



Review Paper

Behavioural determinants of COVID-19 vaccination acceptance among healthcare workers: a rapid review

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ABSTRACT

Objectives: Vaccinating healthcare workers (HCWs) against COVID-19 has been a public health priority since rollout began in late 2020. Promoting COVID-19 vaccination among HCWs would benefit from identifying modifiable behavioural determinants. We sought to identify and categorize studies looking at COVID-19 vaccination acceptance to identify modifiable factors to increase uptake in HCWs.

Study design: Rapid evidence review.

Methods: We searched MEDLINE and Cochrane databases until May 2021 and conducted a grey literature search to identify cross-sectional, cohort, and qualitative studies. Key barriers to, and enablers of, vaccine acceptance were categorized using the Theoretical Domains Framework (TDF), a comprehensive theoretical framework comprising 14 behavioural domains.

Results: From 19,591 records, 74 studies were included. Almost two-thirds of responding HCWs were willing to accept a COVID-19 vaccine (median = 64%, interquartile range = 50–78%). Twenty key barriers and enablers were identified and categorized into eight TDF domains. The most frequently identified barriers to COVID-19 vaccination were as follows: concerns about vaccine safety, efficacy, and speed of development (TDF domain: *Beliefs about consequences*); individuals in certain HCW roles (*Social/professional role and identity*); and mistrust in state/public health response to COVID-19 (*Social influences*). Routinely being vaccinated for seasonal influenza (*Reinforcement*), concerns about contracting COVID-19 (*Beliefs about consequences*) and working directly with COVID-19 patients (*Social/professional role and identity*) were key enablers of COVID-19 vaccination among HCWs.

Discussion: Our review identified eight (of a possible 14) behavioural determinants of COVID-19 vaccine acceptance among HCWs that, if targeted, could help design tailored vaccination messaging, policy, campaigns, and programs to support HCWs vaccination uptake.

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Introduction

Since late 2020, breakthroughs in vaccine development have been crucial for curbing the COVID-19 pandemic which as of February 2022 has caused an estimated 5.7 million deaths globally.¹ As vaccine programs continue to be rolled out, albeit at markedly differing paces worldwide,² addressing COVID-19 vaccination acceptance and uptake among high-priority groups such as

healthcare workers (HCWs) remains an urgent public health challenge. High uptake of COVID-19 vaccines among HCWs, along with the wider public, is needed to achieve maximal effectiveness, especially in light of emerging variants of concern.³

There is a growing literature on factors linked to vaccination hesitancy, acceptance, and uptake in HCWs, spanning multiple methods and approaches and in particular data collected using surveys and interviews with HCWs worldwide. This breadth poses a challenge to decision-makers faced with developing supports to encourage greater uptake. As such, there is an opportunity to bring consistency across the literature using behavioural frameworks that can enable better links to be made between barriers and

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strategies best suited to address them in HCW vaccination campaigns worldwide.

Framing COVID-19 vaccination uptake as a behaviour enables drawing upon decades of theory-informed empirical research aimed at understanding factors that affect what people think, feel, decide, and ultimately do. Comprehensive frameworks, such as the Theoretical Domains Framework (TDF),^{4–6} synthesise these factors into 14 behavioural domains (*Knowledge; Skills; Social/professional role and identity; Beliefs about capabilities; Optimism; Beliefs about consequences; Reinforcement; Intentions; Goals; Memory, attention, and decision processes; Environmental context and resources; Social influences; Emotion; and Behavioural regulation*) that represent over 30 theories of behaviour and behaviour change reflecting key, modifiable factors that influence behaviour. An advantage of synthesising the existing literature with such frameworks is that it is possible to: a) assess which type of barrier to getting vaccinated is appearing most and least in the literature; b) assess whether there are under-considered domains that are deserving of greater attention given their known relationship with decisions and action generally; and c) enable linkage to tools that suggest particular behaviour change techniques best suited to address particular domains.⁷ Using this behavioural lens, we conducted a rapid evidence review of factors linked to COVID-19 vaccination acceptance in HCWs and use the TDF to bring consistency across the literature.

Objectives

To identify key behavioural determinants of COVID-19 vaccination among HCWs and use a comprehensive theoretical framework to bring consistency across the literature.

Methods

Study design

Rapid reviews are a form of evidence synthesis that use abbreviated systematic review methods to answer pressing health questions in short time frames, often for localized decision-making purposes. Although not a replacement for a full systematic review, rapid reviews still follow the principles of robust evidence synthesis including comprehensive searches, rigorous extraction, and transparent reporting.^{8,9} This type of methodology has been extensively used during the COVID-19 pandemic given the need for time-sensitive evidence synthesis to inform public health policy and practice.¹⁰

Data sources

We conducted ongoing searches for primary studies in MEDLINE, Cochrane Register of Clinical Trials, and the Cochrane COVID-19 Study Register in accordance with a registered protocol (PROSPERO registration: CRD42021253533). The search strategy can be found in [Appendix 1](#). We included peer-reviewed papers, preprints, and published reports of primary studies meeting our eligibility criteria below. The latest search of these databases was done on May 24, 2021. In addition, we manually searched four publicly available reports which focused on COVID-19 vaccination in Canada as part of a grey literature search.^{11–14}

Study inclusion/exclusion criteria

We included studies investigating COVID-19 vaccination among HCWs (e.g., doctors, nurses, pharmacists, hospital staff; role could be self-identified) and excluded studies where general public samples only were used. Self-report measures of COVID-19 vaccination willingness/intention/hesitancy/acceptance (referred to as

'vaccination acceptance' hereafter) were included and vaccination acceptance had to relate to self-vaccination rather than HCWs vaccinating others as part of their clinical role. We excluded studies that only measured COVID-19 vaccination knowledge. We included studies conducted since the onset of the COVID-19 pandemic (January 2020 onwards) and we included cross-sectional, cohort and qualitative studies.

Data extraction

Citations from all searches were de-duplicated and entered into Abstrackr software, a free online screening tool that uses machine learning capabilities to predict the likelihood of relevance of each citation (<http://abstrackr.cebm.brown.edu/>). Two researchers conducted independent screening at level 1 (title and abstract) and level 2 (full-text) with discrepancies resolved via consensus meetings. Data extraction was undertaken using a standardised data extraction form which captured data on study characteristics and reported determinants of COVID-19 vaccination among HCWs. Factors affecting COVID-19 vaccination acceptance were coded to key barriers and enablers and mapped onto the TDF. A barrier/enabler was considered 'key' if it had been coded in ≥ 3 separate studies. Given the rapid review methodology, no study quality assessment was done.

Results

Study characteristics

From 19,591 records, a total of 74 studies met our inclusion criteria^{15–88} (see [Appendix 2](#) for PRISMA flow diagram). [Appendix 3](#) provides an overview of each study. Fifty-five studies were published peer-reviewed papers, 16 were preprints, and two were published reports. Fifty-nine of 74 studies collected data in the period since COVID-19 vaccine approval (November 2020 onwards). Seventy-one of 74 studies used cross-sectional survey designs, two were qualitative studies,^{21,36} and one was a cohort study.⁴³ Twenty-three of 74 studies were conducted exclusively in North America. Fifty-one studies were conducted outside of North America: Europe (France^{33,63}, Germany^{20,42,59}, Greece and Cyprus,⁶⁸ Greece,^{52,62} Italy,^{25,26,50} Poland,^{45,76} Slovenia,⁶⁵ Turkey^{34,41,46,84,87} and UK^{15,83}); Asia (China,^{31,73,81,86} Hong Kong,^{49,82} India,⁷⁵ Pakistan,⁶⁹ Taiwan⁴⁷ and Vietnam³⁸); South America (Colombia¹⁸); Central America (Mexico²²); Africa (Cameroon,³⁰ Democratic Republic of Congo,⁶⁰ Egypt,^{29,37,71} Ghana¹⁶ and Uganda⁴⁰); Middle East (Iraq,¹⁷ Israel,^{27,88} Lebanon,⁸⁵ Palestine^{54,67} and Saudi Arabia^{19,66,77}) and multiple countries.^{45,64,80}

Fifty-one of 74 studies recruited general HCWs samples of which seven recruited mixed samples that included HCWs as well as participants from the general public and/or patients.^{17,35,43,47,56,65,87} Twenty-three of 74 studies recruited specific professions/specialities: medical students,^{40,51,71} skilled nursing facility staff,³⁶ dental professionals/students,^{55,88} paediatricians,³⁴ intensive care staff,⁴² physicians,¹⁸ nurses,⁶⁷ non-physicians,^{24,32} nursing home/assisted living staff,⁷⁹ continuing care workers,⁷⁰ pharmacy professionals,⁶¹ personal support workers,⁷⁸ nurses/trainee nurses,^{49,53,64,82} ophthalmology residents,⁴⁵ emergency medical services personnel,⁵⁹ doctor and nurses.⁷³

Rates of COVID-19 acceptance among HCWs

Almost two-thirds of responding HCWs were willing to accept a COVID-19 vaccine (number of studies (k) = 72; median = 64%; interquartile range (IQR) = 50–78%). Among North American studies, the median average of responding HCWs willing to accept a COVID-19 vaccine was also 64% (k = 21; IQR = 56–80%). In rest-of-the-world studies, 62% of responding HCWs were willing to accept

a vaccine for COVID-19 ($k = 51$, IQR = 49–77%). Among studies conducted in the period since COVID-19 vaccine approval (November 2020 onwards), 64% ($k = 57$; IQR = 53–80%) of responding HCWs were willing to accept a COVID-19 vaccine.

Behavioural determinants of COVID-19 vaccination acceptance among HCWs

Eight (of a possible 14) TDF domains appear to be important determinants of COVID-19 vaccine acceptance among HCWs (Fig. 1): Knowledge [$k = 9$]; Environmental context and resources [$k = 10$], Social influences [$k = 22$]; and Beliefs about consequences [$k = 56$], Beliefs about capabilities [$k = 3$], Social/professional role and identity [$k = 41$], Reinforcement [$k = 29$], and Emotion [$k = 9$] (Table 1). Compared to data focusing on COVID-19 vaccination in the general public,⁸⁹ similar barriers to and enablers of COVID-19 vaccination in HCWs were identified. Domains that do not seem to be important determinants of COVID-19 vaccination among HCWs include: Skills, Behavioural regulation, Memory, attention and decision processes, Goals, and Optimism. Figs. 2 and 3 depict the 20 most frequent key barriers and enablers (coded in ≥ 3 studies), respectively.

TDF domains represented within the literature

Knowledge: A lack of knowledge about COVID-19 vaccines was cited as a barrier in nine studies.^{36,48,50,54,64,71,78,83,85} One study tested the relationship statistically between HCW knowledge and vaccination acceptance, where HCWs with ‘high’ knowledge about COVID-19 vaccines had 1.86 times greater odds of accepting a COVID-19 vaccine vs those with ‘low’ knowledge.⁶⁴ A qualitative study highlighted that ‘complex information, conflicting and changing guidance, overwhelming amounts of material, and poor provision of information in other languages contributed to a lack of trust, confusion, and ultimately vaccine hesitancy’ (p8).⁸³

Environmental context and resources: Access to and trust in reputable information sources about COVID-19 and COVID-19 vaccines was seen as an enabler to vaccine acceptance in six studies.^{17,19,25,26,38,86} Moreover, one study found that financial support such as paid sick leave during the pandemic was associated with vaccine acceptance among HCWs.²⁴ In terms of barriers, one study found that a lack of availability and accessibility of COVID-19 vaccines was linked to lower vaccine acceptance among HCWs.⁸⁵

Social influences: Ten studies found mistrust towards governments and public health bodies was associated with lower vaccination acceptance.^{16,30,35,36,51,64,68,70,80,85} At a more local level, two studies found that trust in how hospital management had handled the pandemic was linked to lower vaccine acceptance.^{64,68}

Beliefs about consequences: This domain was one of the most frequently identified across studies and related specifically to beliefs related to vaccine safety, efficacy, and necessity. In 30 studies, safety concerns centered on the risk of possible adverse events (e.g., side effects).^{15,19,24,31,32,36,37,42,45,46,48,51,55,57,61,63–67,69,70,72,74,79,80,82–85} Concerns about the speed at which COVID-19 vaccines had being developed was seen in 10 studies.^{19,24,27,32,35,46,57,70,74,83} Twelve studies found that HCWs questioned the efficacy of COVID-19 vaccines.^{19,35,37,46,61,64,69,75,77,82–84} 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 six studies.^{24,30,46,67,71,82}

Emotion: General fear about COVID-19 was associated with higher vaccination acceptance in five studies.^{33,37,41,64,76}

Beliefs about capabilities: Three studies found that confidence in overcoming any challenges or difficulties in getting vaccinated was associated with higher acceptance in three studies.^{70,73,86}

Social/professional role and identity: One consistent finding was that vaccination acceptance was lower in non-physicians such as nurses.^{16,20,22,25–27,32,33,54,58–60,62,63,65,68,70,72,75,81,84,90} It may be that certain HCW groups have specific needs and concerns that

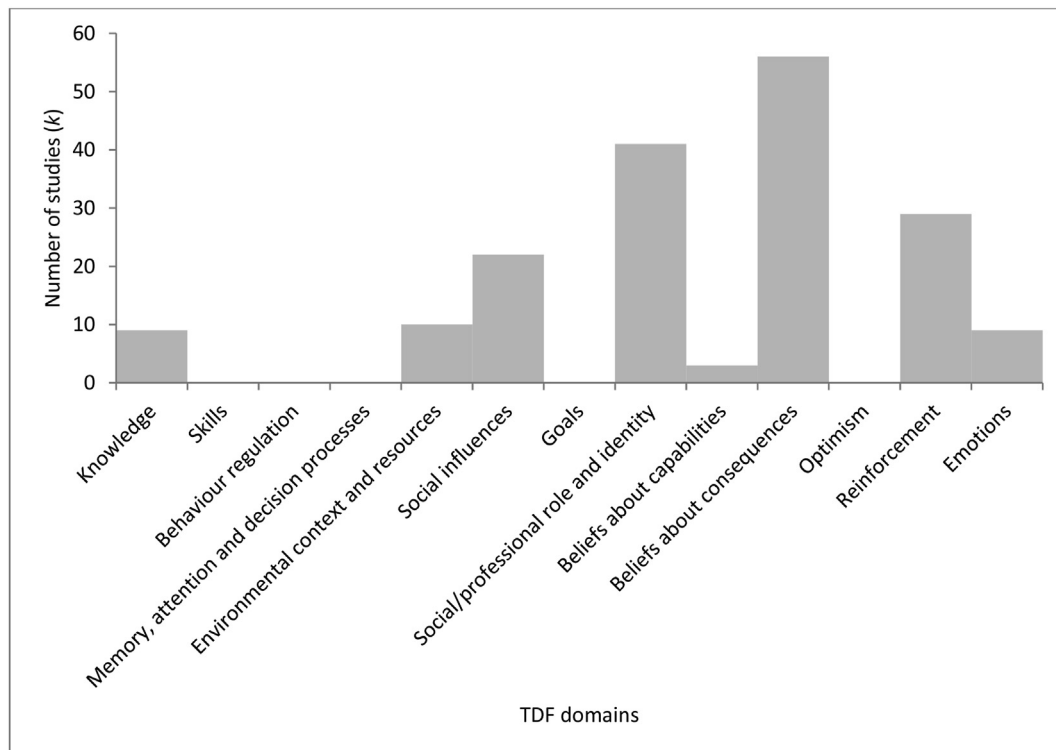


Fig. 1. Frequency of Theoretical Domains Framework (TDF) factors within 74 studies of COVID-19 vaccination acceptance among healthcare workers (HCWs). Notes. TDF domain *Intention* not listed, given that study vaccination acceptance outcome is synonymous with this construct.

Table 1
Theoretical Domains Framework (TDF) factors associated with COVID-19 vaccination acceptance among healthcare workers (HCWs).

TDF domain	Definition	Barriers	Enablers
<i>Knowledge</i>	What do HCWs know & how does that influence what they do? Do they have the procedural knowledge? (i.e., knowing how to do something)	Insufficient knowledge about COVID-19 ⁷⁰ and COVID-19 vaccines ^{35,47,49,53,63,77,82,84} (number of studies [k] = 9)	
<i>Environmental context and resources</i>	What in HCWs environment influence what they do and how do they influence?	Limited availability and accessibility of COVID-19 vaccines (k = 1) ⁸⁴	Access to and trust in reputable scientific/non-scientific information sources about COVID-19 and COVID-19 vaccines (e.g., cues to action) (k = 6) ^{16,18,24,25,37,85} Receiving financial support during the pandemic (e.g., paid sick days) (k = 1) ²³ Trust in how hospital management has handled the pandemic (k = 2) ^{53,67}
<i>Social influences</i>	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?	State/government/public health agency/media mistrust (k = 10) ^{15,29,34,35,50,63,67,69,79,84} Negative influences of social contacts, family members, ⁸⁴ and political figures ⁷⁴ in relation to vaccine acceptance ⁷⁹ (k = 5)	
<i>Beliefs about consequences</i>	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?	Concerns about vaccine safety (e.g., side-effects) (k = 30) ^{14,18,23,30,31,35,36,41,44,45,47,50,54,56,60,62–66,68,69,71,73,78,79,81–84} Beliefs about COVID-19 vaccine efficacy ^{18,34,36,45,60,63,68,74,76,81,83} and efficacy against variants of concern specifically ⁸² (k = 12) Concerns about rushed vaccine development (k = 10) ^{18,23,26,31,34,45,56,69,73,82} Beliefs that vaccine not necessary (e.g., feel in good health, already protected) (k = 6) ^{23,29,45,66,71,82}	Concerns about being infected by COVID-19 (e.g., perceived susceptibility to COVID-19 and its severity) (k = 10) ^{23,26,31,33,38,40,44,47,81,86} Positive attitudes and confidence towards COVID-19 vaccines (e.g., perceived benefit) (k = 6) ^{17,34,38,41,49,60} Belief that getting vaccinated will protect family specifically (k = 5) ^{21,24,39,50,53} Belief that getting vaccinated will protect patients specifically (k = 3) ^{24,50,53}
<i>Social/professional role and identity</i>	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?	Vaccine acceptance lower among nursing professionals vs physicians ^{16,20,22,25–27,32,33,54,58–60,62,63,65,68,70,72,75,81,84} or dietary, housekeeping, and administrative staff ⁷⁹ (k = 22)	Working directly patients generally ^{44,48,74} and with COVID-19 patients specifically ^{20,27–29,82} (k = 8) When getting vaccinated seen as a professional ²⁴ or collective/prosocial responsibility ^{23,49} (k = 3) Belief that vaccination for COVID-19 should be mandatory for HCWs (k = 3) ^{34,52,66} Pharmacists who are managers/owners were more likely to accept a vaccine than pharmacy technicians (k = 1) ⁶¹ An increase in the unemployment rate within the dental sector coincides with a rise in willingness for a COVID-19 vaccine (k = 1) ⁸⁸ Paediatric physicians more likely to accept free 80% effective vaccine vs physicians in administrative roles (k = 1) ¹⁸ Being a pharmacy student vs medicine student was a significant predictor of COVID-19 vaccine acceptance (k = 1) ⁷¹
<i>Reinforcement</i>	How have their experiences (good and bad) of doing it in the past influence whether or not they do it? Are there incentives/rewards?	Previously tested positive for COVID-19 themselves were more hesitant towards vaccination (k = 2) ^{58,83}	Historical seasonal influenza vaccination (k = 25) ^{15,17,18,20,24,25,29,33,34,40,41,46,48,52,54,63–66,70,76,80,82,83} Members of families/close social network having being infected with COVID-19 (k = 2) ^{16,71} Engaging with COVID-19 infection behaviours (i.e., personal protective behaviour) throughout the pandemic (k = 1) ⁴⁷

Fear about the consequences of contracting COVID-19 ($k = 5$)^{33,37,41,64,76}
 Psychological distress (stress, depression, anxiety) was associated with higher vaccine acceptance ($k = 3$)^{49,76,87}
 Fearing injections was independent predictor of COVID-19 vaccine acceptance ($k = 1$)⁶⁷
 Job satisfaction was associated with higher vaccine acceptance ($k = 1$)⁷³
 Self-efficacy/confidence in overcoming any challenges or difficulties in getting vaccinated ($k = 3$)^{70,73,86}

How do they feel (affect) about what they do and do those feelings influence what they do?

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?

Emotion

Beliefs about capabilities

need to be addressed. Moreover, eight studies found that the role of HCW providing direct care to patients generally and to COVID-19 patients specifically was associated with vaccination acceptance.^{20,27–29,44,48,74,82} Interestingly, one study found that perceived professional responsibility was associated with higher vaccination acceptance which could potentially be leveraged at the healthcare organization level.²⁴ Furthermore, three studies reported that HCWs who believed that COVID-19 vaccination should be mandatory for HCWs were more likely to accept a vaccine.^{34,52,66}

Reinforcement: Previous vaccination behaviour (e.g., seasonal influenza vaccine) was found to be consistently associated with higher acceptance of a COVID-19 vaccine.^{15,17,18,20,24,25,29,33,34,40,41,46,48,52,54,63–66,70,76,80,82,83}

Discussion

Our rapid evidence review used an established behavioural framework to bring consistency across the rapidly expanding literature on COVID-19 vaccine acceptance among HCWs to identify modifiable factors to increase vaccine uptake. Based on evidence from 74 studies published up to May 2021, we found almost two-thirds of responding HCWs were willing to accept a COVID-19 vaccine. Across studies, we identified eight (of a possible 14) domains of TDF, and 20 key barriers and enablers which may have implications for interventions seeking to promote COVID-19 vaccine uptake among HCWs. The most frequently coded TDF domains were *Beliefs about consequences*, *Social/professional role and identity*, and *Reinforcement*, which were broadly operationalized as concerns about the vaccine itself, HCWs in non-physician roles, and previous seasonal vaccine uptake, respectively.

HCWs frequently citing concerns about COVID-19 vaccine safety supports findings from the broader vaccination literature.⁹¹ Although this is undoubtedly a key barrier to vaccination (COVID-19 or otherwise), its frequency can be partially explained by narrow study designs focusing solely on HCW attitudes towards vaccination. As such, although some behavioural domains did not yet emerge as factors associated with COVID-19 vaccine acceptance in HCWs (TDF domains: *Skills*, *Behavioural regulation*, *Memory*, *attention and decision processes*, *Goals*, and *Optimism*), 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 study²⁴ in our sample had used the TDF to inform their survey design, which resulted in key insights into barriers and enablers to vaccination acceptance among Canadian HCWs, many of which extended what is known.

Addressing key barriers and enablers for HCWs should involve multiple approaches at multiple levels; therefore, a one-size-fits-all approach is unlikely to address the range of barriers and enablers expressed by HCWs. In Table 2, we provide a non-exhaustive list of recommendations based on general principles from behavioural science which may help form the basis for behaviour-focused interventions to increase COVID-19 vaccination among HCWs.

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. Although knowledge is undoubtedly important, it is usually insufficient as a stand-alone strategy; therefore, additional evidence-based, modifiable barriers must also be considered.⁹² Despite *Memory*, *attention and decision processes* being part of the TDF, 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 process (e.g., framing effects and memory⁹³), which may also tap into other domains such as *Beliefs about consequences* (e.g., how HCWs

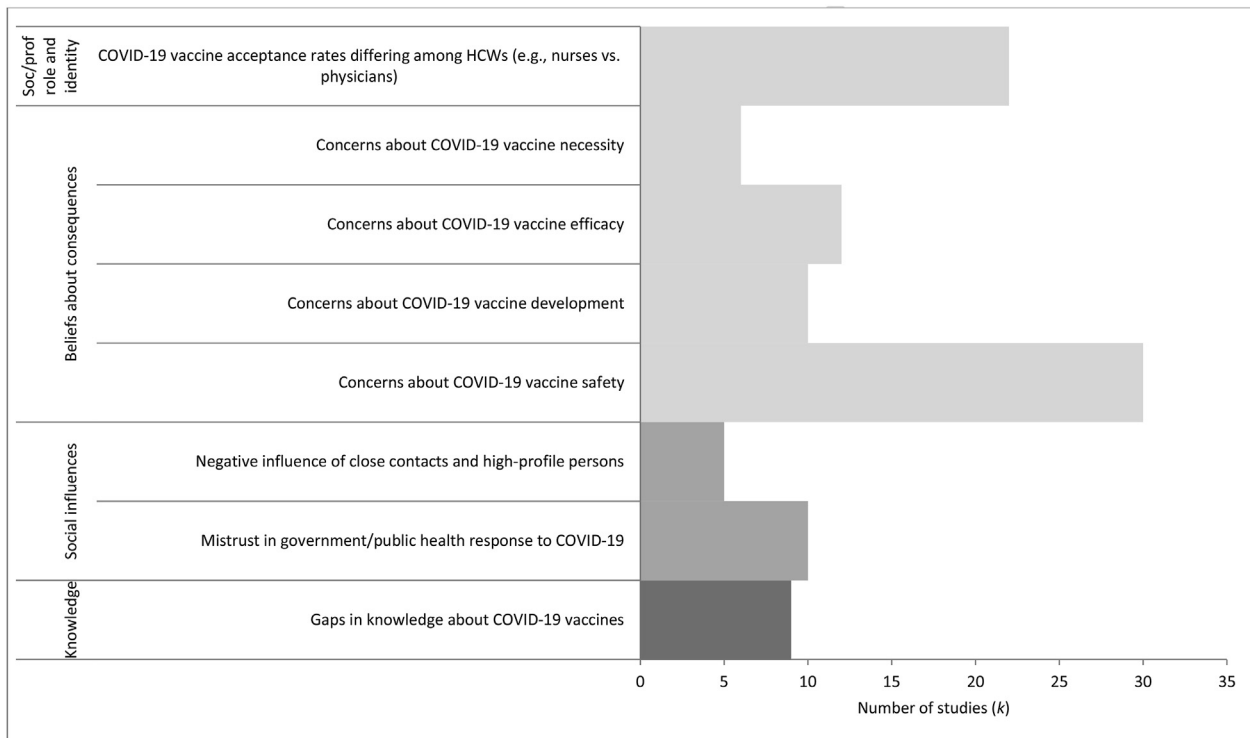


Fig. 2. Frequency of key barriers identified within the literature (only including barriers identified in ≥ 3 studies). Notes. Soc/prof role and identity = Social/professional role and identity.

weighed up beliefs about vaccine necessity vs concerns about possible adverse effects).

Given that COVID-19 vaccines have been rolling out since late 2020, there is an opportunity to assess whether the same factors

associated with vaccine acceptance (intention) are also associated with actual vaccination uptake (behaviour). This will provide insight into the extent vaccine intention predicts behaviour in HCWs, and whether postintentional factors are at play. Evidence

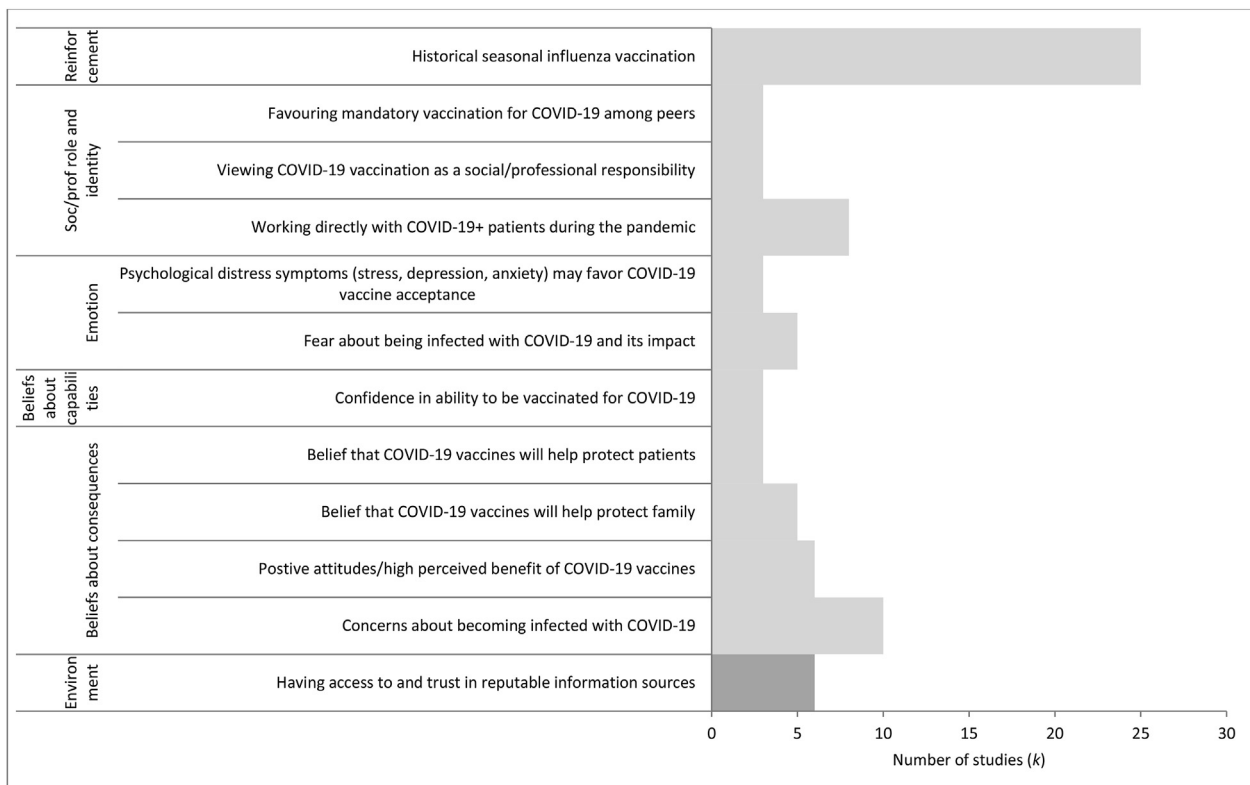


Fig. 3. Frequency of key enablers identified within the literature (only including enablers identified in ≥ 3 studies). Notes. Soc/prof role and identity = Social/professional role and identity; Environment = Environmental context and resources.

Table 2

Identified barriers to and enablers of COVID-19 vaccination acceptance among healthcare workers (HCWs) along with recommendations based on behavioural science principles.

Theoretical Domains Framework (TDF) domain	Barriers and enablers identified	Recommendations based on behavioural science principles
Barriers		
Knowledge	Gaps in knowledge about COVID-19 vaccines (number of studies [k] = 9)	Address knowledge gaps through educational campaigns tailored to different groups of HCWs, disseminated from trusted sources that likely differ for different groups of HCWs; one-size-fits-all knowledge dissemination unlikely to reach those who may benefit most.
Social Influences	Mistrust in government/public health response to COVID-19 (k = 10)	Help rebuild trust through transparent communication about COVID-19 vaccination and community engagement and cultural understanding, especially HCWs from equity-seeking groups. Acknowledging past harms against racialized groups validates feelings of mistrust and aims to rebuild trust by addressing inequities.
	Negative influence of close contacts and high-profile persons (k = 5)	Recognize the importance of people's social circles and prominent public figures and the influence they can have on intention and behaviour. Work within trusted circles and engage meaningfully.
Beliefs about consequences	Concerns about COVID-19 vaccine safety (k = 30)	Reassure and be transparent about vaccine risks using trusted sources and communication modalities that leverage risk communication tools and approaches that go beyond numerical risk and benefit data.
	Concerns about COVID-19 vaccine development (k = 10)	Reiterate how it was possible to develop and approve COVID-19 vaccines relatively rapidly while maintaining all the same checks and balances to ensure a rigorous vaccine development process.
	Concerns about COVID-19 vaccine efficacy (k = 12)	Ensure that the effectiveness of vaccines against COVID-19 and its variants of concern are clear and continue to be updated as evidence accrues. Communicate efficacy using evidenced benefit communication approaches that do not only rely on numeracy. Clarify benefits (where known) across outcomes of importance including infection, severity, side effects, hospitalization and/or death.
	Concerns about COVID-19 vaccine necessity (k = 6)	Reassure the need for vaccines, emphasizing the protection of oneself and others to build towards community immunity.
Social/professional role and identity	COVID-19 vaccine acceptance rates differing among HCWs (e.g., nurses vs physicians) (k = 22)	One-size-fits-all approaches are unlikely to generalize across different groups of HCWs. Working within professional circles (both formal and informal) and leveraging trusted members of each group may help to address their needs and concerns.
Enablers		
<i>Environmental context and resources</i>	Having access to and trust in reputable information sources (k = 6)	Identify and make available reputable and trustworthy sources of information sources more accessible to help counter misinformation about COVID-19 vaccines.
<i>Beliefs about consequences</i>	Concerns about becoming infected with COVID-19 (k = 10)	Reiterate the seriousness of being infected by COVID-19 and potential longer-term consequences (e.g., 'long-covid').
	Positive attitudes/high perceived benefit of COVID-19 vaccines (k = 6)	Emphasize the benefit of vaccines, both from a medical standpoint (e.g., drawing on the benefit of previous vaccines for infectious diseases (e.g., polio)) and personal/social standpoint (e.g., returning to 'normal', seeing family without restrictions).
	Belief that COVID-19 vaccines will help protect family (k = 5)	Leverage the prosocial nature of vaccination which will help protect others.
	Belief that COVID-19 vaccines will help protect patients (k = 3)	Leverage the prosocial nature of vaccination which will help protect others in a work context.

(continued on next page)

Table 2 (continued)

Theoretical Domains Framework (TDF) domain	Barriers and enablers identified	Recommendations based on behavioural science principles
<i>Beliefs about capabilities</i>	Confidence in ability to be vaccinated for COVID-19 (k = 3)	Encourage confidence in ability to be vaccinated, minimize barriers to access which may impact perceived capability and show similar others being vaccinated to help model and build confidence.
<i>Emotion</i>	Fear about being infected with COVID-19 and its impact (k = 5)	Whilst being careful not to stoke fear, reiterate the seriousness of COVID-19 and its societal consequences (e.g., restrictions/lockdowns).
	Psychological distress symptoms (stress, depression, anxiety) may favor COVID-19 vaccine acceptance (k = 3)	Acknowledge that some psychological disorder-thinking (stress, depression, anxiety) may influence personal protective behaviours such as vaccination (although there must be caution with this).
<i>Social/professional role and identity</i>	Working directly with COVID-19+ patients during the pandemic (k = 8)	Encourage those not working in a clinical setting that COVID-19 still poses risks.
	Viewing COVID-19 vaccination as a social/professional responsibility (k = 3)	Instill the notion of vaccination as a professional and social responsibility, to help normalize such behaviour.
	Favoring mandatory vaccination for COVID-19 among peers (k = 3)	Consider mandatory vaccination (although there must be caution with this and if considered, in conjunction with approaches that support addressing other barriers/enablers so as not to undermine trust).
<i>Reinforcement</i>	Historical seasonal influenza vaccination (k = 25)	Leverage successful interventions to increase seasonal influenza vaccination which may be applicable to COVID-19.

from other behavioural literatures suggests a gap between intention and action and approaches 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 actual vaccination.⁹²

Although we have made recommendations based on past learnings from behavioural science (Table 2), there is an opportunity to supplement these principle-based learnings with data from past vaccination campaign interventions⁹⁴ and interventions and/or trials that have been conducted during the COVID-19 pandemic which, unfortunately, have been scarce. A recent systematic review by Schumacher and colleagues identified intervention studies seeking to increase influenza vaccination coverage in HCWs. Among 30 studies, a range of education and promotion (e.g., educational sessions), incentivization (e.g., free vaccination), organisational (e.g., on-site vaccination), and policy (e.g., mandatory vaccination policy) strategies were used with mandatory vaccination policies achieving the highest overall vaccination coverage.⁹⁴ Despite being a topic of some controversy, several countries including England, Australia, France, and Germany have decided to implement mandatory COVID-19 vaccines for HCWs with other countries likely to follow suit.⁹⁵

There is also a need for more research to be conducted with HCWs from equity-seeking groups to help better inform how best to support greater vaccination. Assessing barriers and enablers to vaccine acceptance that equity-seeking groups experience may provide valuable insights into factors driving observed disparities, especially when considered alongside the key barriers and enablers to better support each group.^{96–97}

Limitations

Our study has several limitations. First, our rapid review methodology did not allow for a study quality assessment to be done, which means that we are unable to make a judgement of the quality of the evidence being synthesised. Second, given our desire to ensure that emerging data were captured, we included preprints that had not yet been peer-reviewed. Third, 15 of 74 papers included were conducted before COVID-19 vaccines had been approved (November 2020); therefore, questioning about COVID-19 vaccination would have been hypothetical. However, similar determinants of vaccines were found across all studies, which suggests that opinions about hypothetical vs actual vaccines were broadly consistent in our sample. Fourth, our last search was done in May 2021, meaning that recent studies in this topic area are absent.

Conclusion

Our rapid review identified several behavioural determinants of COVID-19 vaccine acceptance among HCWs which could help inform vaccination messaging, campaigns, programs, and policy to support HCWs globally. This review should help decision-makers to navigate this complex area which requires an evidence-based approach to increase COVID-19 vaccine uptake. We have demonstrated utility in applying behavioural frameworks such as the TDF to help bring coherence to an emerging literature. An advantage of synthesising the existing literature with such frameworks is three-fold: first, it helps to identify key determinants represented in the literature; second, it allows one to consider if there are under-considered determinants deserving of greater attention; and third, it enables linkage between behavioural determinants and behaviour change techniques.⁶ Given the paucity of theory-informed research in our sample, we encourage the use of such frameworks to help inform the development of surveys and

interview guides to ensure that the widest set of potential determinants to vaccination are explored.

Author statements

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Ethical approval

None sought.

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Competing interests

The authors declare no conflicts of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2022.06.003>.

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Review Paper

Cervical cancer screening utilization, and associated factors, in Nepal: a systematic review and meta-analysis



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ABSTRACT

Objective: To systematically appraise the existing published literature on cervical cancer screening utilization, and associated barriers and facilitators, in Nepal.

Study design: Systematic literature review and meta-analysis.

Methods: PubMed/MEDLINE, CINAHL, Scopus, Embase, and, Google Scholar were systematically searched using Preferred Reporting Items for Systematic Review and Meta-Analysis guideline. All quantitative and qualitative studies reporting cervical cancer screening (using the Pap smear test or visual inspection with acetic acid or human papillomavirus test) utilization, barriers, and facilitators for screening were identified. A meta-analysis was performed to estimate Nepal's pooled cervical cancer screening utilization proportion. **Results:** The search yielded 97 records, of which 17 studies were included. Fifteen studies were quantitative and two were qualitative. Of the 17 studies, six were hospital-based and six were community-based. The pooled cervical cancer screening utilization proportion (using Pap smear test) among Nepalese women was 17% from the studies in the hospital settings, and 16% in the community. Six studies reported barriers to cervical cancer screening, of which four reported embarrassments related to the gynecological examination and a low level of knowledge on cervical cancer. Three (of four) studies reported health personnel, and two studies reported screening services-related facilitators for cervical cancer screening.

Conclusion: Our review reported that cervical cancer screening utilization (16%) is more than four times lower than the national target (70%) in Nepal. Multiple barriers such as low levels of knowledge and embarrassment are associated with cervical cancer screening utilization. Health personnel's gender, counseling, and privacy of screening services were commonly reported facilitators. These findings could help to inform future research, and policy efforts to increase cervical cancer screening utilization in Nepal.

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Introduction

Cervical cancer is the fourth most common cancer in women. In 2020, the global estimated age-standardized incidence rate for cervical cancer was 13.3, and the age-standardized mortality rate

was 7.3 per 100,000 women.¹ In Nepal, a low-resource country situated in South Asia where the female population accounts for approximately 55%, the estimated age-standardized incidence, and mortality rates of cervical cancer were approximately 16.4 and 11.1 per 100,000 women, respectively, in 2020.¹ Almost all cervical cancer cases are associated with the carcinogenic human papillomavirus (HPV) infection.² Additional factors such as illiteracy, early age at marriage, limited access to health care, and not undergoing cervical cancer screening contribute to delayed diagnosis

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of cervical cancer.^{3,4} More than 80% of Nepalese people live in rural areas, and women in these areas are at particular risk of delayed diagnosis of cervical cancer.⁵ Furthermore, the country's geographical layout imposes serious constraints on the delivery of health services, particularly in the mountains due to sparse and scattered populations, tough terrain with no transport or difficult road conditions, and seasonal isolation, compared to the hills and the terai (plains) region.⁶ Although women remain asymptomatic for many years after acquiring HPV infection, the pathological changes can be detected by screening, and treatment of precancerous stages helps prevent progression into cancer.^{7–10} Hence, comprehensive cervical cancer screening, treatment, and prophylactic vaccine for HPV would play an important role in reducing the high incidence of cervical cancer among Nepalese women.^{7–11} Currently, there is no nationwide HPV vaccination campaign in Nepal. HPV vaccination was offered to 1096 girls of age 10–26 years attending 17 secondary schools as a pilot program in two districts of Nepal in 2008.¹² The national guideline for Cervical Cancer Screening and Prevention (CCSP) was introduced in Nepal with the goal of screening at least 50% of the target population (women aged 30–60 years) in 2010, which was updated to 70% in 2017.^{13–15} The guideline has also highlighted the importance of integrating cervical cancer screening programs, and prevention, in national health policy and reproductive health programs.^{14,15} There is no national screening programme in Nepal until now. However, the country has adapted the 'screen-and-treat' approach to cervical cancer prevention using the visual inspection with acetic acid (VIA) test and immediately treating precancerous lesions with cryotherapy in accordance with the World Health Organization (WHO) recommendations.^{10,13} In Nepal, VIA tests are available and free of charge at the government health institutions (hospitals or health posts) in 64 of 77 Nepalese districts for women aged 30–60 years.^{13,16} Pap smear test is recommended where technical and laboratory facilities are available for taking the Pap smear and providing the results.¹⁵

Despite the implementation of the national guideline, the cervical cancer screening coverage remained low: 2.4% as reported by the 2003 World Health Survey conducted among 4300 Nepalese women aged 18–69 years to only 5.4% of women aged 30–65 years ever screened in 2015 and 8.2% women of age 30–49 years in 2019.^{17–19}

Limited knowledge of cervical cancer and information regarding benefits of screening, myths, fear of test results, lack of accessibility, lack of privacy, as well as lack of support or permission from husband and family are major obstacles to screening participation.^{20–23} Therefore, the aim of this review was to collate and report the cervical cancer screening utilization percentage, and associated barriers and facilitators to cervical cancer screening, in Nepal. The findings will provide insights into the status of cervical cancer screening delivery and utilization and factors affecting cervical cancer screening participation, as well as inform recommendations for future interventions to increase utilization.

Methods

Protocol and registration

This review was conducted based on a registered protocol in the International Prospective Register of Systematic Reviews [(PROSPERO), ID - CRD42019144645], and a publication with an updated timeline to include studies published in the English language from 1 January 2000 to 31 December 2020.²⁴

Reporting

The systematic review followed the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines.²⁵

Inclusion and exclusion criteria

This study included articles if they fulfilled the following criteria: (i) studies reporting ever screened for cervical cancer using Pap smear test, or VIA or HPV test; (ii) studies reporting barriers and facilitators to cervical cancer screening; (iii) either quantitative and qualitative studies; (iv) studies conducted in Nepal; and (v) studies published in the English language between 1 January 2000 and 31 December 2020. Conference papers, editorials, short communications, studies lacking data on cervical cancer screening utilization, barriers and facilitators to screening, multicountry studies, reports, review articles, and study protocols were excluded.

Outcome measurement

Cervical cancer screening utilization was defined as the percentage of women who had ever been screened for cervical cancer. Furthermore, barriers and facilitators to cervical cancer screening were defined as factors that hinder or encourage women to attend cervical cancer screening.

Data sources and search strategy

We searched for all available articles within the electronic databases PubMed/MEDLINE, CINAHL, Scopus, and Embase. In addition, we searched for available articles using Google Scholar. The search terms were developed using the medical subject heading for cervical cancer and cervical cancer screening methods. We included search terms for treatment, or vaccination or HPV to search articles that may report cervical cancer screening utilization in Nepal. The search terms were modified according to the search criteria for each database. Articles were searched using the following search terms in the following combination:

Uterine cervical neoplasms OR Cervical-Cancer OR Cervical-Neoplasm OR Cervical-Neoplasms OR Cancer-of-Cervix OR Cervical-cancer-screening OR Visual-Inspection OR Papanicolaou-test OR Pap-Smear OR Colposcopy OR Human-papillomavirus DNA tests OR HPV-DNA-Test OR Cryotherapy OR Electrocoagulation OR Thermocoagulation OR Conization OR Papillomavirus-vaccines OR HPV OR Papillomaviridae OR Human-Papilloma-Virus AND Nepal.

Study selection and quality assessment

First, all identified studies were imported into the Covidence online application for search records management. Second, duplicates were removed. Third, two independent authors (ADS and JGA) screened and assessed the titles and abstracts of all studies, followed by a full-text review. Any disagreements between authors were resolved by discussion until consensus was reached. Fourth, the quality of studies was assessed using the Appraisal tool for Cross-Sectional Studies (AXIS) ([Supplement file – Table 1](#)).²⁶

Qualitative studies were subject to quality assessment using the Critical Appraisal Skills Programme (CASP) checklist (Supplement file – Table 2).²⁷

Data extraction and analysis

After quality assessment, data were extracted into a Microsoft Excel spreadsheet. The extracted data items included study type, study setting, first author, publication year, geographical regions — mountain, hill, and terai (plains), district, age group, sample size, and the number of women ever screened for cervical cancer (Table 1). We categorized the barriers and facilitators to cervical cancer screening according to the socio-ecological model proposed by McLeroy et al., which identifies two key concepts: multiple levels (behavior affects, and is affected by multiple levels of influence), and reciprocal causation (individual behavior shapes and is shaped by the social environment).²⁸ According to this model, patterned behavior is the outcome of interest, and behavior is viewed as being determined by intrapersonal, interpersonal,

institutional, community, and public policy factors.²⁸ We adapted the five levels of the model by McLeroy et al. into four levels (individual level, institutional level, community level, and policy level) by collapsing the intrapersonal, and interpersonal levels into individual-level factors based on the emerging themes in the included studies.^{28,29}

An inverse variance-weighted random-effects model for proportion was performed to estimate pooled screening utilization proportion using a Pap smear test with a 95% confidence interval (CI) for studies conducted either in hospital or community settings.³⁰ We considered meta-analyses containing at least five studies.

Results

Study selection

The search resulted in 97 publications from PubMed and MEDLINE, 26 publications from CINAHL, 28 from Scopus, 25 publications from Embase, 10 studies from reference lists, and 999

Table 1 Study characteristics.

Study type	Study setting	Study	Publication year	Ecological region	District	Rural/Urban	Age group (years)	Sample size	Cervical cancer screening	Quality score																				
Quantitative	Health camp	Ranabhat, S. et al. ³²	2014	Terai	Udaypur	Rural	19–55+	90	7	13 [†]																				
		Sherpa, A.T.L. et al. ³¹	2015	Terai	Chitwan	Rural	16–59	1033	405	16 [†]																				
		FHD, UNFPA & CMDN ³³	2016	Mountain Hill	Taplejung & Dolpa Okhaldhunga, Kavrepalanchowk, Myagdi, Pyuthan, Dailekh & Baitadi	Rural and urban	15–49	4277	63	19 [†]																				
	Hospital-based	Hospital-based	Shrestha, J. et al. ³⁶	2013	Hill	Kathmandu	Urban	18–59	105	11	11 [†]																			
			Ranabhat, S. et al. ³⁸	2014	Terai	Chitwan	Urban	18–50+	607	98	14 [†]																			
			Shrestha, S. et al. ³⁵	2017	Terai	Chitwan	Urban	30–60	96	18	15 [†]																			
			Thapa, M. et al. ³⁴	2018	Hill	Kathmandu	Urban	20–40	205	34	12 [†]																			
			Thapa, N. et al. ⁴	2018	Mountain	Jumla	Rural	20–60+	360	49	16 [†]																			
			Shilpakar, O. et al. ³⁷	2020	Hill	Kathmandu	Urban	30–60	390	96	15 [†]																			
			Shrestha, P. et al. ³⁹	2014	Terai	Sunsari	Urban	15–60	100	13	16 [†]																			
	Community-based	Community-based	Ranjit, A. et al. ¹⁸	2016	Mountain Hill	Dolpa Baglung, Bhaktapur, Doti, Kaski, Kathmandu, Lalitpur & Panchthar	Rural and urban	21–65	829	39	20 [†]																			
			Terai	Chitwan, Dhanusha, Makwanpur, Morang, Saptari, Siraha & Sunsari	Rukum	Rural	15–49	594	8	19 [†]																				
											Hill	Kavrepalanchowk	Rural	30–60	180	69	15 [†]													
																		Hill	Syangja	Rural	20–60	207	27	14 [†]						
																									Mountain	Jumla	Rural and urban	20–65	510	91
Terai																														
Terai	Kavrepalanchowk	Urban	30–60	48	–	10 [‡]																								

Note: [†]Quality appraisal of studies — Appraisal tool for Cross-Sectional Studies (AXIS) for quantitative studies, [‡]Critical Appraisal Skills Programme (CASP) checklist for qualitative studies.

studies from Google Scholar. A total of 836 duplicates (Google Scholar = 800 and databases = 36) were removed from the records identified (1185) amounting to 349 records. After title and abstract review, 256 records were excluded for the following reasons: 75 articles were not from Nepal and 181 articles lacked information on cervical cancer. Thus, 93 articles remained for full-text review. After full-text review, 76 articles were excluded because they were either conference papers, editorials, short communications, multicountry studies, reports, review articles, or study protocols, or they presented no data on cervical cancer screening utilization and its associated factors. Thus, 17 articles were included in the review (Fig. 1).^{3,4,18,20,21,31–42}

Quality of included studies

Table 1 includes quality assessment scores. Quantitative cross-sectional studies (n = 15) were subjected to a quality assessment using the AXIS checklist with a score of 55% or above; seven studies scored above 80%.^{3,4,18,26,31–42} Qualitative studies (n = 2) were subject to quality assessment using the CASP checklist for qualitative studies with a score of 10 of 10 points.^{20,21,27}

Study characteristics

A summary of the findings from the 17 articles meeting the inclusion criteria is reported in Table 1.^{3,4,18,20,21,31–42} Fifteen quantitative studies and two qualitative studies representing the three geographical regions [mountain (n = 3 districts), hill (n = 16

districts), and terai (plains; n = 12 districts)] (Fig. 2), 31 (of 77) districts with 52.6% of the total female population in Nepal, and a total of 47 study sites in Nepal were included (Table 1).^{3,4,18,20,21,31–43}

There were six community-based studies,^{3,18,39–42} six hospital-based studies,^{4,34–38} and three health camp-based studies,^{31–33} conducted among women aged 15–65 years, 18–60+ years, and 19–59 years, respectively. All the included studies collected data through face-to-face interviews using a structured questionnaire.^{3,4,18,31–42}

Cervical cancer screening utilization

The pooled screening utilization proportion using the Pap smear test estimated from the studies conducted in the hospital settings was 17.0% (Fig. 3),^{4,34–38} and in the community settings it was 16.0% (Fig. 4).^{3,18,39,41,42}

We compared screening utilization in rural and urban areas among the community-based studies: cervical cancer screening utilization using the Pap smear test ranged from 3.3% (21–65 years) to 14.8% (20–65 years) in rural areas, and 7.3% (21–65 years) to 20.1% (20–65 years) in the urban areas (Table 1).^{18,40}

Cervical cancer screening method

The Pap smear test was reported to be the cervical cancer screening method in 15 studies;^{3,4,18,26,31–42} of these, three studies reported both VIA and Pap smear test as screening methods.^{33,40,42} None of the 17 included studies reported the use of liquid-based cytology or screening by HPV test (see Table 2).

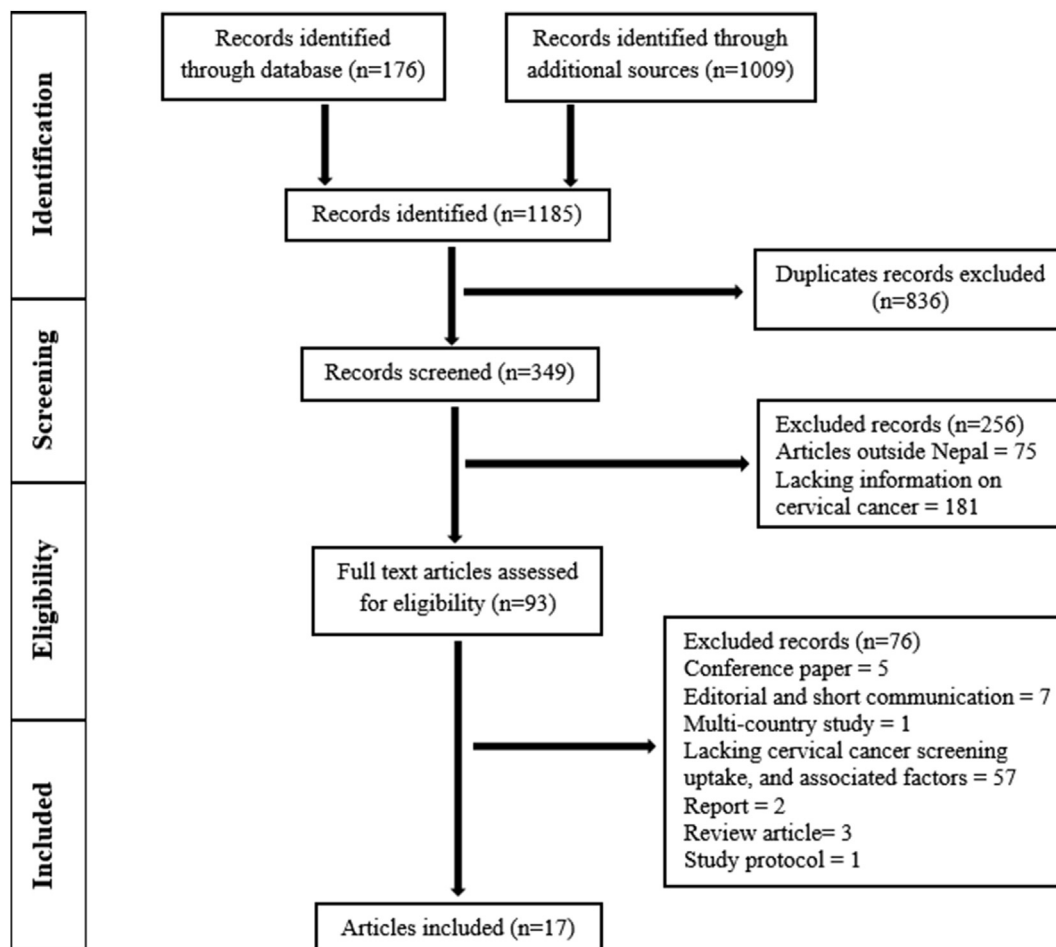


Fig. 1. Selection of papers for review.

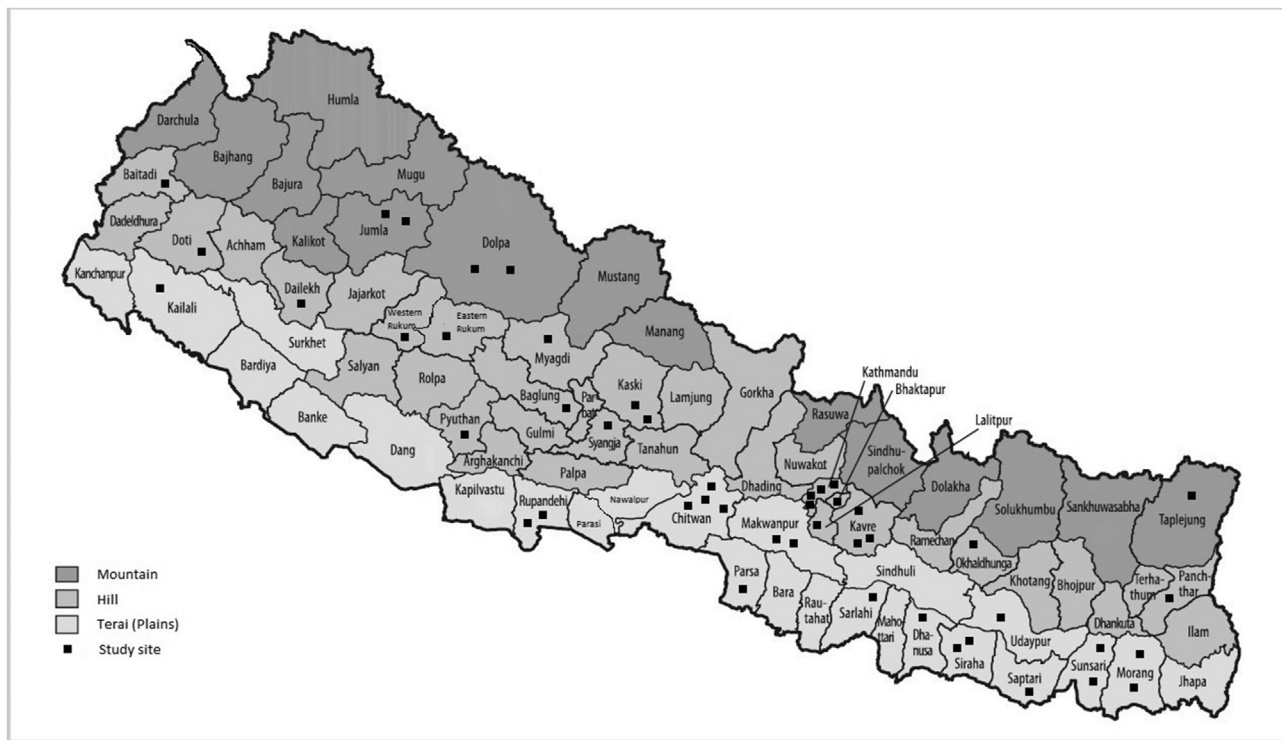


Fig. 2. Map showing 47 study sites from 31 (of 77) districts of Nepal.

Barriers to cervical cancer screening

Two qualitative studies and four quantitative studies reported barriers to cervical cancer screening, which were further categorized into (i) individual level, (ii) institutional level, (iii)

community level, and (iv) policy level as shown in Table 3.^{20,21,31,34,35,37}

Individual-level barriers were the most frequently reported barriers to cervical cancer screening. Four (of six) studies reported embarrassment related to gynecological examination, and low level

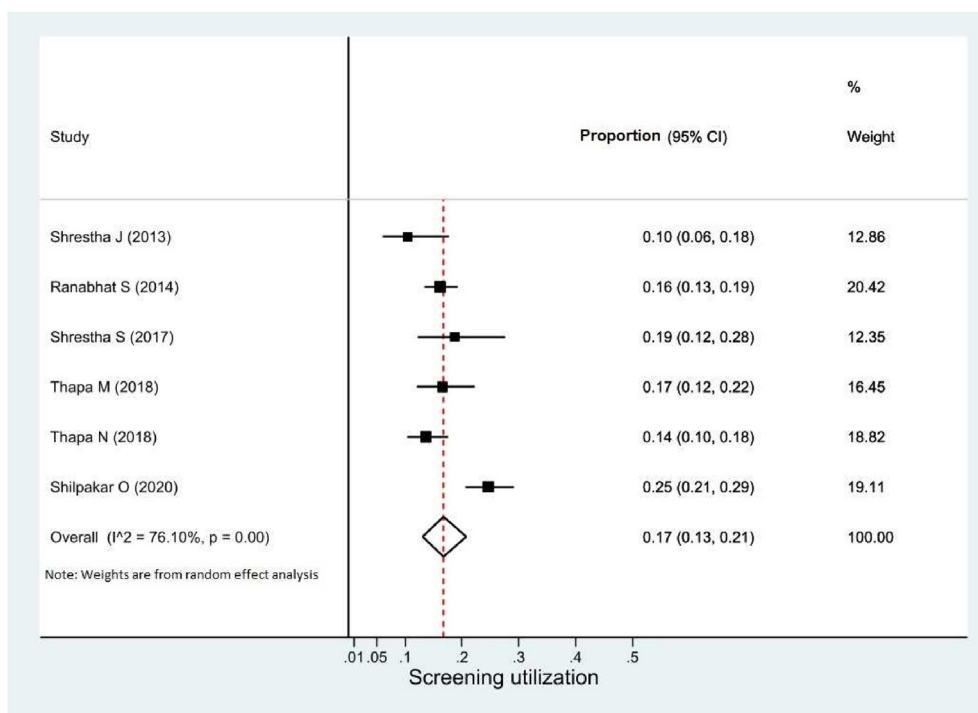


Fig. 3. Forest plot of cervical cancer screening utilization reported in hospital settings in Nepal.

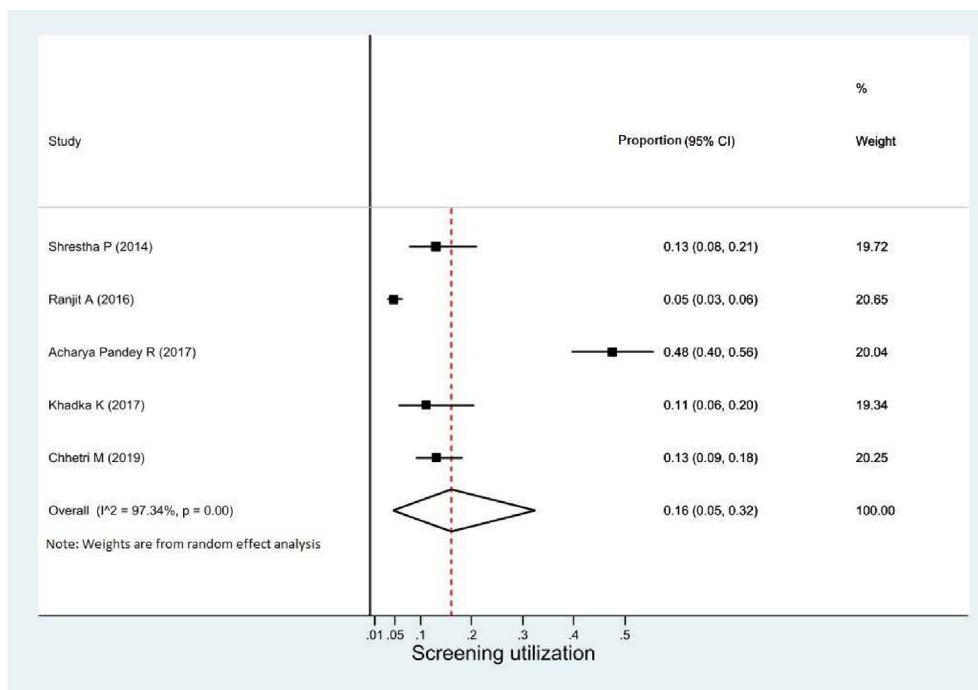


Fig. 4. Forest plot of cervical cancer screening utilization reported in community settings in Nepal.

Table 2

List of studies included in the review for analysis.

Study setting	Author	Title	Publication year
Hospital-based	Shrestha, J. et al. ³⁶	Knowledge, Attitude and Practice regarding Cervical Cancer Screening Amongst Women visiting Tertiary Centre in Kathmandu, Nepal	2013
	Ranabhat, S. et al. ³⁸	Association of Knowledge, Attitude and Demographic Variables with Cervical Pap Smear Practice in Nepal	2014
	Shrestha, S. et al. ³⁵	Knowledge, Attitude and Practice regarding Cervical Cancer Screening Among Women attending a Teaching Hospital, Bharatpur, Chitwan	2017
	Thapa, M. et al. ³⁴	Cervical cancer awareness and practice of pap smear test among women with gynecological problems	2018
	Thapa, N. et al. ⁴	Knowledge, attitude, practice and barriers of cervical cancer screening among women living in mid-western rural, Nepal	2018
	Shilpakar, O. et al. ³⁷	Knowledge, Attitude and Practice (KAP) of Women towards Cervical Cancer Screening at A Tertiary Care Institute in Kathmandu, Nepal	2020
Community-based	Shrestha, P. et al. ³⁹	Knowledge, Attitude, and Practice regarding Pap Smear Test among Women in Ward no. 14, Dharan	2014
	Ranjit, A. et al. ¹⁸	Awareness and prevalence of cervical cancer screening among women in Nepal	2016
	Khadka, K. et al. ⁴¹	Knowledge and Awareness about Cervical Cancer Screening and HPV Vaccine among Females Aged 15–49 Years in Rukum District of Nepal	2017
	Pandey, R.A. et al. ³	Cervical cancer screening behavior and associated factors among women of Ugrachandi Nala, Kavre, Nepal	2017
	Chhetri, M. et al. ⁴²	Awareness and Practice of Cervical Cancer and it's Screening Among Married Women of Syangja, Nepal	2019

of knowledge on cervical cancer screening as individual-level barriers.^{20,21,31,34,35,37}

Facilitators to cervical cancer screening

Two qualitative studies and two quantitative studies reported facilitators to cervical cancer screening, which were further categorized into individual, institutional, community, and policy levels.^{3,20,21,35} A detailed list of facilitating factors is presented in Table 4.

Three (of four) reported institutional level facilitators, in which health personnel–related (female health personnel and counseling), and two studies reported screening services (privacy of examination room, confidentiality, and trust) as facilitators for cervical cancer screening.^{3,35,21}

Discussion

This systematic review focuses on cervical cancer screening utilization as well as barriers and facilitators to cervical cancer screening among Nepalese women.^{3,4,18,20,21,31–42} Our review is likely to have captured all relevant studies published in the English language from 1 January 2000 to 31 December 2020. The pooled cervical cancer screening utilization estimate of the use of Pap smear test from the studies conducted in hospital settings among women aged 18–60+ years was 17.0%; 95% CI: 13%–21%^{4,34–38} and in community settings among women aged 15–65 years was 16.0%; 95% CI: 5.0%–32.0%.^{3,18,39,41,42} Our review reports that cervical cancer screening utilization estimates (16% and 17%) are far below the national target (70% of women aged 30–60 years) for cervical cancer screening utilization.¹⁵ Moreover, the low cervical cancer

Table 3
Barriers to cervical cancer screening.

Individual-level barriers	Institutional-level barriers	Community-level barriers	Policy-level barriers
<p>Embarrassment of gynecological examination Ashamed of having a gynecological examination³¹ Embarrassment/due to shyness^{21,34,35}</p> <p>Fear of screening and results Fear of being diagnosed with cancer^{31,34} Fear of the examination or procedure^{21,34,35,37}</p> <p>Finances Financial barriers and poverty^{20,21}</p> <p>Knowledge on cervical cancer screening Low/limited level of knowledge and information^{20,21,34,35} Misconception about cervical cancer and screening behavior^{20,21}</p> <p>No symptoms/not experiencing the need for screening I'm not ill, so it is not necessary/feeling healthy^{34,35} Only seeking health care when having symptoms²¹ No exact reason³⁴</p>	<p>Health personnel Not recommended by a health worker³⁵ Service providers²⁰ Male doctors/nurses²¹ Lack of trust²¹</p> <p>Screening services Uncomfortable screening experiences²¹ The examination room lacking privacy^{21,37}</p>	<p>Decision making Family dependency²¹ Lack of permission and encouragement from husband²¹ Husband disapproves of cervical cancer screening³⁵ Husband lacks knowledge of risk factors and benefits²¹</p> <p>Socio-cultural aspects Socio-cultural barriers²⁰ Patriarchal society²¹ Fear of social exclusion and gossip²¹ Fear of discrimination by husband and family²¹ Fear of abuse and rejection²¹</p> <p>Community resources Geographical challenges²⁰ Long distance to screening facility²¹</p>	<p>Inaccessibility No access to clinic for screening³⁵</p> <p>Costs for screening Considering screening expensive³⁴</p>

Table 4
Facilitators to cervical cancer screening.

Individual-level facilitators	Institutional-level facilitators	Community-level facilitators	Policy-level facilitators
<p>Personal behavior Personal initiative³ Preventive measure³⁵</p>	<p>Health personnel Health personnel's advice³ Health worker recommendations³⁵ Counseling before the screening²¹ Female doctors/nurses²¹ Trained and skilled staff²¹ Female Community Health Volunteers²¹</p> <p>Screening services Ensuring privacy in the examination room²¹ Reassurance if normal screening result²¹ Confidentiality and trust²¹ Diagnostic purposes³⁵</p>	<p>Societal aspects Women encourage each other and go together²¹ Societal norms²¹</p> <p>Support and motivation Family's advice³ Husband's knowledge about cervical cancer²¹ Family support²¹ Motivation²⁰ Social support²¹</p>	<p>Screening and awareness Arranged health camps³⁵ Awareness program²⁰ Empowerment of women to make health-related decisions²¹ Public awareness campaigns to reduce stigma²¹</p> <p>Access to screening Short distance to screening facility²¹</p> <p>Costs for screening Screening being free of charge²¹</p>

screening utilization coverage identified in our review is especially concerning, given that it reports ever screened or screening at least once in a lifetime for cervical cancer among women. Screening women once in their lifetime by the age of 35 years has been shown to significantly lower the lifetime risk of cervical cancer.⁴⁴ However, screening once by age 35 years and again by 45 years is the WHO recommended global strategy to eliminate cervical cancer.⁴⁵

Cervical cancer screening utilization is reported lower in the rural areas compared to urban areas of Nepal:^{18,40} this may reflect access to health services. However, studies conducted in hospital settings, study sites with ongoing awareness programs, and studies with small sample sizes may have resulted in higher estimates of cervical cancer screening utilization. In addition, one study included in our review reported high cervical cancer screening utilization, which may be the result of ongoing cervical cancer awareness programs run by non-governmental organizations.³ Educational interventions on cervical cancer screening to increase knowledge and empower women by mobilizing community health workers, and use of information communication technology could help increase screening utilization among women in Nepal.^{46–48}

Nepalese women face many barriers to accessing cervical cancer screening. The socio-ecological model proposes that the social environment affects individual behavior and that behavior

both shapes and is shaped by multiple levels of influence.^{28,29} Among the four-level factors from the socio-ecological model of McLeroy et al., and similar to findings reported by Daley et al.,^{28,29} our review found individual-level barriers to be the major barriers reported in the included studies.^{20,21,31,34,35,37} Similar to our review findings, studies have reported that the level of knowledge and awareness of cervical cancer among women is associated with screening utilization.^{46,47} Various studies have emphasized the influence of women's knowledge as an important determinant in the perception of the importance of cervical cancer screening and procedure.^{22,31,49,50}

Studies report that the level of awareness of cervical cancer and available screening services among Nepalese women are either lacking or very low.^{18,20,21,38} These factors are associated with different misconceptions, fears, and lack of concern that characterize women in this region in relation to risk factors, perceived risk, perceived severity; moreover, screening cost for cervical cancer also plays an important role.^{20,21,31,34,35} Pap smear test costs in the range of USD 3–10 in the private institutions, which is exclusive of the unexpected cost, and may not be affordable for all the women in Nepal²⁰ where the median household income was estimated to be US\$ 256 in 2015.⁵¹ Although cervical cancer screening test (VIA) is free of charges at the government health institutions (hospitals and health posts), the associated indirect cost may

hinder the service utilization.^{13,16} Cost estimation for the direct and indirect costs associated with cervical cancer screening is essential to implement a cost-effective screening programme. Furthermore, studies reported that many women still think that cervical cancer screening is not necessary because they do not have any symptoms.^{34,35}

Low level of awareness, low perception of susceptibility and risk as well as misconceptions about the need for screening were the main factors identified in similar studies conducted in India, Bangladesh, Malaysia, and the Philippines.^{52–55} Our review reports similar findings that a low level of awareness of cervical cancer screening is the major barrier to screening utilization.^{20,21,31,34,35} Therefore, health education and empowerment are key factors to strengthen women's awareness and align perceived susceptibilities, seriousness, benefits, and barriers with reality, and facts, which will lead to increased cervical cancer screening participation.^{31,50} However, there is an urgent need for an organized cervical cancer screening program to educate women, provide an individual invitation and follow-up for screening at regular intervals (every 5 years), and treat precancerous or invasive cancer.

Men's support is a facilitating factor for increasing cervical cancer screening utilization among women in low- and middle-income countries, which is an important barrier.^{21,56–59,47–50} Advice from health personnel is one of the major facilitators reported.^{3,35} Previous studies have reported that mobilizing female community health volunteers may be an effective way to increase cervical cancer screening utilization.^{46,47}

Most of the studies included in our review reported on the use of the Pap smear test as the cervical cancer screening method. Using a different screening strategy for cervical cancer such as HPV self-sampling should be further explored as a method for screening women in rural areas with limited access to health services, and to overcome barriers such as privacy and embarrassment.^{60,61} Furthermore, future research should investigate cultural barriers and facilitators, and the associated cost of HPV self-sampling.^{62,63}

Strengths and limitations

This review summarized studies on cervical cancer screening (using Pap smear and VIA) utilization, barriers, and facilitators of cervical cancer screening in Nepal. Our study is limited to PubMed/MEDLINE, CINAHL, and Scopus databases with additional searches in Google Scholar; thus, it may not have identified all studies in this field, particularly those published in non-indexed local journals, non-English language publications, and platforms not covered by the databases searched in this review. We included studies from both rural and urban settings, and with either hospital- or community-based samples. The methodological quality of many of the included studies was poor in relation to sample size, and sampling techniques, which may have introduced bias. Overall, a high degree of heterogeneity was observed in the included studies.

Conclusions

Our review reports that cervical cancer screening utilization (16%) is more than four times less than the national recommended target for screening 70% of eligible women aged 30–60 years in Nepal. Furthermore, limited knowledge of cervical cancer screening and embarrassment related to the screening procedure were the most frequently reported individual-level barriers. The review highlighted facilitators (female health personnel and counseling, and privacy for screening services) for cervical cancer screening, which may inform future interventions.

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Ethics approval

This article is based on published data, and hence ethical approval was not required.

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Competing interests

All authors declared that they have no competing interests.

Authorship contributions

ADS made substantial contributions to the conception and design of the manuscript and wrote the first draft, incorporated coauthors' suggestions, and prepared the final version for submission. ADS and JGA conducted the systematic review search. BG, AS, SS, DN, SG, and CC were involved in the drafting of the article and revising it critically for important intellectual content. JGA, BG, AS, SS, DN, SG, CC, and PK contributed to all the drafts and approved the final version for submission.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2022.06.007>.

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Original Research

Impacts on anxiety symptoms and alcohol consumption among people with disabilities and family caregivers in Latin America and the Caribbean during the first wave of the COVID-19 pandemic

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ABSTRACT

Objectives: The aim of this study was to analyse associations between the COVID-19 pandemic, alcohol consumption and anxiety symptoms among people with self-reported disabilities and family caregivers in Latin America and the Caribbean.

Study design: Cross-sectional study with secondary data analysis of the 'Alcohol Use during the COVID-19 pandemic in Latin America and the Caribbean', a Web-based cross-sectional survey conducted by the Pan American Health Organisation between March and June 2020.

Methods: Descriptive analyses were conducted on the individual, social environment characteristics, COVID-19 infection, quarantine compliance, anxiety symptoms (measured by Generalized Anxiety Disorder Scale [GAD-7]) and change in frequency of heavy episodic drinking during the pandemic. Multinomial logistic regression was used to analyse associations among individuals with self-reported disabilities with anxiety symptoms and change in frequency of heavy episodic drinking during the pandemic.

Results: Family caregivers were more compliant with COVID-19 restrictive measures than individuals with and without disabilities. The majority of participants with disabilities did not change their drinking patterns during the pandemic (64.3%); however, 28.1% reported increased consumption. People with disabilities were 2.17 times more likely to have severe anxiety symptoms than no anxiety symptoms between March and June 2020 in Latin America and the Caribbean.

Conclusions: This study observed a higher prevalence of the maintenance of heavy episodic drinking behaviour during the early phase of the pandemic in people with disabilities and family caregivers than in people without self-reported disabilities in Latin America and the Caribbean. People with disabilities showed more severe anxiety symptoms than those without disabilities, highlighting the need to develop inclusive health and quality-of-life policies to mitigate the effects of the pandemic in this vulnerable population.

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Introduction

The emergence of a new variant of the coronavirus, SARS-CoV-2, has resulted in a global pandemic, altering habits and customs in all populations.¹ Although the COVID-19 pandemic poses a threat to

all, some population groups are at increased risk, including people with disabilities.² Individuals with disabilities experience the so-called 'triple jeopardy' of COVID-19 (i.e. more severe outcomes, limited access to health care and rehabilitation, and social barriers stemming from measures to isolate and mitigate the transmission of SARS-CoV-2).³ For example, the hearing impaired face great difficulties communicating because of the required use of face masks, making lip reading impossible;⁴ the visually impaired rely on touch for their daily activities, exposing them to more sources of contamination;^{2,5} those with cognitive disabilities may have difficulties in understanding the pandemic, hindering care and

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protocols against SARS-CoV-2 infection;^{2,6} and many kinds of disabilities are at a particularly high risk of decreased psychosocial well-being during the pandemic.⁷

The most severe COVID-19 outcomes, including death, are more prevalent in people with disabilities because this population already manifests several comorbidities that are risk factors for severe COVID-19, such as cardiac malformations, respiratory diseases, obesity and innate metabolic problems.^{2,8–10} Evidence shows that Down syndrome is one of the most important clinical risk factors for severe COVID-19 outcomes, even 14 days after the complete vaccination schedule (a 12.7-times increase).¹⁰

The impact of COVID-19 on people with disabilities is so important that the World Health Organisation (WHO) proposed the 'Disability considerations during the COVID-19 outbreak' in March 2020.² The report raised considerations and measures to ensure access to health, water, sanitation services and adequate public health information for this vulnerable population during the COVID-19 outbreak, because of their higher risk of severe outcomes. A rapid review of the impacts of the pandemic on people with physical disabilities highlighted the difficult access to health services and the lack of contextual research, urging the scientific community and policymakers to conduct studies to decide on health access and public health measures in future health crises for people with disabilities.¹¹

Health, socio-economic and social participation disparities evidenced during the COVID-19 lockdown suggest a lack of inclusive responses for people with disabilities, exacerbating prepandemic inequalities and potentiating structural disadvantages.¹² Low- and middle-income countries, such as Brazil, are home to about 80% of the poorest and most socially vulnerable people with disabilities in the world.¹² Moreover, people with disabilities show a higher prevalence of mental health disorders than people without disabilities, and these disorders are highly aggravated by psychosocial stressors, such as public health emergencies, natural disasters and social vulnerabilities, including poverty.^{13–17}

The COVID-19 pandemic increased stress levels for people with disabilities who may resort to misguided coping strategies, such as substance use (e.g. alcohol, tobacco and other drugs).^{18,19} Alcohol is a prominent coping strategy for stress caused by the pandemic. However, studies have shown the association of alcohol consumption with increased anxiety, depression and sleep alteration; thus, worsening the initial stressful situation.²⁰

Owing to all the alcohol-related issues seen at the beginning of the pandemic in 2020, the Pan American Health Organisation (PAHO) conducted the 'Alcohol Use survey during the COVID-19 pandemic in Latin America and the Caribbean'.¹⁹ Results showed that during the pandemic, 32% of participants reported at least one occurrence of heavy episodic drinking;¹⁹ quarantine as a result of the pandemic appears to impact drinking behaviour and anxiety symptoms,²¹ with an increased frequency of self-reported heavy episodic drinking among males.^{22,23}

As people with disabilities show a higher prevalence of mental health disorders than people without disabilities, and family caregivers experience greater stress and reduced employment and income during the pandemic, this study hypothesised that the drinking behaviour of these individuals also changed during the early phase of the pandemic. This study hypothesised that stress and isolation have functioned as significant triggers for alcohol use among these population groups. Thus, this study seeks to analyse associations between the pandemic, alcohol consumption and anxiety symptoms among people with self-reported disabilities and family caregivers in Latin America and the Caribbean between March and June 2020. In addition, this study aims to assess a possible change in the frequency of heavy episodic drinking and anxiety symptoms among people with disabilities and family

caregivers in Latin America and the Caribbean during the first wave of the COVID-19 pandemic.

Methods

Study design and setting

This study used secondary data analysis of the 'Alcohol Use during the COVID-19 pandemic in Latin America and the Caribbean', a Web-based cross-sectional survey conducted by PAHO.¹⁹ The survey covered 33 countries and two territories in Latin America and the Caribbean. An online questionnaire was anonymously answered by participants between 22 May and 30 June 2020. Eligibility was defined as individuals aged ≥ 18 years, living in one of the 35 Latin American or Caribbean countries or territories, who remained in their country since 15 March 2020. Electronic consent was provided by participants before questionnaire completion, and they were informed that they could withdraw from the survey at any moment without providing any justification. This study was approved by the Ethics Review Committee of PAHO.

Self-reported disability

The self-reported disability variable was collected via a single question: 'Do you or any child or adult you live with have a physical, mental or intellectual/developmental disability?' (Yes, I do; Yes, a child or adult; No).

Characteristics of the individual, social environment and health

The following variables were analysed: self-reported socio-demographic characteristics (sex, age [18–29, 30–39, 40–49, 50–59 and ≥ 60 years]); region (Andean [Bolivia, Colombia, Ecuador, Peru, Venezuela], Mesoamerican [Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama], Southern Cone [Argentina, Brazil, Chile, Paraguay, Uruguay], Non-Latin Caribbean [Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Curaçao, Dominica, Grenada, Guyana, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago]); education attainment (under high school, high school diploma or above); employment (unemployed, employed, student or retired); ethnicity (White, Black, Indigenous and mixed/other/not sure); marital status (married/with a partner, divorced/separated/widowed and never married); COVID-19 infection; quarantine compliance; anxiety symptoms; and change in frequency of heavy episodic drinking during the pandemic.

The income variable was extracted from the following question: 'What was the total monthly household income you and other members of your household received in the year ending 31 December 2019? Please include income from all sources such as savings, pension, disability benefits, social security, rent, informal work and insurance as well as wages'. Results were reported in number of minimum monthly wages. The minimum wage was the measure used for all countries, as the amount established by the government as the minimum salary paid for one month of full-time work. All countries in the Latin America/Caribbean use this measurement, so the total monthly income from the household (all members together) in number of minimum monthly wages was requested. Then, income bands were classified into those receiving less than 1 minimum salary wage, 1–4 wages, 5–10 wages, 11–20 wages and >20 wages.

The engagement of participants in social distancing as a consequence of the COVID-19 pandemic was assessed by data related to the quarantine compliance, based on the WHO's

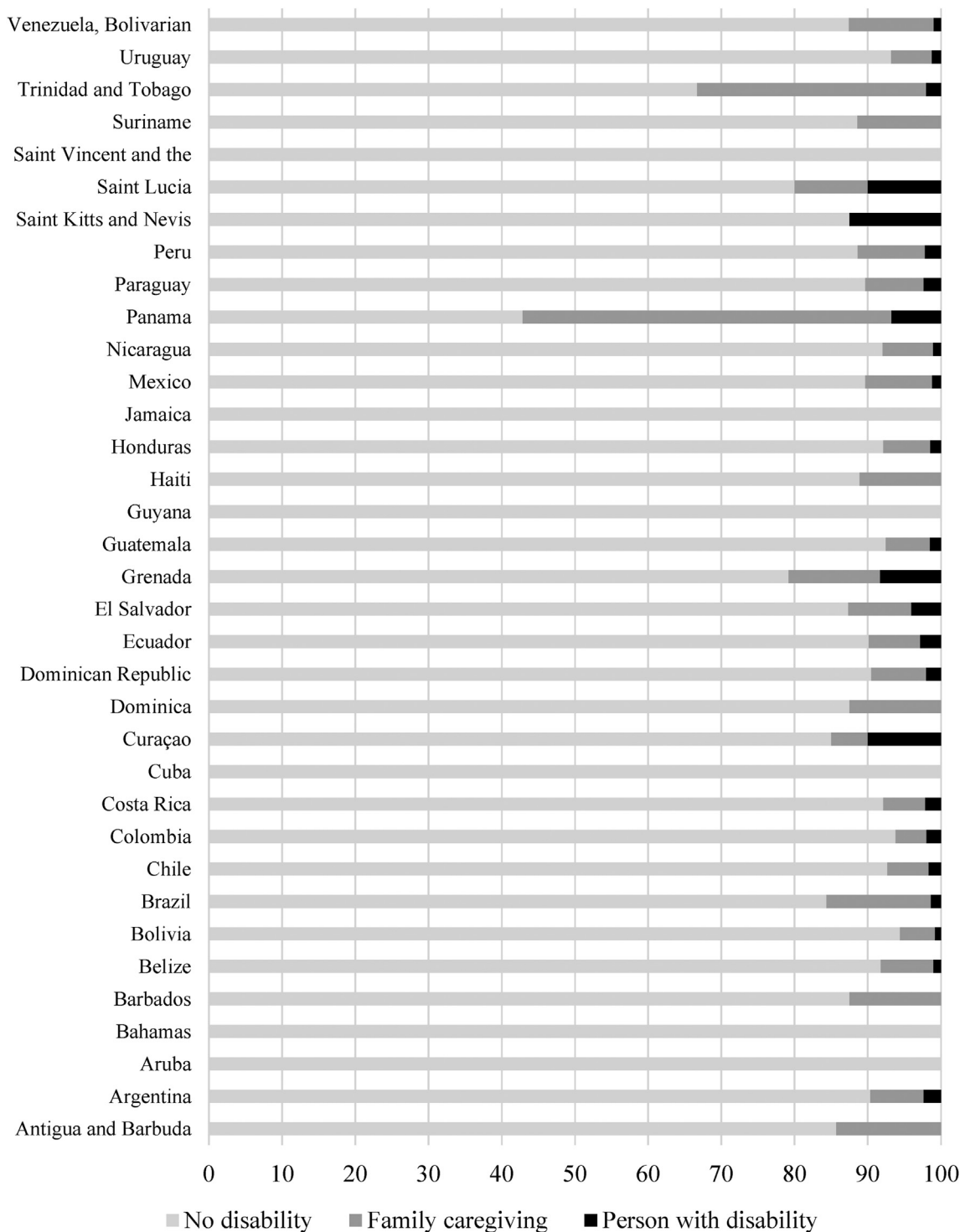


Fig. 1. Distribution of self-reported disability during the pandemic. Data from the ‘Alcohol Use during the COVID-19 pandemic in Latin America and the Caribbean’ survey from the PAHO, 2020.

preventive measures against the spread of COVID-19.²¹ For the affirmative category, we included those who answered one or more of the following statements: working/studying from home, asked to stay in isolation at home after travelling overseas, staying in isolation at home, quarantined to a hotel room and isolated people within home. For the negative category, we included those who responded that they had not taken any precautionary measure and those who only answered ‘avoiding public transport and social

gatherings’ or ‘home-schooling children/keeping pre-school children home from daycare’.

Anxiety symptoms were assessed via the seven-item Generalised Anxiety Disorder Scale (GAD-7).²⁴ Participants were asked to rate the severity of seven anxiety symptoms they experienced over the 2 weeks before answering the questionnaire. The GAD-7 score is calculated by assigning scores of 0, 1, 2 and 3, corresponding to the ‘not at all’, ‘several days’, ‘more than half the days’ and ‘nearly

Table 1
Individual and social environment characteristics during the pandemic according to self-reported disability.^c

Characteristic	No disability (%) [88.2% (n = 10,873)]	Family caregivers (%) [10.1% (n = 1242)]	People with disabilities (%) [1.7% (n = 213)]	P-value ^b
Region ^a				<0.001
Andean	22.8	15.1	25.4	
Southern Cone	41.1	51.3	37.6	
Mesoamerican	33	29.3	32.4	
Non-Latin Caribbean	3.1	4.4	4.7	
Sex				<0.001
Male	35.1	26.8	26.7	
Female	64.9	73.2	73.3	
Age in years (mean)				<0.001
18–29	30.1	24.2	29.6	
30–39	29.9	25	29.6	
40–49	20.5	23.1	16.4	
50–59	12.9	16.8	16	
≥60	6.7	11	8.5	
Education attainment				0.091
Under high school	2	1.5	3.9	
High school or above	98	98.5	96.1	
Income				<0.001
<1 wage	16.4	12.8	25.1	
1–4 wages	32.8	25.9	38.3	
5–10 wages	23	23.1	16.4	
11–20 wages	14.8	16.5	9.3	
>20 wages	13.1	21.7	10.9	
Employment				<0.001
Unemployed	13	13.4	14.1	
Employed	74.7	71.8	63.9	
Student	8.9	10.6	11.7	
Retired	3.4	4.3	10.3	
Ethnicity				<0.001
White	40.7	51.1	37.5	
Black	4.2	4.1	4.9	
Indigenous	1.5	1.6	0.5	
Mixed/Other/Not sure	53.6	43.2	57.1	
Marital status				0.342
Married/With a partner	53.6	53.4	46.3	
Divorced/Separated/Widowed	12.7	13.6	14.3	
Never married	33.7	33	39.4	

Data from the ‘Alcohol Use during the COVID-19 pandemic in Latin America and the Caribbean’, survey from the PAHO, 2020 (n = 12,328).

^a Andean (Bolivia, Colombia, Ecuador, Peru, Venezuela); Mesoamerica (Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama); Southern Cone (Argentina, Brazil, Chile, Paraguay, Uruguay); and Non-Latin Caribbean (Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Curaçao, Dominica, Grenada, Guyana, Haiti, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago).

^b Chi-squared test for categorical variables.

^c From March to June 2020, during the pandemic.

every day’ response categories, respectively. Scores were then added for the seven questions. GAD-7 total score for the seven items ranges from 0 to 21. Scores of 5, 10 and 15 represent cut-off points for mild, moderate and severe anxiety, respectively.

The self-reported change in heavy episodic drinking during the COVID-19 pandemic in 2020, as defined by Valente et al.,²² was analysed and classified as: no change, increased and decreased.

Statistical analyses

Descriptive analyses were conducted on the individual, social environment characteristics, COVID-19 infection, quarantine compliance, anxiety symptoms and change in frequency of heavy episodic drinking during the pandemic. Comparisons were conducted using Pearson's Chi-squared (χ^2) test. All *P*-values <0.05 were considered to be statistically significant. A multinomial logistic regression was used to analyse associations among self-reported disability according to anxiety symptoms by GAD-7 and change in frequency of heavy episodic drinking during the pandemic. Associations with a *P*-value <0.2 in the univariate analyses were incorporated into the multinomial logistic regression via forward selection. The magnitude of the associations was estimated using odds ratios and their respective 95% confidence intervals.

Results

Fig. 1 shows the distribution of the 12,328 participants according to self-reported disability and countries surveyed. Among participants, 10.1% reported being family caregivers and 1.7% reported having a disability. Regarding socio-economic characteristics, there was a higher prevalence of Southern Cone residents in all three population groups (i.e. ‘No disability’, ‘Family caregiver’ and ‘People with disabilities’). Regarding gender, female participants were more prevalent in all three population groups, although the percentage in the ‘No disability’ group was less than the ‘caregiver’ and ‘People with disabilities’ groups. The most frequent age group of participants was the 30–39 years age group, although this age group was less prevalent in the ‘family caregivers’ population. The majority of participants worked were of Mixed/Other/Not Sure ethnicity and received 1–4 wages per household. Family caregivers were the most frequent earners of >20 wages per household (Table 1).

Regarding quarantine compliance, family caregivers were more compliant with COVID-19 restrictive measures than people with and without disabilities. The majority of participants with disabilities did not change their drinking patterns during the pandemic (64.3%); however, 28.1% reported increased alcohol consumption,

which is a higher percentage than reported by family caregivers and those without disabilities (Table 2).

In the multivariate multinomial logistic regression, according to anxiety symptoms (with ‘no anxiety symptoms’ as the reference), people with disabilities were positively associated with moderate and severe anxiety symptoms in the unadjusted model. After adjustment for quarantine compliance, sex, age, income, employment and marital status, the association remained for severe anxiety symptoms. In this case, people with disabilities were 2.17 times more likely to have severe anxiety symptoms than no anxiety symptoms (Table 3). Regarding the change in heavy episodic drinking, the multinomial logistic regression (with ‘no change’ as the reference) showed a negative association with increased consumption among family caregivers, in the unadjusted model, which was not maintained after adjustment (Table 4).

Discussion

To the best of the authors' knowledge, this is the first study to evaluate anxiety symptoms and change in the frequency of alcohol consumption during the pandemic using self-reports from people with disabilities and family caregivers. Regarding quarantine, family caregivers were more compliant than people with and without disabilities. The majority of participants with disabilities did not change their drinking patterns during the pandemic (64.3%); however, 28.1% reported increased alcohol consumption, which is a higher percentage than reported by family caregivers and those without disabilities. People with disabilities were 2.17 times more likely to have severe anxiety symptoms than no anxiety symptoms between March and June 2020 in Latin America and the Caribbean. Moreover, people with disabilities showed the lowest income and labour market insertion.

Results show that family caregivers complied more often with quarantine measures than other population groups in this study. It is important to note a higher prevalence of older and unemployed adults were seen in the family caregivers and people with disabilities groups. It has been shown that family caregivers report the loss of a child with disability as one of the most painful experiences for their families. In this context and with the additional fear of

contamination by COVID-19, aggravated by frustration, boredom, insufficient medical care and inadequate information,² this may explain the higher prevalence of compliance with quarantine measures and social isolation in this population group. Moreover, decreased access to treatment for patients with mental health disorders, difficulty in obtaining medication, economic problems, unemployment, bankruptcy, mourning and general uncertainty about the future in low- and middle-income countries add to the lack of infrastructure and the loss of social rights resulting from the pandemic crisis, which may have increased with the requirement for social isolation.^{12,13}

A study conducted in Australia²⁵ showed that 75% of family members and/or caregivers reported that the pandemic affected their well-being, hindering mental and physical health and worsening financial problems. According to the authors, confinement and balancing work, family and children with specific needs led to a ‘triple jeopardy’ situation. However, the authors also observed positive coping strategies, such as establishing domestic routines, behavioural strategies to support the development of their children or practicing exercises, meditation and social support,² which is in line with the results of the present study. Among the people surveyed by the PAHO, family caregiving was a protective factor against an increasing frequency of heavy episodic drinking.

Other consolidated evidence shows that families and informal caregivers suffered disproportionate burden and stress in addition to reduced employment and income, exacerbating socio-economic disparities.¹³ In the UK, there was a five-fold increase in severe anxiety and a two-fold increase in major depression rates among parents caring children with intellectual disabilities.²⁶ In this context, alcohol emerges as an inadequate self-medication in coping with emotional overload.

Over the years and in various social groups, alcohol has been shown to be not only a recreational substance but also a pharmacological strategy to reduce anxiety and depression.²⁸ However, if used repeatedly, alcohol aggravates anxious episodes, triggering the development of severe anxiety and alcohol dependence.²⁸ Results of the current study show the maintenance of heavy episodic drinking, reinforcing that, in general, alcohol consumption patterns remained unchanged in many population groups, which is in line

Table 2 COVID-19, quarantine compliance, anxiety symptoms and change in frequency of heavy episodic drinking during the pandemic according to self-reported disability.^b

Characteristic	No disability (%) [88.2% (n = 10,873)]	Family caregivers (%) [10.1% (n = 1242)]	People with disabilities (%) [1.7% (n = 213)]	P-value ^c
COVID-19				0.671
Positive	18	18.1	17.8	
Negative	8.9	9.3	6.1	
Not tested	73.1	72.6	76.1	
Quarantine compliance ^a				<0.001
No	29	19.5	30.7	
Yes	71	80.5	69.3	
GAD-7				0.005
No	37.1	36.9	28.6	
Mild	36.5	35.2	33.8	
Moderate	14.7	16.5	18.8	
Severe	11.8	11.4	18.8	
Any use of alcohol during pandemic (yes)	66.3	63.8	51.2	<0.001
Change in frequency of heavy episodic drinking during pandemic				0.043
No change	61.2	65.2	64.3	
Increased	27.5	24	28.1	
Decreased	11.4	10.9	7.6	

Data from the ‘Alcohol Use during the COVID-19 pandemic in Latin America and the Caribbean’, survey from the PAHO, 2020 (n = 12,328).

^a Constructed using questions on precautionary measures. For the affirmative category, we included those who answered one or more of the following statements: Employed/studying from home, asked to stay isolated at home after travelling overseas, isolated at home, quarantined to a hotel room, and isolated people within homes. For the negative category, we included those who responded that they had taken no precautionary measure and who only answered ‘avoiding public transport and social gatherings’ or ‘home-schooling children/keeping pre-school children home from daycare’.

^b From March to June 2020, during the pandemic.

^c Chi-squared test for categorical variables.

Table 3
Association between self-reported disability and anxiety symptoms by Generalised Anxiety Disorder Scale (GAD-7) during the pandemic.^{a,b}

Population group	Anxiety level											
	Mild				Moderate				Severe			
	UnOR (95% CI)	P -value	AdOR (95% CI)	P -value	UnOR (95% CI)	P-value	AdOR (95% CI)	P -value	UnOR (95% CI)	P -value	AdOR (95% CI)	P -value
No disability												
Family caregivers	0.97 (0.84–1.11)	0.674	0.93 (0.79–1.10)	0.456	1.13 (0.94–1.34)	0.172	1.12 (0.90–1.39)	0.286	0.97 (0.80–1.19)	0.815	0.99 (0.77–1.27)	0.987
People with disabilities	1.20 (0.85–1.69)	0.297	1.29 (0.84–1.96)	0.218	1.65 (1.10–2.47)	0.014	1.11 (0.63–1.94)	0.707	2.06 (1.37–3.07)	0.000	2.17 (1.32–3.55)	0.002

AdOR, adjusted odds ratio; CI, confidence interval; UnOR, unadjusted odds ratio.

Data from the 'Alcohol Use during the COVID-19 pandemic in Latin America and the Caribbean', survey from the PAHO, 2020 (n = 12,328).

^a From March to June 2020, during the pandemic.

^b Multinomial logistic regression with 'No anxiety symptoms' as reference. Model adjusted by: Quarantine compliance, Sex, Age, Income, Employment and Marital Status.

Table 4
Association between self-reported disability and self-reported change in Heavy Episodic Drinking during the pandemic.^{a,b}

Population group	Change in heavy episodic drinking							
	Increased				Decreased			
	UnOR (95% CI)	P-value	AdOR (95% CI)	P-value	UnOR (95% CI)	P-value	AdOR (95% CI)	P-value
No disability								
Family caregivers	0.82 (0.73–0.94)	0.008	0.88 (0.74–1.04)	0.153	0.89 (0.73–1.09)	0.293	0.93 (0.74–1.17)	0.553
People with disabilities	0.97 (0.70–1.35)	0.871	0.95 (0.64–1.39)	0.795	0.63 (0.36–1.10)	0.109	0.72 (0.38–1.37)	0.324

AdOR, adjusted odds ratio; CI, confidence interval; UnOR, unadjusted odds ratio.

Data from the 'Alcohol Use during the COVID-19 pandemic in Latin America and the Caribbean', survey from the PAHO, 2020 (n = 12,328).

^a From March to June 2020, during the pandemic.

^b Multinomial logistic regression with 'no change heavy episodic drinking' as reference. Model adjusted by: Quarantine compliance, Sex, Age, Income, Employment and Marital Status.

with several other studies with data from the pandemic in 2020.^{29,30}

Results should be analysed carefully as there are some limitations to the present study. This study was conducted between March and June 2020, at the beginning of the pandemic and at the time when the most strict lockdown rules were in place; thus, results may not represent changes in behaviour that occurred in subsequent months. In addition, self-reporting of disability is a weak instrument because it may be impacted by information bias and the study did not request type of disability information from participants. Self-reported data are subject to recall bias, especially for questions about past behaviour and alcohol consumption, with participants possibly underestimating heavy episodic drinking measures. In addition, it is important to consider that the title of the research survey (i.e. 'Alcohol use during the COVID-19 pandemic in Latin America and the Caribbean') may have potentially introduced a bias in the study, reducing the probability of participation of individuals who do not drink alcohol. Finally, the study participants were recruited online and it may misrepresent the general populations, favouring individuals with access to the internet and electronic equipment.

Conclusions

As hypothesised, this study observed a higher prevalence of the maintenance of heavy episodic drinking behaviour during the early phase of the pandemic in people with disabilities and family caregivers than in people without self-reported disabilities in Latin America and the Caribbean. The majority of participants with disabilities did not change their drinking patterns during the pandemic (64.3%); however, 28.1% reported increased consumption. People with disabilities showed more severe anxiety symptoms than those

without disabilities, highlighting the need to develop inclusive health and quality-of-life policies to mitigate the effects of the pandemic in this 'triple jeopardy'² population.

Author statements

Ethical approval

This study was approved by the Ethics Review Committee of Pan American Health Organisation.

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Competing interests

None declared.

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Short Communication

Implementation of Test-to-Stay programming to minimize learning loss in a pre-K-8 school district

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ABSTRACT

Objectives: Determine if a school-based Test-to-Stay (TTS) program designed to minimize learning loss reduced the incidence of COVID-19 in a US primary school district.

Study design: Observational, simple summary analysis of attendance and effectiveness of a TTS program implemented in a California school district.

Methods: Retrospective analysis of nested medical and demographic data. Survival curves were plotted using a cumulative hazard function to compare the probability of infection among close contacts exposed at school at different points of time between participants who participated in TTS versus those who did not participate in TTS. A Cox proportional hazards regression model with time-dependent covariates was used to estimate the association of TTS status with the incidence of SARS-CoV-2 infection.

Results: Univariate Cox regression analysis revealed that after adjustment, enrollment in TTS was negatively correlated with the risk of SARS-CoV-2 infection (hazard ratio 0.096; 95% confidence interval [CI], 0.024–0.390; $P < 0.001$).

Conclusions: TTS is an effective component of a layered protection strategy to prevent COVID-19 transmission in schools and communities, while minimizing the loss of in-person instruction in primary schools.

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Introduction

The COVID-19 pandemic catalyzed an unprecedented global disruption in education. According to the United Nations Education, Scientific and Cultural Organization (UNESCO), students in the USA experienced full or partial school closure for 71 weeks with the greatest number of closures occurring in 2020. The upheaval of traditional in-person education has left school-aged children particularly affected due to interruption in learning, inequitable technology access, social isolation, and limited access to quality nutrition and safe environments.^{1,2} This negative sequelae of school closures disproportionately affect minority and low-income families, further widening the disparity of education and health in the USA.¹ Early in the pandemic, schools adopted closure policies as a mitigation strategy to prevent the spread of COVID-19. However, as the virus' prevalence continues to stabilize, education systems are

defining new strategies to educate and promote the health and well-being of children.

Test-to-Stay (TTS) is the use of high-frequency, low-barrier testing in a targeted group of individuals to mitigate the harmful effects of quarantine while minimizing the risk of spread of COVID-19 in classrooms and communities. In the K-12 space which includes students ages 5–18 years, that means testing students who have been exposed to COVID-19. TTS has been used in various forms across the country, with state- or district-specific variations, but all with the purpose of protecting children's health while minimizing loss of in-person education. Schools in Utah used TTS in the 2020–2021 school year, and findings suggest this approach was pivotal to keeping kids in school even during the winter surge.³ This program saved an estimated 109,752 days of in-person instruction, with only 3.2% of students who participated in TTS testing positive.³ In December 2021, the Center for Disease Control and Prevention (CDC) issued updated guidance stating that schools may use TTS to minimize the impact of quarantine and limit school absences after a COVID-19 exposure in the K-12 school setting.⁴ Innovative interventions such as TTS are pivotal as we enter a new paradigm of COVID-19. By ensuring in-person instruction, these programs are

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foundational to reducing academic socio-economic inequity while ensuring the health and safety of the population.^{1,2}

Methods

Participants

This retrospective study reviews the incidence rate of COVID-19 in 49,232 students in the Campbell Union School District (CUSD). CUSD is located near San Jose, California and used TTS among students enrolled in pre-kindergarten to 8th grade beginning in September 2021. Diagnosis of COVID-19 was based on the interim guidelines of the CDC and national diagnosis and treatment guidelines for detection of SARS-CoV-2, the virus which causes COVID-19. Individuals were categorized into two groups by their participation in TTS. CUSD students are 46.9% Hispanic/Latino, 23.1% White, and 17.7% Asian/Pacific Islander. A total of 31.6% of students are English Language Learners and 40.9% are enrolled in Free or Reduced Lunch Programs. In total, 6186 students enrolled in TTS in 2021.

Lincoln School District is a pre-K to 12th grade public school district in Lincoln, Nebraska serving 42,258 students. 65.3% of the students are White, 14.3% are Hispanic/Latino, and 6.6% are Black. 9.3% of students are English Language Learners and 33.8% of students are eligible for Free or Reduced Lunch Programs.⁵ Lincoln does not have a TTS program in place. Both school districts have mandated universal masking.

The TTS program involved opt-in semi-weekly testing of all students, teachers, and administrators and consisted of an anterior nares sample for SARS-CoV-2 PCR. Individuals with positive samples were considered positive for COVID-19, isolated, and excluded from school for 10 days per the current CDC recommendation at that time. Upon infection, these individuals were excluded from participation in TTS due to CDC guidance discouraging repeated testing in the first 90 days after infection.

Enrollment and inclusion criteria for TTS were as follows: 1) those considered close contacts (individuals who were in less than 6 feet proximity to a known case for a cumulative of 15 min or more over a 24-h period); 2) both parties were masked during the exposure; 3) ongoing masking was maintained; 4) exclusion from all school extracurricular activities for 7 days; 4) remained asymptomatic; and 5) underwent at least twice weekly testing during the quarantine period. Participants were ineligible for participation in TTS if: 1) opt-ed out of school screening; 2) hospitalized; 3) exposed outside of a school setting; and 4) infected with SARS-CoV-2 in the past 90 days.

Data collection

Data regarding demographics, grade, school, gender, clinical symptoms, and laboratory values were collected by screening specialists. Written consents were obtained from all participants of students participating in TTS.

TTS COVID-19 screening was performed at each school twice a week by Grapefruit Health, an organization of healthcare providers and public health professionals who provide COVID-19 screening, testing, mitigation consultation, and contact tracing services across the USA. As part of the TTS program, Grapefruit used Rapid Antigen Testing with reflex RT-PCR testing with a partner laboratory, with results typically available within 36 h of testing. Tests were obtained by trained laboratory collection personnel. Different modalities and platforms of RT-PCR holding Emergency Use Authorization (EUA) from the FDA were used throughout the course of testing. Patients' symptoms such as fever, cough, sore throat, dyspnea, body chills, headache, myalgia, or gastrointestinal symptoms were recorded and treated as a probable case until

confirmatory PCR resulted. All patients with either a positive rapid antigen and/or a positive (RT-PCR) test via nasopharyngeal swab were considered a confirmed case of COVID-19.

Data were reviewed from September 19, 2021, to November 28, 2021, with the time to event (diagnosis of COVID-19) measured in weeks. The incidence rate of each school was calculated weekly over the course of 11 weeks. The incidence rate was calculated by totaling the number of new COVID-19 cases per district per week and dividing by the sum of the person-time of the at-risk population.

Statistical analysis

Data were analyzed using SPSS, version 28. Survival curves were plotted using a cumulative hazard function to compare the probability of infection at different points of time and to compare the incidence of COVID-19 among participants who participated in TTS versus those who did not participate in TTS. A Cox proportional hazards regression model with time-dependent covariates was used to estimate the association of TTS status with the incidence of COVID-19.

Results

A total of 3794 COVID-19 tests were reviewed. There were 90 positive tests among those who participated in the TTS program and 1052 among those who did not. Of the close contacts who participated in TTS, 2648 remained negative for COVID-19, and two tested positive. The incidence of COVID-19 among individuals who participated in TTS was 0.21% compared to 2.49% among individuals who did not participate in TTS.

Survival analysis began on September 19, 2021, until positive test or end of the study period (whichever came first). The univariate Cox regression analysis revealed that after adjustment, enrollment in TTS was negatively correlated with the risk of COVID-19 infection (hazard ratio 0.096; 95% confidence interval [CI], 0.024–0.390; $P < 0.001$). In other words, those who participated in TTS were 90.4% less likely to test positive in a given week compared to those who did not participate in TTS (see Fig. 1).

Discussion

Persistent absenteeism due to COVID-19 is detrimental to child development, impacting social and emotional well-being, access to nutrition, and learning.^{6,7} Consistent masking, social distancing, hand washing, and adequate airflow are important to reducing in-school COVID-19 transmission.⁸ In addition, modified quarantine procedures and TTS guidelines are new interventions aimed at improving the safety of in-person instruction. This study's results build on existing evidence demonstrating that TTS practices decrease absenteeism and enable more in-person instruction in K-12 schools.⁴ The incidence of COVID-19 infections and thus school exposures was lower for those students who attended schools with TTS than those who did not, saving an estimated 8088 number of days of in-person instruction. This study's findings are congruent with results from TTS programs in New Jersey, Utah, and Massachusetts and suggest that routine school-based COVID-19 screening for students and their close contacts in conjunction with other evidence-based interventions is an efficient and scalable tool to preserve in-person classroom instruction and extracurricular activities and to lessen the inequality gap in public health and education overall.^{3,9,10}

Limitations

Missing demographic information, specifically for non-TTS participants, may have contributed to research bias and

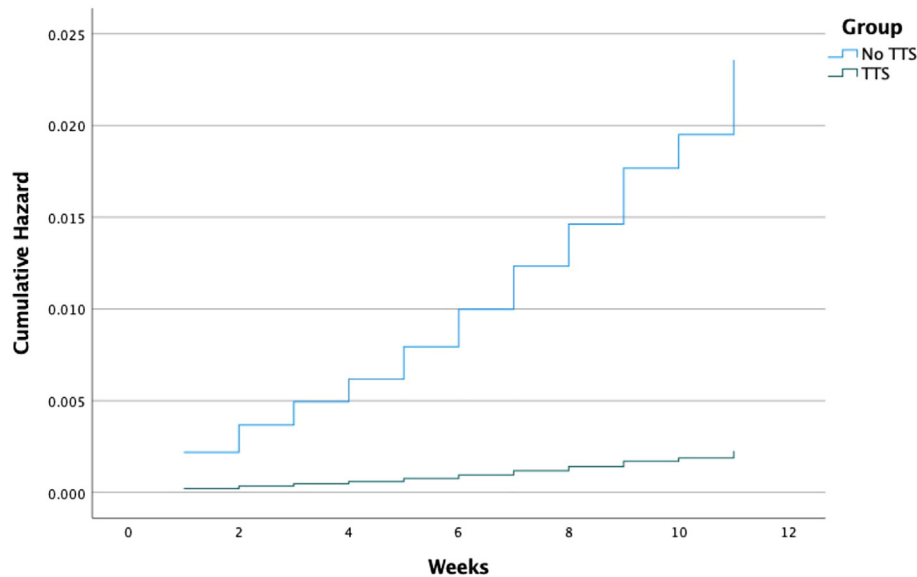


Fig. 1. Proportional hazard of COVID-19 infection for Test-to-Stay participants.

threatened internal validity. In addition, participants may have received COVID-19 testing at other locations and not reported the results to their school district. In the absence of this information, our conclusions regarding the factors associated with incidence and TTS protective qualities may be unreliable. Inevitably, not all confounding variables were controlled for, including socio-economic demographics, which warrants further study. Finally, all subjects in this study lived in Lincoln, Nebraska, and San Jose, CA threatening the external validity and applicability to unlike cohorts. These findings require further validation for generalizability to geographically diverse and prospective cohort studies.

Conclusion

Test-to-Stay in pre-K-8 schools is an effective component of layered protection strategies which schools and communities can use to minimize the risk of COVID-19 infection, while maximizing in-person education. Minimizing the number of missed school days leads to fewer disruptions in school systems that students rely on such as meals and educational resources. Quickly identifying students, staff, and close contacts who test positive for COVID-19 can mitigate infection spread amongst school systems, thus maximizing in-person education for students.

Author statements

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The TTS program in Campbell Union School District was implemented and overseen by Grapefruit Health, of which several of the authors are employees. This study was defined as exempt from human subjects research per section 2 of Northwestern University Human Research Determination Form: HRP-503/V.02/25202019.

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Competing interests

None declared.

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Original Research

Increasing COVID-19 vaccination in the United States: projected impact on cases, hospitalizations, and deaths by age and racial group



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ABSTRACT

Objectives: Minority populations in the United States face a disproportionate burden of illness from COVID-19 infection and have lower vaccination rates compared with other groups. This study estimated the equity implications of increased COVID-19 vaccination in the United States, with a focus on the number of cases, hospitalizations, and deaths avoided.

Study design: This was an observational real-world modeling study.

Methods: Data from the Centers for Disease Control and Prevention (CDC) were used to identify the remaining unvaccinated US population by county, age, and race as of October 22, 2021. The number of COVID-19 cases, hospitalizations, and deaths avoided were calculated based on case incidence and death data from the CDC, along with data on race- and age-specific hospitalization multipliers, under a scenario in which half of the remaining unvaccinated population per county, race, and age group obtained a full vaccine regimen.

Results: Vaccinating half of the remaining unvaccinated population in each age and race subgroup within counties would result in an estimated 22.09 million COVID-19 cases avoided, 1.38 million hospitalizations avoided, and 150,000 deaths avoided over 12 months. Some minority groups, particularly Black and Hispanic/Latino populations, were projected to experience substantial benefits from increased vaccination rates as they face both lower vaccination rates and worse outcomes if infected with COVID-19.

Conclusions: Increasing COVID-19 vaccination in the United States not only benefits the population as a whole but also serves as a potentially useful lever to reduce the disproportionate burden of COVID-19 illness among minority populations.

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Introduction

As of May 2022, more than 83.9 million cases of COVID-19 have been recorded in the United States, claiming the lives of more than 1 million people.¹ The approval of COVID-19 vaccines beginning in December 2020 has provided an important tool to combat the pandemic and prevent many hospitalizations and deaths associated with COVID-19. As of May 2022, approximately 221.3 million Americans have been fully vaccinated, and an additional 37.3 million Americans have received one dose of a two-dose regimen vaccine.² In addition, approximately 103.4 million fully vaccinated

Americans have received a booster dose.² However, vaccine uptake has varied widely across race, age, geography, and other socio-economic factors, contributing to inequities in COVID-19 hospitalizations and mortality in the United States. For example, the adult vaccination rate by US county ranges from 2% to 100% as of October 22, 2021 (Fig. 1).

Lower rates of COVID-19 vaccination have also been observed among vulnerable populations.^{3–5} Using the Centers for Disease Control and Prevention (CDC)'s Social Vulnerability Index (SVI), which accounts for 15 social factors (e.g., poverty, lack of vehicle access, and crowded housing),⁶ we plotted the county-level adult vaccination rates against SVI at two points in time: June 2021 (Fig. 2a) and October 2021 (Fig. 2b). At both time points, higher SVI was associated with lower vaccination rates. Interestingly, an additional 50.4 million US adults were vaccinated between June and

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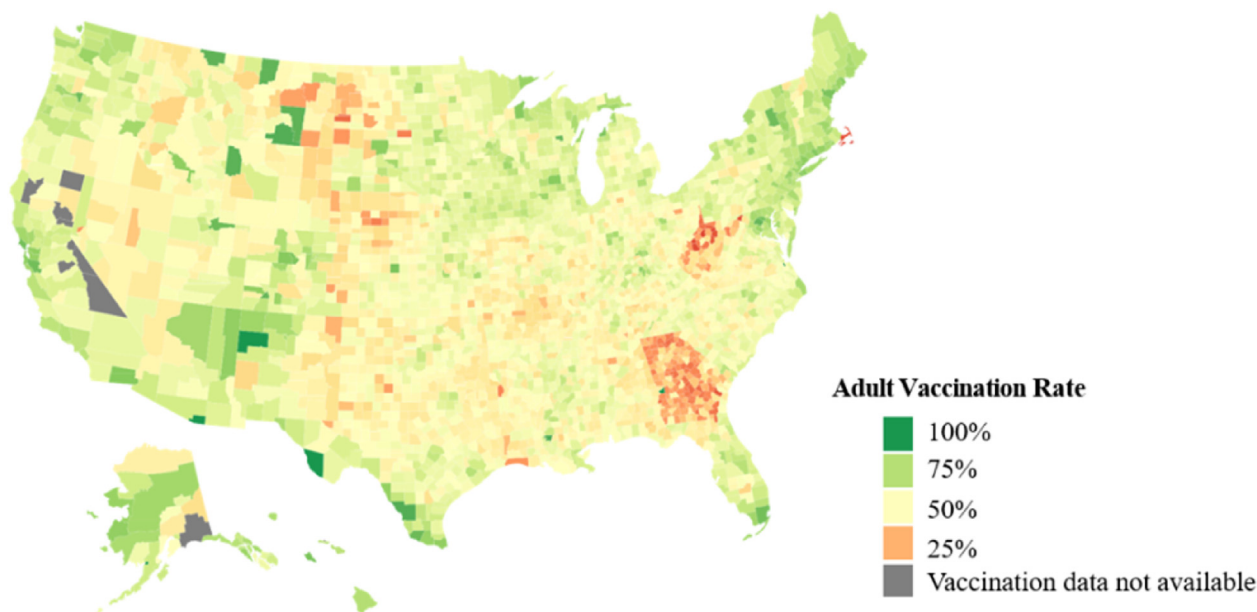


Fig. 1. COVID-19 vaccination rate by US county as of October 22, 2021. CDC, Centers for Disease Control and Prevention; US, United States. Data sources: (1) CDC (2021). COVID-19 vaccinations in the US, county. <https://data.cdc.gov/vaccinations/COVID-19-Vaccinations-in-the-United-States-County/8xkx-amqh>. Accessed October 22, 2021. (2) Texas Department of State (2021). Accessible Vaccine Dashboard Data. <https://dshs.texas.gov/coronavirus/AdditionalData.aspx>. Accessed October 22, 2021. (3) State of Hawai'i – Department of Health, Disease Outbreak Control Division (2021). Hawaii COVID-19 Vaccine Summary. <https://health.hawaii.gov/coronavirusdisease2019/current-situation-in-hawaii/>. Accessed October 22, 2021. (4) CDC (2021). Bridged-Race Population Estimates – Data Files and Documentation. https://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm. Accessed January 18, 2022.

October 2021,⁷ while the Delta variant was circulating in the United States, and this increase appears to have weakened the strength of the negative relationship between vaccination rates and social vulnerability, as can be observed from the slopes of the two lines.

Motivated by these data, we sought to estimate how further increasing vaccination rates could impact COVID-19 cases, hospitalizations, and deaths among adults in the United States, stratified by age and race.

Methods

Model overview

A model was constructed in Excel to estimate the effect of increased COVID-19 vaccination among US adults, stratified by race and age, in terms of avoiding COVID-19 cases, hospitalizations, and deaths. The population of focus was unvaccinated US adults. Race categories included White, non-Hispanic; Hispanic/Latino; Black, non-Hispanic; Asian and Native Hawaiian/Pacific Islander, non-Hispanic; and American Indian/Alaskan Native, non-Hispanic. Age categories included 18–29 years, 30–39 years, 40–49 years, 50–64 years, 65–74 years, 75–84 years, and 85+ years. The time projection of the model was 12 months. We relied on several assumptions and findings from prior analyses and conducted a targeted review of existing CDC data, published literature, news articles, and public reports to identify the most relevant and up-to-date inputs for the model. The detailed model inputs, sources, and embedded assumptions used in the model are described in [Supplemental Tables 1 and 2](#).

Estimating the currently unvaccinated US population

The remaining unvaccinated population was quantified at the county level to identify the target population of expanded vaccination efforts. Vaccination data by county and age group reported by the CDC as of October 22, 2021 were used to inform the number of fully vaccinated adults in the United States. For 96% of US

counties, the October 22, 2021 vaccination counts were directly used as the steady state because vaccination uptake was plateauing in these counties. After fitting logistic curves to the CDC vaccination uptake data, a slightly higher steady-state vaccination rate was predicted for the remaining 4% of counties because they continued to exhibit an upward logistic trend in vaccination.

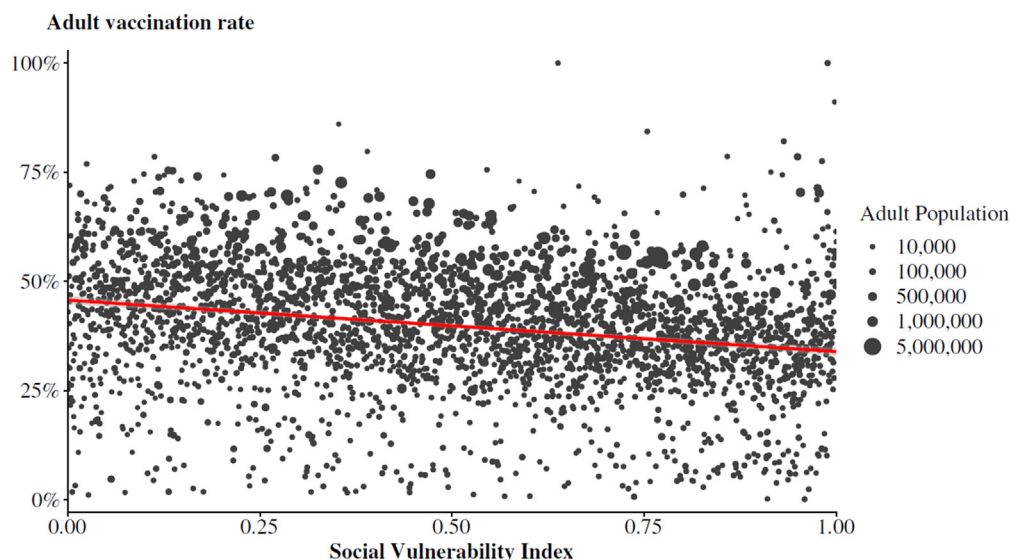
To account for heterogeneity in vaccine uptake across race, the county-by-age steady-state COVID-19 vaccination estimates informed from CDC data were further broken down by race. To do so, the vaccination uptake by race in the United States was weighted by the distribution of races within each county using county-level demographic data from the US Census Bureau (2020). The vaccinated counts across all US counties were summed to estimate the number of unvaccinated adults in the United States by race and age group.

Estimating COVID-19-related outcomes avoided

COVID-19 cases

To calculate the number of cases avoided by race and age, we first estimated the likelihood of an unvaccinated person in each subgroup contracting COVID-19. CDC data were used to estimate the race- and age-specific cumulative incidence of COVID-19 through September 2021, including cumulative incidence of COVID-19 by age group; COVID-19 infection likelihood multipliers by race relative to the White, non-Hispanic population; and the distribution of COVID-19 cases by race within each age group. The ratio of the average monthly COVID-19 case incidence from May 2021 through September 2021 in the United States to the cumulative incidence through September 2021 in the United States was then applied to the cumulative incidence through September 2021 for each race and age subgroup to estimate the monthly incidence of COVID-19 for each subgroup. We projected these monthly incidences forward linearly over 12 months to estimate the incidence of COVID-19 for each subgroup in 2022. To simplify our model, we did not attempt to incorporate any protective effect from potential previous infection with COVID-19.

a. As of June 2021^{a, b}



b. As of October 2021^c

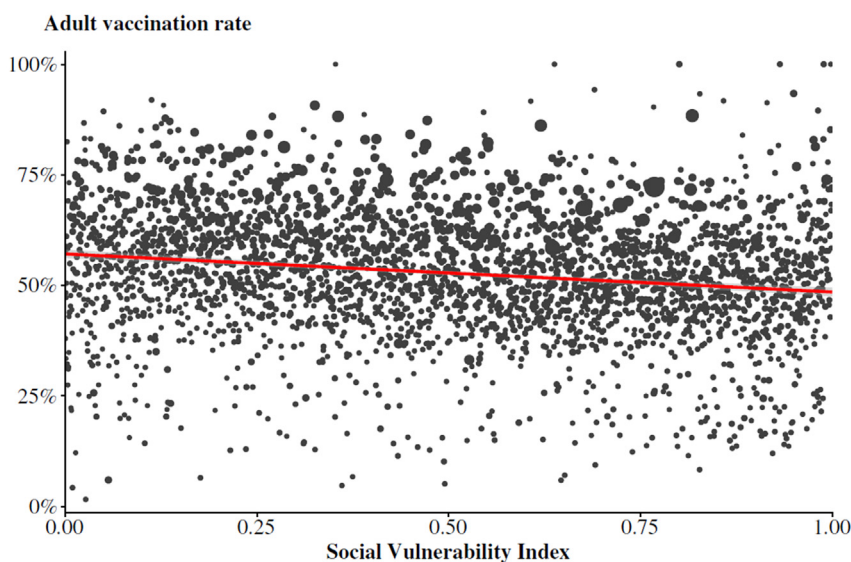


Fig. 2. COVID-19 vaccination rate vs. Social Vulnerability Index by US county as of (a) June 2021 and (b) October 2021. A higher index value indicates greater social vulnerability. Each data point represents an individual county. CDC, Centers for Disease Control and Prevention. Data sources: (1) CDC (2021). COVID-19 vaccinations in the US, county. <https://data.cdc.gov/vaccinations/COVID-19-Vaccinations-in-the-United-States-County/8xxk-amqh>. Accessed June 7, 2021, and October 22, 2021. (2) Texas Department of State (2021). Accessible Vaccine Dashboard Data. <https://dshs.texas.gov/coronavirus/AdditionalData.aspx>. Accessed July 15, 2021, and October 22, 2021. (3) State of Hawai'i – Department of Health, Disease Outbreak Control Division (2021). Hawaii COVID-19 Vaccine Summary. <https://health.hawaii.gov/coronavirusdisease2019/current-situation-in-hawaii/>. Accessed July 15, 2021, and October 22, 2021. (4) CDC (2021). CDC/ATSDR Social Vulnerability Index. <https://www.atsdr.cdc.gov/placeandhealth/svi/index.html>. Accessed January 6, 2022. (5) CDC (2021). Bridged-Race Population Estimates – Data Files and Documentation. https://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm. Accessed January 18, 2022. ^aThe results of a linear regression indicate a slope of -0.118 , an R^2 of 0.06 , an intercept of 0.46 , and a P -value of <0.01 . ^bVaccination data for all counties except those in Texas and Hawaii was accessed June 7, 2021. Vaccination data for counties within Texas and Hawaii was accessed July 15, 2021. ^cThe results of a linear regression indicate a slope of -0.086 , an R^2 of 0.03 , an intercept of 0.57 , and a P -value of <0.01 .

We estimated outcomes once an assumed 50% of the steady-state unvaccinated population in each county would get vaccinated in a scenario of increased vaccination. To calculate the number of cases avoided, we multiplied the likelihood of contracting COVID-19 over the next 12 months if unvaccinated by the number of unvaccinated people in each subgroup who would get vaccinated in the scenario of increased vaccination. We then applied a blended vaccine efficacy rate for preventing COVID-19

infection of 69%, representing a weighted average of the Janssen, Moderna, and Pfizer vaccine efficacies against the Delta variant.^{8–12,a}

^a An average of the upper and lower bound efficacies in preventing infection of the COVID-19 Delta variant was used for the Pfizer and Moderna vaccines.

Table 1
Estimated COVID-19 vaccine uptake by race and age.

Age (years)	Race					Total
	White, non-Hispanic	Hispanic/Latino	Black, non-Hispanic	Asian and Native Hawaiian/Pacific Islander, non-Hispanic	American Indian/Alaskan Native, non-Hispanic	
18–29	53%	58%	46%	67%	59%	54%
30–39	53%	58%	46%	67%	60%	54%
40–49	61%	68%	53%	78%	69%	63%
50–64	68%	76%	60%	87%	76%	69%
65–74	78%	79%	66%	87%	88%	78%
75–84	78%	79%	66%	87%	88%	78%
85+	79%	79%	66%	87%	88%	78%
Total	65%	66%	54%	77%	70%	64%

COVID-19 hospitalizations

To calculate the number of hospitalizations avoided by race and age, we first used CDC COVID-19 hospitalization multipliers (relative to 18- to 29-year-olds) in conjunction with the likelihood of hospitalization for 18- to 29-year-olds from Bhatia and Klausner¹³ to obtain the likelihood of hospitalization given COVID-19 infection for each age group.^b To adjust for race-specific hospitalization rates, we used additional CDC data including the distribution of COVID-19 cases by race within each age group and COVID-19 hospitalization multipliers by race relative to the White, non-Hispanic population. To calculate the number of hospitalizations avoided, the estimated number of COVID-19 cases avoided was multiplied by the likelihood of hospitalization for each age and race subgroup. A blended vaccine efficacy rate for preventing serious illness of 88% was used, representing the weighted average of the Janssen, Moderna, and Pfizer efficacies against the Delta variant.^{12,14}

COVID-19 deaths

To calculate the number of deaths avoided by race and age, we first estimated the race- and age-specific likelihood of death given a COVID-19 infection. We used age-specific infection fatality ratios from O’Driscoll et al.,¹⁵ and then used CDC data on the number of COVID-19 cases and deaths to calculate race- and age-specific unadjusted case fatality ratios. We used these unadjusted case fatality ratios to create a likelihood of death multiplier by race relative to the White, non-Hispanic population within each age group. Using these multipliers and the distribution of COVID-19 cases by race within each age group from the CDC, we calculated the likelihood of death, given a COVID-19 infection, for each race and age subgroup. To calculate the number of COVID-19 deaths avoided, we multiplied our estimated number of COVID-19 cases avoided by the likelihood of death for each age and race subgroup, and we used the blended vaccine efficacy rate for preventing serious illness (88%) as described previously. Because vaccines are more effective at preventing deaths than hospitalizations, using this efficacy rate resulted in a conservative estimate of the number of COVID-19 deaths avoided.

Scenario analysis

Finally, as the results of this study are based on an assumption in which 50% of the currently unvaccinated US population would receive vaccinations, we conducted a scenario analysis to assess the equity implications of increasing or decreasing vaccine uptake. In our scenario analysis, we estimated COVID-19 outcomes by age and

race in scenarios in which 40% and 60% of the currently unvaccinated US population would receive vaccinations.

Results

The estimated steady-state vaccination uptake rates by race and age subgroups are presented in Table 1. Vaccination uptake increased substantially with age, with an estimated 78% of adults aged >65 years being vaccinated compared with 54% of adults between the ages of 18 and 39 years. Vaccination uptake also varied widely by race, with the highest estimated vaccination rate among the Asian and Native Hawaiian/Pacific Islander, non-Hispanic population (77%), and the lowest rate among the Black, non-Hispanic population (54%). Overall, we estimated that 64% of adults in the United States would be vaccinated in the steady state, given vaccination data from the CDC as of October 22, 2021, leaving 91.7 million adults in the United States unvaccinated at the time of the study’s conduct.

Overall, we estimated that vaccinating 50% of the steady-state unvaccinated population would result in the avoidance of 22.09 million cases, 1.38 million hospitalizations, and 150,000 deaths due to COVID-19. The distribution of COVID-19 cases, hospitalizations, and deaths avoided by race within each age group is illustrated in Fig. 3. The counts for each population and the cases, hospitalizations, and deaths avoided by race are presented in more granularity by age group in Supplemental Table 3.

In almost every age group, minorities accounted for a greater share of cases avoided relative to their proportion of the overall US population, indicating that increasing vaccination will help minorities avoid COVID-19 infection slightly more than the White, non-Hispanic population. However, the largest equity implications estimated to result from vaccinating half of the unvaccinated US population were related to hospitalizations and deaths avoided. For 18- to 29-year-olds, minorities compose 45% of the population, but 78% of hospitalizations avoided and 68% of deaths avoided; for 30- to 49-year-olds, minorities compose 43% of the population, but 74% of hospitalizations avoided and 62% of deaths avoided; for 50- to 64-year-olds, minorities compose 33% of the population, but 56% of hospitalizations avoided and 47% of deaths avoided; and for those aged >65 years, minorities compose 24% of the population, but 37% of hospitalizations avoided and 30% of deaths avoided.

The likelihood of dying from COVID-19 is greatly driven by age, with those aged >65 years at much higher risk than those aged <65 years.¹⁵ As the infection fatality ratios for those aged <65 years are less than 1%,¹⁵ we aggregated these age groups to compare COVID-19 deaths avoided per 100,000 population by race for those aged <65 years and ≥65 years (Fig. 4).

For 18- to 64-year-olds, we estimated a larger number of deaths avoided per 100,000 population for the Black, Hispanic/Latino, and American Indian/Alaskan Native populations than we did for the

^b While Bhatia and Klausner estimate the likelihood of hospitalization for 20 to 29-year-olds, we used this as a proxy for the 18 to 29-year-old age group for our calculations.

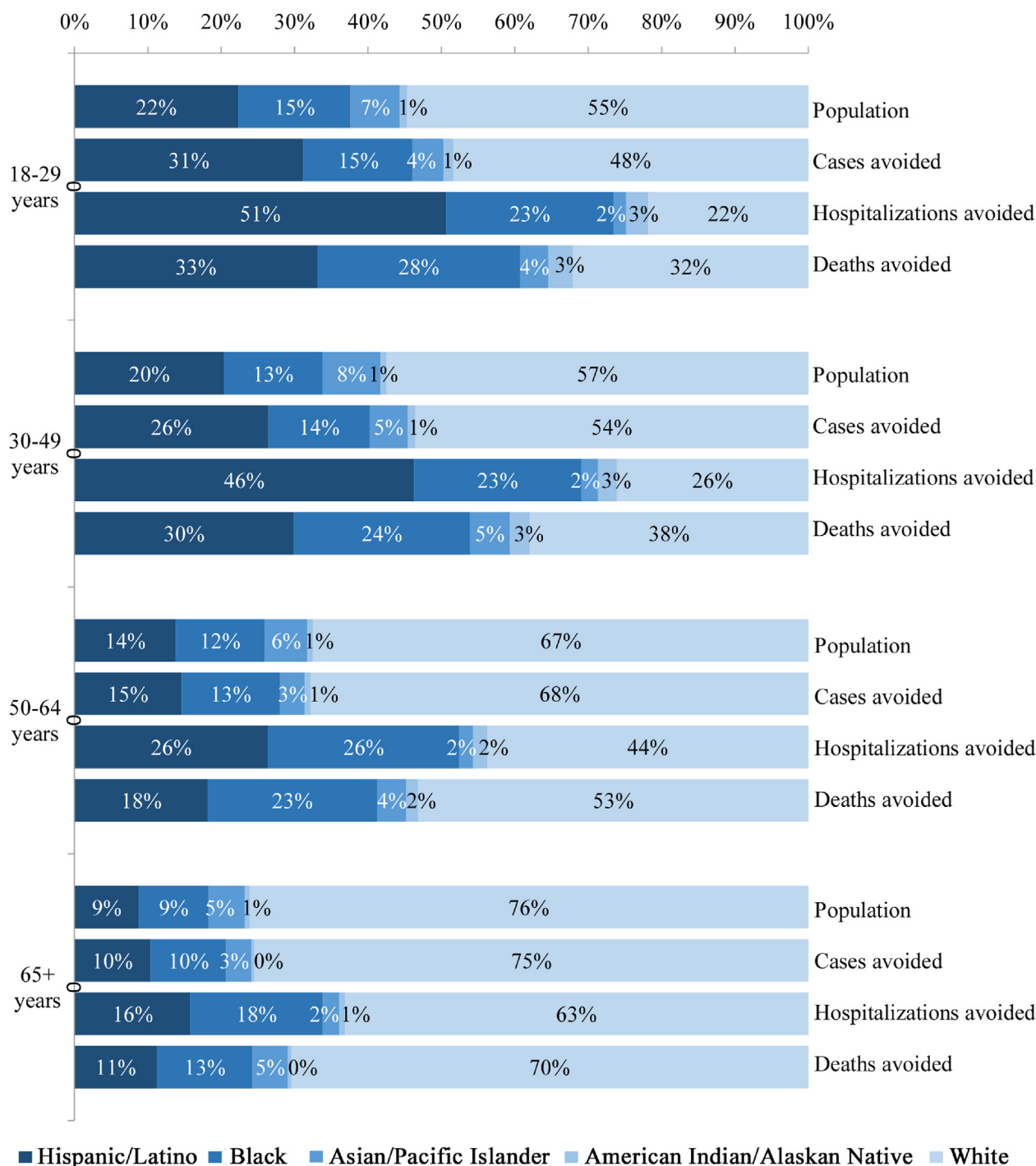


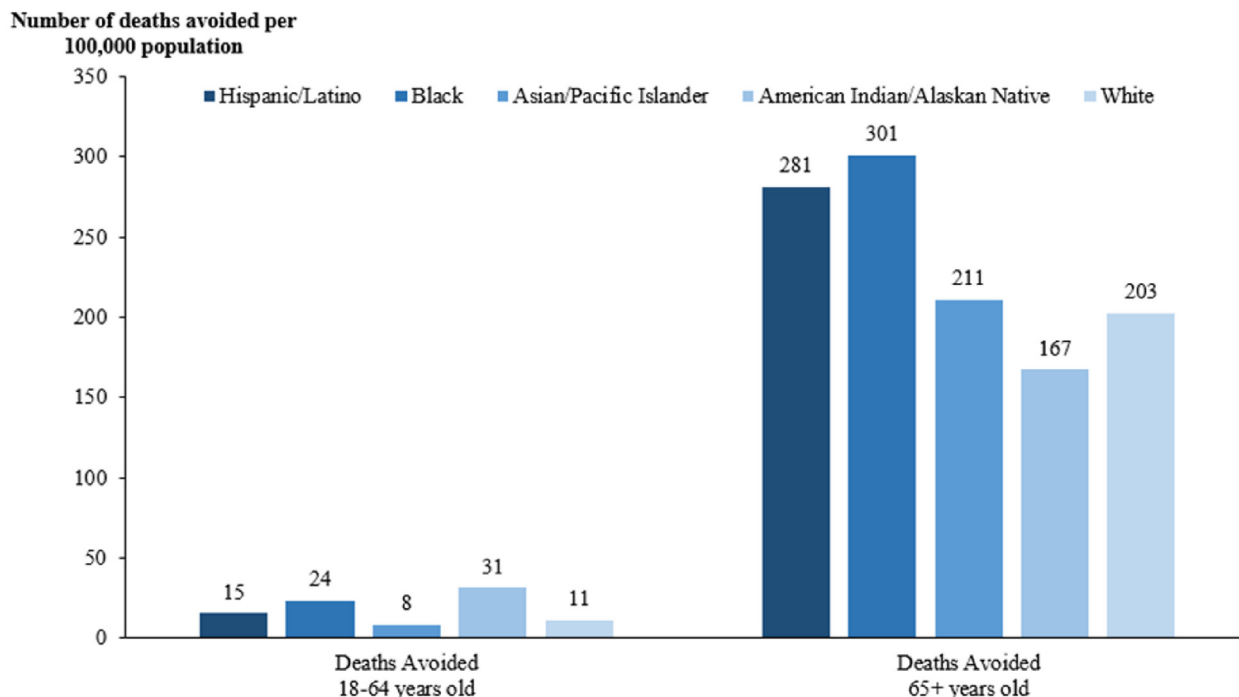
Fig. 3. Distribution of COVID-19 outcomes by race and age group.

White, non-Hispanic population. Most notably, for people aged 18–64 years, vaccinating half of the steady-state unvaccinated White population resulted in 11 deaths avoided per 100,000 population, whereas vaccinating half of the steady-state unvaccinated Black or American Indian/Alaskan Native population resulted in 24 and 31 deaths avoided, respectively, per 100,000 population.

Given the higher death rates associated with COVID-19 among the elderly, our model estimated a greater number of deaths avoided per 100,000 population across all racial groups for those aged ≥65 years. However, Black and Hispanic/Latino populations were estimated to benefit more than White, non-Hispanic people

from increased vaccination. For people aged ≥65 years, vaccinating half of the steady-state unvaccinated White population resulted in 203 deaths avoided per 100,000 population, whereas vaccinating half of the steady-state unvaccinated Hispanic/Latino or Black population resulted in 281 and 301 deaths avoided, respectively, per 100,000 population. This indicates that among older Americans who are at higher risk of death if infected with COVID-19, increased vaccination would especially benefit Black and Hispanic/Latino populations.

Supplemental Figure 1 reports the findings of our scenario analysis by illustrating the number of deaths avoided per 100,000



Abbreviation: US, United States

Fig. 4. COVID-19 deaths avoided per 100,000 US adults by race and age group.

US adults aged ≥ 65 years by race relative to the White, non-Hispanic population in scenarios where 40%, 50% (our current base case), and 60% of the currently unvaccinated US population would get fully vaccinated.

As shown in Supplemental Figure 1, adjusting vaccine uptake does not change our result that more deaths are avoided per 100,000 US adults aged ≥ 65 years for Hispanic/Latino, Black, and Asian/Pacific Islander populations than for the White, non-Hispanic population. However, increasing vaccine uptake increases the magnitude of these equity implications; in particular, increasing vaccine uptake by 10 percentage points (e.g. from 50% to 60%) results in an additional 15 and 20 deaths avoided per 100,000 US adults aged ≥ 65 years for Hispanic/Latino and Black populations, respectively, relative to the White, non-Hispanic population. Increasing (or decreasing) vaccine uptake would also cause our estimates of overall cases, hospitalizations, and deaths avoided to scale proportionately.

Discussion

Our study estimated that vaccinating half of the remaining unvaccinated US population for COVID-19 would result in the avoidance of 22 million cases, 1.4 million hospitalizations, and 150,000 deaths in 2022. Importantly, our findings indicate that increased vaccination would disproportionately affect outcomes for most minority populations, particularly Black and Hispanic/Latino populations. We estimated that minorities would account for a relatively larger share of COVID-19-associated hospitalizations and deaths avoided, particularly the former.

These results are striking in the context of well-documented evidence regarding COVID-19 outcomes among minority populations. For example, Acosta et al.¹⁶ found that people who were American Indian/Alaskan Native, Hispanic/Latino, Black, or Asian/

Pacific Islander were more likely to be hospitalized, admitted to the intensive care unit, or die compared with non-Hispanic White individuals in the first year of the COVID-19 pandemic (2020). An National Public Radio analysis, using CDC data through September 2020, also found that Black, Hispanic, and Native American populations represented a disproportionate share of COVID-19 cases and deaths relative to their share of population.¹⁷ The CDC has also recognized the impact of racial inequities on minorities' COVID-19 outcomes.¹⁸

The disproportionate burden of the pandemic on minorities is likely due to both structural and socio-economic factors, including access to health care and differences in types of employment and working conditions.^{19–22} Some of these differences manifest as increased exposure to COVID-19, as minorities are disproportionately more likely to live in higher density housing, rely on public transportation, and work in an essential industry requiring them to work in person.^{21,23} Other differences, such as reduced access to and trust in the healthcare system, may lead minorities to delay or receive suboptimal treatment. All these factors may increase the prevalence of comorbidities among minorities, which also elevates the risk of hospitalization or death due to COVID-19.²⁴ However, Rubin-Miller et al. found that underlying medical conditions and sociodemographic factors did not fully explain why minorities experienced increased hospitalization and death rates from COVID-19, suggesting that racism and discrimination negatively affect COVID-19 outcomes through other avenues.²⁵ These same factors may also help explain why the Black population is less likely to be vaccinated against COVID-19 than other racial groups, as distrust in the healthcare system due to discrimination, lack of healthcare access, inability to take time off from work, and transportation obstacles lead to decreased vaccination uptake.²⁰ While addressing these underlying sources of inequity is important, in the short term, increasing rates of

vaccination is a direct intervention that can reduce both the overall burden and heterogeneity in outcomes associated with the COVID-19 pandemic. Our findings highlight the urgent need for additional research to identify policies that can increase vaccine uptake in the United States, especially among minority populations.

The results of this study should be considered in light of several limitations. First, as our results are based on data as of October 2021, our model takes into account the Alpha and Delta variants of the COVID-19 virus, but not the Omicron variant, which began circulating in the United States in December 2021.²⁶ The Omicron variant and future variants could affect the number of individuals who decide to get vaccinated (either for primary or booster vaccination), potentially increasing vaccinations similar to what occurred following the Delta surge in the summer of 2021 and therefore changing the steady-state vaccination rate used in our model. In addition, hospitalization and death rates are lower for Omicron, which may be associated with a reduced impact of increased vaccination on the number of hospitalizations and deaths avoided.²⁷

Second, our estimates regarding COVID-19 outcomes also depend on assumptions regarding vaccine efficacy. Vaccine efficacy may diminish as immunity wanes and new variants emerge; for example, breakthrough cases were more common for the Omicron variant than the Alpha and Delta variants, which would lead to fewer cases avoided through increased vaccination in our model.²⁸ Diminishing vaccine efficacy also gives rise to the need for booster shots, which may complicate the definition of “fully vaccinated.” Future research is warranted to account for newer COVID-19 variants and the associated changes in vaccine efficacy and policies surrounding boosters. Regardless, although our estimates of the absolute numbers of COVID-19 outcomes avoided depend on vaccine efficacy and considerations surrounding boosters, our equity conclusions would not fundamentally change. Adjusting vaccine efficacy would have a similar effect as adjusting the vaccine uptake in our scenario analysis; while it may affect the magnitude of the equity implications, minorities continue to account for a disproportionate share of cases, hospitalizations, and deaths avoided, so closing the vaccination gap is critical to reducing disease burden among those populations.

Third, when projecting future cases avoided due to increased vaccination, we also assumed that monthly incidence of COVID-19 would remain constant over the next 12 months. Although we recognize that this is not realistic and that the number of new cases would surge and decline throughout the next year, we accounted for this variability by averaging the monthly incidence of COVID-19 from May through September 2021 when calculating projected cases avoided per month. May through September 2021 included both highs and lows of COVID-19 case incidence; cases were at a low in May and June, averaging 640,000 new cases per month, while cases were at a high in August and September due to the Delta variant, averaging 4.2 million new cases per month.²⁹ The average monthly incidence from May through September 2021 of 2.2 million thus represents both the surges and declines in COVID-19 case incidence that may occur in the next year. In addition, when projecting future cases avoided due to increased vaccination, our model was not well suited to address the indirect effects of vaccination related to herd immunity. Because of the uncertainty in the scientific community around how to quantify the indirect effects of vaccination, as well as our primary goal to illustrate the equity implications of increased vaccination, we chose to pursue a simplified model to best present equity results and avoid false precision. Therefore, these findings may underestimate the number of cases, hospitalizations, and deaths avoided due to increased vaccination.

Conclusion

Overall, we estimated that vaccinating half of the steady-state unvaccinated US population in each age and race subgroup would result in avoiding 22.09 million COVID-19 cases, 1.38 million hospitalizations, and 150,000 deaths. Because minorities are more likely to become seriously sick or die of COVID-19 and because some minorities, particularly Black people, are currently less likely to be vaccinated than their White counterparts, minorities are estimated to compose a disproportionately higher share of avoided COVID-19 outcomes relative to their population. Therefore, US minorities would receive the highest benefit from increases in current rates of COVID-19 vaccination. Further research is warranted to develop policy strategies to improve vaccine uptake in the United States.

Author statements

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Ethical approval

Data in this study were previously collected from publicly available sources and did not include any identifying information; thus, no ethical review was required.

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Competing interests

B.B. and J.K.D. are employees of Janssen, which is a manufacturer of a COVID-19 vaccine. N.K., E.S., J.L., C.F., J.M., Y.S., D.E., and P.L. are employees of Analysis Group, Inc., which received consulting fees from Janssen Scientific Affairs, LLC, for this study.

Availability of data and materials

The county-level vaccination data set used in the present study was downloaded from the CDC repository on October 22, 2021, and is available from the corresponding author on reasonable request. The data set continues to be updated, and the up-to-date data set is available at <https://data.cdc.gov/Vaccinations/COVID-19-Vaccinations-in-the-United-States-County/8xkx-amqh>. The data on national vaccination uptake by race and, separately, by age used in the present study were downloaded from the CDC repository on November 2, 2021, and are available from the corresponding author on reasonable request. The data set continues to be updated, and the up-to-date data set is available at <https://covid.cdc.gov/covid-data-tracker/#vaccination-demographics-trends>. Data on county-level population demographics are available from the CDC repository at https://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm. Data on SVI (Social Vulnerability Index) are available from the CDC repository at https://www.atsdr.cdc.gov/placeandhealth/svi/data_documentation_download.html. Other inputs used in the model are presented in the tables in the Supplemental Material. Intermediate data sets created during the present study are available from the corresponding author on reasonable request.

Authors' contributions

N.K., E.S., J.L., B.B., and P.L. conceived the study. All authors contributed to the study design. C.F. and J.M. led the literature search, data collection, and analysis. C.F., J.M., Y.S., and D.E. conducted data analysis. All authors were involved in the interpretation of the results. J.L., C.F., and J.M. drafted the article, and N.K., E.S., P.L., B.B., and J.K.D. critically revised it. All authors have read and approved the final article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2022.06.019>.

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Original Research

Perspectives of public health professionals on border control practices for COVID-19 management in Europe



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ABSTRACT

Objectives: During the COVID-19 pandemic, internal European borders were temporarily re-established to mitigate the outbreak. Much research on pandemic border control measures has focused on quantifying their effectiveness for infectious disease control as well as on their social consequences for cross-border life in the European Union. However, little attention has been paid to the impacts for the practice and organisation of cross-border public health. To address this gap, the present study analysed the experiences and perspectives of public health professionals working in European border regions regarding border control measures in the pandemic.

Study design: Qualitative interview-based study.

Methods: In total, 27 semistructured interviews with public health professionals were conducted in the border regions between Germany, the Netherlands and Belgium. Participants were asked about their perspectives on border control and the spread of COVID-19 in the region. Interviews were performed between December 2020 and April 2021 and carried out in German, English, Dutch and French.

Results: Before the COVID-19 pandemic, borders had become largely invisible with extensive cross-border social life and mobility. Participants were sceptical about the role of cross-border mobility as a pandemic driver and consequently the effectiveness of enforcing border control for reducing the spread of COVID-19 in their border regions. At the same time, participants raised concerns about the negative consequences for the social fabric and provision of cross-border public health.

Conclusions: Public health professionals highlighted the uncertain role of border control measures for regional infectious disease control in border regions. Rather than border control, sustainable cross-border communication and collaboration is crucial to ensure effective pandemic management in border regions.

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Introduction

During the COVID-19 pandemic, despite the World Health Organisation recommendations against travel restrictions,¹ border control measures were imposed at an unprecedented global scale to regulate and reduce the spread of the novel virus. Although border control measures varied in their rigidity, they posed significant challenges to the ideals of a 'borderless' European Union (EU), where borders have been systematically

dismantled over recent decades.² These challenges were particularly evident in European border regions because an estimated 37.5% of EU citizens live in these border areas³ and, in 2020, almost 2 million EU residents worked across the border in a neighbouring country.⁴

The widespread pandemic securitisation of borders across the EU was rather controversial. Advocates justified it as necessary to contain the spread of COVID-19 and protect citizens' health and security.⁵ Critics, on the other hand, pointed to international and European laws, disruptions for cross-border life, socio-economic costs and the inappropriateness of nationalistic, rather than collaborative, responses to a global crisis.^{6–8} Numerous studies

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have focused on assessing the effectiveness of border controls for COVID-19 management. These studies, largely based on quantitative modelling, have yielded inconclusive and sometimes conflicting findings,^{9,10} with some showing that travel-related measures reduced the spread of disease^{11,12} and others describing limited or no effects.¹³ In addition, the insights provided by modelling approaches have been criticised for lacking ‘real-life’ evidence and contextual understanding of public health experiences related to border control and cross-border movements.^{10,14}

From the beginning of the pandemic, social sciences and public health scholars have reflected upon the meanings and consequences of border control on cross-border realities in the EU. For instance, Novotný and Böhm analysed the experiences of German-Czech cross-border commuters, highlighting the complexities of navigating different national COVID-19 regulations and the lack of cross-border management systems supporting commuters during the pandemic.¹⁵ A similar study by Opiola and Böhm focused on the challenges created by border control measures for cross-border governance in Polish borderlands.¹⁶ Another research by Medeiros et al. argued that ‘covidfencing’ strategies adopted by many EU countries highlighted the urgent need for improving cross-border cooperation in economic, social, as well as public health spheres.²

Although different studies investigated the experiences of EU cross-border commuters and the role of national border policies for the governance of border regions, the present article focuses on the practices, experiences and organisation of cross-border public health. Specifically, the experiences of public health professionals involved in COVID-19 management in the border region between North Rhine-Westphalia (NRW) in Germany, the Netherlands and Belgium were analysed. This study aimed to understand how local public health professionals perceived and experienced border control measures in their border region. By exploring their perspectives, this study provides in-depth, empirical insights on the role and consequences of pandemic border control in a specific European border region.

Methods

Study design and participants

NRW, the Netherlands and Belgium have a shared border of about 500 km and constitute one of the EU’s oldest and most integrated internal border areas. For instance, in 2019, 7490 Dutch and 5160 Belgian people worked in NRW.¹⁷ Before the COVID-19 pandemic, public health professionals working in the region had initiated and developed various forms of cross-border collaborations for infectious disease control (IDC), such as notification forms for various infectious diseases and antimicrobial resistance.¹⁸

During the pandemic, the three countries applied different border control policies, making this border region a particularly rich research setting (Panel 1). To explore the perspectives of public health professionals, an empirical research based on the collection of semistructured interviews with German, Dutch and Belgian public health professionals involved in the local management of the COVID-19 pandemic was conducted. Based on purposive and snowball sampling, participants in relevant border regions from all three countries were recruited via e-mail or phone through the authors’ professional networks and participants’ contacts. Relevant regions included the NRW districts of Borchen, Kleve, Viersen, Heinsberg, Aachen, Euskirchen and Düren, the Dutch provinces of Dutch-Limburg, Gelderland and Twente, and the Belgian provinces of Belgian-Limburg and Liège.

Procedures

Between December 2020 and April 2021, interviews were conducted through video or phone calls. Reflecting the region’s linguistic diversity, interviews were held in German, Dutch, French and English by the authors L.D. and A.K. who are native or fluent in the respective language. The interviews were conducted using a predetermined topic guide (Panel 2) focusing on the respondents’ perspectives related to the public health management of COVID-19 in their border region, with particular emphasis on cross-border aspects. The topic guide was informed by the main research question of this study and a literature review on cross-border COVID-19 management published between December 2019 and December 2020, which was conducted iteratively by L.D. and A.K. The topic guide was piloted during the first three interviews and refined accordingly.

The interviews were audio recorded and transcribed verbatim. Postinterview peer debriefings allowed for iterative preliminary analysis and assessment of data saturation. Following deidentification, interview transcripts were entered into NVivo 12 (QSR International). The interviews were analysed using thematic analysis.¹⁹ Coding followed the themes covered in the topic guide, with additional themes emerging inductively during the analysis process (Panel 3). Due to the language requirements, L.D. and A.K. separately coded a subset of transcripts; where in doubt, they compared and discussed codes until reaching consensus. Analysis and validation of the analysis were done through discussions among L.D., A.K. and K.H. As an additional validation step, two online group feedback meetings in Dutch and German with the participants were organised; the results from these discussions resulted in adaptation and refinement of the analysis. All quotes cited in the following sections were translated, where necessary, into English by the authors. Quotes (Panel 4) are anonymised by using a letter–number combination (e.g., G1, N2, B3), with the letters indicating Germany, the Netherlands and Belgium, respectively.

All participants provided written informed consent. The study was approved by the research ethics committee of the Faculty of Health, Medicine and Life Sciences of Maastricht University (the approval number is FHML-REC/2021/002).

Results

In total, 38 experts across the three countries were approached to participate in the study; however, 11 declined or did not reply, resulting in a final sample size of 26 interviews and one written reply (11 in Germany, 10 in the Netherlands and six in Belgium). Of the 27 participants, 13 were female and 14 were male. Nine experts attended the feedback sessions. Participants joined the online interview from their workplace or from home. Most respondents worked in different positions for the regional public health services. The remaining participants included general practitioners and staff at public administrations, disaster relief organisations, and COVID-19 test and contact tracing centres. Most respondents held senior positions, although there were also a few participants with junior positions. Interviews lasted between 23 and 86 minutes.

Borders in the pre-COVID-19 pandemic life of the German-Dutch-Belgium borderland

Participants characterised the border regions between NRW, the Netherlands and Belgium as highly interwoven, where nation-state borders were largely invisible in prepandemic everyday life. Interviewees, who are also the residents of border regions, considered borders an ‘artificial concept’ (N3) and ‘only a line on a map’ (B1).

Panel 1

Border control policies in North Rhine-Westphalia (NRW) in Germany, the Netherlands and Belgium.

Throughout the COVID-19 pandemic, Germany, the Netherlands and Belgium pursued different and frequently changing border control policies, creating a complex and often confusing situation for border residents and public health professionals alike. While only a very general overview can be provided here, the timeline of measures and their changes in three countries can be found on the website of Interreg Euregio Meuse-Rhine Pandemic.²⁰ Border control policies demonstrated a continuum of verifying degrees of limitations for cross-border mobility, with border closure as the most radical measure. The Netherlands opted against border closures but issued negative travel advice, including for Germany and Belgium, and entry bans from select, high-risk areas (e.g. virus mutation areas). While Germany temporarily closed its borders with several of its neighbours, the political will was to keep the Dutch and Belgian borders open. Although Germany, too, issued travel alerts for the Netherlands and Belgium on classifying them as high-risk areas, special emphasis was placed to ensure the seamlessness of essential border crossings and 'small border traffic' (i.e. short trips of <24 hours). Of the three countries in this study, Belgium followed the most restrictive border strategy. In March 2020 and January 2021, the country temporarily and physically (e.g. through barricades) closed its borders for all non-essential inbound and outbound travel for several months. As in Germany, exceptions to ensure travel for essential purposes have been included in the Belgian legislation. The following example illustrates the complexity around border policies between the three countries. As part of their border management, all three countries introduced various requirements for testing and quarantining. For instance, in December 2020, travellers going from Belgium to the Netherlands by car did not require a negative COVID-19 test. At the same time, when travelling vice versa, a negative test was required if travellers stayed for more than 48 hours in Belgium. For commuters from Germany to the Netherlands, there were no test nor quarantine restrictions in late 2020 and early 2021, whereas commuters from the Netherlands to Germany were required to register in Germany before their arrival and to have a negative PCR or a rapid antigen test taken no more than 48h before arrival.

PCR, polymerase chain reaction.

Panel 2

Detailed interview guide.

1. Introduction and the role in COVID-19 public health management

a. Can you please introduce yourself and explain your current role in the management of COVID-19 pandemic? What are your core responsibilities? Can you elaborate on it? What do you usually do on a daily basis?

2. The role of cross-border travelling in the borderland and specifically during COVID-19, and border-related outbreaks

- a. What is the meaning of the border for everyday life of people in this region? Is there a lot of border crossing - examples? Do you yourself cross the border often? For shopping? Visiting friends? For work? To go for a hike? In this region, do people identify with their specific country or is there more like a borderland life, borderland identity, borderland language?
- b. Have there been any infectious disease outbreaks in this region in the last decades which involved cross-border transmissions? Can you elaborate on it more? What did this involve? Was it associated with a particular activity or an event? How has it been managed? How did the border affect public health management back then?
- c. Do you think borders and cross-border travelling have a role in COVID-19? What kind of role? Can you maybe elaborate and give an example?
- d. Did you recognize that the spread of COVID-19 in your region differed from inland territories? How?
- e. Are there particular borderland sites where people from different countries often meet? E.g. in Limburg: IKEA in Heerlen, the Shopping Outlet in Roermond? Why these sites? Have there been outbreaks associated with these places? Can you give an example? Do you think it is important to keep a particular public health attention to these sites? Are there some specific public health measures that have already been taken in these sites?

3. Policies for control and management of cross-border mobilities in the context of COVID-19

- a. Are there particular policies in place to control/manage cross-border travelling with regards to infectious spread? Can you give an example? Are they helpful? Why (not)? Do you think these policies can and should stop the daily travelling for shopping or visiting friends and relatives?
- b. Have there been different public health measures on the other side of the border (mention country)? Which measures differed and how? How did they lead to differences in the spread of COVID-19? Can you give an example?
- c. What is your opinion as a public health professional about the use of border closings during the pandemic? And what do you think of these measures as a resident of this region?
- d. Have you noticed that closing the border/restricting cross-border travelling in Spring 2020 had an impact on the infection rate? Infection scenario? Can you elaborate on it and give an example?
- e. What can the closing of borders in this region mean for control for COVID-19? What type of unintended consequences can occur? For public health? For the daily life of the region? For the economy? For you as a resident?
- f. What do you think about the latest policies?

4. The role of digital tools (e.g. tracking apps)

- a. Do health professionals like you use any digital tracking apps in your work (e.g. Corona Melder)? Which one? How do you use it? Are these apps helpful in understanding cross-border mobilities in your region? Why (not)? How? Can you give an example?
- b. How has the fact that all three countries each developed their own tracking app affected IDC in the border area? Does it make sense that different countries have their own apps? How has this changed after the apps cooperate? Does the app cooperation work in practice?

5. Cross-border collaboration for COVID-19 control

- a. Do you have the impression that there are important differences in public health services and IDC in the different countries? Examples (in data infrastructures, organisation, policies ...)?
- b. How do you and your colleagues collaborate with public health institutions across the border for COVID-19 management? More or less frequently? Institutionalized/incidental? Are there special platforms, policies or standards to facilitate this collaboration? Depending on personal relationships? Specific difficulties here?
- c. Since the beginning of the pandemic, how have these collaborations developed? (More intense? Sharing data? What?) Did they have an impact on IDC and cross-border travelling? What kind of impact?
- d. How could collaborations become even better? What is needed?

6. Cross-border data management

- a. How do you communicate data about COVID-19 infections across borders? Are there specific platforms, websites? Can you give an example on how you communicate such data? Formally and informally with colleagues from different countries?
- b. How did national differences in counting COVID-19 (e.g. COVID-19 deaths) affect cross-border practices of IDC? Example?

7. Recommendations for future public health actions

- a. How do you feel about current practices for COVID-19 management with regards to cross-border mobility? What do you think works well? Why? What should be improved? How?
- b. What can the three countries learn from each other in terms of (cross-border) IDC?

People and goods cross borders daily for numerous purposes, as many residents live in one country and work on the other side of the border, whereas their children might go to kindergarten or school in the third country. In addition, many border region residents have relatives in care homes across the border. Several participants emphasised the border proximity as being a positive factor in their quality of life by

enabling wider choices and opportunities. Examples included making regular use of schools, childcare and health care in the neighbouring country, visiting markets and restaurants, and buying groceries or gasoline where prices are cheapest. However, although borders were perceived as either irrelevant or beneficial for the social life of border region residents, the study participants highlighted that borders

Panel 3
Thematic codes for analysis.

Theme	Sub/themes	Code
Everyday life in border region	Everyday life of a border region, including non-COVID-19 cross-border travelling	Border life
Public health history of border region	Previous outbreaks including the history of cross-border public health communication	Previous outbreaks
Border crossing and COVID-19	Practices and places related to infectious spread Clusters of COVID-19 Differences between infectious spread for inland territories and border regions	Risks and places Clusters Borders and inlands
Public health measures against COVID-19	Within country Cross-border policies (perspectives to the policies from different countries) Actions taken to prevent cross-border spread (e.g. border closure)	In-country policies Cross-border policies Actions
Cross-border collaboration	COVID-19 mutations Collaboration and data exchange across the border Collaboration and data exchange to non-neighboring countries	Mutations Collaborations with neighbors Collaborations with non-neighbors
Tracking apps	Tracking apps	Tracking apps
Recommendations for cross-border COVID-19 management	Recommendations	Recommendations

continue to manifest in jurisdictional and administrative matters, for instance, regarding social security for cross-border workers. These juridical and administrative obstacles became much more visible during the COVID-19 pandemic, hindering the potential for cross-border public health collaborations.

COVID-19 cross-border mobility and consequences of border control measures

Public health professionals provided varied accounts regarding the role of cross-border mobility in the spread of COVID-19 in their border regions. A commonly experienced challenge in this regard was the lack of pertinent data, as most public health data were based on country-specific infrastructures that varied in how a ‘case’ was defined and calculated. However, based on their local and regional pandemic experiences, many experts suggested that cross-border mobility did not play a big role in viral transmission in their region. Most participants did not observe notable spill-overs or virus importation from their neighbouring country and reported that although there were cross-border COVID-19 cases, these did not emerge as the main driver of the local infection scenario.

However, some professionals mentioned border-related movements as an important factor in the infection scenario in their region. They explained this in terms of large differences in COVID-19 incidences between the different sides of the border, whereby lower incidence areas tend to follow the infection trend of the higher incidence area as a result of daily cross-border traffic. At the same time, experts questioned whether it is cross-border mobility as such or different IDC measures that were responsible for higher incidence levels in the neighbouring country.

Many experts argued against the emphasis on borders as drivers of contagion. They explained that mobility, in general, and the resulting social contacts are a cause of infection, but that cross-border mobility is not different nor more risky or more infectious than in-country mobility. Participants challenged the specific focus on border-related movements, whereas in-country movements are largely left unrestricted. Likewise, some participants pointed out that, in their region, virus importation from nearby in-country metropolitan areas probably played a bigger role than importation from across the border.

Several experts questioned the effectiveness of border control measures in Europe. They perceived border closures as political decrees that appear compelling and straightforward on paper but

oversimplify lived realities in border regions and contribute little to IDC on the ground. One participant highlighted that IDC measures onsite, rather than at borders, are more important for the reduction of infection levels and thus for the prevention of local clusters. Some participants stressed that border closures are only effective in curbing viral spread if implemented early (i.e. before there are any cases within the country) and rigorously. However, border closures in the study region came too late and could not be enforced with the necessary rigidity as numerous exceptions were necessary to allow people with so-called essential travel purposes (e.g. families, healthcare workers) to continue to cross the borders. Other participants added that even when implemented early, border closures can only delay the introduction and spread of the virus but never stop it in the real-life context of Europe.

Experts' scepticism about border control practices also stemmed from concerns about the enormous social, economic and health costs linked to the tightly interwoven fabric of their border region. Disruptions of cross-border health care emerged as a crucial worry in this context. Public health professionals highlighted that borderland citizens work for as well as make use of healthcare services in the neighbouring country. Border control measures severely impacted residents' ability to seek care or to provide informal care to their relatives across the border. Similarly, several participants mentioned that border control measures hindered the cross-border transfer of patients and ambulance work, raising concerns that these measures could strain previous efforts and progress of established cross-border relations.

Beyond disruptions of borderland life, many participants expressed worries about the wider symbolism of border control. Experts perceived border control practices within Europe as incommensurable with core European values, such as collaboration, freedom and solidarity. Participants also warned that border-related IDC measures could strengthen right-wing, nationalistic and anti-European ideologies by accentuating the nation-state and demarking people and groups based on national identities.

The crucial role of cross-border collaboration

Participants highlighted the importance of cross-border collaboration and communication for effective public health management of the COVID-19 pandemic. The nature of prepandemic collaborations differed substantially between border regions. In some regions, participants had no or only sporadic previous connections

Panel 4

Representative interview quotes.

Borders in the prepandemic life of the German-Dutch-Belgium borderland	
Extensive cross-border connections	Daily life does not take the border into account. It's <i>un bassin de vie</i> , so we go to school, we work on the other side of the border. The attending physician is sometimes on the other side of the border, the mechanic. You have horses on the other side of the border. It is <i>un bassin de vie</i> . [B3]
Borders have little meaning in everyday life	We're in the centre of Europe. And a border is in fact a very artificial concept. People may have interests in two countries at the same time. They have work in one country, have relatives in another and go shopping in a third country. [N3]
Benefits of living near the border	If you see that in the leisure area, then I think it is a big deal that the border is perceived as positive for people who also drive over to Enschede from the German side on the weekend or then to Winterswijk, just because of the culture. [G1]
Administrative borders remain	What you do notice about the border, is the difficulty for a Dutchman to work in Belgium. Just as we have a DigiD in the Netherlands, you need an eID in Belgium ... I've been working [in Belgium] for a few years now and there are still a lot of programmes I can't open, because I don't have that card. [B2]
COVID-19 cross-border mobility and consequences of border control measures	
Lack of cross-border public health data	You mean: has the fact of having border crossings, has it had an impact on the numbers of the epidemic? I don't have any hard data to measure that. So I don't know how to answer, I can't say yes or no because I don't have the data. My feeling is no. [B3]
Cross-border mobility as pandemic driver	At the moment, there is still a higher incidence in the Netherlands, which was later addressed by more contact restrictions. Yes, I am sure we got some infections from the Netherlands. [G6]
Scepticism about cross-border mobility as pandemic driver	I do not think that crossing the border is the main cause of transmission. After all, the situation for residents living on the Dutch and German side of the border respectively is the same as residents living in two Dutch neighbouring villages. I do not think that the border has much to do with it. [N1] Yes, a political national border was once drawn, but traffic, say, within a country, contributes to spreading as much as border traffic. [B1] We had a handful of cross-border cases with Belgium that were actually of no relevance to our statistics. We rather see that infections are imported from the Cologne-Bonn metropolitan area. [G5]
Border closures are only good on paper	Countering an infection, a pandemic by closing the border is totally ridiculous, it cannot work. In our crisis team, I said it was like trying to prevent basements from being flooded during a storm tide by means of a decree. The best I can do is with sandbags, but I can't do that with a bylaw. [G5] It is natural that after the decision to close the borders one is immediately confronted with the fact that for many citizens it became impossible to lead a normal life, even if they respected the measures. So a whole series of legal exceptions were quickly created. [B3]
Local IDC measures are better	I don't think [a border closure] would have influenced that, but rather the measures that were taken on site. Because it is about reducing the number of infections in the place of residence and then it does not spread further as a cluster. [G6]
Effective only if early	So closing borders, let's say closing borders in May or in April wouldn't have made any sense at all. Restricting mobility in the early stages of the pandemic, for example in February, that would have made sense and would have added much effect on the further development of the crisis, I think. But you need to be fast. It is too late when you close borders when people have been on vacation and return to the Netherlands. [N2]
Effective only if rigorous	I think closing a border in itself is not going to stop the virus. It can at the most, in my opinion, delay a virus or a transmission or another infectious disease. But ultimately, a pathogen crosses borders. [N3] There are too many exceptions. If you look at the legislation, there were always exceptions who was allowed after all [to cross the border] and who wasn't. And then that's not an effective tool. It's simply- we're too mobile for that. [G10]
Everyday life disruptions	I think [the Belgian border closure] was very unhelpful, to be honest. Not going on a holiday is something very different than not seeing your grandchild who's been born, for grandparents for example ... And I think they didn't think it through, that there are so many people who actually work across the border or have things going on across the border, which are important and are not stopped because of the COVID-19 pandemic. [N10]
Barriers for cross-border healthcare provision	And if I stop these necessary visits, that is, visits to the doctor, and also prevent the cross-border exercise of the profession, then I create more damage. There are also many Germans who work in the Belgian hospital, for example. All these things, you have to ask yourself, once I close all of this, what happens then? [G3] It was no problem to transport patients by ambulance from Belgium to Germany. It was more difficult in the opposite direction. When the German ambulance was not allowed to cross the border ... we sent ambulances to Germany to pick up the patients. [B6]
Socio-economic dependencies	As border areas, we can only benefit if we work closely together. Otherwise we are somehow like 'beaten at the wooden fence' [German expression], I'll say it a bit exaggerated. And that is always unstable enough. In the labour market in particular ... That's why you should be a little careful when you have such a border closure. [G1]
Incommensurable with European values	[T]his border closure was consciously perceived here, but more as a blow in our guts with regard to the European idea than as an effective measure to contain infections. [G5]
Nationalistic message	I think it's a shame that, in the end, a nation-state way of thinking was dug up again ... I just think there are people everywhere who say we have to start the nation state again and the EU is not that great. [G11]
National identities	[When] I arrived at the [Belgian] border control ... I had to show papers. And the way cops look at you because you have a yellow license plate, that's very negative, kind of like- How do I say that? Not at all welcoming really It was not immediately accepted when I just showed that I work in [Belgium], I have a paper from the Order of the doctors of Belgium. I have always taken my contract with me to be on the safe side. [B2]

(continued on next page)

Panel 4 (continued)

Borders in the pre-pandemic life of the German-Dutch-Belgium borderland	
The crucial role of cross-border collaboration	
Previous cross-border collaborations	So what is good, what also helps us, is a good connection to the Netherlands, in the border regions here, which has been developed for decades. You know each other through various encounters ... Of course, this helps as a starting point if such a pandemic actually breaks out that you know each other. [G2] Yes, [cross-border communication] was actually a very big problem in the beginning because we didn't even have any phone numbers for them and didn't even know that they are called GGD [Dutch public health service]. And now it is like this, there is this [name] project ... [so] that the border regions get to know each other, that is, at the level of the health authorities. And that way we have phone numbers for the first time. [G9]
Challenges of cross-border work	We cannot exchange data across borders. I have lists of names of people who have been in contact with someone who turned out to be infected, Aachen has lists of names, Heinsberg has lists of names, but we cannot share them. That is not allowed by law. The only official information that can be shared is that an infection has been confirmed. [N5] The system for controlling infectious diseases works quite differently. The Dutch do it quite differently from us in Germany, also on the basis of different legal rules. They work in completely different systems, you cannot say otherwise. [G2]
Existing cross-border collaborations are necessary	I think you need to have established collaborations or collaborative networks based on prior working relationships. I think we haven't gone far enough ... that would make things so much easier and so much lower threshold than is the case now. I think we are in a privileged position by having these working relationships, but they could be more intense and could be taken a step further even. [N2] In general, I think that on many issues, we should often work more closely together as local authorities with our Dutch colleagues. If there are more ties, then it is indeed easier to make contact with issues that suddenly arise. [B1]
Importance of working together in border regions	We're living in 2021 and still, it's basically, you just have two separate countries while you can share so much knowledge ... Instead of working against each other, Belgium should say, look, we close the borders, we don't want Dutch people in Belgium, make sure there is communication with Dutch people. [B2] I think it is important for us, when the war is over, in peacetime, to learn about the working methods of colleagues across the border. How did you deal with this pandemic? What is the role of the public health service, what role do general practitioners have? Are there protocols you work with? [G5]

with the public health authorities in their neighbouring countries and lacked understanding of how public health was organised across the border. As a result, they encountered many challenges in the management of cross-border COVID-19 cases. For example, when a Belgian doctor who lives in Germany but works in Belgium became infected and had to be hospitalised, the German public health department did not know which Belgian authority to inform nor how to inform the doctor's patients. Another German participant described that reporting cross-border cases to their Dutch counterpart was initially a lengthy process because they did not have a direct phone contact with the Dutch regional public health office.

In other regions, participants could draw on previously established cross-border public health collaborations (e.g. shared notification spreadsheets for certain infectious diseases, previous Euroregional projects, a border-liaison employee and local government contacts). In these regions, participants reported that pre-existing networks helped them reduce the time communicating with their cross-border counterparts. However, even when pre-COVID-19 cross-border channels were in place, participants stated that the contacts were ineffective or insufficiently institutionalised to enable systematic and sustainable collaboration in a pandemic context. A key reason mentioned for the breakdown of cross-border cooperation was that it became deprioritised because compliance with national IDC policies was the primary focus, whereas cross-border aspects were a voluntary 'add-on' for which there were no resources.

Irrespective of whether cross-border channels of collaboration had been in place before the COVID-19 pandemic, participants experienced various difficulties in managing cross-border cases. Experts strongly emphasised that lack of such cooperation is both obstructing IDC and harming the social life of borderland communities. Participants highlighted that cooperation does not have to result in the homogenisation of policies and national systems, which would be unnecessary and unfeasible, but rather, it should be rooted in clear, working channels of cross-border communication.

Discussion

Expert interviews with public health professionals working in the German-Dutch-Belgian border region illustrated the complexity of cross-border IDC and highlighted the consequences of border control measures for both the social fabric of borderlands and cross-border public health collaboration. The research setting of this study is characterised by a high level of mobility, and social and cultural integration, which might be not characteristic of other border regions within and beyond the EU. However, lessons learned from this study are important to current discussions regarding the role and consequences of border control measures for cross-border public health work and future outbreak preparedness.

Literature on border control measures to mitigate the COVID-19 pandemic highlighted varied and inconclusive results from modelling and observation studies.^{21,22} Research from specific settings, such as Hong Kong,²³ Australia,²⁴ New Zealand²⁵ and Taiwan,²⁶ reported that strict and early border control policies have contributed to significant reductions in the number of COVID-19 cases. Border policies introduced by EU member states raised concerns,^{2,8} especially in the very dynamic border regions, such as the one explored in this study. However, rather than looking into the effectiveness of these measures for the containment of COVID-19, the present study focused on the consequences of border control measures for the realities of public health practices and cross-border IDC in a densely populated region.

Echoing research on border closure between two Australian states,²⁷ the results from the present study pose a crucial question to national and international public health authorities: how to reflect on and integrate the realities of continuous integration and globalisation of the modern world into current national strategies of public health securitisation? In line with various international calls for better international cooperation,^{28,29} experts interviewed in this study argued for the building of long-term and sustainable channels for cooperation of public health authorities across borders. Current national practices and policies of IDC often do not consider the cross-border

mobilities that constitute the social life of border region residents. Better understanding and communication about cross-border mobility, rather than prohibition and securitisation, should be integrated into future IDC planning at national, European and global levels.

This study highlighted how border control measures have disproportionately affected the social life of borderland residents who faced difficulties in navigating their cross-border work and family responsibilities. This situation required public health professionals to adopt additional measures and invest extra time towards helping residents navigate the different COVID-19 requirements of the three countries. Although it was argued by state authorities that national border controls were put in place to support the pandemic response, in the highly integrated region of NRW, Belgium and the Netherlands, it created additional work for public health professionals and disrupted previously established cross-border collaborations.

The present study had several limitations. First, a limited number of participants were enrolled, and they were not distributed equally between the three countries. However, the interview data did achieve saturation. Second, the research was conducted between December 2020 and April 2021 during the first year of the COVID-19 pandemic. As the pandemic continues to evolve, it is important to collect and compare public health professionals' experiences relating to the consequences of border control measures from different border regions within and outside of the EU.

The current research highlighted the importance of contextualisation of IDC measures. Working in border regions, participants anticipated difficulties related to cross-border communication and collaboration in the context of a large-scale pandemic. The expertise of public health professionals who have experience and understanding of the dynamics of border regions is essential for addressing the current pandemic as well as for preparing for future outbreaks. Rather than border control, sustainable cross-border communication and collaboration is crucial to ensure effective pandemic management in border regions.

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Ethical approval

The study was approved by the research ethics committee of the Faculty of Health, Medicine and Life Sciences of Maastricht University (the approval number is FHML-REC/2021/002).

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Competing interests

The authors declare no conflict of interest.

Data sharing

The data from this study are not available for open access but can be requested directly from the corresponding author.

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Original Research

Sociodemographic characteristics associated with a higher wish to complain about health care

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ABSTRACT

Objectives: Previous research has shown that patients who are older, less educated, or have lower income are less likely to lodge complaints about health care. This variation may reflect less wish to complain or inequitable access to complaint channels or remedies. We aimed to investigate associations between sociodemographic characteristics and health users' wish to complain.

Study design: This was a randomized case vignette survey among 6756 Danish men aged 45–70 years (30% response rate).

Methods: Assuming they received the care in vignettes about prostate cancer (prostate-specific antigen) testing, participants rated their wish to complain on a 5-point Likert scale. Information on sociodemographic characteristics was obtained through self-reports and municipality-level information from national registries.

Results: Lower education was associated with an increased wish to complain (mean Likert difference 0.44 [95% CI 0.36–0.51]; $P < .001$). The wish to complain was higher among unemployed men (difference 0.16 [95% CI 0.04–0.28]; $P < .011$) and those with a chronic illness (difference 0.06 [95% CI 0.02–0.10]; $P < .004$). Given the same healthcare scenarios, there was no difference in wish to complain among health users who were retired, living rurally, or from lower income groups.

Conclusions: Health users who are less educated, lower income, elderly, or from rural or minority communities appear to be as likely, or more likely, to wish to complain about health care as others. Yet, younger, well-educated, and higher income citizens are overrepresented in actual complaint statistics. The finding suggests persisting inequalities in the suitability or accessibility of complaint processes for some groups of patients.

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Introduction

Patient complaints, compensation claims, and malpractice lawsuits (collectively referred to as “complaints”) are an important issue in modern health care.^{1–4} Complaints may identify opportunities to improve the quality and safety of health care and may also have tangible consequences for patients, healthcare professionals, and others.¹ Patients have a range of reasons for complaining about their care, including a desire to be heard, to receive an apology or

compensation, or to protect others from similar harm.^{5–7} Furthermore, studies have shown that in some areas of health care such as surgery, complaints are especially common.^{8,9}

Previous research has found differences in complaint rates among different groups of patients with patients who have lower incomes, are less educated, are older, and are from minority communities being underrepresented among complainants.^{6,10–15} These studies typically use complaints data from regulatory authorities and thus focus on those patients who were successful in lodging a complaint.^{13,15} The reasons for these disparities are unclear. Healthcare users with limited socio-economic resources might be more tolerant of unsatisfactory care than others. Alternatively, these patients might wish to complain but may be

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deterred from doing so by complaint processes that are difficult to access or navigate, a fear of negative repercussions, or distrust of authorities. In this survey, we used hypothetical case vignettes to investigate the association between sociodemographic characteristics and healthcare users' wish to complain.

Methods

Procedures

This study is a subanalysis of a cross-sectional vignette survey developed with public and patient involvement.¹¹ We drew a random sample of 24,000 men aged 45–70 years from the Danish health authorities' national register of all Danish citizens. The inclusion of participants is illustrated in Fig. 1, and sample size considerations are described below. Following two waves of invitations in January and March 2019, 6756 people completed the survey (response rate of 30%). As described elsewhere, our sample was reasonably representative of men aged 45–70 years in regard to sociodemographic and personality characteristics when compared with Danish and international data.^{16,17} We used Research Electronic Data Capture¹⁷ and delivered the survey to our target group through the Danish authorities' digital mailbox for secure communication with citizens.¹²

Case vignettes described different scenarios of prostate-specific antigen (PSA) screening for prostate cancer in men.¹⁸ We allocated participants randomly into one of 30 scenarios, which illustrated different levels of patient involvement in the decision about having a PSA test, different decisions made (to have a PSA or not), and different patient outcomes. Although some scenarios described poor communication by a doctor, or a poor clinical outcome (an eventually fatal prostate cancer), there was no clear clinical negligence in any of the scenarios. Scenarios are described in detail elsewhere,¹⁹ and an example of a case scenario is provided in

Table 1. Assuming they had received the health care described in the scenarios, participants rated their wish to complain about the health care provided in different scenarios using a Likert scale ranging from 1, very unlikely, to 5, very likely.

In Denmark, health users can lodge a complaint through two medical legal paths, which are both free of charge: one may lead to monetary compensation through a patient injury compensation organization ("compensation claim") and the other to non-monetary forms of accountability through a state disciplinary board that may issue a reprimand to a clinician or initiate procedures that may lead to license withdrawal ("disciplinary complaint"). Patients can choose one, or both, paths depending on the remedy sought. Participants therefore responded to two items: 'How likely is it that you would claim compensation?' and 'How likely is it that you would complain about the doctor's care?' In our analyses, to provide an overall ("combined complaint") estimate of the healthcare user's wish to complain, a simple average of ratings was used.

Participants were also asked about their sociodemographic characteristics, including marital status, highest completed education, current employment, chronic illness (cardiovascular, diabetes, chronic obstructive pulmonary disease, cerebrovascular disease, cancer, or other), and about their experience with the medical condition in the vignette (PSA test for prostate cancer detection). In describing their highest completed education, the following levels were used: primary school, high school, vocational education, up to 3 years of higher education, 3–4 years of higher education, and >4 years of higher education. We also drew data from the Danish municipalities' statistics database (www.noegletal.dk) about the sociodemographic characteristics of the participant's place of living. These data are a standard measure in Denmark and include statistics about municipality-level population density, tax per citizen, and proportion of citizens with a higher education.^{20,21} In addition, we recorded the proportion of citizens with non-

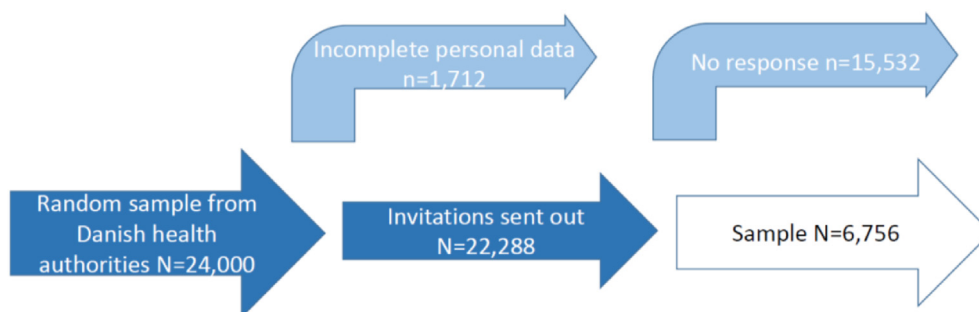


Fig. 1. Inclusion of survey participants.

Table 1
Extracts from one case vignette version.

"Imagine that you are seeing your doctor for a 'health check'. The doctor asks a number of questions for symptoms such as shortness of breath, abdominal pain, etc. Your answer to all those questions is 'No'. The doctor also asks if there are any other issues to discuss. Your answer again is 'No'. Afterwards, the doctor does a stethoscope examination of your chest. He also does a blood pressure, heart rate check-up, and a manual abdominal examination and tells you that everything seems ok"
[...]
"Your doctor tells you about a blood test for prostate cancer. It is called PSA. The doctor also informs you that it is a personal decision whether you want to have the test or not. Therefore, a guidance tool has been developed to help making the decision [...] The doctor hands out the tool and invites you to go through it. Afterwards, the doctor offers to talk to you to clarify questions etc."
[...]
"After carefully going through the material, you have a conversation about the test with your doctor. You decide NOT to have a PSA test done" [...]
"You subsequently have surgery aiming at totally eradicating the cancer. At first, you are informed that eradication was successful. However, you have side-effects like erectile dysfunction, urinary problems and slight fecal incontinence. Afterwards you are told that the prostate cancer is not entirely removed but unluckily has spread to other parts of the body. You receive chemo and radiation therapy but you understand that you probably will live for no more than 3 years. You are sad and have a conversation with your family. You wonder if the cancer could have been detected at an earlier stage, if it could have been totally eradicated, or if one - given the situation - would have rather lived without knowing about the cancer" [...]

Western origin using a measure that has previously been used to understand behavioral differences between ethnic subgroups in the population.²²

Statistics and power analysis

For the complaints outcome measure, 100 participants per group were required to detect a 0.45 standard deviation effect on Likert scale ratings between groups with an α of 0.05 and a 0.90 statistical power.^{18,19} To compensate for the non-response and non-normality of the measurements, we included 300 additional participants per group, or 400 per scenario, totaling 12,000 participant invitations overall.²⁰ We had permission to launch up to three invitation waves, should response rates among scenarios be uneven. Comparisons of the likelihood to complain were conducted between groups with linear regression, reporting mean differences with 95% confidence intervals, and *P* values were computed by bootstrapping with 1000 repetitions, thereby compensating for residual non-normality. Our main analysis reports fully adjusted models, including all sociodemographic factors, as well as adjusting for the 30 randomization groups and age. In a supplementary analysis, we report partly adjusted models for compensation claims and disciplinary complaints, including each sociodemographic factor separately, but still adjusting for randomization group and age. We previously found that healthcare users' wish to complain is

associated with the course of health care and degree of patient involvement in case vignettes.¹⁹ Therefore, we statistically tested for interactions between these variables and the sociodemographic factors included in our analyses.

Results

The average age of respondents was 59.1 years (standard deviation 7.3 years). Other baseline sociodemographic characteristics are shown in Table 2.

Table 3 shows the association between sociodemographic factors in our model and respondents' wish to complain according to Likert ratings. A sensitivity analysis, which separately analyzed compensation claims and disciplinary complaints, found that the findings remained unchanged across these two subtypes of complaints (see Supplementary Table 1).

As shown in Table 3, men with lower education expressed an increased wish to complain with a clear gradient across the level of education achieved. Compared with respondents currently in a paid job, unemployed men were more likely to express a wish to complain about health care.

In separate analyses, we investigated whether some groups of respondents were particularly likely to respond to an unfavorable outcome (an eventually fatal cancer) with an increased wish to complain. We did not identify any statistically significant

Table 2
Baseline sample characteristics and complaint response means.

Respondent characteristics		Respondent number	Combined complaint likelihood (^a), mean (SD)
All measures		N = 6756 (%)	2.08 (0.87)
Age group (years)	45–50	939 (14%)	2.07 (0.94)
	50–55	1223 (18%)	2.06 (0.89)
	55–60	1369 (20%)	2.09 (0.86)
	60–65	1403 (21%)	2.11 (0.89)
	65–70	1821 (27%)	2.07 (0.82)
Marital status	Living together	5370 (79%)	2.06 (0.86)
	Partner, living apart	312 (5%)	2.14 (0.88)
	Single	1073 (16%)	2.14 (0.93)
Education	Primary school	864 (13%)	2.27 (0.95)
	High school	332 (5%)	2.11 (0.85)
	Vocational	2062 (31%)	2.18 (0.86)
	Up to 3 years of higher education	835 (12%)	2.08 (0.86)
	3–4 years of higher education	1524 (23%)	2.00 (0.85)
	More than 4 years of higher education	1138 (17%)	1.83 (0.82)
Affiliation with labor market	Student	11 (0%)	2.59 (1.46)
	Unemployed	250 (4%)	2.25 (1.00)
	Working	4445 (66%)	2.06 (0.88)
	Retired	2049 (30%)	2.10 (0.85)
Chronic disease	No	3976 (59%)	2.04 (0.86)
	Yes	2779 (41%)	2.13 (0.89)
Experience with prostate cancer	No	4437 (66%)	2.09 (0.87)
	Yes	2318 (34%)	2.07 (0.88)
Municipality-level measures			
Population density (citizens/km ²)	1st (lowest) quartile	1811 (27%)	2.10 (0.85)
	2nd quartile	1597 (24%)	2.09 (0.85)
	3rd quartile	1802 (27%)	2.09 (0.87)
	4th (highest) quartile	1545 (23%)	2.04 (0.93)
Taxable income per citizen	1st (lowest) quartile	1738 (26%)	2.08 (0.85)
	2nd quartile	1697 (25%)	2.11 (0.85)
	3rd quartile	1946 (29%)	2.08 (0.90)
	4th (highest) quartile	1374 (20%)	2.03 (0.89)
Proportion citizens aged 25–64 years with higher education	1st (lowest) quartile	1819 (27%)	2.11 (0.86)
	2nd quartile	1629 (24%)	2.11 (0.86)
	3rd quartile	1639 (24%)	2.07 (0.88)
	4th (highest) quartile	1668 (25%)	2.03 (0.90)
Proportion of non-Western immigrants	1st (lowest) quartile	1708 (25%)	2.09 (0.87)
	2nd quartile	1879 (28%)	2.07 (0.83)
	3rd quartile	1532 (23%)	2.10 (0.90)
	4th (highest) quartile	1636 (24%)	2.06 (0.91)

^a Likert scale from 1, very unlikely, to 5, very likely.

Table 3
Fully adjusted model for complaint likelihood^a.

Respondent characteristics		Adjusted combined complaint likelihood (^a)	
		Mean Likert score difference, (95% CI)	P-value
Age group (years)	45–50	Reference	.
	50–55	–0.02 (–0.09; 0.06)	0.685
	55–60	–0.02 (–0.09; 0.05)	0.592
	60–65	0.01 (–0.07; 0.08)	0.885
	65–70	–0.04 (–0.12; 0.04)	0.325
Marital status	Living together	Reference	.
	Partner, living apart	0.07 (–0.03; 0.16)	0.161
	Single	0.02 (–0.03; 0.08)	0.407
Education	Primary school	0.44 (0.36; 0.51)	<0.001
	High school	0.26 (0.16; 0.36)	<0.001
	Vocational	0.35 (0.29; 0.42)	<0.001
	Up to 3 years of higher education	0.24 (0.17; 0.31)	<0.001
	3–4 years of higher education	0.16 (0.10; 0.23)	<0.001
Affiliation with labor market	More than 4 years of higher education	Reference	.
	Student	0.29 (–0.47; 1.05)	0.453
	Unemployed	0.16 (0.04; 0.28)	0.011
	Working	Reference	.
	Retired	–0.00 (–0.07; 0.06)	0.908
Chronic disease	No	Reference	.
	Yes	0.06 (0.02; 0.10)	0.004
Experience of prostate cancer	No	Reference	.
	Yes	–0.01 (–0.05; 0.03)	0.781
Municipality-level measures Population density (citizens/km ²)	1st (lowest) quartile	Reference	.
	2nd quartile	0.01 (–0.05; 0.08)	0.654
	3rd quartile	0.06 (–0.03; 0.14)	0.177
	4th (highest) quartile	0.05 (–0.06; 0.16)	0.335
	Taxable income per citizen	Reference	.
Taxable income per citizen	1st (lowest) quartile	0.05 (–0.02; 0.11)	0.155
	2nd quartile	0.03 (–0.04; 0.10)	0.423
	3rd quartile	0.01 (–0.07; 0.09)	0.811
	4th (highest) quartile	Reference	.
Proportion citizens aged 25–64 years with higher education	1st (lowest) quartile	–0.01 (–0.08; 0.05)	0.653
	2nd quartile	–0.07 (–0.15; 0.00)	0.054
	3rd quartile	–0.07 (–0.15; 0.01)	0.099
	4th (highest) quartile	Reference	.
Proportion of non-Western immigrants	1st (lowest) quartile	–0.04 (–0.10; 0.02)	0.190
	2nd quartile	0.02 (–0.06; 0.09)	0.666
	3rd quartile	0.01 (–0.07; 0.09)	0.800
	4th (highest) quartile	Reference	.

^a Model adjusts for all variables reported in the table as well as 30 randomization groups. [Supplementary Table 2](#) provides separate analyses for compensation and disciplinary complaints.

differences. Furthermore, we studied whether some groups of respondents were particularly likely to respond to greater levels of patient involvement with a reduced intent to complain. Although higher levels of patient involvement generally led to a reduced wish to complain, this effect was less pronounced among men with less education ($P = .044$, average difference 0.25 on Likert scale [95% CI 0.01; 0.49]).

In our analyses, we could not establish any association between respondents’ residence in urban or rural areas and their wish to complain. Likewise, no association could be demonstrated between wish to complain and age or municipality-level data on taxable income and ethnicity. These findings were consistent across both categories of complaints, namely, those seeking compensation and those raising concerns about the doctor’s standard of care.

Discussion

Some groups of patients are less likely to lodge complaints about health care. To date, it has not been clear whether this observation reflects less wish to complain or inequitable access to complaint systems. In our web-based case vignette survey, we aimed to investigate sociodemographic factors associated with healthcare users’ wish to complain. Keeping everything else equal, we found an association between lower levels of education and an increased wish to complain about health care. In addition, healthcare users

who were unemployed and those with a self-reported chronic illness expressed an increased wish to complain. Those who were retired or living in rural areas or in predominantly non-Western communities were similarly likely to wish to complain compared with those of working age, those living in cities, or those in predominantly Western communities.

Discussion of study findings

We know that some groups of patients are underrepresented in complaint statistics. In a recent study from Denmark, where filing a compensation claim is free of charge and patient advice offices offer guidance on where and how to lodge a complaint, the odds of filing a compensation claim were lower among patients with lower incomes.¹⁰ This concurs with previous international findings regarding the socio-economic profile of complainants compared with non-complainants. In the United States, studies led by Burstin¹² and Studdert¹³ found lower complaint rates among patients with lower incomes. Studdert et al. suggested that while this group of patients are more likely to be among those who suffer negligence, their socio-economic status may inhibit opportunities to secure legal representation. Similarly, in a study from New Zealand, Bismark et al. found that after controlling for the presence and severity of injury, patients from the most socioeconomically deprived areas were significantly less likely to complain.¹⁵

There are three possible explanations for these prior findings. One readily rebuttable possibility is that patients with lower socio-economic status receive better care and are therefore less prone to complain. This hypothesis is completely at odds with a strong body of evidence across multiple specialties showing that patients with less education, lower incomes, and minority ethnicity are less likely to receive standard treatment and more likely to experience adverse events.^{13,15,23,24,25} A second possibility—explored in our study—is that patients with lower socio-economic backgrounds may be more satisfied with the health care that is provided and less interested in making a complaint. Our findings suggest that this second explanation is unlikely to be true. Given the same healthcare scenarios, the wish to complain about health care was no lower among health users who were retired, living rurally, or from lower taxable income groups. Compared with those in a job, those who were unemployed more commonly expressed a wish to complain about health care. The third and most likely explanation is that disparities exist in access to complaint processes as a result of complaint information, processes, and remedies being more familiar—or more suited—to some groups of patients than others.

Our analyses expose health users' educational background as an important factor in understanding complaint behavior. Our study found that the urge to complain is higher among those with lower levels of education. This finding is at odds with previous medicolegal research. Higher education was shown by Fishbain et al. to be an independent factor for filing a lawsuit.²⁶ Studdert et al. previously noted that citizens with lower levels of education complain less about health care¹³ and findings from the previously mentioned Danish register study on national compensation claim figures agree.¹⁰ Furthermore, when studying interactions between educational background and patient involvement, we found the “preventive” effect of greater patient involvement on the wish to complain to be smaller in respondents with lower education. This finding could reflect the challenges of ensuring appropriate involvement in healthcare users with varied educational backgrounds.²⁷ In this regard, Sepucha et al. previously demonstrated that healthcare users are not necessarily able to accurately assess how well informed they are.²⁸ In their study, they found lower education to be associated with feeling well informed about screening decisions irrespective of the individual's actual understanding of the decision in question.

Likewise, our findings on retired health users encourage reconsideration of previous assumptions regarding the propensity to complain among older adults. Research by Burstin et al.,¹² Studdert et al.,¹³ Bismark et al.,¹⁵ and Birkeland et al.¹⁰ found that older patients lodge fewer complaints about health care. Nonetheless, the present study suggests that retired men are as likely as working-age men to express a wish to complain. Similarly, our analyses do not suggest a decreased desire to complain among health users from non-Western communities, although previous research has documented that patients from ethnic minorities are less likely to lodge a complaint.^{10,15} Finally, we found a slightly increased wish to complain among respondents who self-reported a chronic illness. We do not know the reason for this finding, although a possible explanation might be previous negative experiences with health care. Again, however, our findings challenge previous reports showing that patients with comorbidities are underrepresented among complainants.¹⁰

Healthcare users' experience of care, including their perception of the quality of care and communication, is likely to influence their wish to complain. However, whether or not they actually lodge a complaint may depend on other factors, such as knowledge about how to complain, access to complaints processes, trust in authorities to respond to complaints fairly, and costs associated with litigation. Previous research has consistently found that health

users with few socio-economic resources are underrepresented in complaints to courts, compensation bodies, medical regulators, and disciplinary boards. Our study adds further nuance by suggesting that the reason for fewer complaints may not be a lower wish to complain. Health users who are less educated, lower income, elderly, or from minority communities may feel at least as much desire to complain about healthcare provision as do others and indeed are more likely to experience substandard care or adverse events.²⁹ Yet, they do not necessarily succeed in carrying their concerns through into a formal complaint.

Limitations

This study has several limitations. First, it is a single-country study with uncertain generalizability to other countries with different complaint systems. Furthermore, the survey design assessed respondents' wish to complain immediately after reading through a hypothetical scenario in which they imagined themselves receiving a particular course of care. From our data, we do not know whether some groups of participants are more likely to change their mind over time. For example, health users with little education might later reflect on the healthcare interaction and decide that it was satisfactory or that they would be unlikely to benefit from a complaint. Similarly, in this study, we do not take into account other psychological factors such as personality traits or prior experience of complaints processes.

We also cannot rule out the possibility that differences between respondents' wish to complain and actual complaint figures arise from healthcare quality dissimilarities. However, it seems implausible that well-educated and employed healthcare users receive substandard quality healthcare to a degree that accounts for their overrepresentation in actual complaint figures.

Furthermore, in our study, we used municipality-level information as a proxy for respondents' income together with self-reported working status. In future studies, more accurate financial status could be collected directly from respondents or through linkage with tax records. However, the agreement between municipality-level education figures and self-reports regarding the association between highest-attained education and wish to complain indicates that municipality-level data may adequately describe respondents in a larger scale survey like the present one.

In addition, because of the focus on prostate cancer, we excluded women. Existing research has shown conflicting findings regarding gender differences in complaint behavior. Some studies suggest that men are more likely to complain about health care,³⁰ whereas others suggest that most complaints are filed by women.^{6,10,14} Bismark et al. found no sex differences in complaint rates after adjusting for increased health care usage among women after taking into account the higher proportion of women in caregiving roles who may therefore file a complaint on behalf of a child or relative.¹⁵ Similarly, in Burstin et al.'s study, sex was not independently associated with the risk of malpractice claims.¹² Finally, the possibility of non-response bias must be kept in mind. Although comparisons with national statistics suggest that our sample was reasonably representative of the sociodemographic characteristics of adult men, the possibility of residual bias cannot be entirely ruled out.^{16,17} In our previous study of our sample's sociodemographic representativeness, we found that older individuals and those residing in rural areas or in areas with lower tax base more likely to respond to the survey.¹⁶ It is possible that these groups had more time to respond to a survey and may therefore also have more time to lodge a complaint. However, in this study, neither income nor rural location was associated with the wish to complain. Hence, we do not expect this factor to have large influence in the present study.

Conclusion

Previous studies have shown that healthcare users with lower income, less education, older age, and minority backgrounds are underrepresented in complaints about health care despite being more likely to receive substandard health care and to experience adverse events. The findings of this study suggest that these disparities are not due to a reduced wish to complain. Despite efforts to increase the accessibility of complaint remedies, inequalities persist. This matters for two reasons. First, at an individual level, complaints offer patients an opportunity to resolve concerns and access remedies such as compensation. Second, at a systems level, complaints provide the health system with valuable information on opportunities for improvement. Further research is needed to understand the barriers that prevent healthcare users from translating a wish to complain into a formal complaint. In the meantime, healthcare organizations and complaint agencies should remain mindful that their complaint statistics are likely to omit many patients with limited socio-economic resources who wanted to complain about the health care they received but never realized their intentions.

Author statements

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Ethical approval

The authors obtained written consent from study participants, and the study was conducted in accordance with Danish research ethics regulation (please see Danish Health Data Agency authorization n. FSEID-00003692) and EU General Data Protection Regulation 2016/679 and Directive 95/46/EC.

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Competing interests

The authors declare that they have no competing interests.

Disclaimer

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Authors' contributions

S.B. collected, analyzed, and interpreted the data used in this study and was a major contributor in writing the article. S.M. assisted in analyzing the data and writing the article. M.J.B. and B.M. assisted in interpreting the data and writing the article. All authors read, commented, and approved the final article.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2022.06.009>.

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Themed Paper – Original Research

Unwillingness to cooperate with COVID-19 contact tracing in Japan

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ABSTRACT

Objectives: Contact tracing for COVID-19 relies heavily on the cooperation of individuals with authorities to provide information of contact persons. However, few studies have clarified willingness to cooperate and motivation to provide information for contact tracing. This study sought to describe willingness to cooperate and motivation to report contact persons for COVID-19 contact tracing among citizens in Japan, and to assess any associated sociodemographic factors.

Study design: Cross-sectional study.

Methods: This was an online-based survey using quota sampling. Participants were asked about their willingness to cooperate in reporting contacts for COVID-19 contact tracing if they tested positive. Participants also responded to questions regarding their reasons for cooperating or not cooperating and provided sociodemographic data. Multiple logistic regression analysis was performed to clarify associations between sociodemographic factors and willingness to cooperate.

Results: This study included 2844 participants. The proportion of participants who were not willing to cooperate in reporting contacts was 27.6%, with their main reasons being concerns about causing trouble for the other person and being criticised for revealing their names. Willingness to cooperate was lower among men, young adults and those with an educational level less than a university degree.

Conclusions: To improve the effectiveness of contact tracing, educational campaigns, such as reducing the fear and stigma associated with COVID-19, may be important. Furthermore, it is essential to understand that individuals may have contacts whom they do not wish to disclose to others and to be considerate when handling such situations.

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Introduction

Contact tracing is the process by which public health officials identify individuals who have been exposed to a person infected with a pathogen. Contact tracing is a standard procedure in the control of certain infectious diseases.^{1,2} In the coronavirus disease 2019 (COVID-19) pandemic, contact tracing is one of the key

strategies for mitigating the transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) to reduce the number of cases and mortality associated with COVID-19.^{3–5} COVID-19 contact tracing is mainly used to identify and provide supported quarantine to individuals who were in contact with people infected with SARS-CoV-2. In addition, contact tracing can also be used to find settings or events where the infection may have occurred.⁵

The first step in contact tracing is to identify people who have been in contact with confirmed COVID-19 cases. The standard method for identifying contacts is to interview an individual (or an individual's caregiver), although digital technology, such as contact tracing applications, are also now widely used.^{3,6} Whether an interviewer can elicit enough information regarding contacts from

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the infected individual or their caregiver depends on the interviewee's memory, willingness to cooperate and motivation to report contacts.² However, social stigma associated with COVID-19 disincentivises cooperation regarding contact tracing, because social stigma drives people to hide their illness to avoid discrimination.^{7–9} Social stigma has been observed in other infectious diseases, such as tuberculosis and sexually transmitted infections, and this reduces the effectiveness of contact tracing.^{10,11} In addition, social and economic insecurity may deter individuals from participating in contact tracing programmes.⁸ People who are socially insecure may be concerned that their social status would be threatened if it was known that they had been diagnosed with COVID-19.⁷ For individuals who are financially insecure, the reduction in their income because of the quarantine of family members may inhibit their willingness to cooperate with reporting contacts.³ These potential factors may make it difficult to identify all contacts by interview, even if there is recollection of all contacts.^{3,7} In fact, COVID-19 contact tracing does not work well in many countries.¹² One of the reasons for this is that contacts are not adequately revealed during interviews because there is a lack of trust in public health authorities.^{12,13} However, few studies have investigated willingness of individuals to cooperate and their motivation to report contacts for COVID-19 contact tracing among citizens, especially in Japan.^{8,9,12,13}

Therefore, the purpose of this study was to describe the willingness to cooperate in COVID-19 contact tracing, the motivation for willingness or unwillingness to cooperate, and to assess any associated sociodemographic factors in Japan.

Methods

Study sample and data collection

This was a cross-sectional study conducted using an online survey. The survey was conducted between 14 and 18 January 2021. At the time of the survey, the number of confirmed COVID-19 cases in Japan had significantly increased. In addition, the Japanese government had declared a state of emergency in the Tokyo metropolitan area on 7 January 2021, for the second time since April 2020.¹⁴ Participants in the study were recruited from the registrants of a Japanese Internet research service company, MyVoice Communication, Inc., which had approximately 1.07 million registered participants as of August 2021. This study aimed to collect data from 3000 men and women, aged 20–79 years, from all regions of Japan. Quota sampling based on age, sex and residential area was used. The 3000 participants were stratified by sex, age (5-year age groups) and residential area (i.e., Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku and Kyushu regions), then set a target number of respondents for each group to be consistent with the census data in Japan.

The Internet research service company randomly chose potential respondents from the registered participants and invited them to participate in the survey by email on 14 January 2021. The questionnaires were placed in a secured section of a Web site and potential respondents received a specific URL in their invitation email. When the number of participants who voluntarily responded to the questionnaire reached the target number of respondents for each group, responses were no longer accepted for that group. The survey was concluded on 18 January 2021 when the target number of respondents was reached for all groups. Reward points, valued at 80 yen (approximately 0.7 US dollars as of November 2021), were provided as incentives for participation.

This study was approved by the Ethics Committee of Tokyo Medical University, Tokyo, Japan (No: T2019-0234). Informed consent was obtained from all respondents.

Assessment of participants' willingness to cooperate in reporting contacts and reasons for COVID-19 contact tracing

To measure willingness to cooperate in reporting contacts and reasons for COVID-19 contact tracing, survey items were developed based on the COVID-19 Snapshot Monitoring questionnaire, which was created by the World Health Organisation (WHO) in Europe to monitor public perceptions of COVID-19.^{15,16} Participants were asked whether they would share all the names of people they had been in contact with if they tested positive for COVID-19 and were asked to share the names with health authorities. Two response options were provided: 'I would share all names for sure' and 'I may not share all names'. Participants were then asked to provide a reason for their response using multiple answer questions: choices for why participants would share all names for sure included 'I believe this helps stop the spread of COVID-19' and 'this is my responsibility as a citizen'; choices for why participants may not share all names included 'I believe people would blame me for having shared their name' and 'I would cause inconvenience to the people whose names I share'.

Assessment of sociodemographic factors

Participants reported their sex, age, marital status, occupation, residential area and living arrangement. The research company provided categorised data on educational attainment and annual household income level.

Statistical analysis

Regarding participants' willingness to cooperate in reporting information about contacts, if the participants responded 'I would share all names for sure', it was determined that participants were willing to cooperate and those who chose 'I may not share all names' were deemed an unwilling to cooperate. This study reports the percentage of participants who were and were not willing to cooperate with contact tracing. This study also determined the proportions of the reasons for which the participants were willing and not willing to cooperate. The characteristics of the participants who were willing to cooperate and those who were not were compared using a Chi-squared test.

Multiple logistic regression analysis was performed to clarify the association between each sociodemographic factor and the willingness to cooperate in reporting contacts. The dependent variable was set as a dichotomous variable, coded as '1' if the participant was willing to cooperate and '0' if not willing. The independent variables were sex, age (20–39, 40–59 and 60–79 years), marital status, occupation, residential area, living arrangement, educational attainment and household income. Statistical analyses were performed using SPSS Statistics for Windows, version 28 (IBM Japan, Tokyo, Japan). Two-sided *P*-values < 0.05 were considered to be statistically significant.

Results

Of the 3000 participants selected for this study, 156 participants with incomplete data were excluded from the analysis. Therefore, the analysis set consisted of 2844 participants (age range 20–79 years, median: 51 years, SD: 15.8). See [Table 1](#) for participant characteristics.

The proportion of participants who were not willing to cooperate in reporting contacts was 27.6%. A significantly higher proportion of participants who were not willing to cooperate in reporting contacts were men, aged 20–39 years or 40–59 years and

Table 1
Participant characteristics.

Characteristic	Total		Participants willing to cooperate in reporting contacts ^a		Participants unwilling to cooperate in reporting contacts		P-value ^c
	N = 2844		N = 2058		N = 786		
	n (%)		n (%)		n (%)		
Sex							
Men	1406	(49.4)	957	(68.1)	449	(31.9)	<0.001
Women	1438	(50.6)	1101	(76.6)	337	(23.4)	
Age (years)							
20–39	752	(26.4)	488	(64.9)	264	(35.1)	<0.001
40–59	1095	(38.5)	787	(72.5)	308	(28.4)	
60–79	997	(35.1)	783	(78.5)	214	(21.5)	
Marital status							
Not married	1147	(40.3)	787	(68.6)	360	(31.4)	<0.001
Married	1697	(59.7)	1271	(74.9)	426	(25.1)	
Occupation							
Company employee	958	(33.7)	644	(67.2)	314	(32.8)	<0.001
Self-employed	162	(5.7)	119	(73.5)	43	(26.5)	
Professional	113	(4.0)	78	(69.0)	35	(31.0)	
Civil servant	104	(3.7)	81	(77.9)	23	(22.1)	
Student	46	(1.6)	25	(54.3)	21	(45.7)	
Full-time homemaker	588	(20.7)	470	(79.9)	118	(20.1)	
Part-time job	389	(13.7)	272	(69.9)	117	(30.1)	
Unemployed or retired	484	(17.0)	369	(76.2)	115	(23.8)	
Residential area							
Tokyo metropolitan area ^b	893	(31.4)	658	(73.7)	235	(26.3)	0.286
Other areas	1951	(68.6)	1400	(71.8)	551	(28.2)	
Living arrangement							
Alone	494	(17.4)	345	(69.8)	149	(30.2)	0.167
With other	2350	(82.6)	1713	(72.9)	637	(27.1)	
Educational level							
University graduate or above	1477	(51.9)	1072	(72.6)	405	(27.4)	0.788
Below university graduate level	1367	(48.1)	986	(72.1)	381	(27.9)	
Annual household income							
<3 million yen [approximately <26,000 USD]	635	(22.3)	461	(72.6)	174	(27.4)	0.977
3 to <5 million yen [26,000 to <44,000 USD]	797	(28.0)	572	(71.8)	225	(28.2)	
5 to <7 million yen [44,000 to <61,000 USD]	599	(21.1)	434	(72.5)	165	(27.5)	
≥7 million yen or more [≥61,000 USD]	813	(28.6)	591	(72.7)	222	(27.3)	

^a Participants were asked whether they would share all names of people with whom they had been in contact if they tested positive for COVID-19 and were asked to share names with healthcare authorities. Two response options were provided: 'I would share all names for sure', and 'I may not share all names'. When a participant responded 'I would share all names for sure' it was determined that the participants were willing to cooperate in reporting contacts and if the participant responded 'I may not share all names', they were not willing to cooperate.

^b Tokyo metropolitan area includes Tokyo, Kanagawa, Saitama and Chiba prefectures.

^c P-value was calculated using the Chi-squared test.

were not married compared with women, those aged 60–79 years and those who were married.

The predominant reasons for willingness to cooperate in reporting contacts for COVID-19 were 'I believe this helps stop spread of COVID-19' (84.8%) and 'This way I can protect other people' (76.4%) (Fig. 1). The predominant reasons for unwillingness to cooperate were 'I would cause inconvenience for the people whose names I share' (47.6%) and 'I believe people would blame me for having revealed their name' (33.7%) (Fig. 2).

In terms of sociodemographic factors, men (odds ratio [OR]: 0.62, 95% confidence interval [95% CI]: 0.51–0.76), aged 20–39 years (OR: 0.57, 95% CI: 0.44–0.74) or 40–59 years (OR: 0.77, 95% CI: 0.62–0.96), and those with an education level less than a university degree (OR: 0.79, 95% CI: 0.66–0.95) were significant factors for not being willing to cooperate in reporting contacts (Table 2). Unemployment or retirement was a significant factor in the willingness to cooperate in reporting contacts compared with being company employees (OR: 1.39, 95% CI: 1.04–1.85).

Discussion

This study found that 27.6% of participants would not be willing to cooperate in reporting contacts for COVID-19 contact tracing. The main reasons were being concerned about causing trouble for the persons whose names were reported and being criticised for reporting these names. Some sociodemographic factors, such as sex, age and educational level, were associated with willingness to cooperate and with the motivation to report contacts. The study results can be used to understand the problems of contact tracing and to consider measures to address these issues.

Some studies have reported the potential for concealment of COVID-19 information among citizens.^{9,13,17} O'Connor et al. showed that 55% of COVID-19 patients experiencing some symptoms tried to conceal their symptoms when asked by others.¹⁷ Schneider et al. reported that only 50% of cases for COVID-19 contact tracing in the USA disclosed at least one person with whom they had been in contact.⁹ These previous studies and results from the present study

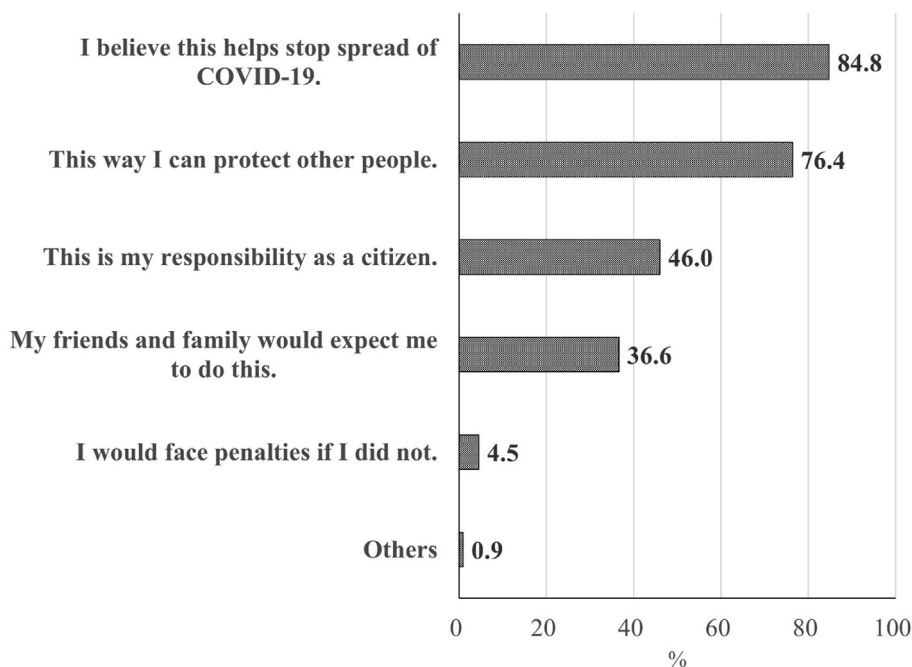


Fig. 1. Reasons for willingness to cooperate in reporting contacts for COVID-19.

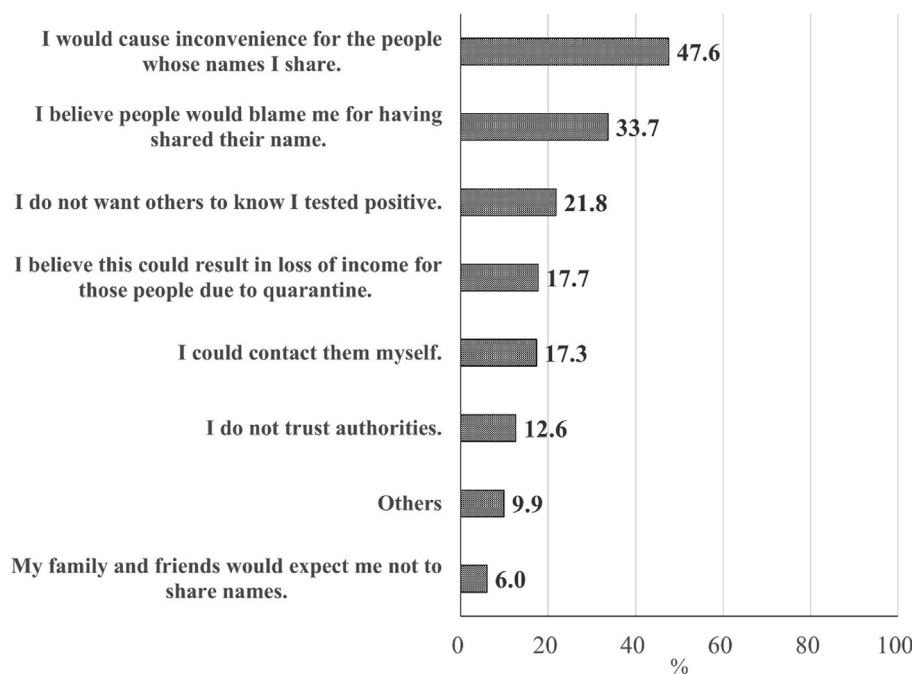


Fig. 2. Reasons for unwillingness to cooperate in reporting contacts for COVID-19.

suggest that collecting information related to COVID-19 by interviewing patients may not be sufficient to elicit necessary information, even if all the contacts are recollected.

The current results showed that participants who were men, young adults or those with a low educational level tended to be unwilling to cooperate in reporting contacts, compared with participants who were women, older adults or had a higher level of education. When contact tracing by interview is performed with men, young adults or those with a low educational level, it is

important to consider that it may not be possible to elicit all contact persons. Regarding differences by sex, a previous study reported that women tend to be more open with communication about their health needs than men.¹⁸ In the context of COVID-19, it has been reported that women are less likely than men to conceal information, such as COVID-19-related symptoms.¹⁷ Regarding age, previous studies have reported that honesty increases with adulthood, and a similar tendency has been reported for COVID-19-related health information.^{17,19,20} The differences in the willingness to

Table 2
Individual factors associated with willingness to disclose persons with whom they have had contact.

Characteristic	N	Odds ratio ^a	95% Confidence interval	P-value
Sex				
Men	1406	0.62	(0.51–0.76)	<0.001
Women	1438	1.00		
Age (years)				
20–39	752	0.57	(0.44–0.74)	<0.001
40–59	1095	0.77	(0.62–0.96)	0.023
60–79	997	1.00		
Marital status				
Not married	1147	1.00		
Married	1697	1.07	(0.85–1.35)	0.549
Occupation				
Company employee	958	1.00		
Self-employed	162	1.24	(0.84–1.83)	0.271
Professional	113	0.96	(0.63–1.48)	0.860
Civil servant	104	1.59	(0.98–2.59)	0.062
Student	46	0.65	(0.35–1.21)	0.173
Full-time homemaker	588	1.21	(0.88–1.66)	0.234
Part-time job	389	0.95	(0.72–1.27)	0.745
Unemployed or retired	484	1.39	(1.04–1.85)	0.027
Residential area				
Tokyo metropolitan area ^b	893	1.10	(0.91–1.32)	0.333
Other	1951	1.00		
Living arrangement				
Alone	494	1.00		
With other	2350	1.02	(0.78–1.33)	0.882
Educational level				
University graduate or above	1477	1.00		
Below University graduate level	1367	0.79	(0.66–0.95)	0.013
Annual household income				
<3 million yen [approximately <26,000 USD]	635	0.97	(0.73–1.27)	0.805
3 to <5 million yen [26,000 to <44,000 USD]	797	0.92	(0.73–1.17)	0.496
5 to <7 million yen [44,000 to <61,000 USD]	599	1.01	(0.79–1.29)	0.954
≥7 million yen or more [≥61,000 USD]	813	1.00		

^a Odds ratios were calculated and adjusted for all individual variables.
^b Tokyo metropolitan area included Tokyo, Kanagawa, Saitama and Chiba prefectures.

cooperate by sex and age in our results may be due to such differences in open communication and honesty. Meanwhile, the difference in willingness to cooperate in reporting contacts by educational level in the present study results may be because of the difference in perceived social stigma level related to COVID-19 infection. Social stigma associated with COVID-19 infection is one of the factors that inhibit willingness to cooperate in reporting contacts among citizens.^{7,8} The perceived social stigma level varies by individual. Perry reported that individuals with low educational levels have a high level of perceived social stigma associated with COVID-19 infection.⁸

A previous study in the USA showed that social and economic insecurity was associated with unwillingness to cooperate with COVID-19 contact tracing.⁸ However, the present study results showed no association between household income level and willingness to cooperate in contact tracing. The possible factor contributing to this difference may be the dissimilarity in health-care costs associated with COVID-19 in the two countries. One of the reasons underlying the unwillingness of economically insecure persons in the USA to cooperate relates to concerns about medical costs.⁸ In contrast, in Japan, most of the costs of testing and treatment related to COVID-19 are covered by medical insurance and public funds, and the cost to the individual is minimal.²¹ Thus, household income may not impact the willingness to cooperate with COVID-19 contact tracing in Japan.

The extent to which a contact can be identified depends on the memory and willingness of the patient or the individual's caregiver.² In the present study, the main reasons for not being willing to cooperate to report contacts were concerns about causing trouble for the persons whose names were reported and about

being criticised for reporting them. This result may suggest that not only social stigma associated with COVID-19 but also concerns about the burden that would be placed on the contact persons if they needed to be quarantined, and the problems that arise when contact is brought to light, may lower the willingness to cooperate with contact tracing among citizens in Japan. Further research may be needed to clarify the association between these factors and willingness to cooperate with contact tracing. Regarding social stigma, WHO guidelines on social stigma associated with COVID-19 state measures to prevent stigma, such as using people-first language that respects and empowers people, spreading the facts and engaging social influencers.⁷ To improve the willingness to cooperate with COVID-19 contact tracing, an educational campaign based on these recommendations and involving social media may be important.⁷ In addition, if the contacted person needs to be quarantined, they may incur financial losses, particularly for those in informal or hourly employment. Individuals may face other problems, such as being dismissed or penalised for missing important opportunities, not appearing at court hearings or being unable to take school examinations. Legislation and a system for compensating financial losses and preventing penalties due to quarantine may be required.³ Furthermore, there could be some contacts in an individual's life that they may not wish to disclose, such as cheating on their partner, gatherings related to their sexuality and parties or assemblies where anonymity is required. It is possible that the individual may feel uneasy about disclosing information of such contacts so as not to cause trouble for themselves and the contacted persons. It is important to understand that there are such circumstances in the lives of individuals and to offer discretion.²² A system that ensures privacy and anonymity during

contact tracing and testing may be a factor in mitigating these concerns.²² The extent to which contact information can be elicited depends not only on the willingness to cooperate but also on the individual's memory; thus, it is important that the interviewer is trained to successfully elicit relevant information from the individual's memories and use digital technology.^{2,12,23}

The strengths of the present study include the large sample size and selection of participants from all regions of Japan using quota sampling. However, there are some limitations of this study that must be considered. First, participants were recruited from a single Internet research company; thus, the results may be impacted by this selection bias. Second, the degree of willingness to cooperate in reporting contacts was not measured in this study. There may be varying degrees of willingness to cooperate, ranging from very uncooperative to very cooperative, considering that there may be some information of contacts that they wish to conceal, among participants who answered that they might not share all names. In addition, the degree of willingness to disclose contacts may be different based on the type of contact person, such as work colleagues, private acquaintances and family members. Third, in this study, we evaluated the willingness to cooperate in reporting contacts if the participants tested positive for COVID-19. We did not evaluate the willingness in any actual COVID-19 patients. The willingness to cooperate among actual COVID-19 patients may differ from the results of this study. Fourth, the participants were asked to respond with a choice of reasons why they would or would not cooperate with contact tracing; however, the options presented may not completely or clearly represent the true reason for the participant. To clarify the reasons, it may be necessary to use a questionnaire based on the principles of creating patient-reported outcome measures, such as conducting focus group interviews and checking validity and reliability. Fifth, the results may only be directly applied to Japanese populations. Japan is a more collective society than most Western countries.²⁴ The willingness to cooperate in reporting contacts in the Japanese population may be higher than in Western countries, since Japanese people may put the interests of society ahead of personal privacy. In the case of other populations with different cultural, ethnic and geographical backgrounds, the proportion of participants who are not willing to cooperate in reporting contacts may be very different. Despite these limitations, to the best of our knowledge, no previous study has clarified the willingness to cooperate in reporting contacts for COVID-19 contact tracing in Japan or evaluated their motivation, or assessed the associated sociodemographic factors.

In conclusion, for COVID-19 contact tracing in Japan, this study found that 27.6% of participants would not be willing to cooperate in reporting all persons with whom they have had contact, mainly due to concerns about causing problems for the persons whom they are reporting and being criticised for reporting their names. The results indicate that the willingness to cooperate in reporting contacts was lower among several sociodemographic groups, such as men, those aged 20–59 years and those with an educational level less than a university degree. To improve the effectiveness of contact tracing, educational campaigns to reduce the fear and stigma associated with COVID-19 may be important. In addition, the present study results also suggest that unwillingness to cooperate with contact tracing in Japan is not only due to social stigma associated with COVID-19 but also concerns about the burden placed on the contact persons if they needed to be quarantined and problems that arise when the contact is brought to light. It may be necessary to understand that individuals have contacts they do not wish to disclose to others and to be considerate when handling such situations. These results may be useful in enhancing the

efficacy of contact tracing for COVID-19 and other contagious infections in the community.

Author statements

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Ethical approval

This study was approved by the Ethics Committee of Tokyo Medical University, Tokyo, Japan (No: T2019-0234). Informed consent was obtained from all respondents.

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Competing interests

The authors declare that they have no competing interests.

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Original Research

Vaccination, life expectancy, and trust: patterns of COVID-19 and measles vaccination rates around the world

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ABSTRACT

Objectives: We estimate patterns of covariation between COVID-19 and measles vaccination rates and a set of widely used indicators of human, social, and economic capital across 146 countries.

Study design: We conduct exploratory analyses of social patterns that uphold vaccination success for COVID-19 and measles.

Methods: We use publicly available data on COVID vaccination rates and other country-level indicators from Our World in Data, Human Development Report, Corruption Perception Index, and the World Bank to devise bivariate correlations and multiple regression models.

Results: About 70% of the variability in COVID-19 vaccination rates in February 2022 can be explained by differences in the Human Development Index (HDI) and, specifically, in life expectancy at birth. Trust in doctors and nurses adds predictive value beyond HDI, clarifying controversial discrepancies between vaccination rates in countries with similar levels of HDI and vaccine availability. Cardiovascular disease deaths, an indicator of general health system effectiveness, and infant measles immunization coverage, an indicator of country-level immunization effectiveness, are also significant, though weaker, predictors of COVID-19 vaccination success. Measles vaccination in 2019 is similarly predicted by HDI and trust in doctors and nurses.

Conclusions: The remaining variability in COVID-19 vaccination success that cannot be pinned down through these sets of metrics points to a considerable scope for collective and individual agency in a time of crisis. The mobilization and coordination in the vaccination campaigns of citizens, medical professionals, scientists, journalists, and politicians, among others, account for at least some of this variability in overcoming vaccine hesitancy and inequity.

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Introduction

Comedian Dave Barry recalled his mother telling him, ‘Son, it is better to be rich and healthy than poor and sick’.¹ This still holds when examining COVID-19 vaccination patterns worldwide. In this article, we discuss the relative contribution to predicting COVID-19 and measles vaccination rates from a set from widely used, publicly available indicators of human, social, and economic capital.

There has been a significant increase in life expectancy over the last two hundred years in many societies. Humankind has become

more adept, collectively, to sustain life for its members, although externalities, in terms of climate impact, have begun to raise doubt on the longer-term prospects of this accomplishment. Life expectancy serves as a synthetic measure of the capacity of society to prevent death in a certain period. Given that the avoidance of death is one of humankind’s major goals, life expectancy is, therefore, a useful metric to capture the effectiveness of social organization for public health at a certain time and place.

Vaccination has played a considerable role in reducing the mortality inflicted by preventable diseases² over the last two centuries. Vaccines have been, therefore, an important cause of the recent increase in life expectancy across the world. This also holds true for the COVID-19 pandemic, which has visibly lowered life expectancy in most countries.^{3,4} There is convincing evidence that vaccination against COVID-19 has prevented numerous deaths globally.^{5,6}

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At the same time, rates of vaccination have varied widely during the pandemic. Societal resources shape a collectivity's ability to immunize its members against infection through vaccination.⁷ COVID-19 vaccination has been unevenly implemented because of differences in availability of vaccines, uneven logistics of vaccine distribution, and people's variable trust in vaccines and mainstream science and expertise.^{8–12} In this article, we explore and discuss the correlation between the success of vaccination campaigns against COVID-19 in mid-2021 and early 2022 and pre-pandemic life expectancy (estimated in 2019), alongside other measures of human, social, and economic capital, at country level. Our study aimed to answer an essential question: What can such broad patterns of co-variation in vaccination success tell us about the social structures and forms of agency that keep people alive?

Human, social, and economic resources have been of utmost importance in COVID-19 vaccination. They have facilitated earlier access to vaccines and powered the required logistics of a large-scale vaccination campaign. Several studies signalled a positive association between coverage of COVID-19 vaccination, the Human Development Index (HDI), and gross domestic product (GDP) per capita.^{13–16} These studies suggest that GDP per capita and HDI are foci of attention in ecological analyses of COVID-19 vaccination, highlighting vaccine inequity and the importance of social development for a successful vaccination program, or serving as control variables for other predictors. Education and GDP per capita have been shown to contribute to the speed of the COVID-19 vaccination campaign.¹⁷ A positive correlation between measles vaccination and HDI has also been noted.¹⁸ Trust in the state and in the health system has been associated with greater compliance with COVID-19 restrictions in Europe.¹⁹ Generalized trust has contributed to higher resilience against COVID-19 infections and deaths according to Lenton et al.,²⁰ though their study does not discuss the role of vaccination as a possible mediating variable. Trust in medical and scientific experts has been a strong correlate of pro-vaccination attitudes in general^{21–24} and of the declared intention to receive a COVID-19 vaccine internationally.^{25–27} An ecological study of 89 countries documents predictive value for community health skills, importance of religion, and social freedom, when controlling for GDP per capita.²⁸ Social and economic inequality has been associated with lower COVID-19 vaccination rates aggregated at country level,²⁹ and the Gini index has been shown to correlate with vaccination success in bivariate analysis, but not when controlling for GDP.³⁰ Indicators of corruption in the public sector are significant predictors of COVID-19 vaccination in August 2021 when controlling for GDP per capita and strength of the health system,³¹ without controlling for life expectancy or education. Perceived corruption is associated with decreased vaccination coverage globally³² and it also affects trust in mainstream health policy, exacerbating vaccination hesitancy.³³

Although GDP per capita and HDI are often used as predictors in country-level studies, we opt to decentre the focus on societal wealth and to examine independently all three components of HDI—specifically, Gross National Income (GNI) per capita, life expectancy, and national education metrics. We also include a wider array of predictors in an exploratory, comparative analysis, including metrics of trust in the health system and metrics of health system performance. This enables us to empirically identify the high predictive importance of life expectancy, a variable that has been largely neglected in previous ecological analyses of COVID-19 vaccination.

Studies of COVID-19 vaccines have increased since 2020, as was expected,³⁴ but they usually focus on the COVID-19 vaccine without connecting it to other vaccines. We choose to compare predictors' relevance for COVID-19 vaccination with their relevance for measles vaccination, thereby connecting this emerging thread of

research with the broader study of vaccination campaigns' success or failure.

Methods

We accessed publicly available data on COVID vaccination rates and other country-level indicators of human, social, and economic capital from the data sets of Our World in Data (OWID),³⁵ the metrics included in the 2020 Human Development Report (HDR) of the United Nations Development Programme,³⁶ the Corruption Perception Index computed by Transparency International,³⁷ and World Bank data on poverty rates.³⁸ We included in the study all countries and territories with a population larger than 1 million and available information for vaccination rates, according to OWID data, resulting in 146 units of analysis.^d The indicators concerning the 'share of people who trust their national governments' and the 'share of people who trust doctors and nurses in their country' were centralized and published by OWID, using the Wellcome Global Monitor data set.³⁹

Our first dependent variable of interest was the rate of fully vaccinated people, per hundred, measured at two points in time: July 31, 2021 (or the closest day to July 31, 2021) and February 4, 2022 (or the closest day to February 4, 2022). The second dependent variable, included for comparison purposes, is the rate of infants immunized against measles at 1 year of age, in 2019, as reported by HDR. The descriptive statistics and sources for the predictors included in the analysis are presented in the [Supplementary Material, Table S.M.1](#). The control variable for partial correlations was HDI, which aggregates three dimensions: 1) life expectancy at birth; 2) an education index composed of mean years of schooling and expected years of schooling; and 3) GNI per capita.³⁶

Results

An exploration of bivariate correlations indicated a strong relationship between COVID-19 vaccination rates and HDI (bivariate $r = 0.826$ in February 2022, $P = 0.000$). The relationship changed from an exponential to a linear shape during the vaccination campaign from July 2021 ([Fig. 1](#)) to February 2022 ([Fig. 2](#)). In mid-2021, there was a much more abrupt co-variation of vaccination success with HDI, compared with the later stage, when access to vaccines was more widespread and countries' own resources for large-scale collective action became more relevant.

Therefore, an exponential regression model ($R^2 = 66.7\%$) is better fitted for the observed data in July than a linear regression model ($R^2 = 48.3\%$). For February 2022, a linear model is better suited to model the relationship between HDI and vaccination rate ($R^2 = 68.0\%$) than an exponential model ($R^2 = 62.5\%$). A logarithmic model is marginally less fitted ($R^2 = 66\%$) than a linear one, anticipating a turn toward a logarithmic-shaped relationship as more countries on the HDI continuum evolve toward the plateau of high vaccination rates.

A bivariate analysis of vaccination rates and multiple indicators of human, social, and economic capital indicates a broad pattern of covariation ([Table 1](#)). Vaccination rates are higher, on average, in countries with better outcomes in health and education, higher inputs into the health system, lower inequality, lower poverty rates, lower perceived corruption, and higher trust rates.

The indicators that stand out in this pattern through their relative predictive power (other than aggregate HDI) are life expectancy at birth and GNI per capita. Life expectancy at birth

^d The countries included in the analysis are listed in the [Supplementary Material](#).

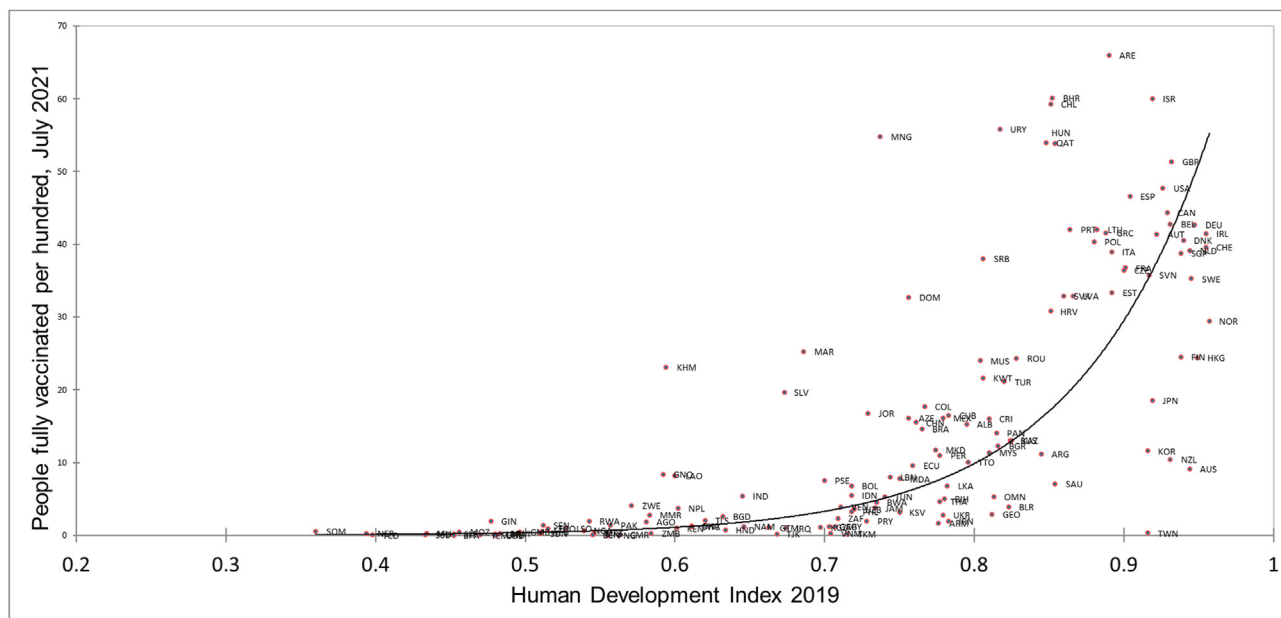


Fig. 1. Scatterplot of rates of fully vaccinated people in July 2021 vs. HDI 2019. Source: Authors' analysis of data from Our World in Data and UNDP Human Development Reports. Linear Pearson correlation: $R = 0.695$ ($P = 0.000$).

correlates at 0.836 with the vaccination rate in February 2022, explaining about 70% of its total variance.^e GNI per capita correlates at 0.706 with vaccination rates in February 2022, explaining about 50% of the total variance, which makes it the second strongest predictor in the bivariate analysis. Mean years of schooling also correlates at 0.688 with the February 2022 vaccination rate.

The three components of HDI have differential predictive power for COVID-19 vaccination success (Table 2). A multiple regression model of the vaccination rate in February 2022 on the three dimensions of HDI (Model 1 includes mean years of schooling, and Model 2 includes expected years of schooling) indicates that, when controlling for the other dimensions, the strongest predictor remains life expectancy. The model including all three HDI dimensions does not lead to a substantial increase in predictive power. This is because life expectancy, GNI per capita, and mean and expected years of schooling are strongly intercorrelated and the latter do not contribute much in terms of additional explanatory power.

The educational component of HDI and GNI per capita are less powerful predictors than life expectancy in a multivariate model. Either of education or GNI per capita may be statistically significant, but not both, depending on the chosen indicator for education (Model 1 and Model 2). The mean value of years of schooling in Model 1 is not a statistically significant predictor, but GNI per capita is. In Model 2, the expected value for years of schooling retains statistical significance, but GNI per capita does not. In Model 3, we see that life expectancy is the strongest predictor for measles vaccination, followed by mean years of schooling. The same holds if we include expected years of schooling instead.

Going back to partial correlations, other indicators of educational outcome at country level do not add predictive power beyond HDI. There are statistically significant bivariate correlations between vaccination rates and Programme for International Student Assessment (PISA) scores (Table 1). Still, the partial

^e The inequality of life expectancy, estimated in HDR, is also strongly correlated with vaccination rate, but it is collinear with life expectancy, and thus, it does not add predictive information.

correlations for each of the PISA scores become statistically insignificant when controlling for HDI, life expectancy, or GNI (PISA scores are only available for 67 countries). This indicates that, at country level, literacies influence vaccination success insofar as they translate into higher life expectancy and GNI.

Although a wide variety of indicators of human, social, and economic capital are correlated with vaccination success, both in July 2021 and February 2022, their predictive relevance is overlapping with HDI. As we can see in Table 1, partial correlations when controlling for HDI are, as a rule, statistically insignificant. Two indicators of social capital contribute to predicting vaccination success beyond HDI: the share of people who trust doctors and nurses and the share of people who trust their national government. Trust seems to play a significant role in the country-level success of COVID-19 vaccination and also of measles immunization.

Indicators of health system effectiveness retain statistically significant partial correlations with the vaccination rate in February 2022 when controlling for HDI. Cardiovascular (CVD) death rate has a partial correlation of -0.300 ($P = 0.000$), and the proportion of infants immunized for measles before 1 year of age has a partial correlation of 0.231 ($P = 0.006$). Although CVD prevalence is higher in more developed countries, the associated mortality is higher in less developed countries. This makes this indicator a powerful proxy to capture the effectiveness of a country's medical system and overall social organization in increasing lifespan. The proportion of infants immunized for measles is a more specific indicator, pointing to a country's performance in vaccination infrastructure. The prevalence of diabetes is not correlated with the COVID vaccination rate when controlling for HDI, despite diabetes being a risk factor for severe COVID infections, which was associated with priority in the early vaccination campaigns.

The pattern of correlations for predicting infant measles vaccination for 1-year olds is very similar with COVID-19 vaccination. The strongest bivariate predictors are life expectancy and HDI. When controlling for HDI, trust in the national government and trust in doctors and nurses remain statistically significant, but other indicators do not — except national poverty rates, which are relevant for measles but not for COVID-19 vaccination. Conversely, CVD

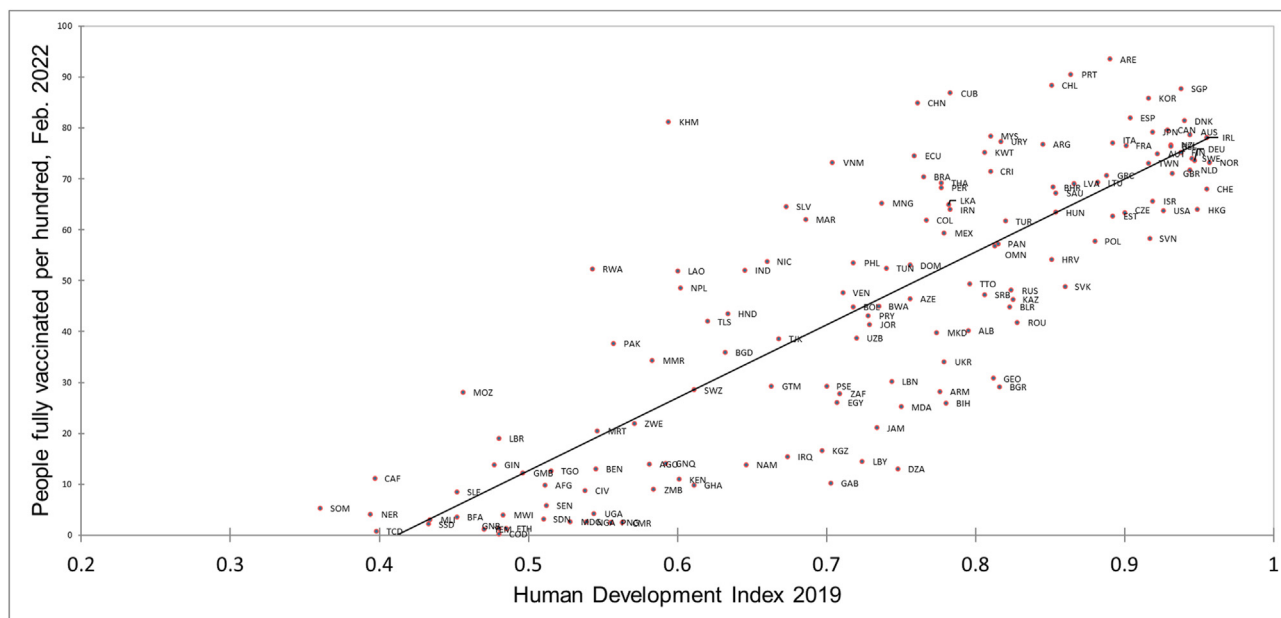


Fig. 2. Scatterplot of rates of fully vaccinated people in February 2022 vs. HDI 2019. Source: Authors' analysis of data from Our World in Data and UNDP Human Development Reports. Linear Pearson correlation: $R = 0.826$ ($P = 0.000$).

death rate remains significant for COVID-19 vaccination when controlling for HDI, but not for measles.

In Table 3, we estimated a multiple linear regression of vaccination rates in February 2022 on HDI and the predictors that retained statistical significance when controlling for HDI: trust in doctors and nurses, trust in national government, infants immunized for measles, and CVD death rate. In Model 4, HDI remained the strongest predictor of vaccination success. The share of people who trust doctors and nurses and trust in the national government are no longer statistically significant, when they are both included in the model. The other two health outputs remained statistically significant. We then excluded trust in the national government in Model 5, given that it correlates highly with trust in doctors and nurses. As a result of this model respecification, in Model 5, trust in doctors and nurses became statistically significant. In Model 5, the national poverty rate is also a marginally statistically significant predictor for COVID-19 vaccination.

As discussed before, a similar understanding holds for measles vaccination (Table 3, Model 6). HDI is also the strongest predictor of the rate of infants immunized for measles. The lower beta coefficient also reflects the nonlinear relationship, which is better approximated by a logarithmic curve, because of the vaccination plateau (Fig. 3). Therefore, the predictive relevance of HDI goes beyond COVID-19 vaccination, covering previous, better institutionalized vaccines as well. The rate of trust in doctors and nurses is also a significant predictor of measles vaccination. CVD rate does not add a statistically significant predictive power for measles vaccination. Neither does the national poverty rate, despite having a significant partial correlation when controlling for HDI.

The relationship between COVID-19 vaccination rates and trust in doctors and nurses, while controlling for HDI and other country-level health outcomes, is useful to clarify divergences that rank prominently in public debate. The Gallup 2019 report shows that, globally, 41% of people trust medical staff 'a lot', but there is wide variability in this distribution. The proportion is highest in Western Europe (68%) and Northern Europe (65%), Australia and New Zealand (65%), South Asia (61%), going to 52% in North America, 45–46% in Southern Europe and Southern Africa, 35% in the Middle

East, Central America and Mexico, 30% in North Africa, 28% in South America, and plummeting to 25% in Eastern Europe, East Asia, and Central Africa.³⁹ What we find noteworthy is covarying with the success of COVID-19 vaccination, particularly regarding the lag of the US in relation to other high HDI countries, and the differences between Romania and Bulgaria in Eastern Europe compared with the countries of Southern Europe. Therefore, trust in medical staff can explain why COVID-19 vaccination trajectories among countries in the same HDI categories have been quite different (See Fig. S.M.1 in the Supplementary Material).

Specific pandemic policies have also played a role in the success of vaccination campaigns. We can examine their influence by using the Stringency Index computed in the Oxford COVID-19 Government Response Tracker program (OxCGRT),⁴⁰ which synthesizes governmental measures during COVID-19, covering closure and containment such as social distancing and lockdowns, health policies and vaccination, and economic support mitigating the impact of the pandemic. Since January 1, 2022, OxCGRT has begun reporting distinct values of stringency for vaccinated and unvaccinated people, in countries where policies are differentiated. By subtracting the vaccinated from the unvaccinated stringency index, we obtain a measurement of governmental incentives to vaccinate. The differential index values cannot be used in a quantitative analysis as predictors for vaccination rates in February 2022, because the data set is incomplete for the reference dates of January–February 2022, as many values have been added subsequently (March 2022 and later). Still, we can inquire into the countries with the highest differences in stringency, as highlighted by OxCGRT⁴¹ and see how they fare as regards COVID-19 vaccination success, in February 2022. For each country included in the top list for highest maximum and average differences in stringency between the unvaccinated and the vaccinated, we examined whether the country is much higher (++) , higher (+) , below (–) , or much below (––) the linear regression line between vaccination and HDI, as presented in Fig. 2. We find that Ukraine (––) lies much below the line, Germany (–) lies slightly below the line, whereas all others can be found either on the line (Oman and Hungary) or above the line: France (+) , Lithuania (+) , Turkey (+) , Argentina

Table 1

Bivariate Bravais–Pearson correlations and partial correlations controlling for HDI 2019 between vaccination rates and indicators of human, economic, and social capital indicators.

Variables	Bivariate correlations					Partial correlations when controlling for the HDI 2019		
	Metric	People fully vaccinated per hundred, Feb. 2022 (OWID)	People fully vaccinated per hundred, July 2021 (OWID)	Infants immunized for measles for 1-year olds, 2019 (HDR)	Human Development Index (HDI) 2019	Metric	People fully vaccinated per hundred, Feb. 2022 (OWID)	Infants immunized for measles at 12 months, 2019 (%) (UNDP HDR)
People fully vaccinated per hundred, Feb. 2022 (OWID)	Pearson correlation	1	0.739**	0.623**	0.847**	N/A		
	Sig. (2-tailed)		0.000	0.000	0.000		x	
	N	146	130	142	139			
People fully vaccinated per hundred, July 2021 (OWID)	Pearson correlation	0.693**	1	0.404**	0.695**	N/A		
	Sig. (2-tailed)	0.000		0.000	0.000			
	N	138	144	139	143			
Human Development Index (HDI) 2019	Pearson correlation	0.826**	0.695**	0.622**	1	N/A		
	Sig. (2-tailed)	0.000	0.000	0.000				
	N	145	143	147	152			
Life expectancy at birth 2019 (HDI component)	Pearson correlation	0.836**	0.647**	0.638**	0.923**	N/A		
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Component of HDI		
	N	146	144	148	152			
Mean years of schooling 2019 (HDI component)	Pearson correlation	0.688**	0.594**	0.575**	0.924**	N/A		
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Component of HDI		
	N	145	142	147	150			
Expected years of schooling 2019 (HDI component)	Pearson correlation	0.788**	0.643**	0.575**	0.915**	N/A		
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Component of HDI		
	N	142	139	147	147			
GNI per capita 2019 in 2017 PPP (HDI component)	Pearson correlation	0.706**	0.744**	0.422**	0.818**	N/A		
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Component of HDI		
	N	142	139	147	147			
Inequality in life expectancy 2015–2020 (HDR data set)	Pearson correlation	−0.793**	−0.641**	−0.668**	−0.936**	N/A		
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Collinear with HDI		
	N	143	140	148	148			
Inequality in education 2019 (HDR data set)	Pearson correlation	−0.663**	−0.530**	−0.584**	−0.847**	N/A		
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Collinear with HDI		
	N	137	135	142	143			
Inequality in income 2019 (HDR data set)	Pearson correlation	−0.286**	−0.337**	−0.302**	−0.378**	Partial correlation	0.037	−0.099
	Sig. (2-tailed)	0.001	0.000	0.000	0.000	Sig. (2-tailed)	0.683	0.266
	N	126	123	130	131	df	123	127
Gini Index 2019 (HDR data set)	Pearson correlation	−0.298**	−0.242**	−0.262**	−0.335**	Partial correlation	−0.023	−0.092
	Sig. (2-tailed)	0.001	0.006	0.002	0.000	Sig. (2-tailed)	0.799	0.293
	N	132	130	134	137	df	128	130
PISA Score for Reading 2018 (OWID)	Pearson correlation	0.529**	0.428**	0.295*	0.791**	Partial correlation	0.159	0.082
	Sig. (2-tailed)	0.000	0.000	0.016	0.000	Sig. (2-tailed)	0.209	0.518
	N	65	67	66	67	df	62	63
PISA Score for Mathematics 2018 (OWID)	Pearson correlation	0.451**	0.375**	0.309*	0.748**	Partial correlation	0.044	0.113
	Sig. (2-tailed)	0.000	0.002	0.011	0.000	Sig. (2-tailed)	0.727	0.367
	N	66	68	67	68	df	63	64
PISA Score for Science 2018 (OWID)	Pearson correlation	0.513**	0.379**	0.285*	0.732**	Partial correlation	0.168	0.080
	Sig. (2-tailed)	0.000	0.001	0.019	0.000	Sig. (2-tailed)	0.182	0.522
	N	66	68	67	68	df	63	64
World Bank - Poverty ratio	Pearson correlation	−0.641**	−0.580**	−0.560**	−0.670**	Partial correlation	−0.225	−0.261
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Sig. (2-tailed)	0.116	0.061
	N	51	51	50	51	df	48	47
	Pearson correlation	−0.637**	−0.494**	−0.536**	−0.705**	Partial correlation	−0.167	−0.213*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Sig. (2-tailed)	0.066	0.018

World Bank - National poverty ratio	N	123	120	125	127	df	119	121
Extreme poverty rate (OWID)	Pearson correlation	-0.654**	-0.468**	-0.389**	-0.770**	Partial correlation	-0.068	0.065
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Sig. (2-tailed)	0.496	0.521
	N	145	97	102	103	df	100	99
Corruption Perception Index CPI 2020 (Transparency International)	Pearson correlation	0.689**	0.663**	0.480**	0.766**	Partial correlation	0.135*	-0.004
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Sig. (2-tailed)	0.109	0.965
	N	144	142	146	150	df	140	142
Share of people who trust their national government 2018 (OWID, from Wellcome Global Monitor)	Pearson correlation	0.053	-0.069	0.182*	-0.066	Partial correlation	0.217*	0.266*
	Sig. (2-tailed)	0.564	0.462	0.046	0.463	Sig. (2-tailed)	0.018	0.003
	N	120	116	121	124	df	117	118
Share of people who trust doctors and nurses in their country 2018 (OWID, from Wellcome Global Monitor)	Pearson correlation	0.575**	0.413**	0.497**	0.536**	Partial correlation	0.267*	0.272*
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Sig. (2-tailed)	0.002	0.002
	N	129	126	131	134	df	126	128
Health expenditure % of GDP in 2017 (HDR data set)	Pearson correlation	0.348**	0.326**	0.270**	0.387**	Partial correlation	0.014	0.054
	Sig. (2-tailed)	0.000	0.000	0.001	0.000	Sig. (2-tailed)	0.868	0.523
	N	138	136	142	144	df	135	139
Physicians per 1000 people 2019 (HDR data set)	Pearson correlation	0.620**	0.576**	0.511**	0.775**	Partial correlation	-0.033	0.076
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Sig. (2-tailed)	0.698	0.368
	N	139	136	145	144	df	135	141
Hospital beds per 1000 people 2019 (HDR data set)	Pearson correlation	0.394**	0.309**	0.399**	0.564**	Partial correlation	-0.149	0.078
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	Sig. (2-tailed)	0.092	0.375
	N	131	128	135	134	df	127	131
Cardiovascular death rate (OWID)	Pearson correlation	-0.497**	-0.376**	-0.221**	-0.410**	Partial correlation	-0.300**	0.055
	Sig. (2-tailed)	0.000	0.000	0.008	0.000	Sig. (2-tailed)	0.000	0.520
	N	145	137	142	144	df	141	138
Prevalence of diabetes (OWID)	Pearson correlation	0.238**	0.120	0.125	0.269**	Partial correlation	0.031	-0.056
	Sig. (2-tailed)	0.004	0.165	0.139	0.001	Sig. (2-tailed)	0.714	0.509
	N	144	136	141	144	df	141	138
Infants immunized for measles at 12 months, 2019 (%) (UNDP HDR)	Pearson correlation	0.623**	0.404**	1	0.622**	Partial correlation	0.231**	N/A
	Sig. (2-tailed)	0.000	0.000		0.000	Sig. (2-tailed)	0.006	
	N	142	139	148	147	df	138	

Partial correlations that are statistically significant for $P = 5\%$ are marked in bold.

Source: Authors' analysis on publicly available data from OWID, UNDP HDR, Transparency International, and The World Bank.

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

Table 2
Multiple regression model of the rate of people fully vaccinated in Feb. 2022 on HDI components: life expectancy, GNI per capita and mean years of schooling in 2019.

Independent variables:	Model 1 Dependent variable: People fully vaccinated (%), February 2022		Model 2 Dependent variable: People fully vaccinated (%), February 2022		Model 3 Dependent variable: Infants immunized for measles at 12 months (%), 2019	
	Beta	Sig.	Beta	Sig.	Beta	Sig.
Life expectancy at birth 2019	0.674**	0.000	0.522**	0.000	0.513**	0.000
GNI per capita 2019 (in 2017 PPP)	0.206**	0.006	0.113	0.121	−0.140	0.150
Mean years of schooling 2019	0.003	0.968	N/A		0.275*	0.011
Expected years of schooling	N/A		0.270**	0.002	N/A	
Listwise N	142		142		147	
Adjusted R square	0.700		0.719		0.408	

Source: Authors' analysis of publicly available data from UNDP HDR and Our World in Data.

Coefficients that are statistically significant for P = 5% are marked in bold.

** Coefficient is significant at the 0.01 level (2-tailed).

* Coefficient is significant at the 0.05 level (2-tailed).

(++), Colombia (++), Ecuador (++), Italy (++), Morocco (++), and Pakistan (++). This incipient analysis suggests a pattern of positive influence from differential stringency on vaccination success. Future research should further explore the influence of specific incentives on vaccination, using the OxCGRT data set and other measurements of governmental intervention.

Discussion

Our exploratory analysis of social patterns that uphold vaccination success, in the case of COVID-19 and measles, highlights the role of HDI as the strongest predictor among a set of widely used measures of human, social, and economic capital. This finding is convergent with previous research. However, while most studies focus on the income component of HDI, we find that, among the three HDI dimensions, life expectancy is most relevant in accounting for COVID-19 and measles vaccination success, despite being largely neglected in previous ecological analyses of COVID-19 vaccination.

Education outcomes, measured through mean years of schooling, expected years of schooling, or PISA results, add less explanatory power than life expectancy, in regard to COVID-19 and

measles vaccination. This supports the argument that vaccination success is less a matter of overcoming deficits in scientific literacy, and more a matter of establishing public trust in a health system and science with proven anterior performance in keeping people healthy and alive.¹²

In accord with previous research at the individual level, our analysis also highlights the role of trust, specifically in doctors and nurses as a predictor of vaccination success. This indicator remains statistically significant when controlling for HDI and other generic and specific indicators of health system effectiveness (CVD mortality and measles vaccination coverage, respectively). Trust is statistically significant in partial correlation and multiple regression models of both COVID-19 and measles vaccination, while other indicators concerning economic inequality, perceived corruption, and inputs into the health system do not add predictive value beyond HDI. National poverty rates seem to remain a relevant predictor for both types of vaccination, though statistical significance is oscillating around the 5% threshold, depending on model specification.

COVID-19 vaccines prove to be part of the Matthew effect of accumulating advantages and exacerbating disadvantages that the

Table 3
Multiple regression model of vaccination rates on HDI, trust indicators, and cardiovascular death rate.

Independent variables:	Model 4 Dependent variable: COVID-19 vaccination rate in February 2022		Model 5		Model 6 Dependent variable: Infants immunized for measles at 12 months, 2019 (%)	
	Standardized coefficient Beta	Sig.	Standardized coefficient Beta	Sig.	Standardized coefficient Beta	Sig.
HDI 2019 (HDR data set)	0.588**	0.000	0.472**	0.003	0.389**	0.001
World Bank National poverty rate	−0.030	0.677	−0.145*	0.044	−0.109	0.283
Share of people who trust doctors and nurses in their country, 2018 (OWID)	0.177	0.065	0.150*	0.021	0.287**	0.001
Cardiovascular death rate	−0.197**	0.000	−0.219**	0.000	0.098	0.216
Infants immunized for measles at 12 months, 2019 (%) (UNDP HDR)	0.135**	0.020	0.143**	0.038	Dependent variable	
Share of people who trust their national government, 2018 (OWID)	−0.001	0.094	Not included		Not included	
Adjusted R square	0.753		0.703		0.395	
Listwise N	105		111		111	

Source: Authors' analysis of publicly available data from UNDP HDR and Our World in Data.

Coefficients that are statistically significant for P = 5% are marked in bold.

** Coefficient is significant at the 0.01 level (2-tailed).

* Coefficient is significant at the 0.05 level (2-tailed).

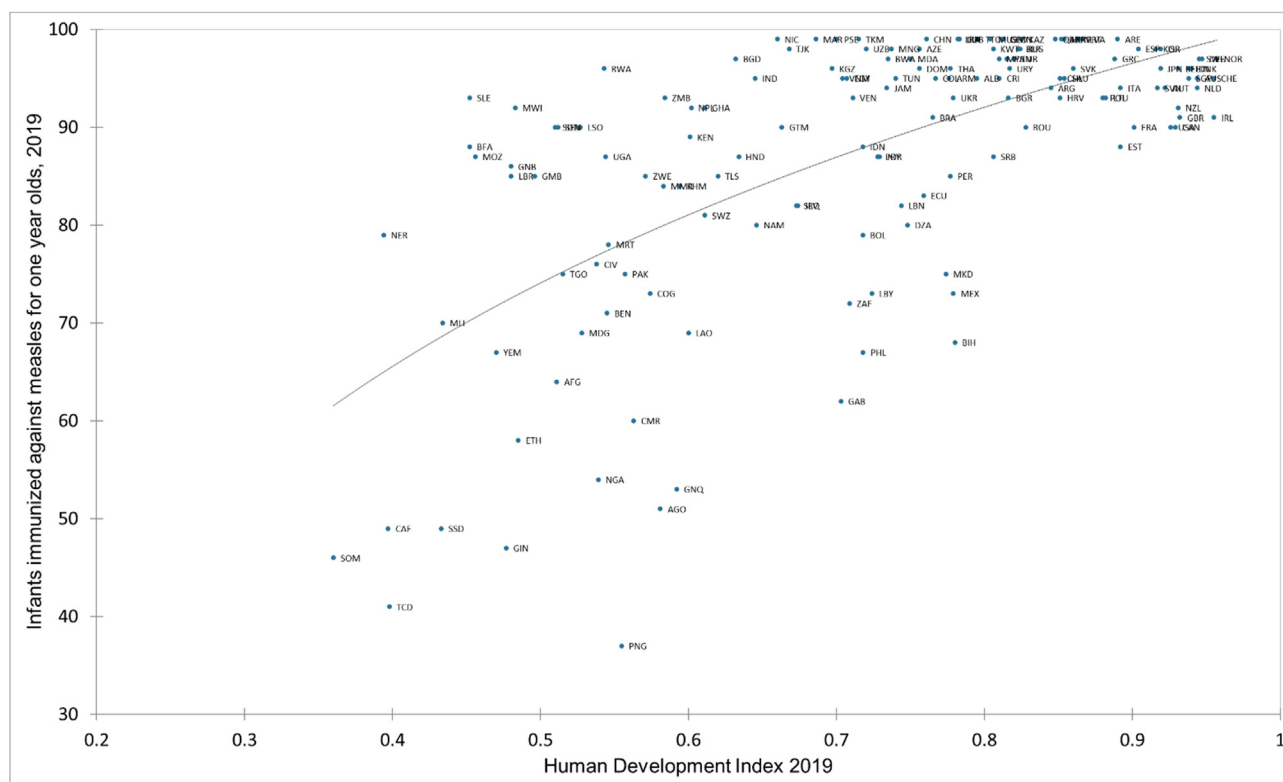


Fig. 3. Scatterplot of rates of infants immunized against measles for 1-year olds, 2019, vs. HDI 2019, with a logarithmic growth trendline. Source: Authors' analysis on data from UNDP Human Development Reports.

pandemic inflicted on societies and communities across the world.⁴² At the same time, the remaining 28% of variability that cannot be determined through these sets of metrics points to a considerable scope for collective and individual agency in a time of crisis. For example, countries with an HDI of approximately 85 ranged from rates of 40%–80% for fully vaccinated people. Differential stringency of pandemic policies, between unvaccinated and vaccinated people, may have played a role in stimulating vaccination. The mobilization and coordination in the vaccination campaigns of citizens, medical professionals, scientists, journalists, and politicians, among others, account for at least some of this variability in overcoming vaccine hesitancy and inequity.

Public health policies and campaigns should focus on consolidating trust in the medical system, especially regarding doctors and nurses, because this is an important factor for the success of vaccination programs, independent from other social development factors aggregated by HDI. This finding could be especially influential in countries that, despite having access to vaccines, lag behind desired levels of vaccination coverage. The high relevance of life expectancy as a predictor for the vaccination rate suggests that future research in this field should move beyond the focus on national income as a proxy for social development, toward a more inclusive approach that takes into account the quantity and quality of life in a given society.

For the most part, the limitations of the present study are derived from its pursuit of a wide reach, in terms of countries and variables included in the analysis, and from its ecological and correlational approach. Given that some countries do not take part in specific international research programs or reporting initiatives, there is missing data for some of the independent variables (see [Table S.M.1 in the Supplementary Material](#)), which we handled through pairwise deletion. We did not take into account internal

variability between states or regions of a given country. Measurement of all variables, at country level, could be affected by heterogeneous definitions among different national contexts and by differential performance of national data collection infrastructures. It has been documented that COVID-19 testing has been more widespread in countries with a higher governmental capacity,⁴³ and this finding may also be relevant for the country-level metrics used in this study. Therefore, some of the bivariate or partial correlations that appear to be statistically insignificant may be affected by lower measurement quality, rather than indicating, with certainty, an absence of the respective association. Like other ecological studies, our research does not purport to test any causal relationship, but to identify, through exploratory analysis, possibly influential factors at macro level. Our discussion of the role of trust in health professionals and other aggregated metrics induces a risk of an ecological fallacy, as we document a country-level association for variables that are hypothetically connected at the individual level. Last but not least, there remains a risk of omitted confounding variables, hidden beyond the observed country-level patterns.

Author statements

Ethical approval

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Competing interests

None.

Author contribution

All authors made a significant contribution to the development of this manuscript and approved the final version for submission.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2022.06.027>.

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