

Factors affecting healthcare worker COVID-19 vaccination acceptance and uptake: a living behavioural science evidence synthesis (v2, May 18th, 2021)

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Research Questions: 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?

Contents	Page
Summary of key findings	3
Introduction	4
Objectives	5
Methods	6
Results	
Study characteristics	8
Objective 1: Rates COVID-19 vaccination acceptance among HCWs	20
Objective 2: Rates COVID-19 vaccination uptake among HCWs	20
Objective 3: Factors associated with higher and lower COVID-19 vaccination acceptance and uptake among HCWs	22
Objective 4: Factors associated with higher and lower COVID-19 vaccination acceptance and uptake among HCWs from equity-seeking groups	37
Discussion	40
References	44
Appendices	52

Key Findings

- We identified 64 studies (including 32 studies that were added for version 2 update) that assessed factors associated with vaccination acceptance and uptake among healthcare workers (HCWs); only 6 studies were conducted in Canada.
- 42/64 studies were conducted in the period since COVID-19 vaccines have been approved (spanning Nov, 2020 - Apr, 2021).
- The overall median percentage of HCWs willing to accept a COVID-19 vaccine was 64% ($k=58$; IQR=46-79%). In Canada specifically, 69% of HCW respondents were willing to accept a vaccine for COVID-19 ($k=6$; median=69%, IQR=59-78%). Among studies conducted since vaccines have been approved, the median rate of acceptance was 58% ($k=37$; IQR=46-79%).
- 4 studies measured actual COVID-19 vaccination uptake among HCWs which ranged from 51-89%; none of these studies were conducted in Canada.
- Based on the Capability, Opportunity, and Motivation-Behaviour (COM-B) model, factors associated with vaccine acceptance and uptake focused predominantly on Opportunity and Motivation. Capability factors identified focused on 'Knowledge'; Opportunity factors identified included 'Environmental context and resources' and 'Social influences', and Motivation factors identified included 'Beliefs about consequences', 'Beliefs about capabilities', 'Social/professional role and identity', 'Reinforcement', and 'Emotion'. These cover 8 of 14 domains of the Theoretical Domains Framework.
- Concerns and erroneous beliefs about COVID-19 vaccine safety, efficacy, and necessity were common across studies and 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 remains unclear given limited available data to date.
- HCWs that have a history of accepting influenza vaccination were more accepting of COVID-19 vaccines.
- New studies added to version 2 of this report, are highlighting the importance of Social influences on vaccination acceptance and uptake among HCWs, in line with [data from the general public](#).
- Overall, 11/64 studies assessed whether vaccine acceptance was associated with race and ethnicity. 10/11 found some evidence that racialized (e.g., Black, Latinx, Asian) respondents are less likely to express vaccine acceptance vs. White respondents.
- Of these, just 1 study explicitly explored determinants of vaccination acceptance based on race/ethnicity. 2 of 14 domains from the Theoretical Domains Framework were associated with COVID-19 vaccine acceptance: 'Social influences' and 'Beliefs about

consequences'. Namely, concerns about vaccine development were more common among Black, Latinx, and Asian vs. White respondents while concerns over safety were identified across groups.

- There remains a paucity of published Canadian research looking at vaccination acceptance in HCWs since the approval of COVID-19 vaccines. There is a clear need for more Canadian research to help understand the factors associated with vaccination acceptance and uptake among HCWs and in particular those from equity-seeking groups to help better inform how best to support greater vaccination.

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. As of May 17, 2021, it is estimated almost 3.4 million people have died from COVID-19, including almost 25,000 Canadians (cf. Johns Hopkins [COVID tracker](#)). As vaccine programs continue to be 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]).

Capability-, Opportunity- and Motivation-related factors of individuals are shaped by the multiple social, cultural, historical, community, governmental, clinical, and environmental levels that influence acceptance and uptake of COVID-19 vaccination. We drew upon the overarching

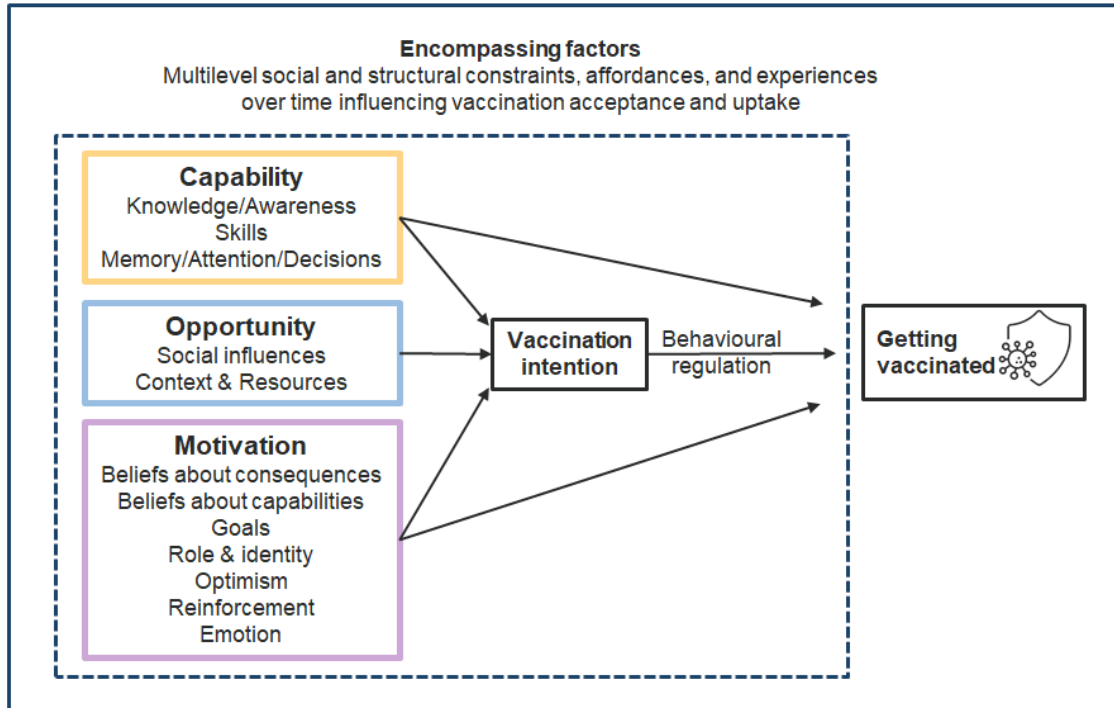
COM-B model to situate 14 key behavioural factors that can drive vaccination intention and uptake (**see Figure 1**). These 14 factors are reflected in the Theoretical Domains Framework (TDF), a synthesis of decades of research and evidence of the key, modifiable factors that influence behaviour [2–4]. TDF factors are linked to specific behaviour change techniques [5] that can be used to address particular barriers and enablers to vaccination, thus linking barriers to solutions. Using these approaches can enable exploration of 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 understand and address behaviour change in other health-related contexts but have yet to be fully leveraged to address COVID-19 vaccination acceptance and uptake [6].

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 those 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 globally and 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 globally and in Canada.

Figure 1. Potential drivers of vaccination acceptance and uptake based on the COM-B model and Theoretical Domains Framework, embedded within social and structural factors



Methods

Data sources

We identified 5 databases that have been capturing published peer-reviewed papers, preprints, published reports, and unpublished datasets relating to our research questions. The following links represent the most recent publically-available reports based on the databases:

- [Rapid Evidence Review: What are the barriers and facilitators to individuals' willingness to be vaccinated for COVID-19? \[7\]; Understanding and promoting COVID-19 vaccine uptake among marginalized communities in RI \[8\] \(Database managed by Kristin Konnyu, co-author on this report. Manually searched up until Apr 20, 2021\).](#)
- [COVID-19 Rapid Evidence Profile #24: What is known about strategies for encouraging vaccine acceptance and addressing vaccine hesitancy or uptake? \[9\] \(Most recent search: Nov 18, 2020\).](#)
- [Evidence Synthesis Briefing Note: COVID-19 Vaccine Uptake Among Health Care Workers \[10\] \(Most recent search: Jan 22, 2021\).](#)

- [Evergreen Rapid Review on COVID-19 Vaccine Knowledge, Attitudes, and Behaviours – Update 3](#) [11] (Most recent search: Feb 3, 2021).
- [COVID-19 Living Evidence Profile #1: What is known about anticipated COVID-19 vaccine roll-out elements?](#) [12] (Most recent search: Apr 9, 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 and 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 public samples only (we are capturing these data as part of another LBSES focusing on the general public, see [Gen Pub LBSES v1](#)).
- *Outcome:* Studies that only included a measure of vaccination knowledge. Vaccination acceptance and uptake in relation to vaccinating others (e.g., family members, patients).

Data extraction

Data sources were manually screened and cross-referenced for relevant studies (version 1 final search date: Feb 3, 2021; version 2 final search date: Apr 20, 2021). A standardised data extraction form (see **Appendix 1**) was used to extract relevant data relating to study characteristics, behavioural specification (based on the AACTT tool [13]), factors affecting vaccination acceptance and uptake based on the COM-B model and TDF, and equity-related data. 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 [14], intersecting categories of privilege and oppression [15], and those considered part of an [equity approach by PHAC](#). 'k' refers to the number of studies. Where available, we have captured key statistical analyses (odds ratios (OR); adjusted odds ratios (ORA)) on the factors associated with higher or lower vaccination acceptance and uptake.

Results

Study characteristics

A total of 64 studies (including 32 studies that were added for version 2 update) met our inclusion criteria [16–79]. **Table 1** provides an overview of the 64 studies. 45 were published peer-reviewed papers, 15 were preprints, three were published reports, and one study was an unpublished dataset. 42 studies collected data in the period since COVID-19 vaccine approval (spanning Nov, 2020 - Apr, 2021). Apart from 2 qualitative studies [20,39] and 1 quantitative cohort study [37], all other studies used cross-sectional survey designs. 58/64 studies measured COVID-19 vaccination acceptance; 4 studies measured uptake [37,52,65,72], and 2 qualitative studies did not report quantitative data on vaccination acceptance/uptake [20,39].

19/64 studies were conducted exclusively in North America [20,24,30,35,39,41,46,49,50,52,53,58,62,64–67,71,73] of which 5 were conducted in Canada [24,41,53,62,71]. 1 study collected data from Canada, France, and Belgium [74]. 44 studies were conducted outside of North America: Israel [27,79]; China [29,75]; Italy [26,48]; Taiwan [45]; Mexico [21]; Saudi Arabia [19,59,70]; Turkey [32,42,44,78]; Greece [54]; Greece and Cyprus [61]; Germany [36,43]; UK [37,72]; Lebanon [77]; Slovenia [57]; Poland [69]; Columbia [18]; Palestine [60]; Egypt [40,63]; Ghana [16]; India [68], Hong Kong [47,76]; France [25,31]; Cameroon [28]; Indonesia [38]; Democratic Republic of Congo [51]; Nepal [55]; Zambia [22]; [40]; Malta [33,34]; multicounty (Europe) [56]; multicountry (Asia) [23]; multicountry (Arabian Gulf) [17].

40/64 studies recruited broad HCW samples. 20/64 studies recruited specific professions/specialities: medical students [49,63]; skilled nursing facility staff [39]; dental professionals [79]; paediatricians [32]; intensive care staff [43]; physicians [18]; nurses [60]; long-term care home staff [72]; non-physicians [24,30], nursing home/assisted living staff [73], continuing care workers [62], pharmacy professionals [53], personal support workers [71], nurses/trainee nurses [47,56,76], lab medical professionals [22], physicians/trainee physicians [33]. 4/64 studies recruited mixed samples including HCWs, general public, and patients [35,45,57,78]

Table 1. Evidence of COVID-19 vaccination acceptance and uptake among healthcare workers (k=64)

Author	Publication status	Country	Design	Sample	Sample size	Data collection period	Mean % vaccine acceptance [actual uptake]	COM-B model factors (<i>TDF domains</i>)
North American studies (k=20), listed in order of end of data collection period								
INSPQ	Published (report)	Quebec, Canada	CS	Gen pop (inc. HCW)	NR	Apr - May, 2020 & Sep, 2020	73%	N/A
Lucia et al.	Published	USA	CS	HCWs (medical students)	168	Sep 14-30, 2020	77%	Opportunity (<i>Social influences</i>) Motivation (<i>Beliefs about consequences</i>)
Gadoth et al.	Preprint	USA	CS	HCWs (non-physicians)	609	Sep 24 - Oct 16, 2020	32%	Opportunity (<i>Environmental context and resources</i>) Motivation (<i>Social/professional role and identity; Beliefs about consequences</i>)
Verger et al.*	Published	Canada data only	CS	HCWs	1,055	Oct-Nov, 2020	45%	Opportunity (<i>Social influences</i>) Motivation (<i>Beliefs about consequences; Reinforcement</i>)
Shekhar et al.	Published	USA	CS	HCW	3,479	Oct 7 - Nov 9, 2020	36%	Motivation (<i>Social/professional role and identity; Beliefs about consequences</i>)

Unroe et al.	Published	USA	CS	HCW (nursing home and assisted living staff)	8,243	Nov 14-17, 2020	45%	Motivation (<i>Social/professional role and identity; Beliefs about consequences</i>)
SafeCare-BC	Published (report)	British Columbia, Canada	CS	HCW (continuing care workers)	1,503	Dec, 2020	57%	Opportunity (<i>Social influences</i>) Motivation (<i>Social/professional role and identity; Beliefs about consequences; Beliefs about capability; Reinforcement</i>)
Shaw et al.	Published	USA	CS	HCW	5,287	Nov 23 - Dec 5, 2020	58%	Motivation (<i>Social/professional role and identity; Beliefs about consequences</i>)
Kuter et al.	Published	USA	CS	HCWs	12,034	Nov 13 - Dec 6, 2020	64%	Capability (<i>Knowledge</i>) Motivation (<i>Social/professional role and identity; Beliefs about consequences; Reinforcement</i>)
Meyer et al.	Published	USA	CS	HCW	16,158	Dec 4-22, 2020	53-80%	Motivation (<i>Beliefs about consequences</i>)
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

Harrison et al.	Published	USA	Qual	HCWs (skilled nursing facility staff)	58 staff (5 focus groups)	Dec 17-23, 2020	NR (Qual data)	Capability (<i>Knowledge</i>) Opportunity (<i>Social influences</i>) Motivation (<i>Beliefs about consequences</i>)
Canadian PSW Network	Unpublished dataset	Canada	CS	HCW (personal support workers)	562	Jan 5, 2021	64%	Capability (<i>Knowledge</i>)
Desveaux et al.	Preprint	Ontario, Canada	CS	HCWs (non-physicians)	8,634	Jan 4-12, 2021	80%	Opportunity (<i>Environmental context and resources</i>) Motivation (<i>Social/professional role and identity; Beliefs about consequences; Reinforcement</i>)
Grumbach et al.	Published	USA	CS	Gen pub & HCW samples	3,161 (Gen pub); 1,803 (HCWs)	Nov 27, 2020 - Jan 15, 2021	66% (Gen pub); 84% (HCWs)	[Determinants broken down among equity-seeking groups, see Objective 4] Opportunity (<i>Social influences</i>) Motivation (<i>Beliefs about consequences</i>)

Berry et al.	Published	USA	Qual	HCWs	193 staff from 50 facilities participated in 26 meetings	Dec 30, 2020 - Jan 15, 2021	NR (Qual data)	Motivation (<i>Beliefs about consequences</i>)
Schrading et al.	Published	USA	CS	HCWs	1,542	Jan 4, 2021	[86%]	Motivation (<i>Beliefs about consequences</i>)
Ontario College of Pharmacists	Published (report)	Canada	CS	HCW (pharmacy professionals)	6,677	Jan 12-21, 2021	79%	Motivation (<i>Social/professional role and identity; Beliefs about consequences</i>)
Oliver et al.	Preprint	USA	CS (inc. FTR)	HCWs	1,933	Dec 23, 2020 - Feb 16, 2021	[81%]	Motivation (<i>Social/professional role and identity; Beliefs about consequences; Reinforcement</i>)

Author	Publication status	Country	Design	Sample	Sample size	Data collection period	Mean % vaccine acceptance [actual uptake]	COM-B model factors (<i>TDF domains</i>)
International studies (k=45), listed in order of end of data collection period								
Papagiannis et al.	Published	Greece	CS	HCW	461	Feb 10-25, 2020	43%	Motivation (<i>Social/professional role and identity</i>)
Zigron et al.	Published	Israel	CS	HCWs (dental professionals)	506	Mar - Apr, 2020	85%	Motivation (<i>Social/professional role and identity</i>)
Fu et al.	Preprint	China	CS	HCW	352	Mar 17-18, 2020	76%	Opportunity (<i>Social influences</i>) Motivation (<i>Beliefs about consequences</i>)
Wang et al.	Published	Hong Kong	CS	HCW (nurses)	806	Feb 26 - Mar 31, 2020	40%	Motivation (<i>Social/professional role and identity; Beliefs about consequences; Reinforcement</i>)
Ali et al.	Published	Multiple (Arabian Gulf)	CS	Gen pop (inc. HCW)	1,250	Mar 28 - Apr 4, 2020	75%	N/A
Harapan et al.	Published	Indonesia	CS	Gen pop (inc. HCW)	264	Mar 25 - Apr 6, 2020	67-93%	N/A

Dror et al.	Published	Israel	CS	Gen pop (inc. HCW)	829	Mar 26 - Apr 9, 2020	61-78%	Opportunity (<i>Environmental context and resources</i>) Motivation (<i>Social/professional role and identity; Beliefs about consequences</i>)
Detoc et al.	Preprint	France	CS	Gen pop (inc. HCW)	1,421	Mar 26 - Apr 20, 2020	82%	N/A
Fouogue et al.	Preprint	Cameroon	CS	HCW	464	Apr 14-29, 2020	49%	Opportunity (<i>Social influences</i>) Motivation (<i>Beliefs about consequences</i>)
Kwok et al.	Published	Hong Kong	CS	HCW (nurses)	1,205	Mar - Apr, 2020	63%	Motivation (<i>Social/professional role and identity; Beliefs about consequences; Emotion</i>)
Nzaji et al.	Published	Democratic Republic of Congo	CS	HCW	613	Mar 20 - Apr 30, 2020	28%	Motivation (<i>Social/professional role and identity; Beliefs about consequences</i>)
Parajuli et al.	Published	Nepal	CS	HCW	230	Apr – May, 2020	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 (<i>Social/professional role and identity; Beliefs about consequences; Reinforcement; Emotion</i>)

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 (<i>Knowledge</i>) Motivation (<i>Beliefs about consequences; Reinforcement</i>)
Grech & Gauci	Published	Malta	CS	HCW (physicians and their trainees)	123	Sep, 2020	62%	Capability (<i>Knowledge</i>) Motivation (<i>Beliefs about consequences; Reinforcement</i>)
Wang et al.	Published	China	CS	HCWs	3,726	Sep 15-20, 2020	79%	Motivation (<i>Social/professional role and identity; Beliefs about consequences</i>)
Kose et al.	Published	Turkey	CS	HCW	1,138	Sep 17-20, 2020	69%	Motivation (<i>Beliefs about consequences; Reinforcement</i>)
Verger et al.*	Published	France and Belgium data only	CS	HCWs	1,623	Oct-Nov, 2020	46%	Opportunity (<i>Social influences</i>) Motivation (<i>Beliefs about consequences; Reinforcement</i>)
Di Gennaro et al.	Published	Italy	CS	HCWs	1,723	Oct 1 – Nov 1 2020	67%	Opportunity (<i>Environmental context and resources</i>) Motivation (<i>Social/professional role and identity; Reinforcement</i>)

Temsah et al.	Preprint	Saudi Arabia	CS	HCWs	2,007	Nov 1-12, 2020	9-24% (depending on type of COVID-19 vaccine)	Motivation (<i>Beliefs about consequences</i>)
Barry et al.	Preprint	Saudi Arabia	CS	HCW	1,512	Nov 4-14, 2020	70%	Opportunity (<i>Environmental context and resources</i>) Motivation (<i>Beliefs about consequences</i>)
Gönüllü et al.	Published	Turkey	CS	HCWs (paediatricians)	506	Nov 1-15, 2020	83%	Motivation (<i>Social/professional role and identity; Beliefs about consequences; Reinforcement</i>)
Ledda et al.	Published	Italy	CS	HCWs	787	Sep - Dec, 2020	75%	Capability (<i>Knowledge</i>) Motivation (<i>Beliefs about consequences</i>)
Castañeda-Vasquez et al.	Published	Mexico	CS	HCWs	43	Oct - Dec, 2020	94%	Motivation (<i>Social/professional role and identity</i>)
Kaplan et al.	Published	Turkey	CS	HCWs	1,574	Dec, 2020	85%	Opportunity (<i>Social influences</i>) Motivation (<i>Beliefs about consequences; Reinforcement; Emotion</i>)

Patelarou et al.	Preprint	Multiple (Europe)	CS	HCWs (nursing students)	2,249	Dec, 2020	44%	Capability (<i>Knowledge</i>) Opportunity (<i>Social influences</i>) Motivation (<i>Beliefs about consequences; Reinforcement; Emotion</i>)
Karagiannidis et al.	Published	Germany	CS	HCWs (intensive care staff)	2,305	Dec 3-12, 2020	64%	Motivation (<i>Beliefs about consequences</i>)
Qattan et al.	Published	Saudi Arabia	CS	HCWs	673	Dec 8-14, 2020	51%	Motivation (<i>Social/professional role and identity; Beliefs about consequences; Reinforcement</i>)
Raftopoulos et al.	Published	Greece & Cyprus	CS	HCWs	2,238	Dec 1-15, 2020	48%	Opportunity (<i>Social influences</i>) Motivation (<i>Social/professional role and identity</i>)
Chew et al.	Published	Multiple (Asia)	CS	HCWs	1,720	Dec 12-21, 2020	96%	Motivation (<i>Social/professional role and identity; Beliefs about consequences</i>)
Petravić et al.	Published	Slovenia	CS (inc. FTR)	Gen pub (inc. HCWs)	12,042 (2,068 were HCWs)	Dec 17-27 2020	59%	Opportunity (<i>Social influences</i>) Motivation (<i>Social/professional role and identity; Beliefs about consequences; Reinforcement</i>)
Kukreti et al.	Published	Taiwan	CS	HCW & patient samples	500 (HCWs); 238 (patients)	Sep 24 - Dec 31, 2020	23% (HCWs); 31% (patients)	Motivation (<i>Beliefs about consequences; Reinforcement</i>)

Youssef et al.	Preprint	Lebanon	CS	HCWs	1,800	Dec 10-31, 2020	58%	Opportunity (<i>Environmental context and resources; Social influences</i>) Motivation (<i>Beliefs about consequences</i>)
Alvarado-Socarras et al.	Published	Columbia	CS	HCWs (physicians)	1,066	Jan, 2021	Free vaccine that was 60% effective: acceptance rate=77% Free vaccine that was 80% effective: acceptance rate=91%	Motivation (<i>Social/professional role and identity; Reinforcement</i>)
Hussein et al.	Preprint	Egypt	CS	HCW	496	Dec 1, 2020 - Jan 1, 2021	46%	Motivation (<i>Beliefs about consequences; Emotion</i>)
Rabi et al.	Published	Palestine	CS	HCWs (nurses)	639	Jan 1-7, 2021	40%	Opportunity (<i>Social influences</i>) Motivation (<i>Beliefs about consequences; Emotion</i>)
Szmyd et al.	Published	Poland	CS	HCWs	1,971	Dec 22, 2020 - Jan 8, 2021	83%	Motivation (<i>Beliefs about consequences; Reinforcement; Emotion</i>)
Yurttas et al.	Published	Turkey	CS	Gen pub, patient & HCW samples	320	Jan 4-13, 2021	53%	Motivation (<i>Emotion</i>)

Saied et al.	Published	Egypt	CS	HCWs (medical students)	2,133	Jan 8-15, 2021	54%	Capability (<i>Knowledge</i>) Motivation (<i>Social/professional role and identity; Beliefs about consequences; Reinforcement</i>)
Singhania et al.	Published	India	CS	HCWs	754	Jan 20-24, 2021	80%	Opportunity (<i>Social influences</i>) Motivation (<i>Social/professional role and identity; Beliefs about consequences</i>)
Hall et al.	Published	UK	Coh	HCW	29,378	Dec 7, 2020 - Feb 5, 2021	[89%]	Motivation (<i>Social/professional role and identity; Reinforcement</i>)
Tulloch et al.	Preprint	UK	CS	HCWs (long-term care home staff)	2,128	Jan 21-28, 2021	[51%]	Opportunity (<i>Environmental context and resources</i>) Motivation (<i>Beliefs about consequences</i>)
Agyekum et al.	Preprint	Ghana	CS	HCWs	234	Jan 16 - Feb 15, 2021	39%	Opportunity (<i>Social influences</i>) Motivation (<i>Social/professional role and identity; Reinforcement</i>)

Table 1 notes: Greyed boxes in the data collection period column represent studies conducted from Nov 2020 onwards. COM-B model = Capability, Opportunity, and Motivation-Behaviour model; Coh = cohort study; CS = cross-sectional survey; Exp = Experimental study design; Gen pub = general public; FTR = free-text responses; HCW = healthcare worker, N/A = studies that did not capture these factors; NR = not reported; Qual = qualitative; TDF = Theoretical Domains Framework. * = Verger et al. collected data from Canada, France, and Belgium so was included in both North America and International sections.

Objective 1: COVID-19 vaccination acceptance rates among HCWs

Overall: 58/64 studies included a mean % for COVID-19 vaccination acceptance. Across 58 studies, almost two thirds of respondents were willing to accept a COVID-19 vaccine (median=64%, IQR=46-79%). Among North American studies ($k=16$; *Verger et al. Canadian dataset included here), 58% of respondents were willing to accept a COVID-19 vaccine (median=58%, IQR=45-75%). % (see **Figure 2**). In Canada specifically ($k=6$), 69% of respondents were willing to accept a vaccine for COVID-19 (median=69%, IQR=59-78%). In studies conducted outside of North America ($k=43$; *Verger et al. European dataset included here), 64% of respondents were willing to accept a COVID-19 vaccine (median=64%, IQR=48-82) (see **Figure 3**). Among studies conducted in the period since COVID-19 vaccine approval (spanning Nov, 2020 - Apr, 2021) ($k=37$); 58% of HCW respondents were willing to accept a COVID-19 vaccine (median=58%, IQR=46-79%).

Studies that sampled HCWs and the general public: 8 studies sampling from the general public also provided data on HCWs [17,25,27,36,38,41,58,64]. Four studies reported no differences in vaccination acceptance between general public vs. HCWs [17,27,41,58]. Two studies reported higher rates of acceptance among HCWs vs. general public (OR=1.53, 95% CI: 1.27-1.85) [25]; (ORa=1.57, 95% CI: 1.12-2.20) [38]. Two studies did not report comparison data [36,64].

Objective 2: COVID-19 vaccination uptake rates among HCWs

4/64 studies measured uptake of COVID-19 vaccines [37,52,65,72], although none were conducted in Canada. 2 UK studies reported uptake rates of 51% among 2,128 long-term care home staff [72] and 89% among 22,324 HCWs [37] whilst 2 USA studies reported uptake rates of 81% among 1,933 HCWs [52] and 86% among 1,398 HCWs [65]. Data from the [Government of Canada website](#) is currently no longer reporting on COVID-19 vaccination uptake among HCWs.

Figure 2. Box-and-whisker plots showing mean % vaccination acceptance rates among HCWs over time (May, 2020 - Jan, 2021) for North American studies (k=16)

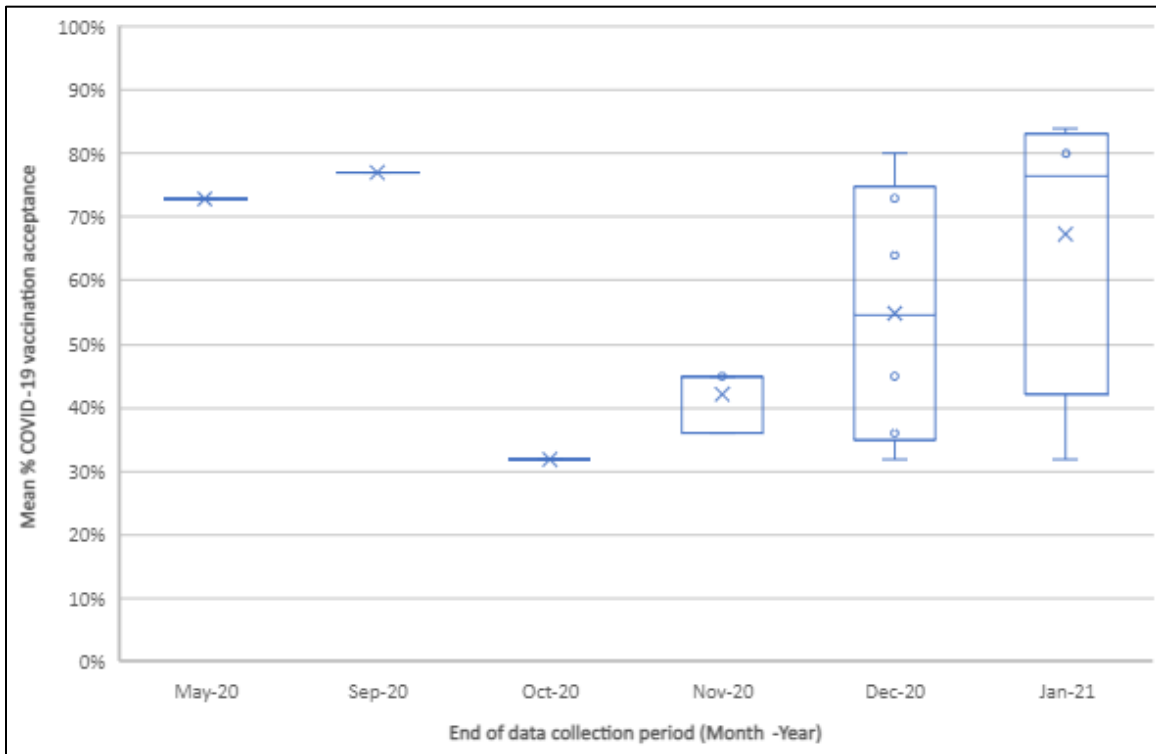
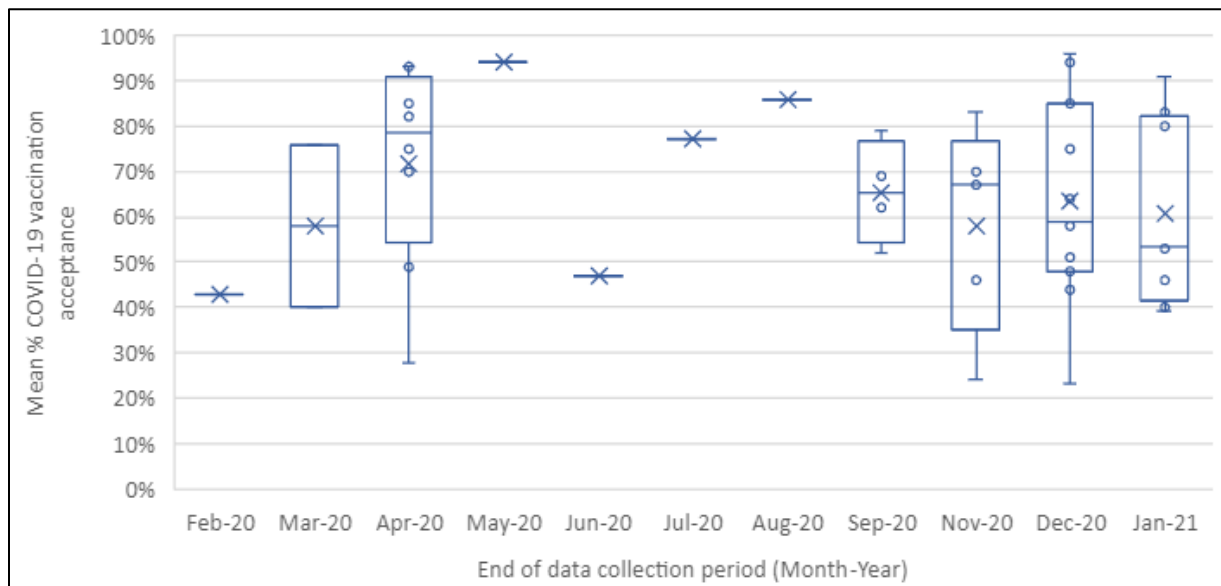


Figure 3. Box-and-whisker plots showing mean % vaccination acceptance rates among HCWs over time (Feb, 2020 - Jan, 2021) for studies conducted outside of North America (k=43)



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

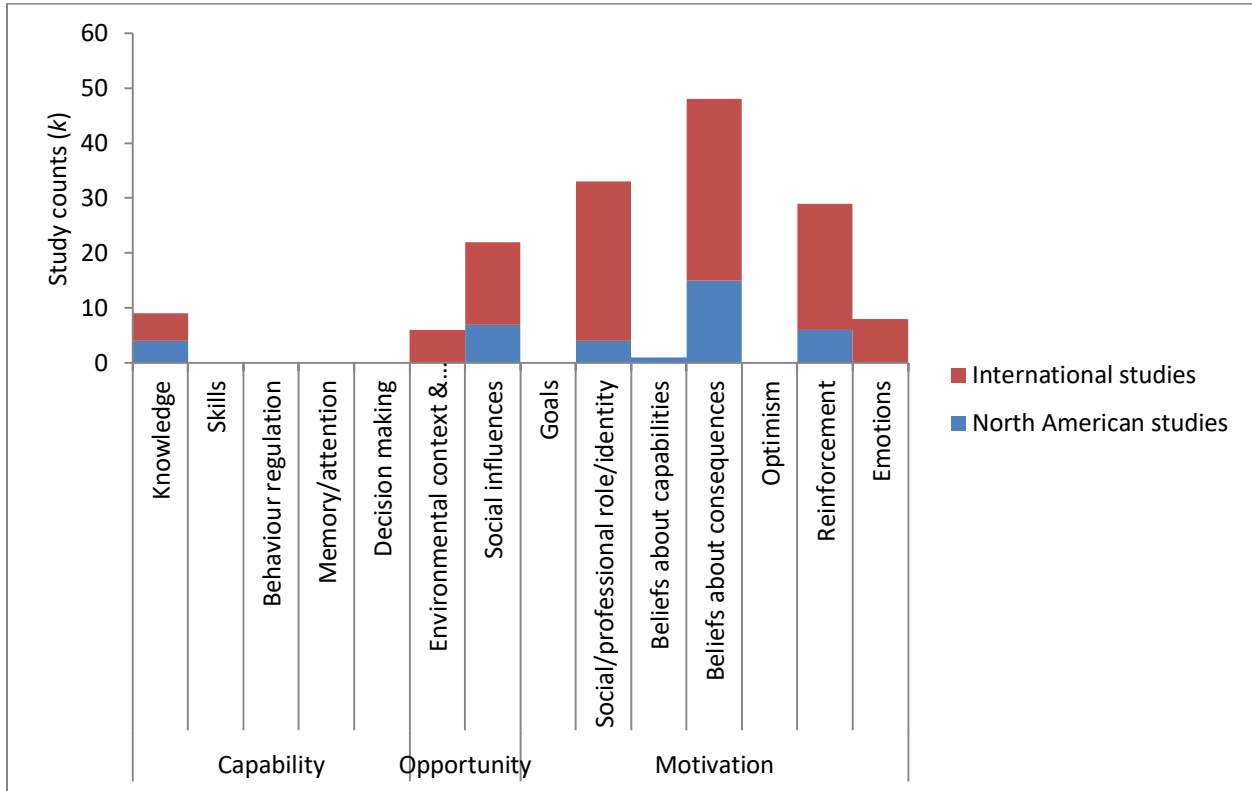
56/64 studies provided evidence on the potential factors influencing COVID-19 vaccine acceptance and uptake in HCWs which were mapped using the COM-B model (Capability, Opportunity, Motivation) and the TDF. 11/64 studies assessed COVID-19 acceptance among certain equity-seeking groups [30,35,37,46,52,58,64–67,73], with 1 study performing analysis looking at determinants based on HCW race/ethnicity [35] (see **Objective 4**).

8 (of a possible 14) TDF domains appear to be important determinants of COVID-19 vaccine acceptance in HCWs (see **Figure 4**):

- **Capability** (Knowledge [$k=9$]) (see **Table 2**).
- **Opportunity** (Environmental context and resources [$k=7$]; Social influences [$k=16$]) (see **Table 3a & 3b**).
- **Motivation** (Beliefs about consequences [$k=46$]; Beliefs about capabilities [$k=1$]; Social/professional role and identity [$k=15$]; Reinforcement [$k=23$]; Emotion [$k=8$]) (see **Table 4a & 4b**).

There were no new domains represented between versions 1 and 2 of this report. The 8 domains identified here encompass the 7 domains identified (no Beliefs about capabilities) in our LBSES focusing on COVID-19 vaccination acceptance and uptake among the general public ([Gen Pub LBSES v1](#)). As such, our findings indicate that drivers of vaccination acceptance appear to remain consistent to date, even in light of authorised vaccines (since Nov 2020) and regardless of whether we are focusing on the general public or HCWs. Domains that have not emerged to date as important determinants of COVID-19 vaccine acceptance and uptake among HCWs included: Skills; Behavioural regulation; Memory, attention and decision processes; Goals; and Optimism.

Figure 4. Frequency of Capability, Opportunity and Motivation factors associated with COVID-19 vaccination acceptance and uptake among healthcare workers across $k=58$ studies up to April 20th, 2021



Capability-related factors associated with higher and lower COVID-19 vaccination acceptance among HCWs

Knowledge is the key Capability-related domain identified within this literature. A lack of knowledge about COVID-19 vaccines was cited as a barrier in three studies [33,34,71]. 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 [56]. 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 [80]), 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). Among

new studies added to version 2 of this report, Capability-related factors continued to centre on knowledge about COVID-19 vaccines. 4 studies reported that a lack of knowledge was associated with lower acceptance [39,46,48,77], including 1 qualitative study [39]. Other Capability-focused domains such as Behavioural regulation and Memory, attention and decision processes remain overlooked within this literature.

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)?)	
Knowledge factors associated with lower acceptance	<ul style="list-style-type: none"> • $k=7$ → Insufficient knowledge/education/understanding about novel vaccines [33,34,71] <ul style="list-style-type: none"> ○ 72% PSWs agreed that insufficient education has been provided to them on potential vaccines [71] ○ 78% of HCWs reported that ‘not knowing enough about the vaccine’ was a barrier to vaccination [46] ○ Not enough information (73%) cited as reason for vaccine refusal [48] ○ QUAL DATA: a lack of understanding about the vaccine containing live or attenuated virus [39] ○ Having reliable and adequate information regarding the vaccine (ORa=1.98, 95% CI 1.36-2.88) was negatively related to vaccine acceptance [77]
Knowledge factors associated with higher acceptance	<ul style="list-style-type: none"> • $k=2$ → ‘High’ knowledge about COVID-19 vaccines vs. ‘low’ knowledge (ORa)=1.86, 95% CI: 1.35-2.56) [56] <ul style="list-style-type: none"> ○ ‘Good’ self-rated COVID-19 knowledge level, vs. ‘very bad’ (OR=0.63, 95% CI: 0.44-0.90) [63]

Opportunity-related factors associated with higher and lower COVID-19 vaccination acceptance among HCWs

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 [56]. Another study found HCWs who worked on COVID-19 wards had higher vaccination acceptance versus those that worked on non-COVID-19 wards [27]. 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 [24]. Two studies, including one conducted in Canada, found mistrust towards governments and public health bodies was associated with lower vaccination acceptance [28,62]. 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 [56]. One Chinese study found that vaccination intention of social contacts was a barrier to vaccination acceptance among HCWs [29]. Social influence seems to be a factor that is more frequently being captured since version 1 of this report. 4 new studies highlighted Social influence factors associated with higher vaccination acceptance [16,49,61,77]. Perceptions about trust/mistrust among public health agencies and their overall performance in handling the COVID-19 pandemic were prominent, which is in line with [data focusing on vaccination acceptance in the general public](#).

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

TDF Domain (Definition)	
Environmental Context and Resources (What in HCWs environment influence what they do and how do they influence?)	
Environmental context and resource factors associated with lower acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Working in a healthcare facility (during the pandemic) decreased acceptance to vaccinate (ORa=0.63, 95% CI: 0.48-0.82) [56] • $k=1 \rightarrow$ Using Facebook as main information source about anti-COVID-19 vaccination was significantly associated with an increased risk of vaccine hesitancy (ORa=1.48, 95% CI 1.06-2.07) [26]
Environmental context and resource factors associated with higher acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Resources – relied of reputable information sources (e.g., Centre for Disease Control website) (ORa=1.51, 95% CI: 1.13-2.01) [19] • $k=1 \rightarrow$ Working on a COVID-19 ward (94%) vs. non-COVID-19 ward (77%) ($p<0.01$) [27] • $k=1 \rightarrow$ vaccination acceptance was more likely among HCWs if direct financial supports (e.g., paid sick days) were provided (74% vs. 25%, $p<0.01$) [24]

	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Limited availability (ORa=2.16, 95% CI: 1.46-3.20) and accessibility (ORa=1.68, 95% CI: 1.14-2.47) to the vaccine were positively related to vaccine acceptance [77]
<p>TDF Domain (Definition)</p>	
<p>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?)</p>	
<p>Social influence factors associated with lower acceptance</p>	<ul style="list-style-type: none"> • $k=4 \rightarrow$ State/government/public health agency/media mistrust [28,62] [74] <ul style="list-style-type: none"> ○ QUAL DATA: "For people of color, there's rightful scepticism of things that are pushed by government and people in power who are generally white men. So, there's rightful scepticism so I think that's where there's a lot of this." [39] (see Objective 4) • $k=2 \rightarrow$ 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) [29] <ul style="list-style-type: none"> ○ Recommendation by family members (ORa=0.48, 95% CI: 0.28-0.81) was negatively related to vaccine acceptance [77]
<p>Social influence factors associated with higher acceptance</p>	<ul style="list-style-type: none"> • $k=5 \rightarrow$ Trust in the government (ORa=1.85, 95% CI: 1.49-2.29) [56], public health agencies, and hospitals <ul style="list-style-type: none"> ○ Medical students willing to take the vaccine were more likely to trust public health experts: 'I trust the information I am receiving about the COVID-19 vaccine from the public health experts': willing group (93%), hesitant group (66%), $p < 0.01$ [49] ○ Rating of the overall management of COVID-19 pandemic in the country (OR=1.21, 95% CI: 1.03-1.41) [61] ○ Rating of the COVID-19 pandemic management from the public hospitals (OR=1.12, 95% CI: 1.03-1.23) [61] ○ Recommendation by health authorities (ORa=1.98, 95% CI: 1.34-2.91) or health facilities (ORa=2.68, 95% CI: 1.80-3.99) were positively linked to vaccine acceptance [77]

	<ul style="list-style-type: none"> ○ HCWs who agreed to the accuracy of measures taken by the government to fight COVID-19 were more likely to accept the COVID-19 vaccine (ORa=2.77; CI 95%: 1.37-5.62) [16] ● $k=1$ → Endorsement and testing by colleagues, friends or family, or political figures significantly influenced the willingness of HCWs to get vaccinated [68] ● $k=1$ → Recommending other people for vaccination was significantly related factors to a willingness for COVID-19 vaccination [42]
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Opportunity-related factors associated with higher and lower COVID-19 vaccination uptake among HCWs

Among new studies added to version 2 of this report, 1 study looking at vaccination uptake in a long-term care home reported that common reasons for staff not receiving the vaccine included staff being off-site during vaccination sessions (37%) which reflects an organizational barrier that some HCWs may face [72] (see Table 3b).

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

TDF Domain (Definition)	
Environmental Context and Resources (What in HCWs environment influence what they do and how do they influence?)	
Environmental context and resource factors associated with lower uptake	<ul style="list-style-type: none"> ● UPTAKE $k=1$ → Common reasons for staff not receiving the vaccine included staff being off-site during vaccination sessions (37%) [72]
Environmental context and resource factors associated with higher uptake	<ul style="list-style-type: none"> ● Nothing identified to date

Motivation-related factors associated with higher and lower COVID-19 vaccination acceptance among HCWs

One of the most frequently identified determinants of HCWs 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) [24,30,33,34,40,44,50,56,62,66,67,73,76] and the speed at which vaccines were being developed [19,24,27,30,44,50,62,67]. Two Canadian studies reported these associations [24,62].

Four studies found that HCWs questioned to efficacy of COVID-19 vaccines [40,44,56,76]. 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 [24,28,44,76]. From the Emotion domain, general fear about COVID-19 was associated with higher vaccination acceptance among HCWs [31,56].

One consistent finding was that vaccination acceptance was lower in non-physicians such as nurses [27,30,31,51,54,66], 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) [62].

Two studies found that HCWs providing direct care to patients generally [67] and to COVID-19 patients specifically [66] 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 [24]. 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 [24,31,44,56,76].

Among new studies added to version 2 of this report, concerns and erroneous beliefs about COVID-19 vaccine safety, efficacy, and necessity were common and associated with lower vaccination acceptance. For the Reinforcement domain, past seasonal influenza vaccination remained a consistent predictor of COVID-19 vaccination acceptance, seen in 7 new studies [16,26,32,37,46,52,59,69].

Table 4a. 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?)	
Beliefs about consequence factors associated with lower acceptance	<ul style="list-style-type: none"> • $k=9$ → Beliefs about rushed vaccine development/insufficient data developed [19,24,27,30,44,50,62,67] <ul style="list-style-type: none"> ○ ORa=0.39, 95% CI: 0.30-0.52 [19] ○ ORa=5.10, 95% CI: 3.75-6.94 [24] • $k=6$ → Beliefs that vaccine not necessary (e.g., feel in good health, not needed to tackle COVID-19) [24,28,44,76] [60,63] <ul style="list-style-type: none"> ○ ORa=2.12, 95% CI: 1.51-2.97 [24] ○ 'Natural immunity' was independent predictor of vaccine acceptance (OR=5.80, 95% CI: 4.50-8.29) [60] ○ Perceived necessity: 'very good' self-perception of own health status was a significant predictor of COVID-19 vaccine acceptance, vs. 'very bad' (OR=0.73, 95% CI: 0.57-0.95) [63] • $k=23$ → Belief about vaccine safety (e.g., side-effects) [24,30,33,34,40,44,50,56,62,66,67,73,76] [39,43,46,52,57,59,60,65,74,77] <ul style="list-style-type: none"> ○ ORa=2.44, 95% CI: 1.71-3.48 [24] ○ ORa=0.41, 95% CI: 0.23-0.73 [77] ○ OR=2.00, 95% CI: 1.39-2.87 [60] ○ QUAL DATA: among staff who said that they would not get the vaccine right away, general concerns about the safety and effectiveness of the vaccine were common. These vaccine-related fears were attributed to the speed of vaccine development and concerns about long-term adverse effects of receiving the vaccine [39] • $k=6$ → Beliefs about vaccine efficacy [40,44,56,76] [68,70] <ul style="list-style-type: none"> ○ OR=7.06, 95% CI: 3.98-12.52) [68]
Beliefs about consequence factors	<ul style="list-style-type: none"> • $k=4$ → Belief in vaccine safety [19,29,53] [49] <ul style="list-style-type: none"> ○ (ORa=1.55, 95% CI: 1.12-2.14) [19]

<p>associated with higher acceptance</p>	<ul style="list-style-type: none"> ○ OR=1.54, 95% CI: 1.35-1.75 [29] ● $k=2 \rightarrow$ Belief in vaccine efficacy [19,53] <ul style="list-style-type: none"> ○ ORa=1.54; 95% CI: 1.26–1.88 [19] ● $k=2$ Getting vaccinated will protect patients (ORa=0.44, 95% CI: 0.31-0.62) [24] [48] ● $k=3 \rightarrow$ Getting vaccinated will protect family (ORa=0.21, 95% CI: 0.15-0.30) [24] [20,48] ● $k=5 \rightarrow$ Beliefs about high risk of becoming infected [29,31] [23,45,75] <ul style="list-style-type: none"> ○ OR=2.10, 95% CI: 1.78-2.43 [29] ○ ORa=2.48, 95% CI: 1.93-3.20 [31] ○ OR=1.89, 95% CI: 1.33-2.68 [75] ○ OR=1.29; 95% CI: 1.03-1.63 [45] ○ ORa=5.08, 95% CI 2.22-11.62 [23] ● $k=1 \rightarrow$ Vaccine confidence [47] ● $k=3 \rightarrow$ Positive attitude towards a COVID-19 vaccine (ORa=11.49; 95% CI: 5.88–22.46) [51] [32,42]
<p>TDF Domain (Definition)</p>	
<p>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?)</p>	
<p>Social/professional role and identity factors associated with lower acceptance</p>	<ul style="list-style-type: none"> ● $k=13 \rightarrow$ Vaccine acceptance higher among doctors vs. nurses (78% vs. 61% [27]; 61% vs. 34% [54]); intent to delay vaccination higher nurses vs. doctors (OR=4.14) [30]; vaccination acceptance lower among nurses vs. physicians (ORa=0.57, 95% CI: 0.45-0.73) [31]; vaccination acceptance doctors vs. nurses/other HCWs (ORa=1.59; 95% CI:1.03–2.44) [51]; physicians (80%) more likely to vaccinate than nurses (41%), ancillary services (46%) and allied health professionals (51%) [66] [16,21,26,52,57,68,75] <ul style="list-style-type: none"> ○ OR=0.70, 95% CI: 0.54-0.90 [75] ○ OR=3.62; 95% CI: 1.21-10.78 [68] ○ ORa=2.85; 95% CI: 1.10-7.4 [16] ○ Being a non-MD health professional (ORa=1.82, 95% CI 1.31-2.50) significantly associated with an

	<p>increased risk of vaccine hesitancy [26]</p> <ul style="list-style-type: none"> ○ Vaccination rejection increased significantly among HCWs not belonging to the medical guild (OR=4.46, 95% CI: 2.08-9.67) vs. non-medical guild (i.e., nursing, dental, psychology and laboratory personnel). [21] ● Healthcare assistants 'unsure' about vaccination (30% unsure), nurses were highest HCW group to say 'no' about vaccination (20%) [62] ● $k=1$ → Dietary, housekeeping, and administrative staff were more likely to intend to vaccinate compared to clinical care staff including nurse aids and nurses ($p<0.01$) [73] ● $k=1$ → Pharmacists who are managers/owners were more likely to accept a vaccine (85%) than were pharmacy technicians (66%) [53]
<p>Social/professional role and identity factors associated with higher acceptance</p>	<ul style="list-style-type: none"> ● $k=1$ → When getting vaccinated seen as a professional responsibility (ORa=0.31, 95% CI: 0.23-0.40) [24] ● $k=1$ → Collective responsibility towards the vaccine [47] ● $k=2$ → Direct medical care providers (49%) vs. non-direct care providers (34%) would accept vaccination [67] <ul style="list-style-type: none"> ○ OR=1.44, 95% CI: 1.29-1.61 [46] ● $k=1$ → Those working directly with COVID-19 patients (ORa=1.63, 95% CI: 1.14-2.33) [76] ● $k=2$ → Belief that vaccination for COVID-19 should be mandatory for HCWs <ul style="list-style-type: none"> ○ Participants believing the vaccine should be mandatory ($p<0.01$) [32] ○ OR=43.65, 95% CI: 24.59-77.50 [59] ● $k=1$ → An increase in the unemployment rate within the dental sector coincides with a rise in willingness for a COVID-19 vaccine [79] ● $k=1$ → Significantly associated with an increased probability to get vaccinated against COVID-19: being a physician (OR=7.27, 95% CI: 2.80-18.90), being member of the nursing personnel (OR=6.91, 95% CI: 2.63-18.11), being a member of the paramedical staff (OR=6.91, 95% CI: 2.63-18.11) [61] ● $k=1$ → Willingness included an increased pro-socialness index

	<p>score (a measure of responsibility/actions to help or benefit others) (ORa=7.36, 95% CI 4.16-13.01, p<0.01) [23]</p> <ul style="list-style-type: none"> • k=1 → Paediatric physicians more likely to accept free 80% effective vaccine vs. physicians in administrative roles (ORa=3.72, 95% CI: 1.36-10.20) [18] • k=1 → Being a pharmacy student vs. medicine student was a significant predictor of COVID-19 vaccine acceptance (OR=2.26, 95% CI: 1.35-3.81) [63]
<p>TDF Domain (Definition)</p>	
<p>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?)</p>	
<p>Reinforcement factors associated with lower acceptance</p>	<ul style="list-style-type: none"> • k=4 → Not routinely receiving seasonal influenza vaccinations <ul style="list-style-type: none"> ○ Those not having influenza vaccination less than half as likely to want COVID-19 vaccination [62] ○ OR=0.36, 95% CI: 0.18-0.71 [46] ○ OR=0.25, 95% CI: 0.13-0.49 [59] • k=1 → HCWs who indicated that they do not know if their relatives had been diagnosed with COVID-19 were less likely to accept the COVID-19 vaccine compared with those whose relatives had been diagnosed with COVID-19 (ORa=0.37; CI 95% 0.15-0.94) [16]
<p>Reinforcement factors associated with higher acceptance</p>	<ul style="list-style-type: none"> • k=9 → Historical influenza vaccination [24,31,44,56,76] [42,57,74] <ul style="list-style-type: none"> ○ ORa=0.52, 95% CI: 0.41-0.68) [24] ○ ORa=4.69, 95% CI 3.59-6.11) [31] ○ ORa=2.03, 95% CI: 1.47–2.81) [76] ○ ORa=2.38, 95% CI: 1.57- 3.59 [56] ○ ORa=0.37, 95% CI 0.29-0.48 [26] ○ Influenza vaccination in 2019 season (p<0.01) [32] ○ OR=2.08, 95% CI: 1.45-2.98 [69] • k=2 → Likelihood of having influenza vaccine [33,34] • k=1 → COVID-19 infection behaviours (i.e. personal protective behaviour) (OR=2.32, 95% CI: 1.52-3.56) associated with vaccine willingness [45]

	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Those that had previously paid for a vaccine vs. not previously paying for a vaccine more willing to accept free COVID-19 vaccine 80% effective (ORa=2.91, 95% CI: 1.83-4.64) [18] • $k=1 \rightarrow$ Presence of confirmed COVID-19 infection in close social network were the significant predictors of COVID-19 vaccine acceptance among studied medical students (OR=0.54, 95% CI: 0.37-0.80) [63]
TDF Domain (Definition)	
Emotion How do they feel (affect) about what they do and do those feelings influence what they do?	
Emotion factors associated with lower acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Fearing injections ($p=0.03$) was independent predictor of vaccine acceptance (OR=1.50, 95% CI: 1.04-2.13) [60]
Emotion factors associated with higher acceptance	<ul style="list-style-type: none"> • $k=4 \rightarrow$ Fear about COVID-19 [31,56] <ul style="list-style-type: none"> ○ ORa=1.58, 95% CI: 1.21-2.07 [31] ○ ORa=2.15, 95% CI: 1.62-2.84 [56] ○ OR=1.56, 95% CI: 1.43-1.70 [69] ○ The FC-19S (fear of COVID-19 scale) score received by those who were willing to get the COVID-19 vaccine was significantly higher, 19 ± 6.7 (median=18; min=7-max=35), than the score received by those who were not 17.7 ± 6.9 (median=17; min=7-max=35) ($p<0.01$) [42] • $k=1 \rightarrow$ Fear of genetic mutation [40] • $k=1 \rightarrow$ COVID-19 vaccination acceptance was associated with greater work stress [47] • $k=1 \rightarrow$ Willingness to get vaccinated is significantly strengthened by depression symptoms in the past week (OR=1.05, 95% CI: 1.01-1.09, $p=0.01$) [69] • $k=1 \rightarrow$ Higher scores on COVID-19 related anxiety was related to vaccine acceptance (OR=1.09, 95% CI: 1.03-1.16) [78]
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?)	
Beliefs about capability factors associated with lower acceptance	<ul style="list-style-type: none"> • Nothing identified to date
Beliefs about capability factors associated with higher acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Not concerned about challenges or difficulties in getting vaccinated [62]

Motivation-related factors associated with higher and lower COVID-19 vaccination uptake among HCWs

Similar barriers described above were also identified among studies measuring vaccination uptake itself (see Table 4b). Tulloch et al. and Schradling et al. reported that concerns about vaccine development and vaccine safety were reasons for non-uptake [65,72]. Oliver et al. reported that concerns about vaccine safety continued to predict lower vaccine receipt (ORa=0.39, 95% CI: 0.28-0.55) [52]. Interestingly, a qualitative study found that among HCW that had already been vaccinated, many stated that what convinced them to get the vaccine was the perceived positive impact on their residents or family. For example, one nurse stated: *“I got vaccinated because I don't want my patients to have to keep visiting family through a window”* (p5) [20].

In terms of the domain Social/professional role and responsibility domain, two studies measured factors associated with COVID-19 vaccination uptake (see Table 4b). Oliver et al. found that a role in nursing (ORa=0.37, 95% CI: 0.21-0.65), administration (ORa=0.46, 95% CI: 0.26-0.78), or allied and other health professionals (ORa=0.48, 95% CI: 0.27-0.81) remained significant for decreased odds of vaccine receipt compared to physicians and advanced practice providers [52]. Additionally, Hall et al. found that uptake was lower among certain hospital staff, namely those working as a porter, security, or in estates (ORa=0.61, 95% CI: 0.42-0.90) or midwife (ORa=0.74, 95% CI: 0.57-0.97) [37] [37].

Table 4b. Motivation-related factors associated with COVID-19 vaccination uptake 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?)	
Beliefs about consequence factors associated with lower acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Beliefs about rushed vaccine development/insufficient data developed <ul style="list-style-type: none"> ○ UPTAKE The most common reasons for staff not receiving the vaccine were: concerns about lack of vaccine research (37%) [72] • $k=2 \rightarrow$ Belief about vaccine safety (e.g., side-effects) <ul style="list-style-type: none"> ○ UPTAKE The primary reason for declining a COVID-19 vaccine was concern about vaccine safety (45%) [65] ○ UPTAKE Concerns about vaccine safety continued to predict lower vaccine receipt (ORa=0.39, 95% CI: 0.28-0.55). Concerns about being experimented on continued to predict lower vaccine receipt (ORa=0.44, 95% CI: 0.31-0.60) [52]
Beliefs about consequence factors associated with higher acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Getting vaccinated will protect family and patients <ul style="list-style-type: none"> ○ UPTAKE QUAL DATA: Among staff who had already been vaccinated, many stated that what convinced them to get the vaccine was the effect on their residents or family. For example, one nurse stated: "I got vaccinated because I don't want my patients to have to keep visiting family through a window" [20]
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?)	
Social/professional role and identity factors associated with lower acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Vaccine acceptance higher among doctors vs. nurses <ul style="list-style-type: none"> ○ UPTAKE A role in nursing (ORa=0.37, 95% CI: 0.21-0.65), administration (ORa=0.46, 95% CI: 0.26-0.78), or allied and other health professionals (ORa=0.48, 95% CI: 0.27-0.81) was associated with lower

	<p>acceptance vs. physicians and advanced practice providers [52]</p> <ul style="list-style-type: none"> • $k=1 \rightarrow$ UPTAKE Less likely to be vaccinated if worked as a porter, security, or in estates (ORa=0.61, 95% CI: 0.42-0.90) or midwife (ORa=0.74, 95% CI: 0.57-0.97) [37]
Social/professional role and identity factors associated with higher acceptance	<ul style="list-style-type: none"> • Nothing identified to date
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?)	
Reinforcement factors associated with lower acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Not routinely receiving seasonal influenza vaccinations <ul style="list-style-type: none"> ○ UPTAKE Participants were less likely to have been vaccinated if they had a previous infection (ORa=0.59, 95% CI: 0.54-0.64) [37]
Reinforcement factors associated with higher acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Historical influenza vaccination <ul style="list-style-type: none"> ○ UPTAKE Influenza vaccine receipt (ORa=3.57, 95% CI: 2.30-5.56) was also associated with a higher odds of COVID-19 vaccine uptake [52]

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

Equity-related factors and COVID-19 vaccination acceptance and uptake in Canada

Four Canadian studies [24,41,53,62] investigated equity-related factors associated with COVID-19 vaccination acceptance. One Canadian report [71] did not assess equity-related factors in relation to vaccination acceptance. No new Canadian studies looking at equity-related factors were added to version 2 of this report.

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 [24].
- 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” [62].
- 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 [62].
- 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 [24].

Equity-related factors and COVID-19 vaccination acceptance and uptake outside of Canada

11 studies (all conducted since vaccine approval, Nov 2020) assessed COVID-19 acceptance and/or uptake among certain equity-seeking groups [30,35,37,46,52,58,64–67,73]. Only 1 study assessed determinants based on race/ethnicity [35] (see Table 5). 9 studies were conducted in the USA and 2 were conducted in the UK [37,72], therefore applicability to Canada is uncertain. 8 studies measured COVID-19 vaccination acceptance [30,35,46,58,64,66,67,73] and 3 measured vaccine uptake [37,52,65].

COVID-19 vaccination acceptance in HCWs from equity-seeking groups

3 studies [30,64,73] 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 [64]. 2 studies [66,67] found that some racialized groups expressed more acceptance than others. For example, Shaw found that Asian respondents (73.8%) and White (58.4%) respondents were more likely to express vaccine acceptance than other groups [66]. Shekhar et al. found that vaccine acceptance was lower among Black and Latinx HCWs and that Black, Native American, Hawaiian, and Pacific Islander HCWs would rather wait to review vaccine safety data before accepting the vaccine [67]. 1 study found that race, ethnicity and indigeneity were not associated with accepting a COVID-19 vaccine [58]. Among new studies added to version 2 of this report, Kuter et al. (USA) reported intention to receive a COVID-19 vaccine varied by race/ethnicity: Asian (74%), White (70%), Hispanic (54%), Black (30%), and multiple/other races (59%). The likelihood of intending to be vaccinated was lower among HCWs identifying as Black (OR=0.23, 95% CI: 0.19-0.27), Hispanic (OR=0.51, 95% CI: 0.39-0.67), and those reporting multiple/other races (OR=0.58, 95% CI 0.47-0.73) versus those identifying as White [46]. Grumbach et al. (USA) reported likeliness of vaccine uptake relative to White respondents was 0.24 (0.10-0.60) for Black respondents, 0.50 (0.31-0.79) for Latinx respondents, 0.37 (0.27-0.51) for Asian respondents, 0.28 (0.15-0.53) for respondents of other races, and 0.49 (0.29-0.82) for respondents of multiple races [35]. We were able to map determinants of vaccination acceptance to the TDF according to race/ethnicity; Beliefs about consequences and Social influence were represented (see Table 5).

Table 5. Opportunity- and Motivation-related factors associated with COVID-19 vaccination acceptance among HCWs from equity-seeking groups

TDF Domain (Definition)	
Social influences (What do others do? What do others think of what people do or what they should do? Who are they and how does that influence what they do?)	
Social influence factors associated with lower acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Distrust in companies making vaccines was associated with lower vaccine acceptance [35] <ul style="list-style-type: none"> ○ Black (ORa=3.08, 95% CI: 2.00-4.73), Latinx (ORa=1.85, 95% CI: 1.38-2.48), and Asian ORa=1.34, 95% CI: 1.04-

	1.72) expressed more distrust in companies making vaccines than White respondents.
TDF Domain (Definition)	
Beliefs about consequence (What are the good and bad things that can happen from what people do and how does that influence whether they'll do it in the future?)	
Beliefs about consequences factors associated with lower acceptance	<ul style="list-style-type: none"> • $k=1 \rightarrow$ Concerns over vaccine efficacy was associated with lower vaccine acceptance [35] <ul style="list-style-type: none"> ○ Black (ORa=2.39, 95% CI: 1.58-3.61), Latinx (ORa=2.04, 95% CI: 1.58-2.64) and Asian (ORa=1.85, 95% CI: 1.51-2.27) respondents reported greater concern than White respondents [35] • $k=1 \rightarrow$ Concerns over a rushed approval process <ul style="list-style-type: none"> ○ Black (ORa=2.10, 95% CI: 1.44-3.05), Latinx (ORa=1.68, 95% CI: 1.34-2.10) and Asian (ORa=1.81, 95% CI: 1.53-2.15) respondents reported greater concern than White respondents [35]

COVID-19 vaccination uptake in HCWs from equity-seeking groups

Hall et al. found that HCW participants were less likely to have been vaccinated if they were from Black, Asian, or minority ethnic groups, especially if they were Black (ORa=0.26, 95% CI: 0.21-0.32) or lived in areas of higher deprivation (ORa=0.75, 95% CI: 0.65-0.87) [37]. Similarly, Schradung et al. reported that the non-Hispanic Black HCWs had the lowest vaccine acceptance rate of all participants (65%) [65]. Oliver et al. found that COVID-19 vaccination receipt was lower among Black (58%) compared with White (91%) HCWs; and lower among Hispanic (69%) compared with non-Hispanic (84%) HCWs. Identifying as Black was associated with a decreased vaccine receipt (ORa=0.38, 95% CI: 0.24-0.59). Based on free responses/thematic analysis, the theme of mistrust was identified in only 8% of statements. However, statements aligning with the theme of mistrust in the vaccine were more frequently cited among HCWs who identified as Black, and Black HCWs provided reasons for hesitancy more frequently than other racial/ethnic groups. Participants highlighted the historical medical experimentation on minority groups, political involvement in the COVID-19 pandemic response overall and in the development and distribution of the vaccine [52].

Discussion

Overview

This report details version 2 of our LBSES looking at factors affecting COVID-19 vaccination acceptance and uptake among HCWs. A total of 64 studies (including 32 new studies added to version 2 of this report), 6 in Canada, were identified up to Apr 20, 2021.

Almost two thirds of HCW respondents were willing to accept a COVID-19 vaccine ($k=58$; median=64%, IQR=46-79%). Among 37 studies conducted in the period since COVID-19 vaccine approval (spanning Nov, 2020 - Apr, 2021), 58% of HCW respondents were willing to accept a COVID-19 vaccine ($k=37$; median=58%, IQR=46-79%). In Canada, COVID-19 vaccination acceptance rates among HCWs ranged from 57% to 80% ($k=6$; median=69%, IQR=59-78%) indicating that a majority of HCWs in Canada want to get the COVID-19 vaccine.

Based on the Capability, Opportunity, and Motivation-Behaviour (COM-B) model [1], a number of important factors were identified that focused primarily on Opportunity and Motivation. Capability factors focused on Knowledge; Opportunity factors included Environmental context and resources and Social influences, and Motivation factors included Beliefs about consequences, Beliefs about capabilities, Social/professional role and identity, Reinforcement, and Emotion. These cover 8 of 14 domains of the Theoretical Domains Framework (TDF). These domains encompassed those identified in version 1 of our LBSES focusing on COVID-19 vaccination acceptance and uptake among [the general public](#) which suggests that the same barriers to COVID-19 vaccinations may apply, regardless of target (e.g., HCW or member of the public).

A number of important factors were identified that focused primarily on the Opportunity and Motivation of HCWs to accept a COVID-19 vaccine. Specifically, concerns and erroneous beliefs about COVID-19 vaccine safety, efficacy, and necessity (captured under Beliefs about consequences) were common and associated with lower vaccination acceptance and uptake among HCWs (based on analysis from 4 studies). Mistrust of governments and public health agencies (captured under Social influences) was associated with lower vaccination acceptance and routine seasonal vaccination (captured under Reinforcement) was consistently associated with higher likelihood of vaccine acceptance and uptake. Whilst public health agencies should ensure that the needs of vaccine hesitant individuals are met, they must also ensure that motivated individuals (57-80% of Canadian HCWs) are able to access vaccines. As such, it is important to continue to focus on Opportunity-related barriers (e.g., Environmental context

and resources) that fall outside of a HCWs control but may impact their vaccination intention and behaviour.

10 studies reported differences in COVID-19 vaccination acceptance and/or uptake among equity-seeking groups. There was evidence that racialized respondents (e.g., Black, Latinx, and Asian) are less likely to express vaccine acceptance/uptake compared to White respondents. Only 1 of these 10 studies explored determinants of acceptance and/or uptake based on race/ethnicity [35]. In terms of TDF domains, Concerns about vaccine development (captured under Beliefs about consequences) and mistrust about companies making vaccines (captured under Social influence) were more common among Black, Latinx, and Asian versus White respondents while concerns over safety were identified across groups. Findings from this one study may help inform strategies and programs addressing the specific needs and concerns of such equity-seeking groups. Additional research is needed to understand the factors influencing one's acceptance and/or uptake of COVID-19 vaccines among equity-seeking groups in Canada (e.g., perspectives among Canadian indigenous communities are lacking) and globally.

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 [24] 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 [81]). There is a need for more research, and in particular Canadian research, to be conducted among equity-seeking groups to help better inform how best to support greater vaccination. Assessing barriers and enablers to vaccine acceptance that racialized groups experience may provide valuable insights into factors driving observed disparities, especially when considered alongside the COM-B related barriers/enablers that each racialized group experience to better support each group.

Future directions for this LBSSES

Given that COVID-19 vaccines have been rolling out over the past 6 months, we expect to see more research to investigate drivers of actual uptake (seen in 4/32 studies added to version 2 of this report), in addition to factors associated with vaccination acceptance. 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 individuals who do develop strong intentions and acceptance for the COVID-19 vaccine translate their strong intention into vaccination [81]. From an equity-seeking group perspective, future versions of this LBSSES will continue to assess what is driving observed differences in vaccination acceptance and uptake. Moreover, we will connect with Canadian researchers 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.

Future planned LBSSES

- 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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References

- 1 Michie S, Stralen MM, West R. The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implement Sci* 2011;**6**.
- 2 Atkins L, Francis J, Islam R, *et al*. A guide to using the Theoretical Domains Framework of behaviour change to investigate implementation problems. *Implement Sci* 2017;**12**. doi:10.1186/s13012-017-0605-9
- 3 Cane J, O'Connor D, Michie S. Validation of the theoretical domains framework for use in behaviour change and implementation research. *Implement Sci* 2012;**7**.
- 4 Michie S, Johnston M, Abraham C, *et al*. Making psychological theory useful for implementing evidence based practice: a consensus approach. *BMJ Qual Saf* 2005;**14**.
- 5 Michie S, Richardson M, Johnston M, *et al*. The behavior change technique taxonomy (v1) of 93 hierarchically clustered techniques: building an international consensus for the reporting of behavior change interventions. *Ann Behav Med* 2013;**46**. doi:10.1007/s12160-013-9486-6
- 6 The British Psychological Society Covid-19 Behavioural Science and Disease Prevention Taskforce. Optimising vaccination uptake for Covid-19. British Psychological Society 2021.
- 7 Konnyu K, Benitez G. What are the barriers and facilitators to individuals' willingness to be vaccinated for COVID-19? Center for Evidence Synthesis in Health, Department of Health, Policy and Practice, Brown University 2020. <https://www.brown.edu/public-health/cesh/news/2021/01/what-are-barriers-and-facilitators-individuals%E2%80%99-willingness-be-vaccinated-covid-19>
- 8 Konnyu K, Benitez G. Understanding and promoting COVID-19 vaccine uptake among marginalized communities in RI. Center for Evidence Synthesis in Health, Department of Health, Policy and Practice, Brown University 2021. <https://www.brown.edu/public-health/cesh/news/2021/05/understanding-and-promoting-covid-19-vaccine-uptake-among-marginalized-communities-ri>
- 9 McMaster Health Forum. What is known about strategies for encouraging vaccine acceptance and addressing vaccine hesitancy or uptake? McMaster Health Forum 2020.
- 10 Ontario Ministry of Health. COVID-19 Vaccine Uptake Among Health Care Workers. Ontario Ministry of Health 2021.
- 11 Public Health Agency of Canada. Evergreen Rapid Review on COVID-19 Vaccine Knowledge, Attitudes, and Behaviors – Update 3. Public Health Agency of Canada 2021.

- 12 McMaster Health Forum. COVID-19 Living Evidence Profile #1: What is known about anticipated COVID-19 vaccine roll-out elements? McMaster Health Forum 2021.
- 13 Presseau J, McCleary N, Lorencatto F, *et al.* Action, actor, context, target, time (AACTT): a framework for specifying behaviour. *Implement Sci* 2019;**14**:102. doi:10.1186/s13012-019-0951-x
- 14 O'Neill J, Tabish H, Welch V, *et al.* Applying an equity lens to interventions: using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. *J Clin Epidemiol* 2014;**67**:56–64. doi:10.1016/j.jclinepi.2013.08.005
- 15 Etherington N, Rodrigues IB, Giangregorio L, *et al.* Applying an intersectionality lens to the theoretical domains framework: a tool for thinking about how intersecting social identities and structures of power influence behaviour. *BMC Med Res Methodol* 2020;**20**:169. doi:10.1186/s12874-020-01056-1
- 16 Agyekum MW, Afrifa-Anane GF, Kyei-Arthur F, *et al.* Acceptability of COVID-19 vaccination among health care workers in Ghana. *medRxiv* 2021;;2021.03.11.21253374. doi:10.1101/2021.03.11.21253374
- 17 Ali KF, Whitebridge S, Jamal MH, *et al.* Perceptions, Knowledge, and Behaviors Related to COVID-19 Among Social Media Users: Cross-Sectional Study. *J Med Internet Res* 2020;**22**:e19913. doi:10.2196/19913
- 18 Alvarado-Socarras JL, Vesga-Varela AL, Quintero-Lesmes DC, *et al.* Perception of COVID-19 Vaccination Amongst Physicians in Colombia. *Vaccines* 2021;**9**. doi:10.3390/vaccines9030287
- 19 Barry M, Temsah M-H, Alhuzaimi A, *et al.* COVID-19 vaccine confidence and hesitancy among healthcare workers: a cross-sectional survey from a MERS-CoV experienced nation. *medRxiv* 2020;;2020.12.09.20246447. doi:10.1101/2020.12.09.20246447
- 20 Berry SD, Johnson KS, Myles L, *et al.* Lessons learned from frontline skilled nursing facility staff regarding COVID-19 vaccine hesitancy. *J Am Geriatr Soc* 2021;**n/a**. doi:10.1111/jgs.17136
- 21 Castañeda-Vasquez DE, Ruiz-Padilla JP, Botello-Hernandez E. Vaccine Hesitancy against SARS-CoV-2 in Health Personnel of Northeastern Mexico and its Determinants. *J Occup Environ Med* 2021;**Publish Ahead of Print**.https://journals.lww.com/joem/Fulltext/9000/Vaccine_Hesitancy_against_SARS_CoV_2_in_Health.97927.aspx

- 22 Chawe A, Mfuno RL, Syapiila PM, *et al.* Knowledge, attitude and practices of COVID-19 among medical laboratory professionals in Zambia. *Afr J Lab Med* 2021;**10**.<https://ajlmonline.org/index.php/ajlm/article/view/1403/1889>
- 23 Chew NWS, Cheong C, Kong G, *et al.* An Asia-Pacific study on healthcare workers' perceptions of, and willingness to receive, the COVID-19 vaccination. *Int J Infect Dis* 2021;**106**:52–60. doi:10.1016/j.ijid.2021.03.069
- 24 Desveaux L, Savage RD, Tadrous M, *et al.* Beliefs associated with Intentions of Non-Physician Healthcare Workers to Receive the COVID-19 Vaccine in Ontario, Canada. *medRxiv* 2021;:2021.02.19.21251936. doi:10.1101/2021.02.19.21251936
- 25 Detoc M, Bruel S, Frappe P, *et al.* Intention to participate in a COVID-19 vaccine clinical trial and to get vaccinated against COVID-19 in France during the pandemic. *Vaccine* 2020;**38**:7002–6. doi:10.1016/j.vaccine.2020.09.041
- 26 Di Gennaro F, Murri R, Segala FV, *et al.* Attitudes towards Anti-SARS-CoV2 Vaccination among Healthcare Workers: Results from a National Survey in Italy. *Viruses* 2021;**13**. doi:10.3390/v13030371
- 27 Dror AA, Eisenbach N, Taiber S, *et al.* Vaccine hesitancy: the next challenge in the fight against COVID-19. *Eur J Epidemiol* 2020;**35**:775–9. doi:10.1007/s10654-020-00671-y
- 28 Fouogue JT, Noubom M, Kenfack B, *et al.* Poor knowledge of COVID-19 and unfavourable perception of the response to the pandemic by healthcare workers at the Bafoussam Regional Hospital (West Region - Cameroon). *medRxiv* 2020;:2020.08.20.20178970. doi:10.1101/2020.08.20.20178970
- 29 Fu C, wei Z, Pei S, *et al.* Acceptance and preference for COVID-19 vaccination in health-care workers (HCWs). *medRxiv* 2020;:2020.04.09.20060103. doi:10.1101/2020.04.09.20060103
- 30 Gadoth A, Halbrook M, Martin-Blais R, *et al.* Assessment of COVID-19 vaccine acceptance among healthcare workers in Los Angeles. *medRxiv* 2020;:2020.11.18.20234468. doi:10.1101/2020.11.18.20234468
- 31 Gagneux-Brunon A, Detoc M, Bruel S, *et al.* Intention to get vaccinations against COVID-19 in French healthcare workers during the first pandemic wave: a cross-sectional survey. *J Hosp Infect* 2021;**108**:168–73. doi:10.1016/j.jhin.2020.11.020
- 32 Gönüllü E, Soysal A, Atıcı S, *et al.* Pediatricians' COVID-19 experiences and views on the willingness to receive COVID-19 vaccines: a cross-sectional survey in Turkey. *Hum Vaccines Immunother* 2021;:1–8. doi:10.1080/21645515.2021.1896319

- 33 Grech V, Bonnici J, Zammit D. Vaccine hesitancy in Maltese family physicians and their trainees vis-à-vis influenza and novel COVID-19 vaccination. *Early Hum Dev* 2020;:105259. doi:10.1016/j.earlhumdev.2020.105259
- 34 Grech V, Gauci C, Agius S. Vaccine hesitancy among Maltese Healthcare workers toward influenza and novel COVID-19 vaccination. *Early Hum Dev* 2020;:105213–105213. doi:10.1016/j.earlhumdev.2020.105213
- 35 Grumbach K, Judson T, Desai M, *et al.* Association of Race/Ethnicity With Likelihood of COVID-19 Vaccine Uptake Among Health Workers and the General Population in the San Francisco Bay Area. *JAMA Intern Med* Published Online First: 30 March 2021. doi:10.1001/jamainternmed.2021.1445
- 36 Grüner S, Krüger F. The intention to be vaccinated against COVID-19: stated preferences before vaccines were available. *Appl Econ Lett* 2020;:1–5. doi:10.1080/13504851.2020.1854445
- 37 Hall VJ, Foulkes S, Saei A, *et al.* COVID-19 vaccine coverage in health-care workers in England and effectiveness of BNT162b2 mRNA vaccine against infection (SIREN): a prospective, multicentre, cohort study. *The Lancet* 2021;**397**:1725–35. doi:10.1016/S0140-6736(21)00790-X
- 38 Harapan H, Wagner AL, Yufika A, *et al.* Acceptance of a COVID-19 Vaccine in Southeast Asia: A Cross-Sectional Study in Indonesia. *Front Public Health* 2020;**8**:381–381. doi:10.3389/fpubh.2020.00381
- 39 Harrison J, Berry S, Mor V, *et al.* “Somebody Like Me”: Understanding COVID-19 Vaccine Hesitancy Among Staff in Skilled Nursing Facilities. *J Am Med Dir Assoc* Published Online First: 20 March 2021. doi:10.1016/j.jamda.2021.03.012
- 40 Hussein AAM, Galal I, Makhlof NA, *et al.* A national survey of potential acceptance of COVID-19 vaccines in healthcare workers in Egypt. *medRxiv* 2021;:2021.01.11.21249324. doi:10.1101/2021.01.11.21249324
- 41 Institut national de santé publique du Québec. Preliminary opinion on priority groups for COVID-19 vaccination in Quebec. Institut national de santé publique du Québec. 2020.
- 42 Kaplan AK, Sahin MK, Parildar H, *et al.* The willingness to accept the COVID-19 vaccine and affecting factors among healthcare professionals: A cross-sectional study in Turkey. *Int J Clin Pract* 2021;**n/a**:e14226. doi:10.1111/ijcp.14226
- 43 Karagiannidis C, Spies C, Kluge S, *et al.* Impfbereitschaft unter intensivmedizinischem Personal: Ängsten entgegenwirken. *Med Klin - Intensivmed Notfallmedizin* 2021;**116**:216–9. doi:10.1007/s00063-021-00797-1

- 44 Kose S, Mandiracioglu A, Sahin S, *et al.* Vaccine hesitancy of the COVID-19 by health care personnel. *Int J Clin Pract* 2020;**n/a**:e13917. doi:10.1111/ijcp.13917
- 45 Kukreti S, Lu M-Y, Lin Y-H, *et al.* Willingness of Taiwan's Healthcare Workers and Outpatients to Vaccinate against COVID-19 during a Period without Community Outbreaks. *Vaccines* 2021;**9**. doi:10.3390/vaccines9030246
- 46 Kuter BJ, Browne S, Momplaisir FM, *et al.* Perspectives on the receipt of a COVID-19 vaccine: A survey of employees in two large hospitals in Philadelphia. *Vaccine* 2021;**39**:1693–700. doi:10.1016/j.vaccine.2021.02.029
- 47 Kwok KO, Li K-K, WEI WI, *et al.* Influenza vaccine uptake, COVID-19 vaccination intention and vaccine hesitancy among nurses: A survey. *Int J Nurs Stud* 2021;**114**:103854. doi:10.1016/j.ijnurstu.2020.103854
- 48 Ledda C, Costantino C, Cuccia M, *et al.* Attitudes of Healthcare Personnel towards Vaccinations before and during the COVID-19 Pandemic. *Int J Environ Res Public Health* 2021;**18**:2703. doi:10.3390/ijerph18052703
- 49 Lucia VC, Kelekar A, Afonso NM. COVID-19 vaccine hesitancy among medical students. *J Public Health* Published Online First: 26 December 2020. doi:10.1093/pubmed/fdaa230
- 50 Meyer MN, Gjorgjieva T, Rosica D. Trends in Health Care Worker Intentions to Receive a COVID-19 Vaccine and Reasons for Hesitancy. *JAMA Netw Open* 2021;**4**:e215344–e215344. doi:10.1001/jamanetworkopen.2021.5344
- 51 Nzaji MK, Ngombe LK, Mwamba GN, *et al.* Acceptability of Vaccination Against COVID-19 Among Healthcare Workers in the Democratic Republic of the Congo. *Pragmatic Obs Res* 2020;**11**:103.
- 52 Oliver K, Raut A, Pierre S, *et al.* Factors associated with COVID-19 vaccine receipt at two integrated healthcare systems in New York City: A Cross sectional study of healthcare workers. *medRxiv* 2021;:2021.03.24.21253489. doi:10.1101/2021.03.24.21253489
- 53 Ontario College of Pharmacists. COVID-19 Vaccine Administration Participation Readiness Survey Summary. Ontario College of Pharmacists 2021.
- 54 Papagiannis D, Malli F, Raptis DG, *et al.* Assessment of Knowledge, Attitudes, and Practices towards New Coronavirus (SARS-CoV-2) of Health Care Professionals in Greece before the Outbreak Period. *Int J Environ Res Public Health* 2020;**17**. doi:10.3390/ijerph17144925
- 55 Parajuli J, Mishra P, Sharma S, *et al.* Knowledge and attitude about COVID 19 among health care workers working in seti provincial Hospital. *Concern* 2020;**3**:5.

- 56 Patelarou E, Galanis P, Mechili EA, *et al.* Factors influencing nursing students' intention to accept COVID-19 vaccination – A pooled analysis of seven countries. *medRxiv* 2021;:2021.01.22.21250321. doi:10.1101/2021.01.22.21250321
- 57 Petravić L, Arh R, Gabrovec T, *et al.* Factors Affecting Attitudes towards COVID-19 Vaccination: An Online Survey in Slovenia. *Vaccines* 2021;9. doi:10.3390/vaccines9030247
- 58 Piltch-Loeb R, Savoia E, Goldberg B, *et al.* Examining the effect of information channel on COVID-19 vaccine acceptance. *medRxiv* 2021;:2021.01.18.21250049. doi:10.1101/2021.01.18.21250049
- 59 Qattan AMN, Alshareef N, Alsharqi O, *et al.* Acceptability of a COVID-19 Vaccine Among Healthcare Workers in the Kingdom of Saudi Arabia. *Front Med* 2021;8:83. doi:10.3389/fmed.2021.644300
- 60 Rabi R, Maraqa B, Nazzal Z, *et al.* Factors affecting nurses' intention to accept the COVID-9 vaccine: A cross-sectional study. *Public Health Nurs* 2021;n/a. doi:10.1111/phn.12907
- 61 Raftopoulos V, Iordanou S, Katsapi A, *et al.* A comparative online survey on the intention to get COVID-19 vaccine between Greek and Cypriot healthcare personnel: is the country a predictor? *Hum Vaccines Immunother* 2021;:1–8. doi:10.1080/21645515.2021.1896907
- 62 SafeCare-BC. Briefing Note: COVID-19 Vaccine Survey. SafeCare-BC 2020.
- 63 Saied SM, Saied EM, Kabbash IA, *et al.* Vaccine hesitancy: Beliefs and barriers associated with COVID-19 vaccination among Egyptian medical students. *J Med Virol* 2021;n/a. doi:10.1002/jmv.26910
- 64 Savoia E, Piltch-Loeb R, Goldberg B, *et al.* Predictors of COVID-19 Vaccine Hesitancy: Socio-demographics, Co-Morbidity and Past Experience of Racial Discrimination. *medRxiv* 2021;:2021.01.12.21249152. doi:10.1101/2021.01.12.21249152
- 65 Schradling WA, Trent SA, Paxton JH, *et al.* Vaccination rates and acceptance of SARS-CoV-2 vaccination among U.S. emergency department health care personnel. *Acad Emerg Med* 2021;28:455–8. doi:10.1111/acem.14236
- 66 Shaw J, Stewart T, Anderson KB, *et al.* Assessment of US Healthcare Personnel Attitudes Towards Coronavirus Disease 2019 (COVID-19) Vaccination in a Large University Healthcare System. *Clin Infect Dis* Published Online First: 25 January 2021. doi:10.1093/cid/ciab054
- 67 Shekhar R, Sheikh AB, Upadhyay S, *et al.* COVID-19 Vaccine Acceptance among Health Care Workers in the United States. *Vaccines* 2021;9. doi:10.3390/vaccines9020119

- 68 Singhania N, Kathiravan S, Pannu AK. Acceptance of coronavirus disease 2019 vaccine among health-care personnel in India: a cross-sectional survey during the initial phase of vaccination. *Clin Microbiol Infect Off Publ Eur Soc Clin Microbiol Infect Dis* 2021;;S1198-743X(21)00143-9. doi:10.1016/j.cmi.2021.03.008
- 69 Szymyd B, Karuga FF, Bartoszek A, *et al.* Attitude and Behaviors towards SARS-CoV-2 Vaccination among Healthcare Workers: A Cross-Sectional Study from Poland. *Vaccines* 2021;9. doi:10.3390/vaccines9030218
- 70 Temsah M-H, Barry M, Aljamaan F, *et al.* Adenovirus and RNA-based COVID-19 vaccines: perceptions and acceptance among healthcare workers. *medRxiv* 2020;;2020.12.22.20248657. doi:10.1101/2020.12.22.20248657
- 71 The Canadian PSW Network. COVID-19 Vaccination Survey. The Canadian PSW Network 2021.
- 72 Tulloch JSP, Lawrenson K, Gordon AL, *et al.* COVID-19 vaccine hesitancy in care home staff: a survey of Liverpool care homes. *medRxiv* 2021;;2021.03.07.21252972. doi:10.1101/2021.03.07.21252972
- 73 Unroe KT, Evans R, Weaver L, *et al.* Willingness of Long-Term Care Staff to Receive a COVID-19 Vaccine: A Single State Survey. *J Am Geriatr Soc* 2021;69:593–9. doi:10.1111/jgs.17022
- 74 Verger P, Scronias D, Dauby N, *et al.* Attitudes of healthcare workers towards COVID-19 vaccination: a survey in France and French-speaking parts of Belgium and Canada, 2020. *Eurosurveillance* 2021;26:2002047.
- 75 Wang J, Feng Y, Hou Z, *et al.* Willingness to receive SARS-CoV-2 vaccine among healthcare workers in public institutions of Zhejiang Province, China. *Hum Vaccines Immunother* 2021;;1–8. doi:10.1080/21645515.2021.1909328
- 76 Wang K, Wong ELY, Ho KF, *et al.* Intention of nurses to accept coronavirus disease 2019 vaccination and change of intention to accept seasonal influenza vaccination during the coronavirus disease 2019 pandemic: A cross-sectional survey. *Vaccine* 2020;38:7049–56. doi:10.1016/j.vaccine.2020.09.021
- 77 Youssef D, Abbas LA, Berry A, *et al.* Determinants of Acceptance of Coronavirus Disease-2019 (COVID-19) Vaccine Among Lebanese Health Care Workers Using Health Belief Model. *Res Sq* Published Online First: 6 May 2021. doi:10.21203/rs.3.rs-294775/v1
- 78 Yurttas B, Poyraz BC, Sut N, *et al.* Willingness to get the COVID-19 vaccine among patients with rheumatic diseases, healthcare workers and general population in Turkey: a web-based survey. *Rheumatol Int* 2021;41:1105–14. doi:10.1007/s00296-021-04841-3

- 79 Zigran A, Dror AA, Morozov NG, *et al.* COVID-19 Vaccine Acceptance Among Dental Professionals Based on Employment Status During the Pandemic. *Front Med* 2021;**8**:13. doi:10.3389/fmed.2021.618403
- 80 Jacobson Vann JC, Jacobson, RM, Coyne-Beasley, T, Asafu-Adjei, JK, Szilagyi P. Patient reminder and recall interventions to improve immunization rates. *Cochrane Database Syst Rev* Published Online First: 2018. doi:10.1002/14651858.CD003941.pub3
- 81 Presseau J, Desveaux L, Allen U. Behavioural science principles for supporting COVID-19 vaccine confidence and uptake among Ontario health care workers. *Sci Briefs Ont COVID-19 Sci Advis Table* 2021;**2**:12.

Appendices

Appendix 1. Data abstraction forms

Study characteristics	Behaviour specs	Key findings/themes by COM-B and TDF do
Author:	Action(s):	Capability
Year:	Actor(s):	Knowledge:
URL:	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

Equity seeking groups	TDFICOM-B Key findings/themes					
Race/ethnicity/indigeneity groups included:	Group A:		Group B:		Group C:	
	Capability		Capability		Capability	
		Knowledge:		Knowledge:		Knowledge:
		Skills:		Skills:		Skills:
		Behaviour regulation:		Behaviour regulation:		Behaviour regulation:
		Memory/attention:		Memory/attention:		Memory/attention:
		Decision making:		Decision making:		Decision making:
	Opportunity		Opportunity		Opportunity	
		Environmental context & resources:		Environmental context & resources:		Environmental context & resources:
		Social influences:		Social influences:		Social influences:
	Motivation		Motivation		Motivation	
		Intention (capture % intention/hesitant/confident where available)		Intention (capture % intention/hesitant/confident where available)		Intention (capture % intention/hesitant/confident where available)
Other notes:		Goals:		Goals:		Goals:
		Social/professional role/identity:		Social/professional role/identity:		Social/professional role/identity:
		Beliefs about capabilities:		Beliefs about capabilities:		Beliefs about capabilities:
		Beliefs about consequences:		Beliefs about consequences:		Beliefs about consequences:
		Optimism:		Optimism:		Optimism:
		Reinforcement:		Reinforcement:		Reinforcement:
		Emotions:		Emotions:		Emotions:
	Other	Specify:	Other	Specify:	Other	Specify:
	%Mean vaccine intention and/or hesitancy		%Mean vaccine intention and/or hesitancy		%Mean vaccine intention and/or hesitancy	