



The influence of sociodemographic factors on COVID-19 vaccine certificate acceptance: A cross-sectional study

David Smith, David T. Zhu, Steven Hawken, A. Brianne Bota, Salima S. Mithani, Alessandro Marcon, Gordon Pennycook, Devon Greyson, Timothy Caulfield, Frank Graves, Jeff Smith & Kumanan Wilson

To cite this article: David Smith, David T. Zhu, Steven Hawken, A. Brianne Bota, Salima S. Mithani, Alessandro Marcon, Gordon Pennycook, Devon Greyson, Timothy Caulfield, Frank Graves, Jeff Smith & Kumanan Wilson (2023) The influence of sociodemographic factors on COVID-19 vaccine certificate acceptance: A cross-sectional study, *Human Vaccines & Immunotherapeutics*, 19:2, 2220628, DOI: [10.1080/21645515.2023.2220628](https://doi.org/10.1080/21645515.2023.2220628)

To link to this article: <https://doi.org/10.1080/21645515.2023.2220628>



© 2023 The Author(s). Published with license by Taylor & Francis Group, LLC.



[View supplementary material](#)



Published online: 08 Jun 2023.



[Submit your article to this journal](#)



Article views: 892

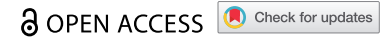


[View related articles](#)



[View Crossmark data](#)

RESEARCH ARTICLE



The influence of sociodemographic factors on COVID-19 vaccine certificate acceptance: A cross-sectional study

David Smith^{a*}, David T. Zhu^{a,b*}, Steven Hawken^{a,c}, A. Brianne Bota^a, Salima S. Mithani^a, Alessandro Marcon^d, Gordon Pennycook^e, Devon Greyson^f, Timothy Caulfield^d, Frank Graves^g, Jeff Smith^g, and Kumanan Wilson^{a,c,h,i,j}

^aClinical Epidemiology Program, Ottawa Hospital Research Institute, Ottawa, Canada; ^bDepartment of Social and Behavioral Sciences, Yale School of Public Health, New Haven, CT, USA; ^cSchool of Epidemiology and Public Health, University of Ottawa, Ottawa, Canada; ^dFaculty of Law and School of Public Health, University of Alberta, Edmonton, Canada; ^eHill/Levene Schools of Business, Department of Psychology, University of Regina, Regina, Canada; ^fSchool of Population and Public Health, University of British Columbia, Vancouver, Canada; ^gPublic Opinion Research, EKOS Research Associates Inc, Ottawa, Canada; ^hDepartment of Pediatrics, University of Ottawa, Ottawa, Canada; ⁱDepartment of Medicine, University of Ottawa, Ottawa, Canada; ^jBruyère Research Institute, Ottawa, Ontario, Canada

ABSTRACT

Vaccine certificates have been implemented worldwide, aiming to promote vaccination rates and to reduce the spread of COVID-19. However, their use during the COVID-19 pandemic was controversial and has been criticized for infringing upon medical autonomy and individual rights. We administered a national online survey exploring social and demographic factors predicting the degree of public approval of vaccine certificates in Canada. We conducted a multivariate linear regression which revealed which factors were predictive of vaccine certificate acceptance in Canada. Self-reported minority status ($p < .001$), rurality ($p < .001$), political ideology ($p < .001$), age ($p < .001$), having children under 18 in the household ($p < .001$), education ($p = .014$), and income status ($p = .034$) were significant predictors of attitudes toward COVID-19 vaccine certificates. We observed the lowest vaccine-certificate approval among participants who: self-identify as a visible minority; live in rural areas; are politically conservative; are 18–34 years of age; have children under age 18 living in the household; have completed an apprenticeship or trades education; and those with an annual income between \$100,000–\$159,999. The present findings are valuable for their ability to inform the implementation of vaccine certificates during future pandemic scenarios which may require targeted communication between public health agencies and under-vaccinated populations.

ARTICLE HISTORY

Received 15 February 2023
Revised 11 May 2023
Accepted 28 May 2023

KEYWORDS

COVID-19; public attitudes; vaccine certificates; vaccine mandates; Canada

Introduction



Achieving high vaccination rates is critical to protecting public health and safely re-opening society following restrictions such as those implemented during the COVID-19 pandemic. Vaccines reduce both the likelihood of being infected as well as the severity of illness from COVID-19, and achieving high vaccination coverage plays a crucial role in helping to mitigate the burden of the pandemic on healthcare systems worldwide.^{1–3}

However, vaccine hesitancy posed, and still remains, a significant issue within the context of COVID-19 with numerous studies reporting low acceptance or high hesitancy. For instance, a recent meta-analysis determined that prevalence of parental acceptance to vaccinate their children was 57% (95% CI: 52–62%).⁴

One method employed to improve vaccination rates and protect society from COVID-19 spread were vaccine passports.⁵ The Ontario Science Table defines a COVID-19 vaccine certificate as “a verifiable attestation by an issuing

body that a person received an approved and complete series of COVID-19 vaccines”.⁶ In Canada and other OECD countries, vaccine certificates have been used in a number of scenarios to gate access to (i) international and domestic travel, (ii) occupations where mandatory vaccination is required such as health care workers and long-term care, (iii) high risk workplaces (i.e., meat packing plants and warehouses), (iv) mass gatherings (i.e., sporting and music events), and (v) restaurants, bars and other indoor spaces.⁷ In Canada, these certificates or “passports” were implemented in 2021 to incentivize COVID-19 vaccination but were gradually discontinued throughout 2022.⁸ Their use is controversial and has been criticized for infringing on individuals’ rights and freedoms.⁹

The institution of vaccine passports resulted in high profile opposition. In January 2022, for instance, long-haul truckers from across Canada occupied the downtown core of Ottawa in protest of federal and provincial government regulations designed to mitigate the spread of COVID-19. These “freedom convoy” protesters viewed these policies as violations of their

CONTACT Kumanan Wilson  kwilson@ohri.ca  Clinical Epidemiology Program, Ottawa Hospital, Civic Campus, Administrative Services Building, 1053 Carling Avenue, Ottawa, Ontario K1Y 4E9, Canada.

*Co-first authors contributed equally to this work.

 Supplemental data for this article can be accessed on the publisher’s website at <https://doi.org/10.1080/21645515.2023.2220628>.

© 2023 The Author(s). Published with license by Taylor & Francis Group, LLC.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way. The terms on which this article has been published allow the posting of the Accepted Manuscript in a repository by the author(s) or with their consent.

personal liberties. Proof of vaccination in the form of vaccine certificates was chief among their concerns.¹⁰ While this incident garnered widespread global media coverage, relatively little is known about attitudes toward vaccine certificates among the broader Canadian public. Furthermore, the social and demographic factors that influence public attitudes toward COVID-19 vaccinations and vaccine certificates in Canada are unclear. The present investigation aimed to fill this knowledge gap using a survey to determine whether and how public approval of COVID-19 vaccine certificates is shaped by socio-demographic factors. The results of our investigation provide insights that can inform how public health entities approach the implementation of vaccine certificates during future pandemics or whenever access to public venues must be gated on the basis of vaccination history.

Methods

We conducted a Canada-wide online survey between April 11 and 24, 2022. The survey was distributed by an established national polling company (Ekos) using a survey panel of Canadians. The probability panel involved random probability selection methods and a live operator to verify that there were no duplicates or fraudulent respondents. The random sample was closed and representative of the general population of Canada's provincial/territorial population distribution, and Random Iterative Method (RIM) weighting system was applied to adjust for any departures from census parameters. The sample size was designed to provide robust parameters within the margin of error of the sample. Respondents received the questionnaire by e-mail and they also received targeted reminder and prompts to complete the questionnaire.

Individuals were eligible to participate if they were ≥ 18 years of age and literate in English or French. Participants were pre-enrolled in a screened survey panel and identity was verified. Every panelist has provided explicit informed consent to participate in surveys (at the time of recruitment into the panel). This research project was approved by the Bruyère Research Institute Research Ethics Board (REB# M16-22-007) and the Ottawa Hospital Research Ethics Board (REB# 20220115-01 H).

Survey questions evaluated vaccine acceptance, factors that influenced vaccine acceptance, opinions on the past, current and future use of vaccine certificates, media and social media use, ideology, political leaning, and demographics (age, gender, income, education, self-reported ethnicity etc.). The survey questions also covered themes related to the facilitators and barriers to the adoption of COVID-19 vaccination and vaccine certificates, particularly, as relates to the role of vaccine certificates in “gatekeeping” various travel, work, and social events. The complete list of survey questions is available in the (Table S1). Oversampling for parents of children occurred, and questions were asked about children's vaccine status, and their opinions on the use of vaccine certificates for children. Prior to release, the validity of the survey instrument was pretested by team members and a convenience sample of ten members of the public to ensure that the survey questions were clear and well-understood. Minor modifications were made to improve survey readability, useability, and flow.

Quantifying vaccine certificate approval amongst participants

In a post-hoc analysis, we generated a composite score for each participant indexing their attitude toward vaccine certificates. The score comprised an average of four Likert (1–5 scale) responses that explicitly probed attitudes toward the certificates (Table S2 for questions 10A, 10B, 11A, and 11b). Participants selected ‘1’ to indicate that they “strongly oppose” the statement in question while a ‘5’ indicated “strongly support.” Therefore, higher Likert scores reflect stronger support for vaccine certificates, while lower scores are associated with opposition to the certificates.

Two participants did not respond to the relevant subset of questions pertaining to vaccine certificate approval and were subsequently removed from the main regression analysis. We excluded 25 participants that responded with “prefer not to say” to four or more demographic questions, which exceeded our upper bound for inclusion. Additionally, we ensured that the distribution of “prefer not to say” responses was not heavily skewed toward any particular set of questions. With the remaining participants ($N = 2522$), we performed a multivariate ordinary least squares (OLS) linear regression to evaluate the influence of demographic factors on attitude scores (Table 1). For statistical purposes, the categories for income, age, education, ideology, and province had to be reduced into a smaller number of levels to facilitate the regression analysis. The original categories for these variables can be viewed in the (Table S3).

Statistical analysis

Descriptive statistics including frequency, mean, and standard deviation (SD) were calculated for all survey questions, as appropriate. We computed a multivariable OLS linear regression to assess the relationship between demographic factors and participant classification scores. Statistical significance was defined as $p < .05$. Statistical procedures were performed in Python with the Statsmodels package (version 0.13.2; Seabold & Perktold, 2010) or in SPSS (version 2022; IBM). Custom Python scripts were used to perform the data cleaning procedures outlined below.

Results

Characteristics of participants

Between April 11, 2022 and April 24, 2022, a total of 2,549 Canadian residents completed the survey (Table S1). The response rate was 15.9% ($N = 2664/16,790$). The majority of respondents were from Ontario (40.4%; $n = 1,031$), born in Canada (86.0%; $n = 2,193$), and spoke English as their native language (75.6%; $n = 1,928$). Most participants (80.6%; $n = 2,055$) had completed some form of post-secondary education. Nearly a quarter of respondents (23.4%; $n = 597$) self-reported one or more minority identities. There were 1,102 respondents (43.2%) with children under age 18 within the household. Politically, 50.0% ($n = 1,275$) of participants self-identified as politically ‘left,’ 27.0% ($n = 688$) were politically ‘right,’ and 17.8% ($n = 453$) were ‘neither’ (Table S4).

Table 1. Multivariate linear regression.

Demographic Factor	p (variable)	Level	B	SE (standard error)	p (category)
Gender	.105	Male (ref)	-	-	-
		Female	.064	.055	.249
		Other	.031	.283	.913
		Prefer not to say	-.781	.370	.035*
Province	.019*	Ontario (ref)	-	-	-
		Atlantic	.178	.112	.112
		British Columbia	.068	.086	.428
		Prairies	-.141	.073	.054
		Prefer not to say	-1.122	.682	.100
		Quebec	-.074	.101	.462
		Territories	-.593	.345	.086
Generation	.861	Both you and parents born in Canada (ref)	-	-	-
		Born in Canada but ≥ 1 parent was not	-.007	.067	.918
		Don't know/prefer not to say	-.639	.787	.417
		Not born in Canada	.020	.091	.828
Language	.234	English (ref)	-	-	-
		Bilingual ^a	.080	.146	.583
		French	-.044	.106	.677
		Other	-.014	.117	.906
		Prefer not to say	-.804	.361	.026*
Minority	< .001***	None (ref)	-	-	-
		A 2SLGBTQ+ person	-.008	.128	.949
		A member of a visible minority	-.305	.112	.007**
		A person with a disability	.119	.113	.294
		Don't know/Prefer not to say	-.681	.136	< .001***
		Indigenous	-.273	.182	.135
		Multiple ^b	.051	.147	.729
Rurality	< .001***	Urban (ref)	-	-	-
		Don't know/Prefer not to say	-.546	.338	.106
		Rural area	-.391	.072	< .001***
		Suburban area	-.006	.061	.918
Ideology	< .001***	Left (ref)	-	-	-
		Don't know/Prefer not to say	-.731	.129	< .001***
		Neither	-1.007	.075	< .001***
		Right	-1.430	.065	< .001***
Age	< .001***	55+ (ref)	-	-	-
		18–34	-.747	.084	< .001***
		35–54	-.512	.071	< .001***
		Unknown	-.819	.146	< .001***
Children	< .001***	No (ref)	-	-	-
		Don't know/prefer not to say	-.810	.501	.106
		Yes	-.309	.065	< .001***
Education	.014*	Postgraduate degree (ref)	-	-	-
		University/College ^c	-.168	.066	.010*
		Prefer not to say	-.687	.338	.042*
		High School diploma or equivalent	-.119	.099	.230
		Primary school	-.356	.233	.127
		Apprenticeship or trades	-.373	.130	.004**
Income	.034*	Income quartile 4 (ref)	-	-	-
		Prefer not to say	-.150	.105	.152
		Income quartile 1	-.180	.093	.052
		Income quartile 2	-.180	.083	.030*
		Income quartile 3	-.239	.076	.002**

(a) Bilingualism is defined as any combination of spoken languages including those specified by participants under the category of "other (please specify)" (b) Participants were classified as "Multiple" if they self-identified as belonging to two or more minority/equity seeking groups (c) Undergraduate degree or college diploma; * $p < .05$, ** $p < .01$, *** $p < .001$; p (variable) reports whether demographic factors contribute significantly to the overall regression model; p (category) reports the difference between each level of a demographic factor and the reference category.

Vaccination attitudes

The majority of participants (91.3%; $n = 2,326$) received one or more doses of a COVID-19 vaccine at the time of their response, with 75.0% ($n = 1,911$) of the total sample reporting receipt of three or more doses. The most common reasons for COVID-19 vaccination included personal health and safety (80.3%; $n = 1,868$), protecting others (78.1%; $n = 1,816$), travel (19.6%; $n = 456$), and work-related requirements (19.0%; $n = 442$). In contrast, the most cited reasons for refusal included: personal freedoms (75.4%; $n = 138$); health and safety concerns surrounding the vaccine (66.7%; $n = 122$); confidence in one's health and natural immunity (56.8%; $n = 104$); not feeling the need to receive a vaccine due to the possibility of previous or current COVID-19 infection (48.6%; $n = 89$); and lack of perceived threat (39.3%; $n = 72$) (Table S1).

Vaccine certificates did not strongly influence the COVID-19 vaccination rates. Of the vaccinated participants ($n = 2326$), only 7.1% ($n = 165$) of participants indicated that the announcement of the COVID-19 vaccine certificates affected their choices. Furthermore, only 46.1% ($n = 76$) of these ($n = 165$) reported that the certificates were the sole reason for obtaining the COVID-19 vaccine. Despite this, some vaccine certificate-related incentives appeared to affect vaccination outcomes. For instance, a slight majority of vaccinated participants (50.9%; $n = 1,183$) rated the desire to attend social events (e.g., movies, restaurants, bars, etc.) as being either a minor (29.5%; $n = 686$) or major (21.4%; $n = 497$) influence (Table S1).

Most participants expressed opposition to the convoy protests that occurred in Ottawa, Canada in early 2022 with 65.6% disagreeing ($n = 1,673$) with both their message and tactics. Of those who indicated some support of the protestors, most (15.3%; $n = 389$) tended to endorse both the protestors' message and tactics (Table S1).

We observed higher support for requiring Canadians to carry certificates to travel (mean = 3.85 on Likert scale of 1–5, SD = 1.61) when they were first introduced compared to present (mean = 3.65, SD = 1.64). Participant support for requiring certificates to attend public events also declined from their first implementation (mean = 3.68, SD = 1.62) to present (mean = 3.44, SD = 1.63) (Table S2).

On average, participants were most likely to rely on public health professionals (mean: 4.06, SD = 1.18) and public health agencies (mean = 3.99, SD = 1.21) as sources of information on matters related to COVID-19. They were least likely to rely on social media (mean = 1.70, SD = 0.96), podcasts (mean = 1.65, SD = 0.99) or American alternative media sources such as Fox News (mean = 1.40, SD = 0.82). For participants who did consume COVID-19 related content on social media, the most common platforms were Twitter (mean = 1.45, SD = 0.90), YouTube (mean = 1.41, SD = 0.84) and Reddit (mean = 1.23, SD = 0.67) (Table S3).

The multivariate linear regression revealed that all demographic variables (except for gender, generation, and language) significantly predicted approval of the use of vaccine certificates ($F_{42,2479} = 25.936$, $p < .001$, adjusted $R^2 = 0.294$) (Table 1).

Public attitudes toward COVID-19 vaccination and vaccine certificates varied geographically (Table 1). Compared to Ontario, residents from the Prairies, Territories, and Quebec

exhibited lower vaccine certificate approval, whereas residents from Atlantic provinces exhibited the highest approval ratings. Participants in rural areas reported lower approval ratings than those in urban or suburban regions (Table 1).

These trends also varied by socioeconomic status (Table 1). Educational attainment of a graduate degree above the bachelor's level predicted the higher approval whereas primary school and apprenticeship/trades were associated with lower approval ratings. Compared to participants in the fourth income quartile, participants in other quartiles reported lower vaccine certificate approval ratings, although the relationship does not appear to be linear (Table 1).

Other sociodemographic predictors included self-reported minority status, political ideology, age, and having children under the age of 18. Participants that self-identified as 2SLGBTQ, Indigenous, or a member of a visible minority demonstrated lower approval of COVID-19 vaccine certificates, compared to those not belonging to any minority group. We observed a significant effect of political ideology on vaccine certificate approval with those self-identifying as 'left' having higher approval than all other groups. Older participants (55+) exhibited the strongest approval while ratings declined in the 18–34 and 35–54 age categories. Having one or more children under the age of 18 in the household was associated with lower approval ratings (Table 1).

Discussion

To the best of our knowledge, this was the first national survey to focus on the sociodemographic factors that influence public attitudes toward COVID-19 vaccines and vaccine certificates specifically in the Canadian general adult population, which is particularly important given the controversial nature of these certificates. Our findings offer valuable insights into the facilitators and barriers to the successful implementation of vaccine certificates as a method of achieving higher vaccine coverage in Canada for future pandemics. The concept of institutional trust is a plausible interpretive lens that may contextualize these findings. For instance, a recent qualitative review provides evidence that a history of systemic, institutional discrimination erodes trust and reduces vaccine uptake.¹¹ The review also notes that institutional trust is influenced by positive interactions with the health care system. There is evidence that racial minority groups experience poorer standards of care,¹² adding support for this interpretation.

We identified several demographic factors that were significant predictors of vaccine certificate approval. All the factors except for gender, language spoken, and generation (i.e., where participants and their parents were born) contributed significantly to the overall regression model. Opposition to vaccine certificates was more commonly associated with younger age, self-identification as a visible minority, rural geographic location, certain forms of educational attainment below the graduate level, household income within the third quartile, and political conservatism. Province of residence was also a relevant factor in our model, but a more granular investigation reveals that only Prairie province scores approached

significance when compared to Ontario as a reference. Further research should explore this given that, to our knowledge, there are currently no data describing inter-provincial differences in COVID-19 mandate acceptance.

A salient finding from the current investigation is that attitudes toward vaccination requirements vary according to political affiliation. Consistent with our results, many studies report that those on the political left show greater support for vaccine certificates than those on the political right.^{13–19} For instance, El-Mohandes et al.¹⁴ found that 70.1% of liberals agreed with legislation requiring proof of vaccination to enter public spaces; in contrast, 53.5% of moderates and only 37.9% of conservatives voiced agreement for the same policy. Similar response patterns were observed when participants were asked about requiring proof of vaccination in the context of employment, government work, university attendance, and international travel.¹⁴ Likewise, Paul et al.¹⁸ report that support for compulsory COVID-19 vaccinations in Austria was lowest among those voting for the right-wing Freedom Party (FPÖ) (26%) and highest among those who cast ballots for the left-leaning Greens (48%). There is also evidence suggesting that this pattern applies to vaccine certificates more generally and is not specific to COVID-19.²⁰

With respect to gender, our non-significant results are inconsistent with the study by Heath et al.,²¹ which found that women were the most receptive to COVID-19 vaccination requirements. Other studies demonstrate that men view COVID-19-related certificates more favorably,^{16,18,19,22} or that, like our current findings, support for vaccine requirements does not vary significantly by gender.¹³ More research is warranted to describe the influence of gender on the Canadian public's attitudes toward COVID-19 vaccines and vaccine certificates.

Our findings suggest a mixed association between education and public attitudes toward vaccine certificates. We found that participants with graduate degrees tended to perceive vaccine certificates more favorably than those who completed a college-level education or apprenticeship; however, there was no significant difference between graduate degree holders and participants with a high school or primary school education. These findings are similar to some existing studies which found a positive association between educational attainment and COVID-19 certificate acceptance.^{13,19,21} Teasdale et al.,¹⁹ for instance, found that 51.6% of those with a college education or higher approved of vaccine certificates for school children, compared to 37.0% with college/technical training and 41.4% of those with high school education or less. On a similar note, we found that higher household income predicted increased COVID-19 vaccine certificate-related attitudes in our regression model, however, this association did not appear to be linear and was not consistently supported by the literature. For instance, Harris et al.¹⁶ found no relationship between income and vaccine certificate acceptance. Paul et al.¹⁸ similarly show that income minimally shapes attitudes relevant to COVID-19 vaccination policy. These findings suggest that more research needs to be conducted to explore the role of socioeconomic status, particularly education and household income, on public attitudes toward COVID-19 vaccines and vaccine certificates in the Canadian general adult population.

We found that older participants were more amenable to vaccine certificates than their younger counterparts. There is strong support for this finding in the literature.^{18,21,22} For example, Paul et al.¹⁸ report that 51% of participants over 65 supported COVID-19 vaccine mandates compared to 35% among those aged 30–65, and 37% for those under 30 years of age. However, Haeder report a more nuanced relationship whereby older age was associated with greater support for general vaccine mandates but not those specific to COVID-19.¹⁷

Our data suggest that self-reported visible minority status was associated with lower rates of approval for COVID-19 vaccine certificates. This finding is corroborated by Largent et al.¹³ who report that only 27% of Black participants approved of COVID-19 vaccine mandates for adults compared with 42.7% of non-Black respondents. Haeder¹⁷ observed similar response patterns in attitudes toward general vaccine mandates with White participants indicating greater support than Black, Hispanic, and Asian subjects.

We found that residence in a rural community predicted negative attitudes toward vaccine certificates while residence in urban areas was associated with more favorable views. Consistent with our findings, Haeder¹⁷ found that participants from rural communities were less likely than those from urban areas to approve of COVID-19 vaccine mandates for children in daycare ($b = -0.418$) and kindergarten to grade 12 ($b = -0.652$), although there were no significant group differences regarding mandates for university students. Rural community residents were also less likely to support COVID-19 vaccine mandates for school teachers and staff for the K12 education levels ($b = -0.360$). Similarly, a systematic review by Hudson & Montelpare²³ found that COVID-19 vaccine hesitancy was higher in smaller, rural communities. Further research is necessary exploring the relationship between COVID-19 certificate acceptance and urbanicity.

Our results demonstrate how the presence of children under age 18 in the household affects perceptions of COVID-19 vaccine certificates among Canadian residents. This finding is comparable to a study by Reczulska et al. who found that having one or more children influenced attitudes toward mandatory childhood COVID-19 vaccinations in Poland.²³ Specifically, 61.2% of respondents with children endorsed the vaccination program, compared with the 45.5% without children. A similar pattern was observed whereby parents were more likely to support punitive legal or financial measures against those unwilling to vaccinate their children. However, in addition to cultural differences, the nature of vaccine mandates in Poland differs from the Canadian context which must be taken into consideration.

Limitations

Our study has several limitations which need to be addressed. First, the scope of our investigation was restricted to Canadian residents, thus, limiting the generalizability of our findings to other countries. Second, as the study design was cross-sectional, participant attitudes toward vaccine certificates within the data-collection window may have been influenced by extraneous acute disruptions, such as the

convoy protests in Ottawa, which might have influenced the effect sizes that we observed. Longitudinal data with longer term follow-up would be useful to determine the stability of opinions over time, especially given the potential for each demographic to be uniquely impacted by events such as the convoy protest. Third, certain demographics were overrepresented or underrepresented, thus limiting the generalizability of our findings. For instance, almost one quarter of participants included in the regression analysis had an income of \$160k or greater whereas recently available census records indicate that roughly ten percent of Canadians had an annual income of greater than \$100,000.²⁴ Fourth, the vaccination rate in our sample was higher than the that of the broader Canadian population at the time of survey completion.²⁵ This may have influenced our results and made evaluations within the unvaccinated group more challenging. Another limitation was the relatively low response rate of 15.9%. Despite the panel being generally representative of the Canadian population, in the current study, there were no separate analyses for the sociodemographic characteristics of the responders and non-responders, such as those who did not have access to internet at this time, which may lead to non-response bias.

Conclusion

The present investigation provides valuable data that can inform public health policy within the Canadian context. COVID-19 vaccine certificates are a valuable tool for mitigating rates of infection across the country, but how these are received by the population varies according to demographic factors such as socioeconomic status, political ideology, residence, rurality, minority status, age, gender, and more. As the long-term viability of vaccine certificates depends on maintaining a broad degree of public support, it is essential to identify the regions and demographics that may be opposed to their implementation. Targeted approaches may then be developed that consider and address the underlying concerns that are unique to different populations, particularly, populations that demonstrate greater distrust of vaccine certificates. Future studies should extend our findings by considering interrelationships between vaccine certificate acceptance and non-demographic factors including media and social media consumption, scientific literacy, or even individual psychological characteristics (e.g., measures of personality). Further research should be conducted to investigate longer term trends in the Canadian public's attitudes toward vaccine certificates to guide future implementation in a more effective, acceptable, and feasible manner.

Disclosure statement

KW is the co-founder and Chief Scientific Officer of CANImmunize Inc. KW also serves on the vaccine safety advisory boards for Medicago and Moderna. The other coauthors report no competing interests.

Funding

This work was supported by the Canadian Institutes of Health Research (CIHR) under Grant #[VCF 179240].

ORCID

Kumanan Wilson  <http://orcid.org/0000-0002-1741-7705>

Author contributions

Conceptualization, A. Brienne Bota, Salima S. Mithani, Kumanan Wilson; Data curation, Frank Graves, Jeff Smith; Formal analysis, David Smith, Steven Hawken, David T. Zhu; Methodology, David Smith, Steven Hawken, David T. Zhu; Supervision, Kumanan Wilson; Writing – original draft, David Smith, David T. Zhu, Kumanan Wilson; Writing – review & editing, David Smith, David T. Zhu, Steven Hawken, A. Brienne Bota, Salima S. Mithani, Alessandro Marcon, Gordon Pennycook, Devon Greyson, Timothy Caulfield, Frank Graves, Jeff Smith, Kumanan Wilson.

Data availability statement

Restrictions apply to the availability of these data. Data were obtained from Ekos Research Associates, Inc. Although these datasets cannot be made publicly available, they may be available upon request from the corresponding author with the permission of Ekos.

Institutional review board statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Bruyère Research Institute Research Ethics Board (REB# M16-22-007) and the Ottawa Hospital Research Ethics Board (REB# 20220115-01 H).

Informed consent statement

Informed consent was obtained from all subjects involved in the study prior to participation in the survey.

References

1. Altmann DM, Douek DC, Boyton RJ. What policy makers need to know about COVID-19 protective immunity. *Lancet*. 2020;395(10236):1527–9. doi:10.1016/S0140-6736(20)30985-5.
2. Kirwan PD, Charlett A, Birrell P, Elgohari S, Hope R, Mandal S, De Angelis D, Presanis AM. Trends in COVID-19 hospital outcomes in England before and after vaccine introduction, a cohort study. *Nat Commun*. 2022;13(1):4834. doi:10.1038/s41467-022-32458-y.
3. Alagoz O, Sethi AK, Patterson BW, Churpek M, Alhanea G, Scaria E, Safdar N, Simuunza MC. The impact of vaccination to control COVID-19 burden in the United States: a simulation modeling approach. *PLoS One*. 2021;16(7):e0254456. doi:10.1371/journal.pone.0254456.
4. Alimoradi Z, Lin CY, Pakpour AH. Worldwide estimation of parental acceptance of COVID-19 vaccine for their children: a systematic review and meta-analysis. *Vaccines*. 2023;11(3):533. doi:10.3390/vaccines11030533.
5. Zhu DT, Mithani SS, Smith D, Wilson K. The global impact of vaccine certificates on COVID-19 vaccine uptake: a scoping review. 2023 Feb 2 [accessed 2023 Apr 27]:39. doi:10.21203/rs.3.rs-2539911/v1.
6. Katz GM, Born KB, de Wit M, McKenzie K, Flood CM, Bell C, Cooper-Simpson C, Evans GA, Gibson JL, Hopkins J, et al. COVID-19 vaccine certificates: key considerations for the ontario context. *Science briefs of the Ontario COVID-19 science advisory table*. 2021;2(39). doi:10.47326/ocsat.2021.02.39.1.
7. Thomas B, Flood CM, Krishnamurthy V, Tanner R, Wilson K. Vaccine ins and outs: an exploration of the legal issues raised by vaccine passports. *C.D. Howe Institute*; 2021 Jun 13 [accessed 2023 Apr 27]. <https://www.cdhowe.org/public-policy-research/vaccine-ins-and-outs-exploration-legal-issues-raised-vaccine-passports>.

8. Government of Canada. COVID-19 proof of vaccination in Canada. 2023 Jan 27 [accessed 2023 Apr 7]. <https://www.canada.ca/en/public-health/services/diseases/coronavirus-disease-covid-19/vaccines/vaccine-proof.html>.
9. Persad G, Emanuel EJ. The ethics of COVID-19 immunity-based licenses (“immunity passports”). *JAMA*. 2020;323(22):2241–2. doi:10.1001/jama.2020.8102.
10. Huang SH, Tsao SF, Chen H, Bin Noon G, Li L, Yang Y, Butt ZA. Topic modelling and sentiment analysis of tweets related to freedom convoy 2022 in Canada. *Int J Public Health*. 2022;67:1605241. doi:10.3389/ijph.2022.1605241.
11. Adhikara B, Cheah PY, von Seidlein L. Trust is the common denominator for COVID-19 vaccine acceptance: a literature review. *Vaccine*. 2022;12:100213. doi:10.1016/j.jvaxc.2022.100213.
12. Shepherd SM, Willis-Esqueda C, Paradies Y, Sivasubramaniam D, Sherwood J, Brockie T. Racial and cultural minority experiences and perceptions of health care provision in a mid-western region. *Int J Equity Health*. 2018;17(1):33. doi:10.1186/s12939-018-0744-x.
13. Largent EA, Persad G, Sangenito S, Glickman A, Boyle C, Emanuel EJ. US public attitudes toward COVID-19 vaccine mandates. *JAMA Netw Open*. 2020;3(12):e2033324. doi:10.1001/jamanetworkopen.2020.33324.
14. El-Mohandes A, White TM, Wyka K, Rauh L, Rabin K, Kimball SH, Ratzan SC, Lazarus JV. COVID-19 vaccine acceptance among adults in four major US metropolitan areas and nationwide. *Sci Rep*. 2021;11(1):21844. doi:10.1038/s41598-021-00794-6.
15. Peng Y. Politics of COVID-19 vaccine mandates: left/right-wing authoritarianism, social dominance orientation, and libertarianism. *Pers Individ Differ*. 2022;194:111661. doi:10.1016/j.paid.2022.111661.
16. Harris JN, Mauro CC, Andresen JA, Zimet GD, Rosenthal SL. COVID-19 vaccine uptake and attitudes towards mandates in a nationally representative U.S. sample. *J Behav Med*. 2023;46(1–2):25–39. doi:10.1007/s10865-022-00317-2.
17. Haeder SF. Joining the herd? U.S. public opinion and vaccination requirements across educational settings during the COVID-19 pandemic. *Vaccine*. 2021;39(17):2375–85. doi:10.1016/j.vaccine.2021.03.055.
18. Paul KT, Eberl J, Partheymüller J. Policy-relevant attitudes toward COVID-19 vaccination: associations with demography, health risk, and social and political factors. *Front Public Health*. 2021;9:671896. doi:10.3389/fpubh.2021.671896.
19. Teasdale CA, Ratzan S, Lathan HS, Rauh L, Kimball S, El-Mohandes A. Acceptability of COVID-19 vaccine mandates among New York City parents, November 2021. *Vaccine*. 2022;40(26):3540–5. doi:10.1016/j.vaccine.2022.05.010.
20. Krok-Schoen JL, Bernardo BM, Weier RC, Peng J, Katz ML, Reiter PL, Richardson MS, Pennell ML, Tatum CM, Paskett ED. Belief about mandatory school vaccinations and vaccination refusal among Ohio appalachian parents: do demographic and religious factors, general health, and political affiliation play a role? *J Rural Health*. 2018;34(3):283–92. doi:10.1111/jrh.12285.
21. Heath K, Altermatt A, Saich F, Pedrana A, Fletcher-Lartey S, Bowring AL, Stoové M, Danchin M, Kaufman J, Gibney KB, et al. Intent to be vaccinated against COVID-19 in Victoria, Australia. *Vaccines*. 2022;10(2):209. doi:10.3390/vaccines10020209.
22. Sprengholz P, Korn L, Eitze S, Felgendreff L, Siegers R, Goldhahn L, De Bock F, Huebl L, Böhm R, Betsch C. Attitude toward a mandatory COVID-19 vaccination policy and its determinants: evidence from serial cross-sectional surveys conducted throughout the pandemic in Germany. *Vaccine*. 2022;40(51):7370–7. doi:10.1016/j.vaccine.2022.01.065.
23. Hudson A, Montelpare WJ. Predictors of vaccine hesitancy: implications for COVID-19 public health messaging. *Int J Environ Res*. 2021;18(15):8054. doi:10.3390/ijerph18158054.
24. Statistics Canada, Table 11-10-0240-01. Distribution of employment income of individuals by sex and work activity, Canada, Provinces and Selected Census Metropolitan Areas. 2022 Mar 23 [accessed 2023 Apr 27]. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1110024001>.
25. Public Health Agency of Canada. Canadian COVID-19 vaccination coverage report. Ottawa: Public Health Agency of Canada; 2022 Apr 29 [accessed 2023 Apr 27]. <https://health-infobase.canada.ca/covid-19/vaccination-coverage/>.