Factors affecting healthcare worker COVID-19 vaccination acceptance and uptake: a living behavioural science evidence synthesis (v1.0, March 31st, 2021)

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Research Question: How can behavioural science help inform messaging to and broader supports for healthcare workers to encourage vaccination for COVID-19? How can behavioural science help address vaccine-related concerns from equity-seeking groups?

Key Findings

- 32 cross-sectional survey-based studies were identified assessing factors related to COVID-19 vaccination acceptance in healthcare workers (HCWs); 12/32 conducted in North America, 5/32 in Canada.
- 13/32 studies collected data as of Nov 2020 (i.e., when COVID-19 vaccines were being approved by health agencies); 10/13 conducted in North America, 4/13 in Canada.
- All studies assessed vaccination acceptance; no studies to date assessed uptake.
- In Canada, vaccination acceptance rates among HCWs ranged from 57% - 80% indicating that a majority of HCWs in Canada want to get the COVID-19 vaccine but that many would benefit from support in addressing identified barriers to acceptance.
- Based on the Capability, Opportunity, and Motivation-Behaviour (COM-B) model, factors associated with vaccine acceptance focused predominantly on Opportunity and Motivation.
- To date, 8/14 domains from the Theoretical Domains Framework (TDF) appear to be important determinants of COVID-19 vaccine acceptance among HCWs: Knowledge; Environmental context and resources; Social influences; Beliefs about consequences; Social/professional role and identity; Reinforcement; Emotion; and Beliefs about capabilities.
- Negative beliefs about COVID-19 vaccine safety, efficacy, and necessity were associated with lower vaccination acceptance.
- Lower vaccination acceptance rates were found among non-physician HCWs (e.g., nurses), although the extent to which this applies to Canadian HCWs is unclear given limited available data.
- HCWs that have a history of accepting influenza vaccination were more accepting of COVID-19 vaccines.

- Age, gender, and HCW occupation were the most commonly measured equity-related factors; however, few studies robustly tested the association between equity-related factors and vaccine acceptance.
- COVID-19 vaccination acceptance was consistently associated with male gender and older age. Acceptance was variably associated with race, ethnicity, and indigeneity, occupation type and setting, education, and health status.
- Given the paucity of Canadian studies exploring differences between HCWs who are also part of equity-seeking groups, more Canadian research is needed to understand the concerns and perceptions of HCWs who are racialized, work in different healthcare settings, and possess different educational backgrounds to better identify how factors impacting vaccine acceptance vary between groups.

Introduction: Leveraging behavioural science to provide a new lens on HCW COVID-19 vaccination

Recent breakthroughs in vaccine development have been crucial for curbing the COVID-19 pandemic. To date, it is estimated almost 2.8 million people have died from COVID-19, including over 22,000 Canadians (cf. John's Hopkins COVID tracker). As vaccine programs are steadily being rolled out across Canada, addressing vaccination acceptance and uptake among high-priority groups such as frontline healthcare workers (HCWs) remains an urgent public health challenge. It is therefore crucial to better understand the factors associated with vaccination acceptance and uptake among HCWs generally and among HCWs from equity-seeking groups (e.g., those experiencing racial, ethnic, and socioeconomic disparities/marginalization). This is especially important given the disproportionate health, economic, and emotional impact COVID-19 has had on equity-seeking groups in Canada.

A behavioural science approach does not imply an individual-focus, nor does it put the onus of responsibility on individuals. Rather, framing COVID-19 vaccination uptake as a behaviour allows us to draw upon decades of research aimed at understanding factors that affect what people think, feel, decide, and ultimately do. Such an approach fully recognizes that what individuals, groups, communities, and populations do is shaped by the past and present experiences, resources, and constraints afforded or not by the social and physical contexts in which they live and work. These experiences and affordances (or lack thereof) ultimately serve to shape the Capability, Opportunity, and Motivation that drive the behaviour of individuals and groups (cf. COM-B model [1]).

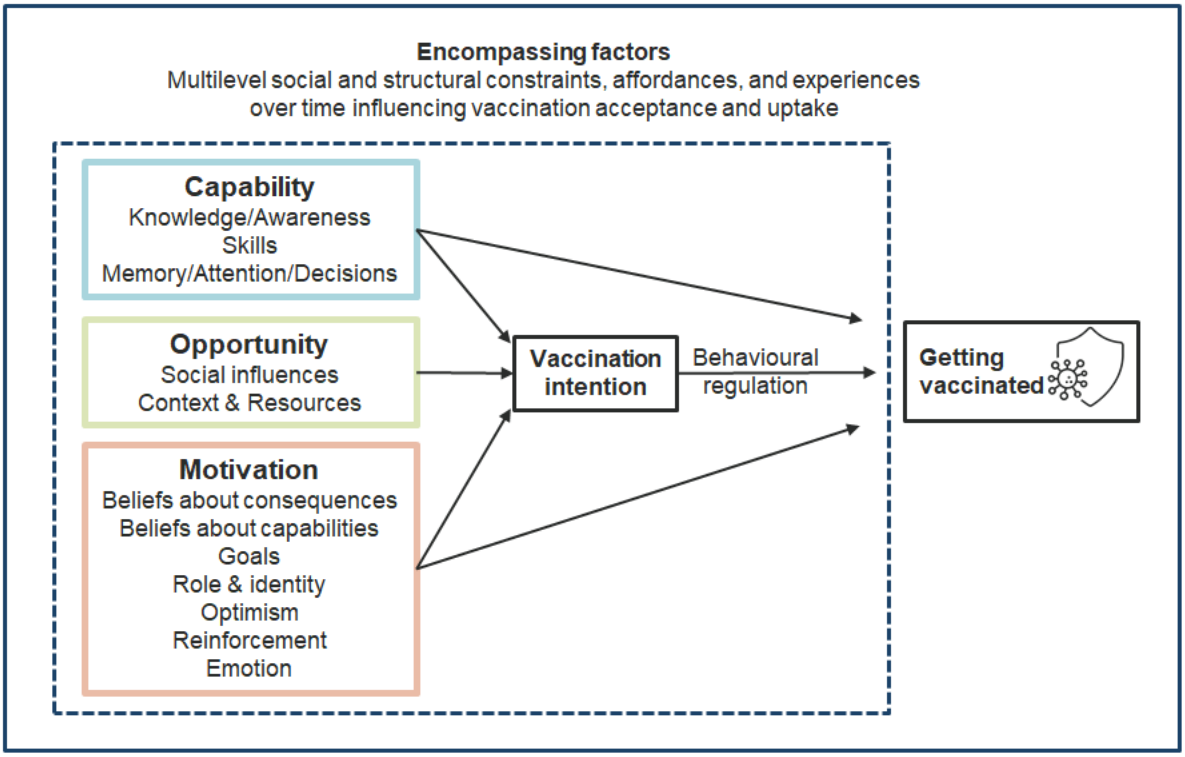
Our behavioural science approach underscores the fundamental agency and self-determination of which every Canadian is deserving, while recognising that it is not the sole responsibility of individual Canadians (and in this case, individual HCWs) to address barriers and enablers that impact on their vaccination behaviour. Rather, the behavioural science approach herein focuses on how the Capability-, Opportunity- and Motivation-related factors of HCWs are shaped by the multiple social, cultural, historical, community, governmental, clinical, and environmental levels that influence HCWs acceptance and uptake of COVID-19 vaccination. We do so by drawing upon the overarching COM-B model to situate 14 key behavioural factors that can drive vaccination intention and uptake (**see Figure 1**). These 14 factors are reflected in the Theoretical Domains Framework (TDF), a synthesis of decades of research and evidence of the key, modifiable factors that influence behaviour [2–4]. TDF factors are linked to specific behaviour change techniques that can be used to address particular barriers and enablers to vaccination, thus linking barriers to solutions. In this living review, we employ behavioural science tools and methods to define the target behaviour (cf. the AACTT tool [5]), understand barriers and enablers driving the target behaviour (cf. COM-B model and TDF [1,3,4]), and suggest strategies and programs to help change the target behaviour (cf. Behaviour Change Wheel and Behaviour Change Technique Taxonomy [1,6]).

Using these approaches allows us to explore whether different factors influence vaccine acceptance in different equity-seeking groups which may point to strategies and programs that address the needs and concerns of these groups. Such approaches have been used extensively to address behaviour change in other health-related contexts but to date have yet to be fully leveraged to address vaccination acceptance and uptake in HCWs. As part of a living behavioural science evidence synthesis (LBSES), we will use perspectives from the COM-B model and TDF to help identify factors affecting vaccination acceptance and uptake among HCWs both globally and in Canada, and in particular among HCWs serving equity-seeking groups.

Living Behavioural Science Evidence Synthesis Objectives

1. Identify rates of vaccination acceptance in HCWs globally and in Canada.
2. Identify rates of vaccination uptake in HCWs in Canada.
3. Identify factors associated with COVID-19 vaccination acceptance and uptake among HCWs globally and in Canada.
4. Identify factors associated with COVID-19 vaccination acceptance and uptake among HCWs serving equity-seeking groups.

Figure 1. Potential drivers of vaccination acceptance and uptake based on the COM-B model and Theoretical Domains Framework



Methods

Data sources

We identified four published evidence syntheses that captured published peer-reviewed papers, preprints, published reports, and unpublished datasets relating to our research question:

- *COVID-19 Rapid Evidence Profile #24: What is known about strategies for encouraging vaccine acceptance and addressing vaccine hesitancy or uptake?* [7] (most recent search: Nov 18th, 2020)
- *Rapid Evidence Review: What are the barriers and facilitators to individuals' willingness to be vaccinated for COVID-19?* [8] (most recent: Sep 28th, 2020)
- *Evidence Synthesis Briefing Note: COVID-19 Vaccine Uptake Among Health Care Workers* [9] (most recent search: Jan 22nd 2021)
- *Evergreen Rapid Review on COVID-19 Vaccine Knowledge, Attitudes, and Behaviours – Update 3* [10] (most recent search: Feb 3rd, 2021)

Inclusion criteria

- *Population:* HCWs in general and particularly those from equity-seeking groups (HCW role could be self-identified).
- *Outcome:* Studies had to include a measure (self-report and/or objective) of COVID-19 vaccination willingness/intention/hesitancy/acceptance (referred to as **vaccination acceptance** hereafter), and/or uptake. Vaccination acceptance/uptake had to relate to HCWs being vaccinated themselves.
- *Time:* Onset of the COVID-19 pandemic (Jan 2020) onwards.
- *Design:* Qualitative and survey (observational) data; cross-sectional, prospective and cohort designs.

Exclusion criteria

- *Population:* General population samples only.
- *Outcome:* Studies that only included a measure of vaccination knowledge. Vaccination acceptance in relation to vaccinating others (e.g., family members, patients).

Data extraction

The four evidence syntheses were manually searched and cross-referenced for relevant studies. A standardised data extraction form (**see Appendix 1**) was used to extract relevant data relating to study characteristics, behavioural specification, and factors affecting HCW vaccination acceptance based on the COM-B model and TDF. Equity-related data were extracted separately with a particular focus on studies conducted in Canada. A list of equity-related factors was created based on factors identified in the PROGRESS framework [11], intersecting categories of privilege and oppression [12], and those considered part of an equity approach by PHAC. This list was used to extract equity-related data from identified articles (**see Appendix 2**). '*k*' refers to the number of studies. Where available, we have captured key statistical analyses (odds ratios (OR); adjusted odds ratios ($OR_{adjusted}$)) on the factors associated with higher or lower vaccination acceptance.

Results

Study characteristics

A total of 35 studies were identified up to Feb 3rd, 2021, three of which were excluded. Two of these studies only included a measure of vaccination knowledge [13,14] and the third measured HCW acceptance to vaccinate their children rather than themselves [15].

Of the 32 studies included in our final sample [16–47], 18 were reported in published peer-reviewed papers, 10 were preprints, three were published reports, and one study was an unpublished dataset (**see Table 1**). All 32 studies used cross-sectional surveys designs; no qualitative studies to date were identified. All 32 studies measured COVID-19 vaccine acceptance; no studies to date measured vaccination uptake or the relationship between acceptance (and related factors) and uptake in HCWs.

12 studies were conducted in North America (USA x7 [24,33,39,42–44,46]; Canada x5 [19,35,40,41,45]), 20 studies were conducted outside of North America (Greece [36]; China [23]; Hong Kong x2 [32,47]; Arabian Gulf countries [16]; France x2 [20,25]; Israel [21]; Cameroon [22]; Indonesia [29]; Democratic Republic of Congo [34]; Nepal [37]; Zambia [18]; Germany [28]; Malta [26,27]; Turkey [31]; Saudi Arabia [17]; Egypt [30]; Multicounty [38]. Survey data were collected between Feb 2020 and Jan 2021. Notably, the majority of North American data (10/12 studies) were collected after Nov 2020, when COVID-19 preliminary trial data was first being published (first COVID-19 vaccine – Pfizer-BioNTech - was approved for emergency use in UK on Dec 2nd 2020 and in USA on Dec 11th 2020). Among studies conducted outside North America, data from 3/20 studies were collected after Nov 2020.

Eight studies recruited general population samples which included data on HCWs [16,20,21,28,29,40,42,42]. The remaining 24 studies exclusively recruited HCWs, of which 11 studies recruited specific occupations/specialities: non-physicians [19,24], nursing home/assisted living staff [46], continuing care workers [41], pharmacy professionals [35], personal support workers [45], nurses/trainee nurses [32,38,47], lab medical professionals [18], physicians/trainee physicians [26]

Table 1. Evidence of COVID-19 vaccination acceptance among HCWs

Author	Publication status	Country	Design	Sample	Sample size	Data collection period	Mean vaccine acceptance %	COM-B model factors (*TDF domains*)
North American studies (*k*=12), listed in order of date of data collection								
INSPQ	Published (report)	Quebec, Canada	CS	Gen pop (inc. HCW)	NR	Apr - May, 2020 & Sep, 2020 (dates NR)	73%	N/A
Gadoth et al.	Preprint	USA	CS	HCWs (non-physicians)	609	Sep 24 - Oct 16, 2020	32%	Opportunity (*Environmental context and resources*) Motivation (*Social/professional role and identity; Beliefs about consequences*)
Shekhar et al.	Published	USA	CS	HCW	3,479	Oct 7 - Nov 9, 2020	36%	Motivation (*Social/professional role and identity; Beliefs about consequences*)
Unroe et al.	Published	USA	CS	HCW (nursing home and assisted living staff)	8,243	Nov 14-17, 2020	45%	Motivation (*Social/professional role and identity; Beliefs about consequences*)
Meyer et al.	Published	USA	CS	HCW	16,158	Dec 4-22, 2020	53-80%	Motivation (*Beliefs about consequences*)

SafeCare-BC	Published (report)	British Columbia, Canada	CS	HCW (continuing care workers)	1,503	Dec, 2020 (dates NR)	57%	Opportunity (*Social influences*) Motivation (*Social/professional role and identity; Beliefs about consequences; Beliefs about capability; Reinforcement*)
Savoia et al.	Preprint	USA	CS	Gen pop (inc. HCW)	1,616	Dec 13-23, 2020	NR	N/A
Piltch-Loeb et al.	Preprint	USA	CS	Gen pop (inc. HCW)	1,627	Dec 13-23, 2020	39%	N/A
Shaw et al.	Published	USA	CS	HCW	5,287	Nov 23 - Dec 5, 2020	58%	Motivation (*Social/professional role and identity; Beliefs about consequences*)
Desveaux et al.	Preprint	Ontario, Canada	CS	HCWs (non-physicians)	8,634	Jan 4-12, 2021	80%	Opportunity (*Environmental context and resources*) Motivation (*Social/professional role and identity; Beliefs about consequences; Reinforcement*)
Ontario College of Pharmacists	Published (report)	Canada	CS	HCW (pharmacy professionals)	6,677	Jan 12-21, 2021	79%	Motivation (*Social/professional role and identity; Beliefs about consequences*)
Canadian PSW Network	Unpublished dataset	Canada	CS	HCW (personal support workers)	562	NR, data published online Jan 5, 2021	64%	Capability (*Knowledge*)

Author	Publication status	Country	Design	Sample	Sample size	Data collection period	Mean vaccine acceptance %	COM-B model factors (*TDF domains*)
International studies (*k*=20), listed in order of date of data collection								
Papagiannis et al.	Published	Greece	CS	HCW	461	Feb 10-25, 2020	43%	Motivation (*Social/professional role and identity*)
Fu et al.	Preprint	China	CS	HCW	352	Mar 17-18, 2020	76%	Opportunity (*Social influences*) Motivation (*Beliefs about consequences*)
Wang et al.	Published	Hong Kong	CS	HCW (nurses)	806	Feb 26 - Mar 31, 2020	40%	Motivation (*Social/professional role and identity; Beliefs about consequences; Reinforcement*)
Ali et al.	Published	Arabian Gulf countries	CS	Gen pop (inc. HCW)	1,250	Mar 28 - Apr 4, 2020	75%	N/A
Detoc et al.	Preprint	France	CS	Gen pop (inc. HCW)	1,421	Mar 26 - Apr 20, 2020	82%	N/A
Dror et al.	Published	Israel	CS	Gen pop (inc. HCW)	829	Mar 26 - Apr 9, 2020	61-78%	Opportunity (*Environmental context and resources*) Motivation (*Social/professional role and identity; Beliefs about consequences*)

Fouogue et al.	Preprint	Cameroon	CS	HCW	464	Apr 14-29, 2020	49%	Opportunity (*Social influences*) Motivation (*Beliefs about consequences*)
Harapan et al.	Published	Indonesia	CS	Gen pop (inc. HCW)	264	Mar 25 - Apr 6, 2020	67-93%	N/A
Kwok et al.	Published	Hong Kong	CS	HCW (nurses)	1,205	mid-Mar - late-Apr, 2020 (dates NR)	63%	Motivation (*Social/professional role and identity; Beliefs about consequences; Emotion*)
Nzaji et al.	Published	Democratic Republic of Congo	CS	HCW	613	Mar 20 - Apr 30, 2020	28%	Motivation (*Social/professional role and identity; Beliefs about consequences*)
Parajuli et al.	Published	Nepal	CS	HCW	230	Apr - May 2020 (dates NR)	94%	N/A
Chawe et al.	Published	Zambia	CS	HCW (lab medical professionals)	208	Jun 10-29, 2020	47%	N/A
Gagneux-Brunon et al.	Published	France	CS	HCW	2,047	Mar 26 - Jul 2, 2020	77%	Motivation (*Social/professional role and identity; Beliefs about consequences; Reinforcement; Emotion*)
Grüner et al.	Published	Germany	CS	Gen pop (inc. HCW)	213	May 18 - Aug 2, 2020	86%	N/A

Grech & Bonnici	Published	Malta	CS	HCW	1,002	Sep 11-19, 2020	52%	Capability (*Knowledge*) Motivation (*Beliefs about consequences; Reinforcement*)
Grech & Gauci	Published	Malta	CS	HCW (physicians and their trainees)	123	Sep, 2020 (dates NR)	62%	Capability (*Knowledge*) Motivation (*Beliefs about consequences; Reinforcement*)
Kose et al.	Published	Turkey	CS	HCW	1,138	Sep 17-20, 2020	69%	Motivation (*Beliefs about consequences; Reinforcement*)
Barry et al.	Preprint	Saudi Arabia	CS	HCW	1,512	Nov 4-14, 2020	70%	Opportunity (*Environmental context and resources*) Motivation (*Beliefs about consequences*)
Patelarou et al.	Preprint	Multicounty (Albania, Cyprus, Czech Republic, Greece, Italy, Kosovo, Spain)	CS	HCWs (nursing students)	2,249	Dec, 2020 (dates NR)	44%	Capability (*Knowledge*) Opportunity (*Social influences*) Motivation (*Beliefs about consequences; Reinforcement; Emotion*)
Hussein et al.	Preprint	Egypt	CS	HCW	496	Dec 1, 2020 - Jan 1, 2021	46%	Motivation (*Beliefs about consequences; Emotion*)

Table 1 notes: Greyed boxes in the data collection period column represent studies conducted from Nov 2020 onwards (when COVID-19 preliminary trial data was first being published); COM-B model = Capability, Opportunity, and Motivation-Behaviour model; CS = Cross-sectional survey; Gen pop = General population sample; HCW = Healthcare worker, N/A = studies that did not capture these factors; NR = not reported; TDF = Theoretical Domains Framework.

Objective 1: COVID-19 vaccination acceptance rates in HCWs

Overall: Data on COVID-19 vaccination acceptance rates were available in 31/32 studies (**see Table 1**). One study [42] sampling from the general population that identified HCWs within did not report on HCW vaccination acceptance specifically, only rates for the overall sample (60% acceptance rate). Across 31 studies, vaccination acceptance rates ranged from 32% [24] - 94% [37]. Across 13 studies that collected data post-vaccine approval for COVID-19 (Nov 2020 onwards), vaccination acceptance rates ranged from 36% [44] - 80% [19]. Among the five Canadian studies, vaccination acceptance rates ranged from 57% [41] - 80% [19]. One study from the USA [33] reported a substantial increase in self-reported intent to receive a COVID-19 vaccine after the Food and Drug Administration voted to recommend an Emergency Use Authorization (Dec 10th 2020) (pre: 53% [n=15,003] → post: 80% [n=1289]).

HCWs vs. General population sample: Eight studies sampling from the general population identified HCWs within [16,20,21,28,29,39,40,42]. Four studies reported no differences in vaccination acceptance between general population vs. HCWs [16,21,39,40]. Two studies reported higher rates of acceptance among HCWs vs. general population (OR=1.53, 95% CI: 1.27–1.85) [20]; (OR$_{adjusted}$))=1.57, 95% CI: 1.12-2.20) [29]. Two studies did not report comparison data [28,42].

Objective 2: COVID-19 vaccination uptake rates

None of the 32 studies identified reported data on COVID-19 vaccination uptake (e.g., % of HCWs being vaccinated). Data from the Government of Canada website reports that as of Mar 26th, 2021, 75% of HCWs targeted for priority vaccinations (i.e., those providing direct medical care to patients) had received at least one dose of a COVID-19 vaccine. Future versions of this LBSES report will capture more recent studies that will likely measure actual vaccination uptake and factors (based on COM-B model and TDF) associated with uptake.

Objective 3: Factors associated with higher and lower COVID-19 vaccination acceptance

24/32 studies provided evidence on the potential factors underlying COVID-19 vaccine acceptance in HCWs which were mapped using the COM-B model and TDF. To date, eight (of a possible 14) TDF domains appear to be important determinants of COVID-19 vaccine acceptance:

- Capability (Knowledge [*k*=4]) (see **Table 2**).
- Opportunity (Environmental context and resources [*k*=4]; Social influences [*k*=4]) (see **Table 3**).
- Motivation (Beliefs about consequences [*k*=21]; Social/professional role and identity [*k*=13]; Reinforcement [*k*=8]; Emotion [*k*=4]; Beliefs about capabilities [*k*=1]) (see **Table 4**).

These domains were similar to those found among the general population [8], although the Reinforcement domain (i.e., historical acceptance of the influenza vaccine) was important for HCWs. Domains that did not emerge to date as important determinants of COVID-19 vaccine acceptance among HCWs included: Skills; Behavioural regulation; Memory/attention; Goals; and Optimism.

Capability-related factors

There is limited evidence for Capability-related factors influencing vaccination acceptance among HCWs to date. A lack of knowledge about COVID-19 vaccines was cited as a barrier in three studies [26,27,45]. One study tested the relationship statistically between HCW knowledge and vaccination acceptance. HCWs with 'high' knowledge about COVID-19 vaccines had 1.86 times greater odds of accepting a COVID-19 vaccine versus those with 'low' knowledge [38]. Despite decision-making (e.g., how do the decisions HCWs make about the behaviour influence whether they do it or not?) being a key Capability-related domain, no studies attempted to measure decision-making. However, it is likely that future studies collecting data on both vaccination acceptance and uptake may delve deeper into the actual decision-making process (e.g., framing effects, memory [48]), which may also tap into other domains such as Beliefs about consequences (e.g., how HCWs weighed up beliefs about vaccine necessity vs. concerns about possible adverse effects).

Table 2. Capability-related factors associated with COVID-19 vaccination acceptance among HCWs

TDF Domain (Definition)	
Knowledge (What do HCW know & how does that influence what they do? Do they have the procedural knowledge (know how to do it)?)	
Factors associated with **lower acceptance**	• *k*=3 → Insufficient knowledge/education about novel vaccines [26,27,45] ○ 72% PSWs agreed that insufficient education has been provided to them on potential vaccines [45]
Factors associated with **higher acceptance**	• *k*=1 → 'High' knowledge about COVID-19 vaccines vs. 'low' knowledge ($OR_{adjusted}$=1.86, 95% CI: 1.35-2.56) [38]

Opportunity-related factors

Singular studies identified factors related to HCWs' environmental context and access to resources which were associated with vaccination acceptance. One study found that student nurses who had worked in a healthcare facility during the pandemic were less likely to accept a COVID-19 vaccine [38]. Another study found HCWs who worked on COVID-19 wards had higher vaccination acceptance versus those that worked on non-COVID-19 wards [21]. A Canadian study found that vaccination acceptance was higher among HCWs if financial support (e.g., paid sick leave) was provided which highlights a key issue at the healthcare organization level [19].

Two studies, including one conducted in Canada, found mistrust towards governments and public health bodies was associated with lower vaccination acceptance [22,41]. Another study found HCWs that had trust in government had 1.85 times greater odds of accepting a COVID-19 vaccine versus those indicating mistrust [38]. One Chinese study found that vaccination intention of social contacts was a barrier to vaccination acceptance among HCWs [23].

Table 3. Opportunity-related factors associated with COVID-19 vaccination acceptance among HCWs

TDF Domain (Definition)	
Environmental Context and Resources (What are the things in HCWs environment that influence what they do and how do they influence?)	
Factors associated with **lower acceptance**	• *k*=1 → Working in a healthcare facility (during the pandemic) decreased acceptance to vaccinate (OR(adjusted)=0.63, 95% CI: 0.48-0.82) [38]
Factors associated with **higher acceptance**	• *k*=1 → Resources – relied of reputable information sources (e.g., Centre for Disease Control website) (OR(adjusted)=1.51, 95% CI: 1.13–2.01) [17] • *k*=1 → Working on a COVID-19 ward (94%) vs. non-COVID-19 ward (77%) (*p*<0.01) [21] • k=1 → vaccination acceptance was more likely among HCWs if direct financial supports (e.g., paid sick days) were provided (74% vs. 25%, *p*<0.01) [19]
TDF Domain (Definition)	
Social influences (What do others do? What do others think of what HCWs do or what they should do? Who are they and how does that influence what they do?)	
Factors associated with **lower acceptance**	• *k*=2 → State/government/public health agency mistrust [22,41] • *k*=1 → Vaccination practice of social contacts (e.g., if others refused, they would be tempted to do the same) (OR=0.40, 95% CI: 0.34-0.47) [23]
Factors associated with **higher acceptance**	• *k*=1 → Trust in the government (OR(adjusted)=1.85, 95% CI: 1.49-2.29) [38]

Motivation-related factors

One of the most important determinants of individuals' willingness to receive a COVID-19 vaccine was their beliefs about consequences, specifically beliefs related to vaccine safety, efficacy, and necessity. Safety concerns centered on the risk of possible adverse events (e.g., side effects) [19,24,26,27,30,31,33,38,41,43,44,46,47] and the speed at which vaccines were

being developed [17,19,21,24,31,33,41,44]. Two Canadian studies reported these associations [19,41].

Four studies found that HCWs questioned to efficacy of COVID-19 vaccines [30,31,38,47]. Moreover, beliefs about the necessity of COVID-19 vaccines (e.g., not feeling at risk because they feel in good health) were also found to be associated with lower vaccination acceptance in four studies including one from Canada [19,22,31,47]. From the Emotion domain, general fear about COVID-19 was associated with higher vaccination acceptance among HCWs [25,38].

One consistent finding was that vaccination acceptance was lower in non-physicians such as nurses [21,24,25,34,36,43], although none of these data were Canadian. Data from the SafeCare-BC report found 30% of healthcare assistants were 'unsure' about vaccination and nurses were the highest HCW group that would decline vaccination (20% of nurses) [41].

Two studies found that HCWs providing direct care to patients generally [44] and to COVID-19 patients specifically [43] was associated with vaccination acceptance. Interestingly, a Canadian study found that perceived professional responsibility was associated with higher vaccination acceptance which could potentially be leveraged at the healthcare organization level [19]. Captured in the Reinforcement domain, past vaccination behaviour (e.g., seasonal influenza vaccine) was found to be consistently associated with higher acceptance of a COVID-19 vaccine, including data from one Canadian study [19,25,31,38,47].

Table 4. Motivation-related factors associated with COVID-19 vaccination acceptance among HCWs

TDF Domain (Definition)	
Beliefs about consequence (What are the good and bad things that can happen from what HCWs do and how does that influence whether they'll do it in the future?)	
Factors associated with **lower acceptance**	• *k*=8 → Beliefs about rushed vaccine development/insufficient data developed [17,19,21,24,31,33,41,44] ○ $OR_{(adjusted)}$=0.39, 95% CI: 0.30–0.52 [17] ○ $OR_{(adjusted)}$=5.10, 95% CI: 3.75-6.94) [19] • *k*=4 → Beliefs that vaccine not necessary (e.g., feel in good health, not needed to tackle COVID-19) [19,22,31,47] ○ $OR_{(adjusted)}$=2.12, 95% CI: 1.51-2.97 [19] • *k*=13 → Belief about vaccine safety (e.g., side-effects))

	[19,24,26,27,30,31,33,38,41,43,44,46,47] ○ OR(adjusted)=2.44, 95% CI: 1.71-3.48) [19] • *k*=4 → Beliefs about vaccine efficacy [30,31,38,47]
Factors associated with **higher acceptance**	• *k*=3 → Belief in vaccine safety [17,23,35] ○ OR(adjusted)=1.55, 95% CI: 1.12-2.14 [17] ○ OR=1.54, 95% CI: 1.35-1.75 [23] • *k*=2 → Belief in vaccine efficacy [17,35] ○ OR(adjusted)=1.54; 95% CI: 1.26–1.88 [17] • *k*=1 → Getting vaccinated will protect patients (OR(adjusted)=0.44, 95% CI: 0.31-0.62) [19] • *k*=1 → Getting vaccinated will protect family (OR(adjusted)=0.21, 95% CI: 0.15-0.30) [19] • *k*=2 → Beliefs about high possibility of becoming infected [23,25] ○ OR=2.10, 95% CI: 1.78-2.43 [23] ○ OR(adjusted)=2.48, 95% CI: 1.93-3.20) [25] • *k*=1 → Vaccine confidence [32] • *k*=1 → Positive attitude towards a COVID-19 vaccine (OR(adjusted)=11.49; 95% CI: 5.88–22.46) [34]
TDF Domain (Definition)	
Social/Professional Role and Identity (How does their role/responsibility (in various settings) influence whether they do or not? How does who they are as a HCW influence whether they do something or not? Is the behaviour something they are supposed to do or is someone else responsible?)	
Factors associated with **lower acceptance**	• *k*=6 → Vaccine acceptance higher among doctors vs. nurses (78% vs. 61% [21]; 61% vs. 34% [36]); intent to delay vaccination higher nurses vs. doctors (OR=4.14) [24]; vaccination acceptance lower among nurses vs. physicians (OR(adjusted)=0.57, 95% CI: 0.45-0.73) [25]; vaccination acceptance doctors vs. nurses/other HCWs (OR(adjusted)=1.59; 95% CI:1.03–2.44) [34]; physicians (80%) more likely to vaccinate than nurses (41%), ancillary services (46%) and allied health professionals (51%) [43] • *k*=1 → Healthcare assistants 'unsure' about vaccination (30% unsure), nurses were highest HCW group to say 'no' about vaccination (20%) [41]

	• *k*=1 → Dietary, housekeeping, and administrative staff were more likely to intend to vaccinate compared to clinical care staff including nurse aids and nurses (p<0.01) [46] • *k*=1 → Pharmacists who are managers/owners were more likely to accept a vaccine (85%) than were pharmacy technicians (66%) [35]
Factors associated with **higher acceptance**	• *k*=1 → When getting vaccinated seen as a professional responsibility (OR$_{adjusted}$=0.31, 95% CI: 0.23-0.40) [19] • *k*=1 → Collective responsibility towards the vaccine [32] • *k*=1 → Direct medical care providers (49%) vs. non-direct care providers (34%) would accept vaccination [44] • *k*=1 → Those working directly with COVID-19 patients (OR$_{adjusted}$=1.63, 95% CI: 1.14-2.33) [47]
TDF Domain (Definition)	
Reinforcement (How have their experiences (good and bad) of doing it in the past influence whether or not they do it? Are there incentives/rewards?)	
Factors associated with **lower acceptance**	• *k*=1 → Those not having influenza vaccination less than half as likely to want COVID-19 vaccination [41]
Factors associated with **higher acceptance**	• *k*=5 → Historical influenza vaccination [19,25,31,38,47] ○ OR$_{adjusted}$=0.52, 95% CI: 0.41-0.68) [19] ○ OR$_{adjusted}$=4.69, 95% CI 3.59-6.11) [25] ○ OR$_{adjusted}$=2.03, 95% CI: 1.47–2.81) [47] ○ OR$_{adjusted}$=2.38, 95% CI: 1.57- 3.59 [38] • *k*=2 → Likelihood of having influenza vaccine [26,27]
TDF Domain (Definition)	
Emotion How do they feel (affect) about what they do and do those feelings influence what they do?	
Factors associated with **lower acceptance**	• Nothing identified to date
Factors associated with **higher acceptance**	• *k*=2 → Fear about COVID-19 [25,38] ○ OR$_{adjusted}$=1.58, 95% CI: 1.21-2.07 [25] ○ OR$_{adjusted}$=2.15, 95% CI: 1.62-2.84 [38] • *k*=1 → Fear of genetic mutation [30] • *k*=1 → COVID-19 vaccination acceptance was associated with greater work stress [32]

TDF Domain (Definition)	
Beliefs about capabilities (Do HCWs think they can (are they confident that they can) and how does that influence whether they do it or not? What increases or decreases their confidence?)	
Factors associated with **lower acceptance**	• Nothing identified to date
Factors associated with **higher acceptance**	• *k*=1 → Not concerned about challenges or difficulties in getting vaccinated [41]

Objective 4: Equity-related factors associated with higher and lower COVID-19 vaccination acceptance

Our synthesis found that most studies looking at HCW vaccination acceptance also collected data on equity-related factors. **Table 5** reports the frequencies of equity-related factors associated with COVID-19 vaccination acceptance among HCWs. Most studies (k=27) conducted some form of analysis (e.g., Chi square, bivariate correlations, ANOVA) to examine the relationship between equity-related factors and vaccination acceptance. However, only a few studies formally analyzed whether equity-related factors predicted vaccination acceptance through multiple regression analyses. The most commonly examined equity-related factors (any analysis) were gender (*k*=24), age (*k*=23), occupation type (*k*=14), physical health (*k*=12), occupation setting (*k*=10), education (*k*=8), and race, ethnicity and indigeneity (*k*=8). Below is a summary of equity-related factors that were assessed in relation to vaccination acceptance in Canadian and non-Canadian studies.

Table 5. Equity-related factors associated with COVID-19 vaccination acceptance among HCWs

Equity-related factors	Studies assessing equity-related factors in relation to vaccine acceptance			Studies reporting a significant association between equity-related factors and vaccination acceptance			Studies identifying equity-related factors that predict vaccination acceptance		
	All (*k*=27)	USA (*k*=7)	Canada (*k*=4)	All (*k*=27)	USA (*k*=7)	Canada (*k*=4)	All (*k*=18)	USA (*k*=5)	Canada (*k*=1)
Gender/sex	24	6	3	19	5	2	11	4	0
Age	23	5	3	14	3	3	6	2	1
Sexuality	1	1	0	0	0	0	0	0	0
Race/ethnicity/indigeneity	8	6	2	7	5	2	5	4	1
Culture/language	0	0	0	0	0	0	0	0	0
Religion/spirituality	2	1	0	0	0	0	0	0	0
Occupation (type)	13	3	2	12	3	2	8	2	0
Occupation setting	10	4	1	7	4	0	4	2	0
Occupation (status)	4	0	0	3	0	0	2	0	0
Private vs. public service	1	0	0	1	0	0	1	0	0
Education	8	4	2	6	4	2	5	3	1
Income	3	1	0	1	1	0	1	1	0
Immigration status	0	0	0	0	0	0	0	0	0
Place of residence	4	1	0	1	1	0	1	1	0
Mental health	1	0	0	0	0	0	0	0	0
Physical health	12	3	1	5	1	1	3	1	0
Family composition	4	0	0	1	0	0	1	0	0
Financial supports	1	0	1	1	0	1	1	0	1

Table 5 notes. Frequencies broken down by all studies (All), studies conducted in the USA, and studies conducted in Canada. Five studies were excluded as they did not assess equity related factors in relation to vaccine acceptance [18, 22, 23, 37, 45].

Equity-related factors and vaccination acceptance: Canadian studies

Four Canadian studies [19,35,40,41] investigated equity-related factors associated with COVID-19 vaccination acceptance. One Canadian report [45] did not assess equity-related factors in relation to vaccination acceptance.

Gender

- The INSPQ report and SafeCare-BC report found male gender was associated with vaccine acceptance [40,41].
- Desveaux et al. found gender did not predict vaccination acceptance [19].

Age

- Three studies found older age was associated with vaccination acceptance [19,40,41].
- Desveaux et al. found that older age (>40 years) predicted greater vaccination acceptance [19].
- The SafeCare-BC report found that continuing care workers in the 24-34 age range were the least sure about getting a vaccine [41].

Race, ethnicity and indigeneity

- Desveaux et al. found interaction effect between race/ethnicity and employment setting such that Filipino HCWs working in continuing care and Caribbean HCWs working in acute care had lower vaccination acceptance vs. European ethnicity [19].
- The SafeCare-BC report noted that those who identified as East/South Asian were more likely than Latino and Black respondents to accept a vaccine. Indigenous respondents were more likely to respond "not sure" [41].
- Among respondents in the SafeCare-BC report who provided reasons for uncertainty or unwillingness to get vaccinated, East/Southeast Asian respondents were most likely to cite concerns over side effects while White and indigenous respondents were the most likely to cite mistrust in government and pharmaceutical companies' recommendations [41].
- Desveaux et al. found that mistrust was associated with lower vaccine acceptance but did not find an interaction between mistrust and race, ethnicity and indigeneity [19].

Health status

- The INSPQ report found that those living with one or more chronic conditions were more likely to accept a vaccine [40].

Occupation type

- SafeCare-BC found that senior leaders were more likely to accept a vaccine than other HCW groups [41].

- The OCP report found that pharmacists had higher rates of vaccination acceptance than pharmacy technicians [35].

Occupation setting

- Desveaux et al. found workplace setting (acute vs. continuing care) was not a significant predictor of vaccination acceptance among HCWs who identified as White [19].

Education

- Desveaux et al. found HCWs who had not completed high school were more likely to express vaccine hesitancy vs. those with university degree [19].
- The INSPQ report found that obtaining a university degree was associated with vaccination acceptance [40].

Financial supports

- Desveaux et al. found HCWs were more likely to get vaccinated if financial supports (e.g., paid sick leave) were provided [19].

Equity-related factors and vaccination acceptance: non-Canadian studies

Gender

17/21 studies found that gender was associated with vaccination acceptance. 15 studies [16,17,20,25–27,31,34,36,38,43,44,46,47] found that male respondents were more likely to accept a vaccine. Four studies [24,28–30] found that gender was not associated with vaccine acceptance. Two studies [39,42] found that women were more likely to get vaccinated.

Age

11/20 studies found that age was associated with vaccination acceptance. Eight studies [20,25,27,30,34,43,44,46] reported that older HCWs were more likely to accept a vaccine. Nine studies did not find an effect for age [17,21,26,29,36,38,39,42,47]. Three studies [16,31,32] found that younger respondents were more likely to express vaccination acceptance.

Race, ethnicity and indigeneity

Six studies from the USA representing recent data (studies conducted from Nov 2020 onwards) found that race, ethnicity, and indigeneity were associated with vaccine acceptance. Three studies [24,42,46] found that White respondents were more likely to accept a COVID-19 vaccine. Savoia et al. surveyed essential workers (61% HCWs) and explicitly examined the impact of past experiences with discrimination and found that those with a history of racial discrimination, more than other types of discrimination, are less accepting of COVID-19 vaccine [42]. Two studies [43,44] found that some racialized groups expressed more acceptance than

others. For example, Shaw found that Asians (73.8%) and White (58.4%) respondents were more likely to express vaccine acceptance than other groups [43]. Shekhar et al. found that vaccine acceptance was lower among Black and Latinx HCWs and that Black, Native American, Hawaiin, and Pacific Islander HCWs would rather wait to review vaccine safety data before accepting the vaccine [44]. One study found that race, ethnicity and indigeneity were not associated with accepting a COVID-19 vaccine [39].

Occupation type

9/11 studies [21,24–27,34,36,43,44] found that physicians and other HCWs with more formal training (e.g., nurse practitioners, pharmacists) were more likely to accept a vaccine than other types of HCWs (e.g., frontline staff, nurses, pharmacy technicians, administrative staff, etc.). One study found that medicine and nursing students were more likely to accept a vaccine than other groups [31]. One study did not find differences between HCW roles [17].

Health status

4/11 studies found an association between respondents' health history and vaccination acceptance. From six studies [16,20,30,31,38,47] that assessed whether chronic conditions or underlying illness was associated with vaccination acceptance, two studies [30,47] found an association. Out of four studies [17,39,42,46] that assessed whether past COVID infections were associated with vaccine acceptance, only one found a significant association [42]. One study found that the higher respondents rated their health status the lower the willingness to vaccinate against COVID-19 [28].

Occupation setting

7/9 studies found that workplace setting was associated with vaccine acceptance. Three studies found that HCWs working in non-clinical care areas were more likely to express vaccine acceptance [38,43,46]. Two studies found that HCWs working in direct patient care were more likely to express vaccine acceptance [33,44]. One study found that those working directly with COVID-19 patients were more likely to express vaccine acceptance [21]. One study found COVID-19 related work stress was associated with greater vaccine acceptance [32]. Two studies did not find an association between workplace setting and acceptance [17,47].

Education

3/6 studies found that respondents who completed a high school degree, some college or university, or postgraduate degrees were more likely to express greater vaccine acceptance [24,42,44]. Two studies found no association between education level and acceptance [29,30].

One study that surveyed HCWs and other vaccine priority groups found that those with post-graduate education were less likely to express vaccine acceptance. However, it is worth nothing that half the sample in this study had already been vaccinated [39].

Equity-related factors summary

Overall, data from non-Canadian studies suggest that HCWs who are older, male-identified, and with more education are more likely to express vaccination acceptance. These findings are consistent with what has been found in the Canadian context where HCWs who are younger, woman-identified, racialized, and with less education are more likely to express vaccine hesitancy. While a few studies [19,41,42,44] attempted to explore which equity-related factors influenced different acceptance rates across equity-seeking groups, more research is needed to understand the concerns and perceptions of HCWs who are racialized, work in different healthcare settings, and possess different educational backgrounds to better identify how factors impacting vaccination acceptance vary between groups. Importantly, Desveaux et al. found that mistrust predicted vaccination acceptance [19] and SafeCare-BC found that White and indigenous groups were more likely to cite mistrust in government recommendations than South or East/Southeast Asian respondents [41]. A deeper exploration of the role of mistrust among HCWs is, thus, warranted.

Discussion

Overview

This report details version 1 of our LBSES looking at factors affecting COVID-19 vaccination acceptance and uptake among HCWs. A total of 32 studies, 5 in Canada, were identified up to Feb 3rd, 2021. All studies measured vaccination acceptance but none to date have assessed uptake rates alongside. In Canada, vaccination acceptance rates among HCWs ranged from 57% - 80% indicating that a majority of HCWs in Canada want to get the COVID-19 vaccine but that many would benefit from support in addressing identified barriers to acceptance.

A number of important factors were identified that focused primarily on the Opportunity and Motivation of HCWs to accept a COVID-19 vaccine. Specifically, negative beliefs about vaccine safety, efficacy, and necessity were associated with lower vaccination acceptance (TDF domain: Beliefs about consequences). Lower vaccination acceptance rates were found among non-physician HCWs (e.g., nurses) (TDF domain: Social/professional role/identity), although the extent to which this applies to Canadian HCWs was unclear. HCWs that had a history of accepting influenza vaccination were more accepting of COVID-19 vaccines (TDF domain: Reinforcement). Based on Canadian data, equity-related factors associated with HCW

vaccination acceptance included being younger, woman-identified, racialized, and with less education. These findings are reflected in the global literature where HCWs who are older, male identified, with more education are more likely to express vaccine acceptance. Though most studies measured some equity-related factors, few formally analyzed whether equity-related factors predicted vaccination acceptance through multiple regression analyses. However, there were some indications that HCW perceptions may vary depending on racial, ethnic, and indigenous identities suggesting a need for more research exploring how HCWs from different equity-seeking groups may differ in their vaccination perceptions, acceptance and uptake.

Future directions for research in this area

Although some behavioural domains did not yet emerge as factors associated with COVID-19 vaccine acceptance in HCWs, there may be opportunity for considering a greater breath of possible barriers and enablers which could be guided by frameworks such as the TDF. Only one study [19] to date had used the TDF to inform their survey, which resulted in key insights into barriers and enablers to vaccination acceptance among Canadian HCWs, many of which extended what is known.

There was some evidence indicating that knowledge was associated with vaccination acceptance among HCWs. Knowledge, or lack thereof, is often seen as a key barrier to behaviour change which is reflected in the abundance of strategies and programs that focus solely on education and providing information. Whilst knowledge is undoubtedly important, it is usually insufficient as a stand-alone strategy, therefore, additional evidence-based, modifiable barriers must also be considered (cf. recent brief from Ontario COVID-19 Science Advisory Table (Presseau et al., 2021)).

While several equity-related factors were assessed in relation to HCW vaccine acceptance, significant gaps remain. For example, only three studies assessed the impact of income and only one study addressed HCW mental health. Furthermore, none of the identified studies formally examined what accounts for observed differences in equity-related factors and vaccination acceptance. Yet, we know from existing frameworks (e.g., PROGRESS [11]) and data on pandemic related inequities in Canada that different sectors of the population are differentially impacted and will likely face challenges to getting vaccinated depending on their unique circumstances. Using a behavioural science lens to assess existing data may help elucidate some of these challenges and suggest short, medium, and long-term strategies to address experienced barriers among HCW from equity-seeking groups.

Future directions for this LBSES

Most studies were conducted before Nov 2020 when COVID-19 vaccines had not yet been developed, tested in clinical trials, or authorised for use. Therefore, questioning would have been framed around 'future' vaccine use rather than 'actual' vaccine use. Future versions of this LBSES will capture studies conducted in 2021 and beyond when vaccines have been approved and rolled out at scale. This will also mean that future versions of this LBSES will capture studies measuring vaccination uptake and factors associated with actual uptake. From a behavioural science perspective, this will provide an opportunity to assess whether the same factors associated with vaccine acceptance (intention) are also associated with actual vaccination uptake (behaviour) and whether vaccine intention predicts behaviour. Evidence from other behavioural literatures suggests a gap between intention and action and measures for bridging this gap offer opportunities for ensuring HCWs who do develop strong intentions and acceptance for the COVID-19 vaccine translate their strong intention into vaccination (Presseau et al., 2021).

From an equity-seeking group perspective, future versions of this LBSES will attempt to better understand what is driving observed differences in vaccination acceptance and uptake. Moreover, we will connect with Canadian researchers (e.g., SafeCare-BC) who are spearheading the important work of nuancing observed differences to vaccine acceptance to better account for how the lived experiences of equity-seeking groups may impact barriers and enablers to vaccine acceptance. Finally, we will assess whether HCWs from equity-seeking groups experience similar barriers to non-HCWs from equity-seeking groups or whether they should be considered a distinct group warranting distinct approaches to addressing vaccine hesitancy.

Future planned LBSES

- Identify which **strategies/techniques** are effective in supporting COVID-19 vaccination acceptance and uptake among HCWs.
- Identify **alignment and gaps** between experienced barriers/enablers and currently tested strategies among HCWs, and any lack of data for certain equity-seeking groups.
- Summarize **actionable implications** in general for HCWs and in particular among HCWs serving equity-seeking groups.

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Appendices

Appendix 1. Data abstraction and coding for survey and qualitative studies

Study characteristics	Behaviour specs	Key findings/themes by COM-B and TDF domains	
Author:	Action(s):	Capability	
Year:	Actor(s):		Knowledge:
Link:	Context(s):		Skills:
Design:	Target:		Behaviour regulation:
Publication status:	Time:		Memory/attention:
Countries/provinces:			Decision making:
Data collection date range:		Opportunity	
			Environmental context & resources:
			Social influences:
		Motivation	
			Intention (capture % intention/hesitant/confident where available)
			Goals:
			Social/professional role/identity:
			Beliefs about capabilities:
			Beliefs about consequences:
			Optimism:
			Reinforcement:
			Emotions:
		Other	Specify:
		%/Mean vaccine intention and/or hesitancy	

Appendix 2. Data abstraction and coding for equity-related factors

Equity factors associated with vaccine acceptance		Key findings
Identity and community	Age:	
	Gender/sex:	
	Sexuality:	
	Race/ethnicity/indigeneity:	
	Culture/language:	
	Religion/spirituality:	
SES	Occupation (type, status):	
	Education:	
	Income:	
Geography	Immigration status:	
	Place of residence (e.g., neighbourhood, housing status):	
	Historical factors (e.g., colonialism, conflict zones):	
Health	Mental health:	
	Physical health:	
Other SDH	Family composition (including marital status):	
	Living with violence:	
	Access to goods (e.g., food) and services (e.g., healthcare, transportation):	
	Social networks/social capital:	
Rx	Target sample:	
	Response rate:	
	M/F ratio:	
	Recruitment strategy:	
Other	Other contextual factors:	