53	< 0.001	0.42–0.67		< 0.001
\$40 K to <\$80 K	962 (17.3%)	215 (22.3%)	747 (77.7%)			0.71	0.59–0.85	0.77	< 0.001	0.64–0.92		0.004
Don't know/no response	1133 (20.3%)	267 (23.6%)	866 (76.4%)			0.66	0.56–0.78	0.69	< 0.001	0.58–0.82		< 0.001
<i>Chronic health conditions (excluding HIV)</i>												
None	2,780 (49.9%)	575 (20.7%)	2,205 (79.3%)	1.70	0.43	Ref	Ref	Not included	Not included	Not included		
1	1536 (27.6%)	294 (19.1%)	1242 (80.9%)			1.10	0.94–1.29	0.226		0.94–1.29		0.226
2+	1243 (22.3%)	258 (20.8%)	985 (79.2%)			1.00	0.84–1.18	0.958		0.84–1.18		0.958
Missing	9 (0.2%)	2 (22.2%)	7 (77.8%)									
<i>Essential worker</i>												
No	3739 (67.2%)	736 (19.7%)	3003 (80.3%)	28.21	< 0.0001	Ref	Ref	Ref	Ref	Ref	Ref	
Yes, health worker	860 (15.4%)	140 (16.3%)	720 (83.7%)			1.26	1.04–1.54	1.13	0.022	0.91–1.41		0.278
Yes, other essential worker	965 (17.3%)	251 (26.0%)	714 (74.0%)			0.70	0.59–0.82	0.69	< 0.001	0.57–0.83		< 0.001
Missing	4 (0.1%)	2 (50.0%)	2 (50.0%)									

[§] Likelihood Ratio Test Statistic

Bold values indicate the p-value is < 0.05 and the result is statistically significant

Table 4 Vaccine Hesitancy and COVID-19 vaccine Psychological Constructs by HIV status, column %

	Mean score (SD) overall	Scale alpha (standardized)	Not living with HIV (n = 5519)	Living with HIV (n = 69)	Test-statistic	p value
<i>WHO Lack of Vaccine Confidence Scale</i> (range from 1 to 5, with higher scores indicating higher lack of confidence)	1.3 (\pm 0.6)	0.949	1.3 (\pm 0.6)	1.6 (\pm 1.1)	W = 151,584	0.005
Missing	40 (0.7%)		38 (0.7%)	2 (2.9%)		
<i>By item</i>			% reporting strongly disagree/disagree/neutral			
Childhood vaccines are important for a child's health			3%	12%	X ² = 26.43	0.001
Getting vaccines is a good way to protect children from disease			3%	12%	X ² = 28.89	0.0004
Having a child vaccinated is important for the health of others in my community			3%	13%	X ² = 26.65	0.0003
Childhood vaccines are effective (VHS 3)			3%	14%	X ² = 33.32	< 0.0001
Generally, I do what my doctor or health care provider recommends about vaccines			8%	16%	X ² = 37.67	0.0008
All childhood vaccines offered by the BC immunization program in my community are beneficial			8%	19%	X ² = 29.98	< 0.0001
The information I receive about vaccines from the vaccination program is reliable and trustworthy			12%	19%	X ² = 17.20	0.02
	Mean score (SD) overall	Scale alpha (standardized)	Not living with HIV (n = 5519)	Living with HIV (n = 69)	Test-statistic	p value
<i>WHO Vaccine Risks Scale</i> (range from 1 to 5, with higher scores indicating higher concerns about vaccine risks)	3.0 (\pm 1.1)	0.678	3.0 (\pm 1.1)	3.0 (\pm 1.1)	W = 186,332	0.82
Missing	46 (0.8%)		44 (0.8%)	2 (2.9%)		
<i>By item</i>			% reporting strongly agree/agree			
New vaccines carry more risks than older vaccines			37%	26%	X ² = 5.76	0.15
I am concerned about potential serious adverse effects of vaccines			45%	48%	X ² = 2.06	0.72
	Mean score (SD) overall	Scale alpha (standardized)	Not living with HIV (n = 5519)	Living with HIV (n = 69)	Test-statistic	p value
<i>TPB Attitudes towards a COVID-19 Vaccine Scale</i> (range from 8 to 40, with higher scores indicating more positive attitudes towards the COVID-19 vaccine)	34.5 (\pm 5.8)	0.932	34.5 (\pm 5.8)	32.5 (\pm 6.6)	W = 168,099	0.004
Missing	702 (12.6%)		690 (12.5%)	12 (17.4%)		
<i>By item</i>			% reporting strongly agree/agree			
COVID-19 is a serious illness			84%	81%	X ² = 1.19	0.86
A COVID-19 vaccine would be beneficial for individuals 60-years and older			84%	68%	X ² = 34.98	0.0002
A COVID-19 vaccine would be beneficial for the health of my community			83%	68%	X ² = 18.36	0.006
A COVID-19 vaccine would be beneficial			83%	67%	X ² = 20.86	0.003
A COVID-19 vaccine would be beneficial for children			75%	61%	X ² = 10.32	0.035
A COVID-19 vaccine would be effective in preventing COVID-19			68%	49%	X ² = 20.32	0.002
A COVID-19 vaccine would be safe			62%	45%	X ² = 14.06	0.007

Table 4 (continued)

	Mean score (SD) overall	Scale alpha (standardized)	Not living with HIV (n=5519)	Living with HIV (n=69)	Test-statistic	p value
A COVID-19 vaccine should be mandatory			45%	35%	X ² =14.31	0.007
	Mean score (SD) overall	Scale alpha (standardized)	Not living with HIV (n=5519)	Living with HIV (n=69)	Test-statistic	p value
<i>Perceived Behavioral Control to receive the COVID-19 vaccine</i>	15.9 (±2.7)	0.634	15.9 (±2.7)	16.3 (±2.7)	W = 133,702	0.19
Scores ranging from 1 to 20, with higher scores indicating higher levels of perceived control)						
Missing	595 (10.6%)		586 (10.6%)	9 (13.0%)		
<i>By item</i>						
It would be difficult to receive the COVID-19 vaccine (Strongly Disagree/Disagree)			62%	59%	X ² =4.90	0.26
I could easily receive a COVID-19 vaccine if I wanted to			66%	61%	X ² =3.41	0.40
It would be completely up to me whether I received the COVID-19 vaccine			68%	72%	X ² =9.30	0.075
How much control do you feel you would have over whether you receive a COVID-19 vaccine? (A lot/some control)			74%	68%	X ² =13.46	0.011
	Mean score (SD) overall	Scale alpha (standardized)	Not living with HIV (n=5519)	Living with HIV (n=69)	Test-statistic	p value
<i>Direct social norms</i> (range from 1 to 20 with higher scores indicating being more influenced by direct social norms)	14.7 (±3.4)	0.713	14.7 (±3.3)	12.7 (±3.8)	W = 176,932	<0.0001
Missing	658 (11.8%)		644 (11.7%)	14 (20.3%)		
<i>By item</i>						
People who are important to me would expect me to receive the COVID-19 vaccine			80%	68%	X ² =26.30	0.0009
Most people who are important to me would think that I should receive the COVID-19 vaccine			81%	67%	X ² =40.31	0.0001
Everyone I know would get the COVID-19 vaccine			57%	49%	X ² =15.07	0.017
I would feel under social pressure to receive a COVID-19 vaccine			49%	39%	X ² =41.47	<0.0001
	Mean score (SD) overall	Scale alpha (standardized)	Not living with HIV (n=5519)	Living with HIV (n=69)	Test-statistic	p value
<i>Indirect Social Norms</i> (range from -10 to 10 with higher scores indicating being more influenced by indirect social norms)	22.0 (±12.0)	0.892	22.1 (±11.9)	18.1 (±15.2)	W = 152,898	0.065
Missing	754 (13.5%)		741 (13.4%)	13 (18.8%)		
Indirect Social Norms: Family Doctor/Primary Healthcare Provider	5.9 (±3.6)		5.9 (±3.6)	5.2 (±4.6)	W = 151,051	0.52
Indirect Social Norms: BC Provincial Health Officer	6.6 (±3.6)		6.6 (±3.6)	5.1 (±4.0)	W = 168,755	0.004

Table 4 (continued)

	Mean score (SD) overall	Scale alpha (standardized)	Not living with HIV (n=5519)	Living with HIV (n=69)	Test-statistic	p value
Indirect Social Norms: Friends	4.1 (±3.3)		4.1 (±3.3)	3.1 (±4.0)	W = 168,559	0.023
Indirect Social Norms: Family	5.4 (±3.7)		5.4 (±3.7)	4.2 (±4.7)	W = 166,096	0.05

Bold values indicate the *p*-value is < 0.05 and the result is statistically significant

wanted to, with no overall differences in the scale score by HIV status ($W = 133,702$; $p = 0.19$).

Overall, participants were influenced by *direct social norms* to receive a COVID-19 vaccine. A large majority agreed that people who are important to them would expect them to receive the COVID-19 vaccine and think that they should receive the COVID-19 vaccine. Agreement for the other two scale items was lower, including “Everyone I know would get the COVID-19 vaccine” and feeling “under social pressure to receive the COVID-19 vaccine”. Participants LWH were significantly less likely to be influenced by direct social norms to receive the COVID-19 vaccine than those not LWH (mean score: 12.7 vs 14.7, respectively; $W = 176,932$; $p < 0.0001$).

Participants were similarly likely to report being influenced by *indirect social norms* overall, however, participants LWH were significantly less likely to be influenced by the BC Provincial Health Officer (the senior public health official directing the COVID-19 public health response), friends, or family. They were equally likely as participants not LWH to report being influenced by their family doctor/primary healthcare provider (PHCP). Among participants LWH, the mean total Indirect Social Norms score was 18.1 (SD = 15.2) compared with 22.1 (SD = 11.9) among those not LWH ($W = 152,898$; $p = 0.065$).

Predictors of Intention to Vaccinate Among Participants Living with HIV

All the psychological constructs were significantly associated with vaccine intention in the overall sample, as expected and as previously shown [20] (all *p*-values < 0.001) (Supplementary Table I).

Participants LWH who had a higher odds of reporting an intention to vaccinate were older (OR 1.05 per year increase; 95% CI 1.00–1.10), reported one or more chronic health conditions (OR 3.50; 95% CI 0.98–13.43), were less likely to lack vaccine confidence (0.40; 95% CI 0.18–0.71) more positive attitudes towards the COVID-19 vaccine (OR 1.31; 95% CI 1.15–1.54), greater influence of direct social norms (OR 1.27; 95% CI 1.08–1.54), and greater influence of indirect social norms from family doctors/PHCPs (OR 1.31; 95%

CI 1.13–1.55), the BC provincial health officer (OR 1.74; 95% CI 1.36–2.48), friends (OR 1.58; 95% CI 1.25–2.20), and family (OR 1.65; 95% CI 1.32–2.25). There was no statistically significant association between intention to vaccinate and perceived vaccine risks, perceived behavioral control, other assessed socio-demographic variables (ethnicity, education, household income, essential worker status), or perceived risk of acquiring COVID-19 due to HIV status. Owing to missing data and small cell sizes, we were not able to assess associations with HIV clinical variables (ART use, undetectable viral load) (Table 5).

Vaccine confidence demonstrated the largest effect, whereby participants LWH who expressed vaccine confidence had 2.5 fold higher odds of vaccine intention compared with those who lacked vaccine confidence. Given the small sample size and high degree of correlation between psychological constructs, adjusted analyses were not performed.

Discussion

In this large population-based sample of women and gender diverse individuals in BC, we found that only two-thirds (65.2%) of participants living with HIV (LWH) reported intending to receive a COVID-19 vaccine if recommended and available to them, significantly lower than participants not LWH (79.6%). HIV status itself, however, was not significantly associated with COVID-19 vaccine intention in adjusted analyses. This finding is illustrative of the wide gap between the strong recommendations for COVID-19 vaccination for all PLWH and current intentions [5, 11, 15]. Findings are further concerning given the large proportion of participants LWH who belong to other communities prioritized for vaccine receipt due to higher risk of COVID-19 infection and severe illness, including those experiencing social inequities and co-morbidities.

The observed effect of HIV status on vaccine intention in unadjusted analyses was explained by differences in the distribution of other key socio-demographic factors, including Indigenous ancestry, being racialized, lower household income, lower education, and essential worker (non-health

Table 5 Bivariable associations between socio-demographic, vaccine hesitancy, and psychological constructs and intention to receive the COVID-19 vaccine among women and gender diverse individuals living with HIV (n=69)

	Crude OR	95% CI	p value
Age (per year increase)	1.05	1.00–1.10	0.048
<i>Indigenous ancestry</i>			
No	Ref	Ref	
Yes	0.38	0.12–1.19	0.10
<i>Racialized</i>			
No (White)	Ref	Ref	
Yes (Indigenous, African/Caribbean/Black, Other/mixed ethnicity)	0.63	0.20–2.03	0.43
<i>Education</i>			
More than High School	Ref	Ref	
High School or less	0.40	0.14–1.13	0.09
<i>Household income</i>			
\$20K + per year	Ref	Ref	
< \$20K per year	0.43	0.11–1.62	0.21
Don't know/no answer	0.71	0.15–3.93	0.68
<i>Chronic health conditions</i>			
None	Ref	Ref	
1 or more	3.50	0.98–13.4	0.05
<i>Essential worker</i>			
No	Ref	Ref	
Yes, health worker	0.44	0.07–2.62	0.35
Yes, other essential worker	0.71	0.20–2.66	0.59
WHO Lack of Vaccine Confidence Scale	0.40	0.18–0.71	0.007
WHO Vaccine Risks Scale	0.69	0.41–1.11	0.141
Attitudes toward the COVID-19 Vaccine Scale	1.31	1.15–1.54	< 0.001
Perceived Behavioral Control Scale	1.23	1.00–1.53	0.058
Direct Social Norms Scale	1.27	1.08–1.54	0.007
Indirect Social Norms: Total Scale	1.16	1.09–1.28	< 0.001
Indirect Social Norms: Family Doctor/Primary Healthcare Provider	1.31	1.13–1.55	0.001
Indirect Social Norms: BC Provincial Health Officer	1.74	1.36–2.48	< 0.001
Indirect Social Norms: Friends	1.58	1.25–2.20	0.001
Indirect Social Norms: Family	1.65	1.32–2.25	< 0.001

Bold values indicate the *p*-value is < 0.05 and the result is statistically significant

related) status, all previously shown to be associated with vaccine intention in the general BC population [20]. These findings are consistent with research from two general population studies in the US which reported nearly 80% of participants overall were likely/somewhat likely to receive the COVID-19 vaccine, with significantly lower prevalence among racialized and lower socio-economic status participants [19, 40].

We also found significant differences in vaccine hesitancy and psychological constructs that shape vaccine intention and uptake behaviors by HIV status. Participants LWH reported lower vaccine confidence, less positive attitudes towards the COVID-19 vaccine, and were less likely to be influenced by direct or indirect social norms to receive the COVID-19 vaccine. These findings are consistent with findings from a US study of Black Americans living with HIV

who reported widespread COVID-19 mistrust, with over half reporting COVID-19 vaccine hesitancy [18].

Findings further suggest that efforts to address vaccine confidence and the psychological constructs measured using the Theory of Planned Behavior are important for supporting vaccine intention and uptake. Among participants LWH, we found that differences in the social determinants of health did not predict vaccine intentions. Rather, those with higher vaccine confidence, positive attitudes toward the COVID-19 vaccine, and those who were more strongly influenced by direct and indirect social norms had significantly higher odds of reporting vaccine intention. Collectively, these data suggest that targeted and consistent messaging from family doctors/PHCPs and senior public health officials stating that COVID-19 vaccines are safe, effective, beneficial, and strongly recommended for PLWH, may be a pathway to improve vaccine confidence and attitudes. Specific

information relevant for PLWH includes data regarding the immunogenicity and safety of COVID-19 vaccines among PLWH [41] and the importance of maintaining engagement in HIV care and adhering to ART even among those who are vaccinated. For reproductive-aged WLWH seeking to conceive, evidence regarding the safety and effectiveness of COVID-19 vaccines during pregnancy and breastfeeding will be further reassuring [42]. The opportunity for HIV care provider-led discussions is particularly relevant given that a majority of PLWH are engaged in HIV medical care and over half expressed being fearful that their HIV status would affect their risk of acquiring COVID-19. Research has shown that WLWH express high trust in their HIV care providers and identify them as the preferred source of relevant non-HIV specific information [43]. As we collectively move into the next “ground game” phase of increasing vaccine coverage, public health campaigns will need to support and foster these trusting relationships.

Efforts to support vaccine decision-making and uptake among PLWH can benefit from adopting community-based research principles of meaningful community involvement and engagement across the COVID-19 vaccine response [44, 45]. Research with WLWH, has highlighted the profound influence that peers have on increasing knowledge and healthcare support for WLWH and these learnings should be extended to support informed vaccine decision-making and uptake of a COVID-19 vaccine.

The prevalence of vaccine intention over the course of data collection (August 2020–March 1, 2021) corresponds with a period of time during which the COVID-19 vaccine was not widely available in Canada [11]. In April 2021, vaccine eligibility expanded from priority groups to the general population, beginning with older individuals and extending to those aged 12+ years by June 2021 [46]. As of July 26, 2021, 81% of BC residents aged 12+ years were partially vaccinated while 62% were fully vaccinated [47]. This first-dose vaccine uptake rate is highly consistent with our estimate of 79.7% of adults reporting vaccine intention. While no provincial estimates are yet available for PLWH, these data provide external validity to our findings.

Limitations

Although the number of participants LWH was small, the proportion of those LWH in this sample was higher than expected through general population-based recruitment strategies [48], enabling comparisons with the general population. Participants LWH in this analysis are comparable to the population of women living with HIV in BC by age and ethnicity, however reported higher education and household income relative to the general population of women living with HIV in BC [30, 48]. We did not have sufficient sample size to conduct separate analyses for women and gender

diverse individuals LWH. However, in bivariable analyses we did not observe significant differences in vaccine intention by gender, which further informed our decision to include both women and gender diverse individuals in analyses. The study sample was drawn from individuals who were sufficiently concerned about COVID-19, reasonably trusting of scientific research, and with sufficient resources (technological, time) to complete the online survey. Thus, our findings may over-estimate the true prevalence of vaccine intention.

Conclusion

Among a sample of women and gender diverse individuals, we found important disparities in vaccine intentions by HIV status. Vaccine intentions are, however, dynamic and may evolve as vaccine delivery programs expand. Ongoing efforts must ensure that people living with HIV, and other historically marginalized populations, continue to have equitable access to vaccines and up-to-date vaccine information. Such efforts must acknowledge that the same socio-structural inequities and injustices that produce HIV risk and consequence for women and gender diverse people undermine vaccine confidence and fuel COVID-19 inequities. Our findings suggest pathways for building vaccine confidence, address vaccine concerns, and support informed vaccination decision-making. In partnership with communities, such pathways can be leveraged to promote COVID-19 vaccine uptake among women and gender diverse people living with HIV.

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Data Availability Data cannot be shared publicly because of ethical restrictions. Data are available from the the UBC Research Ethics Board (contact via cwreb@bcchr.ubc.ca) for researchers who meet the criteria for access to confidential data.

Code Availability R code available on reasonable request to the corresponding author.

Declarations

Conflict of interest The authors declare that they have no competing interests.

Ethical Approval Ethical approval was received from The University of British Columbia Research Ethics Board (H20-01421). All methods performed as a part of this study were in accordance with the UBC Research Ethics Board guidelines.

Consent to Participate Informed consent to participate was obtained from participants.

Consent for Publication Not applicable.

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