Important psychological factors of COVID-19 vaccine hesitancy associated with vaccine uptake in Métis Citizens in Ontario—A population-based data linkage study

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Article Info

Keywords
Vaccination
Vaccine Hesitancy
Psychological Antecedents
Logistic Regression
COVID-19
Indigenous Populations
Métis

Abstract

The COVID-19 pandemic exacerbated existing inequalities and vulnerabilities among marginalized groups, particularly Indigenous Peoples in Canada. We assessed the influence of psychological antecedents of vaccine hesitancy on COVID-19 vaccine uptake among Métis in Ontario, Canada. The Métis Nation of Ontario (MNO) survey, a population-based online survey, was used to capture MNO citizens' "5Cs"—psychological antecedents relating to vaccination intention (confidence, complacency, constraint, calculation, and collective responsibility). Descriptive statistics and multivariable logistic regression models were used to model vaccination status to assess the influence of psychological antecedents of vaccination on vaccination behaviour, by linking survey data to the Ontario COVID-19 Vaccine Database (COVaxON), which captures all COVID-19 vaccinations administered in Ontario. The study cohort size was 3,999, with 3,701 (92.5%) of participating MNO citizens partially or fully vaccinated. Results from five separate logistic regression models suggested four variables/indicators from the 5Cs—*confidence, complacency, calculation, and collective responsibility*—were significantly associated with vaccination status, while constraints was not. This study contributes valuable insight on the factors that may influence the decision to opt out of receiving a COVID-19 vaccination among Métis and can inform the development of targeted public health interventions and educational strategies aimed at dispelling misconceptions about vaccination.

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https://doi.org/10.32799/ijih.v21i1.45536

Introduction

The COVID-19 pandemic had profound and far-reaching negative impacts on the lives of Canadians, exacerbating existing inequalities and vulnerabilities among marginalized groups (Lefebvre et al., 2023; Zaccardi et al., 2023). In countries with a history of colonization, including Canada, Indigenous Peoples are generally at an increased risk of poor health outcomes compared to the rest of the population (Gracey & King, 2009). The reasons for these disparities are complex, but they are rooted in the displacement of Indigenous Peoples from traditional lands and waters, loss of language and culture, family disruption through practices such as residential schooling, and contemporary social and economic marginalization (King et al., 2009). There is evidence that COVID-19 also disproportionately affected Indigenous Peoples in Canada. COVID-related mortality was higher among First Nations and Métis, relative to non-Indigenous Canadians, particularly in younger age ranges, and this excess risk might be in part attributed to social determinants such as poorer housing and lower income (Kopp et al., 2024).

The potentially higher impact of COVID-19 on Indigenous Peoples in Canada was recognized early in the pandemic. Canada's pandemic planning was shaped by the experiences of the 2009 H1N1 influenza pandemic, in which Indigenous Peoples experienced higher rates of infection than the general population (Public Health Agency of Canada, 2010; National Collaborating Centre for Aboriginal Health [NCCAH], 2016). The lessons from the H1N1 pandemic suggested that Indigenous Peoples would be at an increased risk in the COVID-19 pandemic (Kermode-Scott, 2009). During the H1N1 pandemic, Indigenous Peoples accounted for approximately 28% of H1N1-related hospitalizations and 18% of deaths, despite being only 4.3% of the Canadian population at the time (NCCAH, 2016).

In the province of Ontario, as in other Canadian jurisdictions, First Nations, Métis, and Inuit Peoples were named "priority populations" for COVID-19 vaccination (COVID-19 Vaccine Distribution Task Force, 2020). There were also concerns about high rates of vaccine hesitancy among Indigenous Peoples. Indeed, national survey data collected from September to December 2020 found that Métis were significantly less likely to report being "very or somewhat" willing to receive the COVID-19 vaccine than were non-Indigenous Canadians (67.8% vs 77.1%; Statistics Canada, 2021).

Vaccine hesitancy among Indigenous Peoples is not a Canada-specific phenomenon, and had been identified before COVID-19. Levels of vaccine coverage for influenza and other types of preventable diseases have been found to be lower among Indigenous Peoples in Australia, New Zealand, the United States, and Canada (Menzies & McIntyre, 2006). In Australia, influenza vaccine coverage among Aboriginal adults has been significantly lower than in the general population, with studies identifying misconceptions about influenza and the vaccine as key drivers (Menzies et al., 2020).

Vaccine hesitancy is also not unique to Indigenous Peoples. Among citizens of high-income countries, trust in traditional institutions such as government agencies has declined in recent decades (Dalton, 2005). However, the potential for trust among Indigenous populations is further diminished by the history and ongoing burdens of colonization. Indigenous Peoples might perceive the statements made by authorities and government agencies differently from the general population, and in ways influenced by their unique socio-cultural perspectives and collective histories (Wynne, 1996). Among Canadian Indigenous Peoples, historical factors such as medical experimentation and exploitation in health research are at the root of vaccine hesitancy (Mosby & Swidrovich, 2021). These negative past experiences can perpetuate feelings of distrust. Moreover, the government agencies responsible for protecting the public health of Canadians may be the same institutions that were responsible for these aspects of the country's colonial history (Sanders et al., 2024; Sullivan et al., 2023).

Shortly after the beginning of the COVID-19 pandemic, the Métis Nation of Ontario (MNO) undertook a mixed methods research and surveillance project to inform community response to the pandemic. The Métis are one of three constitutionally recognized Indigenous Peoples in Canada (Government of Canada, 1982, p. 2, s. 35) and are a distinct people with a unique history, culture, language, and way of life (Supreme Court of Canada, 2003). Although Métis are equally recognized under the Constitution Act alongside First Nations and Inuit, there is a well-documented gap in Métis-specific health research, including vaccine hesitancy (Gmitroski et al., 2023; Kumar et al., 2012; Macdougall, 2017).

MNO represents more than 28,000 Métis citizens in Canada's most populous province, and maintains the only recognized provincial registry for people who are eligible Métis rights holders in Ontario (Métis Nation of Ontario, n.d.). An online survey of MNO citizens in March 2020 included questions regarding vaccine intention. The study was modelled after one designed by the Métis Nation of Alberta and included a validated scale, known as the "5Cs" model, to assess trust in vaccines and the systems that provide them (confidence); perceived risk of contracting and the severity of the disease (complacency); structural and psychological barriers to vaccination (constraints); efforts in searching for information (calculation); and willingness to protect others (collective responsibility; Betsch et al., 2018). An analysis of the survey data found that MNO citizens who intended to be vaccinated exhibited higher levels of confidence (that the COVID-19 vaccine is safe), lower complacency (belief that COVID-19 is not severe), and higher collective responsibility (willingness to protect others against infection) (Tsui et al., 2024).

Although identifying the importance of these components of vaccine hesitancy in predicting vaccination *intentions* could inform vaccination roll-out and promotion strategies, it is also important to assess the association between the 5Cs and the actual vaccination *behaviours* of MNO citizens. Studies in other populations found considerable fluidity between COVID-19 vaccination

intent and behaviour (Shaw et al., 2022). To more fully understand the importance of these psychological antecedents of vaccination in MNO citizens, we sought to identify the most important components of the 5Cs scale in predicting actual vaccine uptake, and to examine the association between reported vaccination intentions and eventual vaccination behaviour. In this article, we report the results of a study that linked the responses of the MNO community survey to several administrative data sources, including provincial vaccination data, to assess the association between the psychological antecedents of vaccination (as identified in the 5Cs scale) and vaccination uptake.

Methods

Data Sources and Governance

The MNO COVID-19 survey was linked to several Ontario provincial administrative health data sources. The data linkages were conducted at ICES, which holds a repository of confidential health data collected from Ontario's publicly funded health care system (ICES, n.d.). The study was governed by a data governance and sharing agreement between MNO and ICES, in which MNO maintains ownership and control of the survey data and subsequent analyses. Results of this and other components of the study were shared with MNO community members in several ways, including community reports (MNO, 2023). This study was approved by the University of Waterloo Human Research Ethics Board (File# 43607). This project was supported by funding from the Canadian Institutes of Health Research and the Public Health Agency of Canada, through the COVID-19 Immunity Task Force.

The MNO COVID-19 survey was implemented as a population-based online survey, using census sampling of the MNO registry, and achieved a 39% response rate among eligible registered citizens (Tsui et al., 2024). Invitations were sent to all registered MNO citizens with a valid email address on file. In addition, automated telephone notifications were used for those with a valid phone number as part of the survey announcement process, and the survey was promoted through MNO social media and community communication channels. Participation required both registration with the MNO registry and access to electronic contact methods and an online survey platform (Tsui et al., 2024).

Age and sex were taken from the linked Registered Persons Database (RPDB). Highest level of education attained was measured using the MNO COVID-19 survey itself. Comorbidities were derived from validated algorithms using administrative data sources, including the Canadian Institute for Health Information Discharge Abstract Database (DAD), National Ambulatory Care Reporting System (NACRS), Ontario Health Insurance Plan Database (OHIP), and/or the Ontario Drug Benefit Database (ODB). COVID-19 testing status and test results were established through a database combining records from the Ontario Laboratories Information System (OLIS), distributed testing data from laboratories, and the Public Health Case and Contact Management (CCM) Solution system (eHealth Ontario, 2013). Confirmed COVID-19 vaccination status as of December 2022 was ascertained using the Ontario COVID-19 Vaccine Database (COVaxON), which captures all COVID-19 vaccinations administered within Ontario (Hobbs et al., 2023). All self-reported measures were captured through the MNO COVID-19 survey, including beliefs and behaviours pertaining to the COVID-19 pandemic, and separate questions capturing each of the 5C dimensions, using a Likert-type response scale (strongly agree, agree, neither agree nor disagree, disagree, strongly disagree, not sure, and prefer not to say). Respondents were excluded from the study cohort if they had an invalid identifier (i.e., encrypted health card number), invalid or missing information for age or sex, were non-Ontario residents at index date, were younger than 18 or older than 105 years of age at index date, or had a date of last contact across all administrative data sources exceeding 10 years.

Study Design and Statistical Analysis

We examined the association between self-reported intention to get vaccinated and vaccination status based on the COVaxON database, and we also estimated five separate binary multivariable logistic regression models to investigate the association between vaccination status and the each of the five psychological antecedents of vaccine acceptability/hesitancy in the 5Cs model (Betsch et al., 2018). A strategy of separate models was chosen because an important purpose of the research was to identify the factors that were most strongly associated with vaccination (or non-vaccination) to inform vaccine promotion efforts. The vaccination status outcome variable was dichotomized to achieve sufficient power to detect model effects with a limited cohort size. Partially vaccinated and fully vaccinated subjects were grouped, and unvaccinated status represented the reference group.

Due to a limited sample size, particularly among the unvaccinated group, some response categories for the 5Cs Likert scale measures were collapsed to avoid small category counts. For analysis, responses were collapsed into three analytically meaningful categories: Agree (agree/strongly agree), Neither agree nor disagree, and Disagree (disagree/strongly disagree). Responses of "Not sure" and "Prefer not to say" were treated as missing for that item and excluded from analyses involving the corresponding 5C construct. This resulted in variation in analytic sample size across models. Collapsing response categories and treating "not sure" and "prefer not to say" as missing was implemented to maintain interpretability and ensure model stability given the modest cohort size and the relatively small number of non-vaccinated respondents, which would otherwise yield sparse cells and unstable estimates in fully disaggregated models.

All models adjusted for a set of covariates determined theoretically relevant to the analysis, identified *a priori*, which included a diagnosis of a chronic condition within two years prior to the index date (binary), COVID-19 testing/infection status, age group, sex, and level of education attained. Chronic conditions included cancer, chronic kidney disease/renal failure, chronic obstructive pulmonary disease, congestive heart failure, diabetes, asthma, dementia, hypertension, and liver disease (See Appendix A for specific disease diagnosis codes used). In these models age was included as a categorical variable, since it allowed for more meaningful interpretations of the association between age groups and vaccine behaviour. The total number of respondents included in each of the models is summarized in Appendix B.

Results

The study cohort size after applying all exclusions was 3,999, with 3,701 (92.5%) fully/partially vaccinated patients and 298 (7.5%) unvaccinated (Table 1). As shown in Table 1, compared to partially/fully vaccinated, unvaccinated subjects were on average younger (43.2 vs. 47.6 years; $p < 0.0001$), less educated (7.7% vs. 11.5% with graduate or professional degree; $p = 0.0052$), less likely to suffer from a chronic condition (17.5% vs. 24.9%; $p = 0.0039$), and less likely to have received a COVID-19 test (23.2% vs. 42.7%; $p < 0.0001$).

Table 1
Baseline characteristics (as of date of survey administration) stratified by vaccination status

Variables	Values	Overall	Fully/ Partially Vaccinated	No Vaccination	Standardized Difference	*p*-Value
			***N* = 3,999**	***N* = 3,701**	***N* = 298**	
Age (RPDB)	Mean ± SD	47.3 ± 16.3	47.6 ± 16.4	43.2 ± 14.6	0.28	< 0.0001
	Median (IQR)	48 (34-61)	48 (35-61)	41 (32-56)	0.29	< 0.0001
Age Group, *n* (%)	16-29	659 (16.5%)	611 (16.5%)	48 (16.1%)	0.01	< 0.0001
	30-49	1,469 (36.7%)	1,319 (35.6%)	150 (50.3%)	0.30	
	50-59	782 (19.6%)	731 (19.8%)	51 (17.1%)	0.07	
	60-69	752 (18.8%)	716 (19.4%)	36 (12.1%)	0.20	
	70+	337 (8.4%)	324 (8.8%)	13 (4.4%)	0.18	
Sex (RPDB), *n* (%)	Female	2,150 (53.8%)	2,002 (54.1%)	148 (49.7%)	0.09	0.1401
	Male	1,849 (46.2%)	1,699 (45.9%)	150 (50.3%)	0.09	
Highest Level of Education Completed, *n* (%)	College/ University/ Certificate	2,268 (56.7%)	2,097 (56.7%)	171 (57.4%)	0.01	0.0052
	Graduate or Professional Degree	450 (11.3%)	427 (11.5%)	23 (7.7%)	0.13	
	Secondary/ High School or Less	1,193 (29.8%)	1,103 (29.8%)	90 (30.2%)	0.01	
	Missing	88 (2.2%)	74 (2.0%)	14 (4.7%)	0.15	
Chronic Condition, *n* (%)	Yes	974 (24.4%)	922 (24.9%)	52 (17.5%)	0.18	0.0039
Received COVID-19 Test, *n* (%)	Not Tested	2,350 (58.8%)	2,121 (57.3%)	229 (76.9%)	0.43	< 0.0001
	Tested	1,649 (41.2%)	1,580 (42.7%)	69 (23.2%)	0.43	
COVID-19 Test Result, *n* (%)[a]	Not Tested	2,349 (58.7%)	2,120 (57.3%)	229 (76.9%)	0.43	< 0.0001
	Not Positive	1,594 (39.9%)	1526-1530[b]	64-68[b]	0.41	
	Positive	56 (1.4%)	51-55[b]	1-5[b]	0.08	

COVID-19 Infection Status, *n* (%)[a]	Not Tested	2,350 (58.8%)	2,121 (57.3%)	229 (76.9%)	0.43	< 0.0001
	Not Tested Positive	1,593 (39.8%)	∗1525-1529	∗64-68	0.41	
	Tested Positive	56 (1.4%)	∗51-55	∗1-5	0.08	
Vaccination Intentions: "I plan to get vaccinated," *n* (%)	Agree	2,718 (68.0%)	2,680 (72.4%)	38 (12.8%)	1.51	< 0.0001
	Disagree	408 (10.2%)	239 (6.5%)	169 (56.7%)	1.28	
	Neutral/Not Sure	696 (17.4%)	630 (17.0%)	66 (22.2%)	0.13	
	Missing	177 (4.4%)	152 (4.1%)	25 (8.4%)	0.18	
Confidence: "I am completely confident that the COVID-19 vaccine(s) that will be available in Canada will be safe," *n* (%)	Agree	2,244 (56.1%)	2,205 (59.6%)	339 (13.1%)	1.10	< 0.0001
	Disagree	456 (11.4%)	312 (8.4%)	144 (48.3%)	0.99	
	Neither Agree nor Disagree	781 (19.5%)	719 (19.4%)	62 (20.8%)	0.03	
	Missing	518 (13.0%)	465 (12.6%)	53 (17.8%)	0.15	
Constraints: "Everyday stress (such as competing priorities or many demands on my time) will prevent me from getting the COVID-19 vaccine," *n* (%)	Agree	196 (4.9%)	181 (4.9%)	15 (5.0%)	0.01	< 0.0001
	Disagree	2,790 (69.8%)	2,652 (71.7%)	138 (46.3%)	0.53	
	Neither Agree nor Disagree	563 (14.1%)	480 (13.0%)	83 (27.9%)	0.38	
	Missing	450 (11.3%)	388 (10.5%)	62 (20.8%)	0.29	
Complacency: "Vaccination against COVID-19 is unnecessary because the risk of getting the COVID-19 virus in Canada is small," *n* (%)	Agree	153 (3.8%)	98 (2.7%)	55 (18.5%)	0.53	< 0.0001
	Disagree	3,058 (76.5%)	2,950 (79.7%)	108 (36.2%)	0.98	
	Neither Agree nor Disagree	433 (10.8%)	344 (9.3%)	89 (29.9%)	0.54	
	Missing	355 (8.9%)	309 (8.4%)	46 (15.4%)	0.22	

Calculation: "When I think about getting the COVID-19 vaccine, I will weigh benefits and risks to make the best decision possible," *n* (%)	Agree	3,085 (77.1%)	2,892 (78.1%)	193 (64.8%)	0.30	< 0.0001
	Disagree	235 (5.9%)	213 (5.8%)	22 (7.4%)	0.07	
	Neither Agree nor Disagree	379 (9.5%)	341 (9.2%)	38 (12.8%)	0.11	
	Missing	300 (7.5%)	255 (6.9%)	45 (15.1%)	0.26	
Collective Responsibility: "If everyone else gets vaccinated with the COVID-19 vaccine, I won't have to get vaccinated against COVID-19 too," *n* (%)	Agree	167 (4.2%)	128 (3.5%)	39 (13.1%)	0.35	< 0.0001
	Disagree	2,971 (74.3%)	2,875 (77.7%)	96 (32.2%)	1.03	
	Neither Agree nor Disagree	458 (11.5%)	360 (9.7%)	98 (32.9%)	0.59	
	Missing	403 (10.1%)	338 (9.1%)	65 (21.8%)	0.36	

Notes: [a]COVID-19 test result uses a hierarchy (Positive/Presumptive> Indeterminate> Negative> Pending> Cancelled> Rejected).
[b]Ranges reported to prevent any identification of individuals, due to small cell sizes.

Survey respondents' stated vaccination intention on the MNO survey was strongly predictive of their vaccination behaviour. As shown in Table 1, of the 68.0% of respondents to the February–March 2021 survey who reported that they "plan to get vaccinated," 72.4% were either fully or partially vaccinated in December 2022. Of those who did not plan to be vaccinated, 6.5% were in fact either partially or fully vaccinated by December 2022.

In Table 2 we present the binary logistic regression models predicting being fully or partially vaccinated by December 2022. Those who disagreed with the statement "I plan to get vaccinated" at the time of the survey had 98% lower odds of being partially/fully vaccinated, compared to those who agreed with the statement (OR 0.02; 95% CI: 0.01–0.03), after adjusting for sociodemographic factors and comorbidities (See Appendix C for calculation details).

When investigating the association between vaccine hesitancy and vaccination behaviour, four out of the five psychological antecedents of vaccine hesitancy (confidence, complacency, calculation, and collective responsibility) were significantly associated with vaccination status among MNO citizens (Table 2). Lower *confidence* in vaccine safety was strongly associated with lower likelihood of being partially or fully vaccinated. Compared with respondents who expressed confidence in vaccine safety, those who disagreed with this statement were substantially less likely to be vaccinated (OR 0.04; 95% CI: 0.03–0.06). Respondents who disagreed that vaccination was unnecessary because the risk of COVID-19 infection was small (*low complacency*) were much more likely to be vaccinated than those who agreed with this statement (OR 15.7; 95% CI: 10.5–23.5), indicating a strong association between perceived disease risk and vaccination behaviour. MNO

citizens who disagreed that when thinking about getting the COVID-19 vaccine they will weigh benefits and risks to make the best decision possible (*low calculation*) had 39% lower odds of being partially or fully vaccinated (OR 0.61; 95% CI: 0.38–0.98) than did MNO citizens who agreed with the statement. MNO citizens who agreed that they would not have to be vaccinated against COVID-19 if everyone else was vaccinated (*low collective responsibility*) also had their odds of being partially/fully vaccinated lowered by 89% (OR 0.11; 95% CI: 0.07–0.18) relative to those who disagreed with the statement. However, those who disagreed that stresses such as competing priorities or demands on their time would prevent them from getting the COVID-19 vaccine (*low constraints*) had odds of being fully or partially vaccinated that were not significantly different from those who agreed with the statement (OR 1.44; 95% CI: 0.82–2.55).

Table 2

Logistic regression analysis of vaccination status, intention, and 5Cs of vaccine acceptability/hesitancy

Model Variables	Response	Odds Ratio	95% CI	*p*-Value
Vaccination Intentions: "I plan to get vaccinated."	(Ref = Agree)			
	Disagree	0302	0.01-0.03	< 0.0001
	Neutral/Not Sure	0.14	0.09-0.21	< 0.0001
5Cs of Vaccine Acceptability/Hesistancy				
Confidence: "I am completely confident that the COVID-19 vaccine(s) that will be available in Canada will be safe."	(Ref = Agree)			
	Disagree	0.04	0.03-0.06	< 0.0001
	Neither Agree nor Disagree	0.23	0.15-0.34	< 0.0001
Constraints: "Everyday stress (such as competing priorities or many demands on my time) will prevent me from getting the COVID-19 vaccine."	(Ref = Agree)			
	Disagree	1.14	0.82-2.55	0.2027
	Neither Agree nor Disagree	0.49	0.27-0.87	0.0158
Complacency: "Vaccination against COVID-19 is unnecessary because the risk of getting the COVID-19 virus in Canada is small."	(Ref = Agree)			
	Disagree	15.67	10.45-23.51	< 0.0001
	Neither Agree nor Disagree	2.44	1.59-3.74	< 0.0001
Calculation: "When I think about getting the COVID-19 vaccine, I will weigh benefits and risks to make the best decision possible."	(Ref = Agree)			
	Disagree	0.61	0.38-0.98	0.0393
	Neither Agree nor Disagree	0.61	0.42-0.89	0.0104

Collective responsibility: "If everyone else gets vaccinated with the COVID-19 vaccine, I won't have to get vaccinated against COVID-19 too."	(Ref = Disagree)			
	Agree	0.11	0.07-0.18	< 0.0001
	Neither Agree nor Disagree	0.12	0.09-0.17	< 0.0001

Note: Six separate logistic regression models assessing the association between COVID-19 vaccination status (fully/partially vaccinated vs. non-vaccinated [reference]), and vaccine intention and each of the 5C psychological antecedents of vaccine acceptability/hesitancy. Each model adjusted for sociodemographic factors: history of chronic condition in the previous two years (binary flag for any of cancer, chronic kidney disease/renal failure, chronic obstructive pulmonary disease, congestive heart failure, diabetes, asthma, dementia, hypertension, and liver disease), COVID-19 test and infection status, age group, sex, and highest level of education attained. Probability values were assessed using the Wald test.

Limitations

Some limitations to the generalizability of these findings stem from the survey data collection methods. The pool of participants was drawn from a registry of MNO citizens as of January 2021, and findings therefore might not be generalizable to Métis living in Ontario who were not registered or lacked updated contact information. Despite the use of various recruitment channels, including email recruitment, automated telephone notifications, community communication channels, and social media promotion, survey participation required email and internet access, under-representing those who faced barriers to digital engagement and thus possibly introducing a degree of selection bias. The modest response rate of 39% further suggests that respondents may differ systematically from non-respondents with respect to unmeasured factors related to vaccination attitudes or access to preventive care. Therefore, findings are most directly generalizable to registered MNO citizens who were reachable through the available contact mechanisms and able to complete an online survey during the study period.

Survey data collection was cross-sectional, occurring between February and March 2021. With attitudes and beliefs around the pandemic and vaccination constantly evolving, responses to questions about the psychological factors of vaccine hesitancy may have shifted between the time of the survey and the time of vaccination.

Several associations observed in this study were characterized by large odds ratios, particularly for measures of confidence and complacency. These effect sizes should be interpreted cautiously, as the magnitude of the odds ratios likely reflects in part the relatively small number of unvaccinated respondents in the cohort, the high overall prevalence of vaccination, and the analytic necessity of collapsing response categories to ensure model stability. In such settings, odds ratios can appear large even when the underlying absolute differences in vaccination behaviour are more modest. Importantly, the direction and consistency of associations across models are more informative than the precise magnitude of individual estimates.

Discussion

This study is among the first to quantitatively investigate the association between the 5Cs psychological antecedents of vaccine hesitancy and actual vaccination behaviour among an Indigenous population in Canada, and the first to examine this association among MNO citizens. Our investigation found that confidence and complacency were the most important factors in predicting

vaccination among MNO citizens. Lack of confidence in the safety of COVID-19 vaccines had the strongest association with vaccination behaviour, such that individuals reporting low confidence had 25-fold lower odds of being partially or fully vaccinated compared to those reporting confidence. Those who disagreed that the risk of COVID-19 infection was small (complacency) had odds partially or fully vaccinated that were more than 15 times the odds for those who were not complacent, measured by this question.

These findings are in line with a study investigating the factors influencing H1N1 vaccine behaviour among a small sample of Manitoba Métis (Driedger et al., 2015). Like the findings of our present study, that study identified concerns about vaccine safety (confidence) and risk of contracting H1N1 influenza (complacency) as the biggest factors influencing vaccination behaviour.

Our findings are also broadly consistent with the prior analysis of the same MNO survey but examining vaccination intentions rather than confirmed vaccination behaviour (Tsui et al., 2024). In both studies, confidence and complacency emerged as the strongest predictors, with associations in the expected directions. While effect sizes appeared larger in the present analysis, which focused on confirmed partial or full vaccination, differences in magnitude should be interpreted cautiously. The two studies differed in outcome definition (intention versus behaviour), question framing, and analytic approach, all of which could influence the scale of estimated odds ratios. Notably, Tsui and colleagues operationalized "complacency" as disagreement with a statement that COVID-19 is "severe," whereas the present study defined complacency as agreement with a statement that the risk of infection is "small." Despite these differences, both measures captured perceived disease risk and were strongly associated with vaccination outcomes. Together, these findings reinforce the central role of perceived risk and vaccine confidence in shaping COVID-19 vaccination behaviour among MNO citizens. The difference in effect size between the two studies highlights the importance of the question used to capture an underlying concept, and the need for researchers to consider exact question framing when employing evidence-informed interventions into practical health promotion strategies.

Understanding the correlations between these underlying dimensions of belief and vaccination behaviours can provide valuable evidence for developing targeted health education and health promotion initiatives. These findings suggest that the most important areas of focus when addressing issues of vaccine hesitancy among Métis citizens might be to emphasize the potential risks of COVID-19 infection and the safety of COVID-19 vaccines, highlighting that the health risks associated with the infection outweigh the safety risks of the vaccine. On the other hand, the finding that the 5Cs dimension of "constraints" was not predictive of vaccination status suggests that the focus on providing Indigenous-specific vaccination clinics and early access to vaccines for Indigenous Peoples might have reduced barriers to vaccination (Smylie et al., 2022).

To be effective, approaches to promoting vaccination and reducing vaccine hesitancy among Indigenous Peoples should consider the historical and contemporary causes of a lack of confidence in vaccines and mistrust of public health messaging and public health institutions. Qualitative interviews with MNO citizens who were unvaccinated, conducted as part of this project, confirmed that this mistrust and low confidence in vaccine safety was often framed in terms of historical traumas and cultural conflict (Shields et al., 2025). Research in other contexts has suggested that effective messaging to Indigenous Peoples involves developing tailored methods that directly acknowledge the harmful legacies of the past, as well as ongoing disparities (Tinessia et al., 2024).

Conclusion

This study extends research from the largest population-based survey on vaccine hesitancy among Métis (Tsui et al., 2024), and is among the first to link administrative vaccination data and

survey data to examine vaccination behaviour among Indigenous Peoples. Using a 5-dimension model of vaccine hesitancy and validated survey questions (Betsch, 2018), we find that the strongest psychological predictors of MNO citizens not having received COVID-19 vaccines were low confidence in the safety of the vaccines, and feelings that vaccination is unnecessary due to low risk of COVID-19. We interpret this in light of other research which emphasizes the importance of understanding the role of historical colonialism and contemporary inequities as creating the conditions that support these attitudes towards vaccination among Indigenous Peoples. Effectively addressing vaccine hesitancy among Métis, as well as other Indigenous Peoples, requires acknowledging these realities.

Acknowledgements

This study was supported by ICES, which is funded by an annual grant from the Ontario Ministry of Health (MOH) and the Ministry of Long-Term Care (MLTC). Parts of this material are based on data and/or information compiled and provided by the MOH, and datasets were linked using unique encoded identifiers and analyzed at ICES. This project was also supported by a grant from the Canadian Institutes of Health Research (CIHR) and the Public Health Agency of Canada (PHAC), through the COVID-19 Immunity Task Force (CITF) The opinions, results, and conclusions reported in this paper are those of the authors and are independent from the funding sources. No endorsement by the funders, including ICES, the MOH, MLTC, PHAC, CIHR or the CITF is intended or should be inferred.

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Appendix A

Table A
Definitions for each condition included in the chronic disease history covariate

Condition	ICD 9 / OHIP	ICD 10	Drug Subclass
Acute Myocardial Infarction (AMI)*	410	I21	
Asthma*	493	J45	
(All) Cancers†	140-239	C00-C26, C30-C44, C45-C97	
Congestive Heart Failure (CHF)*	428	I500, I501, I509	
Chronic Obstructive Pulmonary Disease (COPD)*	491, 492, 496	J41, J42, J43, J44	
Dementia*	290, 331 (OHIP) / 046.1, 290.0, 290.1, 290.2, 290.3,290.4, 294, 331.0, 331.1, 331.5, F331.82 (DAD)	F00, F01, F02, F03, G30	Cholinesterase Inhibitors
Diabetes*	250	E10, E11, E13, E14	Oral Anti-Glycaemic, Insulin, Anti-Diabetic Agents: Misc
Hypertension*	401, 402, 403, 404, 405	I10, I11, I12, I13, I15	
Renal Failure†	403, 404, 584, 585, 586, v451	N17, N18, N19, T82.4, Z49.2, Z99.2	

Note: Abbreviations: ICD = International Classification of Disease; ODB = Ontario Drug Benefit program database; OHIP = Ontario Health Insurance Plan physician billings database.
* Based on validated case algorithms.
†No validated algorithm, require at least one diagnosis recorded in acute care or two diagnoses recorded in physician billings within a two-year period.
‡ODB prescription drug records are not available for the majority of persons under the age of 65.

Appendix B

Table B
Respondents included in each of the 5Cs models

		Overall	Fully/ Partially Vaccinated	No Vaccination
5Cs Model		**3,999**	**3,701**	**298**
Confidence	Excluded	518 (13.0%)	465 (12.6%)	53 (17.8%)
	Total Subjects Included in Model	3,481 (87.0%)	3,236 (87.4%)	245 (82.2%)
Constraints	Excluded	450 (11.3%)	388 (10.5%)	62 (20.8%)
	Total Subjects Included in Model	3,549 (88.7%)	3,313 (89.5%)	236 (79.2%)
Complacency	Excluded	355 (8.9%)	309 (8.3%)	46 (15.4%)
	Total Subjects Included in Model	3,644 (91.1%)	3,392 (91.7%)	252 (84.6%)
Calculation	Excluded	300 (7.5%)	255 (6.9%)	45 (15.1%)
	Total Subjects Included in Model	3,699 (92.5%)	3,446 (93.1%)	253 (84.9%)
Collective Responsibility	Excluded	403 (10.1%)	338 (9.1%)	65 (21.8%)
	Total Subjects Included in Model	3,596 (89.9%)	3,363 (90.9%)	233 (78.2%)

Appendix C

Calculation Details (Referred to in Results and Discussion Sections)

The comparison of the odds of being vaccinated for those who planned to be vaccinated and those who did not, was calculated as follows:

$$1 - OR_{D\ vs.\ A}(V) = 1 - \frac{ODDS_D(V)}{ODDS_A(V)} = \frac{ODDS_A(V) - ODDS_D(V)}{ODDS_A(V)} = 1 - 2\% = 98\%,$$

where D = disagree and A = agree with the statement "I plan to get vaccinated," and V = partially or fully vaccinated vaccination status.

The phrase "Group A had their odds (for event X) *lowered* by a factor of γ (> 1) when compared to their counterparts in group B" means $ODDS_{GroupA}(X) = \frac{ODDS_{GroupB}(X)}{\gamma}$.

The phrase "Group C had their odds (for event Y) *increase* by a factor of δ (> 1) when compared to their counterparts Group D" means $ODDS_{GroupC}(Y) = \delta \times ODDS_{GroupD}(Y)$.