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Morbid and Mortal Inequities among Indigenous People in Canada and the United States during the COVID-19 Pandemic: Critical Review of Relative Risks and Protections

Naomi Williams
University of Windsor

Amy Alberton
Wichita State University

Kevin Gorey
University of Windsor

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Abstract

The COVID-19 pandemic focused the world's attention on gross racialized health inequities and injustices. For political and scientific reasons much less is known about the plight of Indigenous peoples than about other ethnic groups. In fact, some of the early pandemic evidence suggested that Indigenous peoples, while clearly experiencing prevalent structural violence probably also experience certain cultural protections. Aiming to begin to clarify their relative risks and protections, we conducted a rapid critical research review and sample-weighted synthesis or meta-analysis of the published and gray literature on four COVID-19-relevant outcomes in Canada and the United States between January 1, 2020 and August 1, 2021: vaccination, infection, severe infection, and death rates. Twenty-nine Indigenous-non-Indigenous comparative surveys or cohorts that observed 33, typically age-standardized, incidence or mortality rates or their proxies were included. Consistent with structural violence theory, we found that Indigenous peoples were significantly more likely to be infected, to experience severe COVID-19 illness, or to die as a result of their illness, Indigenous mortal risks (RR = 2.45) being significantly greater than Indigenous morbid risks (RR = 1.40). Consistent with cultural strengths theory, vaccinations seemed equitably distributed (RR = 1.02) with a suggestion of greater vaccine willingness among Indigenous peoples in some places. Clearly, much work remains to be done to decolonize Indigenous research and ultimately practices and policies in North America. Indigenous knowledge user-researcher teams and their allies have much to teach about cultural and ultimately, policy protections.

Evidence of the widespread and harmful impacts of the COVID-19 pandemic across the diverse populations of Canada and the USA is voluminous (Clark et al., 2021; Mateen et al., 2020; Wendt et al., 2021; Wu et al., 2020). While the pandemic has revealed again the much greater relative health risks experienced by racialized/ethnic people, the primary and synthetic evidence thus far has focused on the most prevalently recognized racialized/ethnic groups: Latinx and Black people (Mackey et al., 2021). To date, there has been a relative lack of primary study and a complete absence of synthetic study of the relative morbid and mortal COVID-19-related risks experienced by Indigenous peoples in either Canada or the USA (Douglas et al., 2021; Waldner et al., 2021). This research synthesis aims to fill this glaring knowledge gap.

Indigenous Cultural Strengths

Some Canadian reports during the pandemic suggested that certain First Nations communities were faring better than other Canadian communities in terms of their COVID-19 infection and death rates (First Nations Health Authority, 2020: Waldner et al, 2021). For examples, in August of 2020 COVID-19 infections among First Nations people living on-reserve were about a quarter those of Canada's general population, and in September of 2021 the Indigenous COVID-19 case fatality rate was estimated to be nearly half that of the general population (Banning, 2020a; Government of Canada, 2021). Such preliminary findings clearly suggest protective influences of Indigenous culture. It ought to be noted, however, that great COVID-19 morbidity and mortality variability has been observed across First Nations and that the noted protections were found among Indigenous people living on-reserve (Waldner et al., 2021). Relatedly, the COVID-19 infection rate was also observed to be relatively low among American Indians in Minnesota (Minnesota Department of Health, 2021). The probable importance of culturally resilient protections was underscored by the fact that apparent Indigenous advantages were witnessed despite the historical experiences of prevalent structural violence, including colonization, that typically put First Nations and other Indigenous peoples across Canada and the USA at greater risk of poor health outcomes (Aulandez et al., 2021; Banning, 2020a; Mallard et al., 2021).

Several Indigenous community actions taken during the pandemic may explain their apparent resilience. Certain Indigenous communities in Canada and the USA took exceptional public health measures that included setting roadblocks and checkpoints to control community

access as well as culturally appropriate maintenance of lockdown and quarantine protocols (Banning, 2020a; First Nations Health Authority, 2020 Gopi & Nair, 2020 Weaver, 2020). Indigenous organizations also commonly and widely disseminated public health messages in the most culturally relevant ways including the use of traditional languages (Gopi & Nair, 2020; Richardson & Crawford, 2020). For example, the tribal President of the Navajo Nation, Jonathan Nez, addressed his Nation via Facebook, spreading hope and calling for citizens to "help one another" (Gopi & Nair, 2020, p. 521). Similar messages were disseminated across First Nations in Canada asking community members to focus on traditional ways of knowing and living, specifically, "to be caring about their neighbors like their family" (Banning, 2020a, p. 994). The Chief Medical Officer of the First Nations Health Authority encouraged Indigenous peoples to spend time outdoors on territorial lands (Center for Indigenous Cancer Research, 2020). Perhaps most instructive, Indigenous cultural strengths have seemed to naturally promote COVID-19 vaccination uptake. Furthermore, many First Nations people received the vaccine to protect their community's elders. Indigenous communities have staunchly supported vaccination efforts across Canada, for example, by setting up culturally safe, Indigenous designated, COVID-19 vaccination clinics across Ontario (CBC News, 2021; London Health Sciences Centre, 2021). Such sites used Indigenous nurses and health care system navigators to provide information, referral and support, including traditional and complimentary medicines.

Indigenous communities demonstrated myriad traditional ways of fostering spirits of caring and cooperation during the pandemic. Large ceremonial gatherings, central to many Indigenous cultures, were cancelled (First Nations Health Authority, 2020). At the same time, Indigenous communities found new uses for traditional arts and ceremonies (Banning, 2020b; Weaver, 2020). For example, our principal author along with other Indigenous community members sewed masks for members of Indigenous and non-Indigenous communities alike. Similarly, a jingle dress dancer from the Navajo Nation shared an online dance encouraging others to post similar videos of traditional dances and ceremonial regalia (Banning, 2020b). Indigenous organizations have also promoted connections using online platforms. For example, the USA Native Wellness Institute organized a Native Wellness Power Hour on Facebook, creating a forum for "storytellers, musicians, healers, and comedians," aimed at creating Indigenous unity to combat the pandemic and its aftereffects (Gopi & Nair, 2020, p. 522). Finally, holistic, community-based approaches were taken by Indigenous communities north and south of the Canada-USA border to

provide direct aid and supports, ranging from food and medical supplies to online activities for children (Aulandez et al., 2021; Banning, 2020b; Godin, 2020). For example, a language and culture educator in a remote Oji-Cree community in norther Manitoba took a group of youth onto the land to teach them about finding and harvesting Labrador tea leaves. Not only did the children learn about traditional medicines, but they were also able to use the tea in school and share it with their families and elders (Bellrichard, 2020). Such Indigenous cultural strengths seem protective especially in supporting personal choices that may prevent infections and encourage vaccinations. This rapid review will test that cultural strengths theory with evidence from diverse Indigenous communities across North America.

Structural Violence Experienced by Indigenous People

Despite Indigenous strengths and resiliencies, the evidence on COVID-19 infections has, thus far, been equivocal. Moreover, developing evidence of higher mortality rates among Indigenous peoples is concerning. Gopi and Nair (2020), for example, found that Native Americans had significantly higher COVID-19 complication and mortality rates than other Americans. And despite lower infection rates among American Indians in Minnesota, their deaths due to COVID-19 were approximately 50% greater than the general population's (Minnesota Department of Health, 2021). Evidence suggests that their higher death rates are largely due to structural violence and (neo)colonialism, that disproportionately impact Indigenous people in Canada and the USA. Yellow Horse et al. (2021) found that community structural violence indictors in Arizona predicted higher COVID-19 infection rates among Native Americans. This is probably due to Indigenous experiences of discrimination and consequent suffering across key structures of society: infrastructural, including lack of access to adequate housing and water, as well as barriers to adequate health care and a secure income (Richardson & Crawford, 2020; Weaver, 2020). Such barriers are probably especially pronounced in the USA due to its lack universal health care and comprehensive social services (Dickman et al., 2017).

The historical traumas Indigenous children suffered in residential schools remind us of the centrality of structural violence in Canadian and American history (Truth and Reconciliation Commission of Canada, 2015). Prevalent structural violence perpetuated against Indigenous peoples has been observed across all North America's social structures: education, health care, labor market, banking, housing, child welfare and criminal justice (Alberton, 2020). Historical and

ongoing perpetration of such violence against Indigenous peoples can clearly explain their much more common experiences of chronic health conditions such as diabetes and obesity (Rice et al., 2016; Zamora-Kapoor et al., 2019). These and related, largely preventable, conditions are now well-known risk factors for the most severe COVID-19 infections and deaths (Hussain et al., 2020; Kumar et al., 2020). Such social risk are probably potentiated by the relative underfunding of health care in Indigenous communities, not only in America, but in Canada as well (Owen et al., 2021; Weaver, 2020). Moreover, Indigenous tribal leaders were not included in COVID-19 health care decision-making in Canada or the USA (Godin, 2020; Ortiz, 2020; Owen et al., 2021). All of these factors would seem to bode strongly for more serious and lethal COVID-19 infections among Indigenous people.

Study Hypotheses

Based on this developing evidence, two complementary theoretical perspectives frame this study's questions about the relative protections and risks experienced by Indigenous peoples in North America's two high income countries, Canada and the USA, during the COVID-19 pandemic. Indigenous cultural strengths may be protective, especially where personal behavioral choices are likely to matter most in containing community spread of the virus. While the prevalent experiences of structural violence by Indigenous peoples over the course of their lives within Canada and USA's critical systems probably added much, especially to their mortal risks. We therefore advanced these three hypotheses: (1) Compared to non-Indigenous people, Indigenous peoples are at greater relative risk of being infected with COVID-19, and when infected, of being very seriously ill, and ultimately dying as a result of their infections.

(2) Indigenous relative mortal risks are significantly greater than their relative morbid risks.

(3) Indigenous vaccination uptake is significantly greater than non-Indigenous uptake. And

(4), Indigenous COVID-19-related relative risks are greater in the USA than in Canada.

Methods

Study Selection

Under temporal and fiscal constraints, aiming to synthesize knowledge expeditiously and efficiently for decision makers, publics and future researchers, we performed a rapid review and pooled observational analysis, that is, a meta-analytic review (Deeks et al., 2021; Ganann et al.,

2010; Stroup et al., 2000; Tricco et al., 2015). Such a review pools study findings while critically accounting for their strengths and limitations. The following research literature databases were exhaustively searched from January 1, 2020 to August 1, 2021: *Center for Disease Control and Prevention COVID-19 Database*, *Cumulative Index of Nursing and Allied Health Literature Complete*, *Fist Nations Periodical Index, Google Scholar*, *Indigenous Peoples of North America*, *Indigenous Studies Portal*, *ProQuest Coronavirus Research Database, PubMed*, *Métis Voyageur, PsycINFO*, *Social Services Abstracts*, *Social Work Abstracts*, *Sociological Abstracts*, *StatsCan COVID-19* and the *WHO Covid-19 Database.* Peer-reviewed, published and so-called gray, unreviewed unpublished sampling frames such as government documents or community-based reports were searched to guard against publication bias (de Smidt & Gorey, 1997; Grenier & Gorey, 1998). In an augmenting effort to identify and retrieve relevant Canadian studies, the following government websites were also searched: Canadian Institute for Health Information, Canadian Institutes of Health Research, Health Canada, Indigenous Services Canada, Public Health Agency of Canada, Statistics Canada, and the Social Sciences and Humanities Research Council of Canada; as were Indigenous ones: First Nations Health Authority and Métis Nation. Finally, one reviewer, an Indigenous practitioner, directly contacted all regional offices of Indigenous Services Canada.

Computerized research literature databases as well as government and Indigenous agency websites were searched with exhaustive iterations of this broad keyword search scheme: (COVID-19 or SARS-CoV-2 or coronavirus [anywhere]) and (Indigenous or Aboriginal or First Nations or Inuit or Métis or American Indian [title/abstract]) and (mortality or morbidity or infection or positive case or confirmed case or hospital* or ventilate* or incidence or mortality or death or survival or vaccination [title/abstract]) and (racialized or minoritized or ethnicity or culture [title/abstract]). Eligible studies also had to meet these inclusion criteria: (1) accomplished in Canada or the USA, (2) compared Indigenous with non-Indigenous subsamples (3) reported analytic methods, (4) findings were reported in enough detail to allow for calculation of a practical effect size metric as well as for the assessment of its statistical significance and precision, and (5) samples were powerful enough ($power_{1-\beta} = .80$) to confidently detect (2-tailed $\alpha = .05$) small to modest effects (minimally 50 to 100 participants in each study group; Faul et al., 2007; Fleiss et al., 2003). Then the bibliographies and authors of retrieved studies were snowball-searched for additional eligible studies. The selection process, cross-validated by three cooperating reviewers,

first screened studies based upon their titles and abstracts (one reviewer), and then finally selected studies based upon a review of full manuscripts (three reviewers). Three-way consensus was reached on inclusion of 29 studies. They are indicated with an asterisk in the reference list. Finally, a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) diagram outlining the study selection process is displayed in Figure 1 (Kelly et al., 2016; Moher et al., 2009). One can see that the most commonly excluded study or report, not uncommonly an online government document, was a small Indigenous case series, without a non-Indigenous comparison group and typically, without even a research design sketch.

Synthesis of Study Findings: Meta-Analysis

The unit of analysis for this synthesis was the unique hypothesis test. Indigenous-non-Indigenous comparisons were observed on the uptake of COVID-19 vaccinations, infections, severity of infections, and mortality rates. These were treated as independent hypotheses. Each study could contribute only once to each hypothesis test. If a primary study provided multiple outcomes all related to the same hypothesis, they were pooled so that that study would contribute one data point for that synthetic hypothesis test. A total of 33 such independent study findings of 29 studies were included in this synthesis. Incident or mortal prevalence ratios, odds ratios, rate ratios, or similar measures of effect estimated primary study relative risks (RR). Natural logarithms of study RRs were weighted by their inverse variances so that larger studies carried more weight. Such sample-weighted, random effects were then pooled within domains of interest using sample-weighted regression models (Cooper, 2017; Fleiss et al., 2003; Greenland, 1987). Pooled RRs within 95% CIs were calculated from regression statistics, as were tests of heterogeneity and between-groups synthetic comparisons, distributed as χ^2 and I^2 statistics. All statistical significance decisions were made at the α criterion of 0.05, and for ease of interpretation, all RRs greater than 1.00 indicated non-Indigenous advantages, while those less than 1.00 indicated Indigenous advantages. In terms of further interpreting RRs, an exemplary mortality RR of 2.00 would mean that Indigenous people were twice as likely as White people to die of COVID-19. Finally, after reliable data extraction (86.7% initial agreement between two reviewers which reached consensus with discussion) this synthesis was accomplished with version 3 of Comprehensive Meta-Analysis (Borenstein et al., 2013) and cross-validated by two analysts.

Results

Sample Description

Descriptive characteristics and 33 morbid or mortal outcomes of the 29 studies sampled for this synthesis are displayed in Table 1. Published or released during the COVID-19 pandemic between 2020 and 2021, 24 sampled American and nine sampled Canadian populations, primarily of adults. Only one study sampled younger people less than 25 years of age. Most were national samples, but there were also studies accomplished in New Mexico, Montana (2), Ontario, and Manitoba (3). None disaggregated the experiences of First Nations, Inuit, or Métis people across Canada nor of various American Indian tribal nations. As for critical comparisons, 26 study outcomes were based on Indigenous versus non-Hispanic White comparisons, the remaining seven used non-Indigenous, other or general population comparison groups. Finally, it ought to be noted that four of the studies used the Veterans Health Administration sampling frame, a health care system that is demonstrably more equitable than America's general system of health care as a result of the explicit commitment to "equal health and health care quality for all veterans" (Peterson et al., 2018, p. e1).

The 29, largely administrative data-based, studies were a fairly balanced mix of case- or population-based surveys (14), retrospective cohorts (14) and mixed designs (5), all essentially correlational, designed to estimate COVID-19 vaccinations, infections, their severity and consequent deaths among study groups at one point in time or time period. By design all of the primary studies were adequately powerful, only one study group had marginally less than 100 cases or participants: Indigenous study samples (range = 86 to 145,449, median = 3,739) and non-Indigenous ones (range = 664 to 4,138,164, median = 68,377). Most of the 33 analyses minimally accounted for age in their multivariable analyses (78.8%), nine for age alone, six for age and gender, while 11 accounted for an additional four to 10 covariates. Only six of the analytic plans accounted for socioeconomic factors. It can also be seen in the reference list that eight of the studies were gray literature reports, most typically government documents. The remainder were peer-reviewed, published articles. Finally, as for description of the 33 outcomes displayed the furthest right column of Table 1, 25 of those 33 study outcomes were statistically significant and in the direction of Indigenous disadvantages.

Synthetic Findings

Hypothesis 1. The overall pooled relative risk of COVID-19 among Indigenous peoples in Canada

or the USA was practically and statistically significant. Compared with otherwise similar non-Indigenous people, Indigenous peoples were two-thirds more likely to be infected, to experience severe COVID-19 illness, or to die with the SARS-CoV-2 virus as the primary or contributing cause of death; RR = 1.65 (95% CI 1.34, 2.04) (see top of Table 2). Also, the distribution of Indigeny-outcome associations was observed to be significantly heterogeneous with nearly all of the variability probably being explainable by systematic study factors, that is, by characteristics of the study participants, contexts, and/or research designs; χ^2 (32) = 37,312.84, $p < .05$, $I^2 = 99.9\%$.

Hypotheses 2 through 4. Scanning down Table 2 one can see that, as hypothesized, Indigenous relative mortal risks (RR = 2.45 [95% CI 1.84, 3.27]) were significantly greater than their relative morbid risks (RR = 1.40 [95% CI 1.09, 1.80]). In fact, any risks or protections seemed equitably distributed on vaccination willingness and receipt (RR = 1.02 [95% CI 0.96, 1.07]). Though based on a humble sample of only five studies, this nonsignificant synthetic finding suggests equitable, perhaps even advantaged vaccine uptake among Indigenous peoples in some places. Relatedly, and consistent with this study's theoretical context and supportive of its hypotheses, it seems also that the more virulent the infection and serious the illness the larger the Indigenous disadvantages in both Canada and the USA. For example, Indigenous disadvantages were largest for these outcomes, indicative of the most serious illness: hospitalized (RR = 3.50), admitted to the ICU (RR = 4.70), and ventilator care was required (RR = 3.49) (Manitoba Health, 2021b; Qeadan et al., 2021). As for hypothesis 4, there was insufficient statistical power to test Canada-USA differences on severe illness or mortality rates. But on COVID-19 infection and vaccination rates, Indigenous relative risks in Canada seemed quite similar to those of Indigenous peoples in the USA even after excluding the Veterans Health Administration-based studies.

Addendum Explorations

Given the substantial heterogeneity of outcomes and the fact that study characteristics were implicated, we exhaustively explored potential moderations of the Indigeneity-COVID-19 associations by other participant, contextual, and design characteristics displayed in Table 1. None were statistically significant. A few of these null findings though are interesting and important, their lack of statistical significance notwithstanding. For instance, publication status—published study versus press released gray reports—did not significantly moderate the Indigeneity-outcome association, all but ruling-out publication bias as a potent alternative explanation for this study's central findings. Also of interest, research design—survey versus retrospective cohort and

covariate adjustments (age-standardized/adjusted or not)—did not moderate outcomes. This study's synthetic findings, therefore, also seem robust to differences in study quality.

Finally, a few single-study anecdotes, if not statistically powerful, may at least be of suggestive interest to future researchers and decision makers. For example, the single largest association or between group difference was observed among younger people, less than 65 years of age. Among them a huge mortality disadvantage of American Indian or Alaskan Natives compared to age-matched non-Hispanic White Americans was observed; RR = 6.00 (Bassett et al, 2020). Those younger Indigenous peoples, thought typically to be at least risk of being seriously infected, may actually be at the greatest risk of serious illness and death because of serious comorbid health conditions they probably developed through lifetimes of exposure to North America's oppressive social structures. Most of the reviewed studies analyzed national data, but surely there must be great variability, especially across America's 50 states. Two studies notably found incredibly large Indigenous disadvantages on COVID-19 incidence and mortality with risk ratios ranging from 5.00 to nearly 15.00 in New Mexico (Hatcher et al., 2020; Xian et al., 2021). Such a caveat serves as a reminder that oppression, structural violence, and ultimately suffering and death due to COVID-19 are probably far worse in some geopolitical locations than in others, and are far worse, for example, than this review's reported 'average' pooled associations.

Discussion

The COVID-19 pandemic again identified the vulnerable statuses of certain racialized/ethnic minority people of color in North America. Unfortunately, that advancement of knowledge has pertained almost exclusively to the two most prevalently studied such groups in the West: Latinx and Black people. This rapid review and meta-analysis, the first synthetic study of Indigneny-COVID-19 inequities in North America, hypothesized certain Indigenous protections based upon Indigenous cultural strengths and certain risks related to the historical and ongoing structural violence perpetrated against Indigenous peoples' in North America. Our three hypotheses on Indigeny-COVID-19 were largely supported. First, the pooled relative risk of COVID-19 among Indigenous peoples in Canada or the USA compared with otherwise similar non-Indigenous people was statistically and practically significant, indicating that they were two-thirds more likely to be infected or to die with the SARS-CoV-2 virus as the primary or contributing cause of death (RR = 1.65). Second, Indigenous risk of death (RR = 2.45) was

significantly greater than their risk of infection (RR = 1.40), Indigenous peoples being about one and a half times as like to become ill with COVID-19 and two and a half times as likely to die as a result. Pre-existing, chronic health conditions secondary to lifetime structural violence exposures were likely responsible for the much worse mortal outcomes among Indigenous peoples. Third, despite historical and ongoing structural violence perpetrated against them, providing Indigenous people with every reason to mistrust governments, their vaccination uptake rate was on par with that of non-Indigenous people, who were primarily non-Hispanic White people (RR = 1.02). Our fourth, Canada-USA comparative, hypothesis was insufficiently powerful to test.

Recall that early estimates suggested lower COVID-19 infection rates among First Nations people living on-reserve versus off (Government of Canada, 2021). We had, consequently, expected similar or lower COVID-19 infection rates among Indigenous peoples, but we found their infection rates to be higher, on average, than non-Indigenous people. A couple points may aid interpretations. First, no study eligible for this review analytically accounted for on- or off-reserve/reservation status. And second, the distribution of effects ranged widely. In fact, two USA studies observed much lower infection rates among Indigenous peoples (Romero et al., 2020; Rozenfeld et al., 2020). Therefore, it seems likely that this study's average, relative risk, estimate (RR = 1.40) that aggregated the infections of Indigenous peoples living on- and off-reserve/reservation, is an overestimate of the truth. But this hypothesis must be tested against future evidence. Similarly, while we hypothesized greater vaccine uptake among Indigenous peoples, we found their uptake similar to non-Hispanic White people's (RR = 1.02). Though null, this finding seems one of this study's most practically significant. First, it is stunning that Indigenous peoples, despite having such great levels of structural violence perpetrated against them, would exhibit any health outcome on par with non-Hispanic White people. Second, three studies (two Canadian and one USA) observed vaccination rates among Indigenous peoples that were 5% to 20% greater than non-Indigenous people (Kriss et al., 2021; Lunsky et al., 2021; Statistics Canada, 2021b). Indigenous cultural strengths are clearly implicated. This study's relative protection estimate may be an underestimate of the truth, but again, such remains a hypothesis for future research testing.

Limitations and Future Research Recommendations

In addition to reserve/reservation living status, no primary study that we reviewed specifically reported findings by important within Indigenous community characteristics: First Nations, Métis, or Inuit communities in Canada or tribal nations in the USA. As effects ranged so widely, from approximate relative risks of 0.50 to 5.00, it seems evident that certain Indigenous groups benefit more from Indigenous culture than others. Those residing in socially and geographically close-knit communities, on reserves/reservations for example, probably stand to benefit most. Future research that addresses such within Indigenous variability would allow society to maximally learn about Indigenous culture-based wisdom. Further barriers to our learning from Indigenous communities seems the profound limits of their administrative data collected by federal governments (Davis, 2016; Douglas et al., 2021; Gopi & Nair, 2020; Skye, 2020). In this study's search, for example, about half of the excluded, otherwise eligible, studies were excluded because they were grossly underpowered or recoded and combined groups into "visible minorities," or worse, into an "others" categories (Kader & Smith, 2021; Noppert & Zalla, 2021; Patel et al., 2020). Such fragmented data collection can at best lead to racialized/ethnic misclassifications, at worst, it can act to analytically and practically dismisses all cultural knowledge except that of non-Hispanic White people's, the singular, most often by default, gold standard comparator. In the era of truth and reconciliation more comprehensive and meaningful efforts must be made by Canadian and American governments to work with Indigenous communities to collect and use their data in the most truthful and powerful ways (Stukes & Wu, 2020).

As with all rapid research reviews, this unfunded review was subject to certain resource constraints: human, temporal, and infrastructural. Consequently, we could not follow all PRISMA recommendations (Kelly et al., 2016; Moher et al., 2009). For example, as much of its sampling frame was comprised of online government document releases, reviewers often could not be blind to 'study' findings as they made selection decisions. However, this review demonstrated substantial thoroughness, reliability, and validity in sampling and analysis. Therefore, we believe that despite its rapid nature, our review findings probably approximated those of a full systematic review and meta-analysis. Still, a better-endowed systematic research review and analysis will be needed in a few years' time after more controlled, peer-reviewed primary studies, accomplished by knowledge user-researcher, Indigenous-ally teams, accrue.

Conclusion

This rapid critical research review provided evidence that inequalities exist among Indigenous and non-Indigenous people on COVID-19 related outcomes. Consistent with their lifetime exposures to discrimination and structural violence, Indigenous peoples seemed clearly to be at relatively grave risk of having the most serious and deadly COVID-19 infections. However, consistent with cultural strengths theory, COVID-19 infection occurrences and vaccination uptake seemed much more equitably distributed with certain Indigenous people in some places even demonstrating significant protective advantages over non-Hispanic White people. Clearly, much work remains to be done to support Indigenous research, practices and policies in North America. Indigenous knowledge user-researcher teams and their allies have much to teach us about cultural and ultimately, policy protections.

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Figure 1.
PRISMA Flow Diagram for the Rapid Review Sampling Process

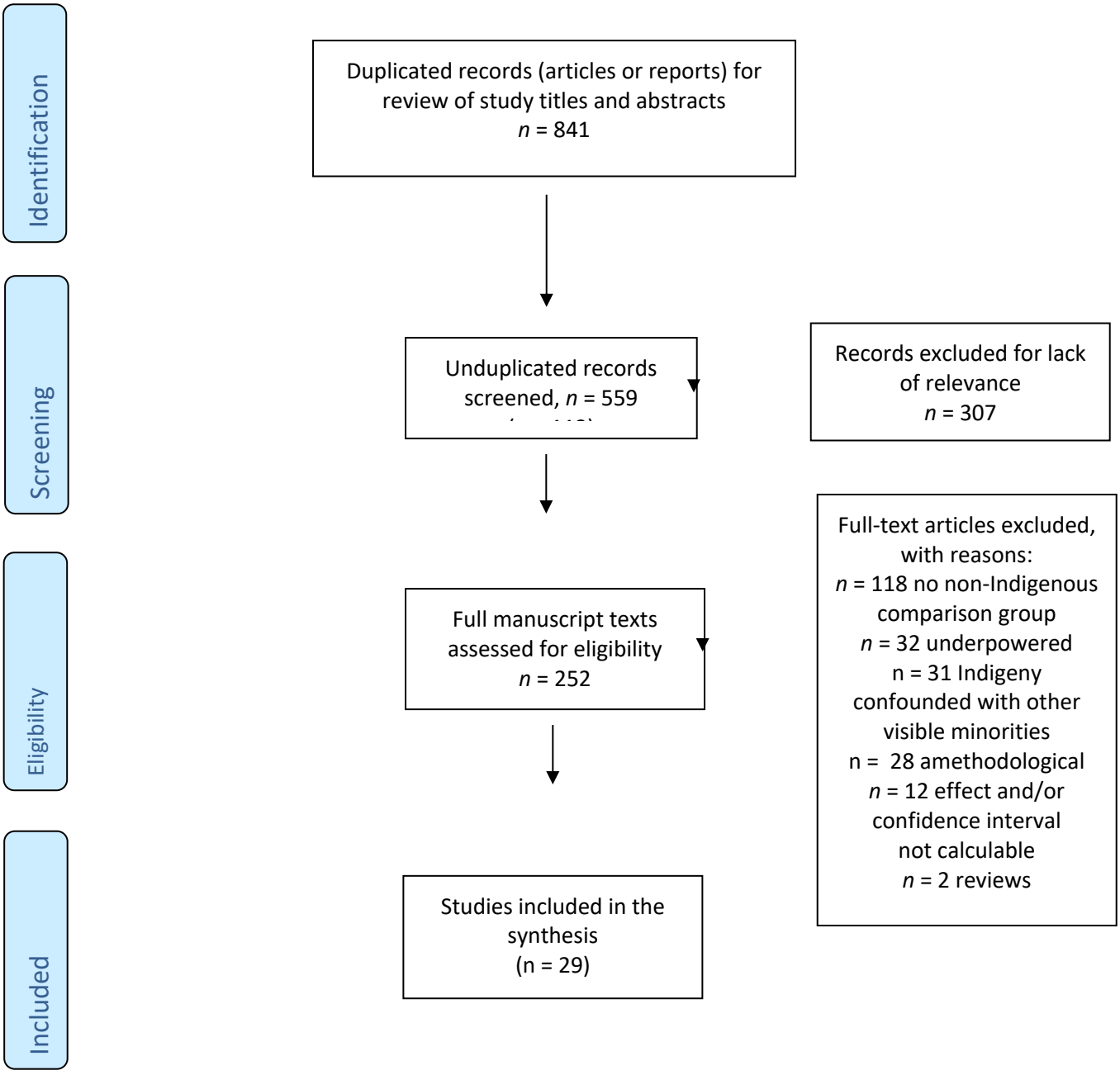

Table 1. *Description of the 29 Studies Included in the Review and Their 33 Outcomes: Indigenous vs Non-Indigenous COVID-Relevant Risk Estimates*

Reference	Populations Places Time Frame	Research design Sampling frame Analytic samples Covariate adjustments[a]	Outcomes Descriptive Statistics Risk ratio (95% confidence interval)
	COVID-19 vaccinations		
Kriss et al., 2021	NHAI/AN vs non-Hispanic White 16 or older USA December 2020 to February 2021	Survey, CDC Vaccine Administration Management System 145,449 & 4,138,164 None	Completed 2-dose vaccination series 83.7% vs 90.3% **PR = 1.08** (1.07, 1.09)
Lunsky et al., 2021	Indigenous, First Nations or Métis vs European 18 or older Ontario January to February 2021	Survey Workers supporting disabled adults 86 & 2,014 Age, gender, education & 6 covariates	Very or somewhat likely to be vaccinated 69.8% vs 82.6% **PR = 1.18** (1.06, 1.31)
Statistics Canada, 2021a	Indigenous vs non-Indigenous 12 or older Canada September to December 2020	Survey Canadian Community Health Survey around 800 & > 2,000 Age	Very or somewhat willing to be vaccinated 71.8% vs 77.1% **PR = 1.07** (1.03, 1.11)
Statistics Canada, 2021b	Indigenous vs non-Indigenous 18 or older 10 provinces April to May 2021	Survey, Public Health Agency of Canada COVID-19 Vaccination Coverage 20,000 Age	Vaccinated (1 or 2 doses) (18-64) 43.0% vs 29.4% PR = 0.68 (0.60, 0.77) (60+) 78.4% vs 80.4% PR = 1.03 (0.98, 1.09) **PR_{pooled} = 0.99** (0.97, 1.01)

	AI/AN vs general population 18 or older	Survey Urban Indian Health Institute	Willingness to be vaccinated
Urban Indian	USA, Indian Country	1,435 & 1,435	75.0% vs 64.0%
Health Institute, 2021	December 2020	None	**PR = 0.85** (0.81, 0.90)
	COVID-19 Infections		
	AI/AN/PI vs White 18 or older	Survey, VHA Corporate Data Warehouse	Positive SARS-CoV-2 test
	USA, Veterans Health Administration	1,487 & 56,526 tests	9.4% vs 8.9%
Fan et al., 2020	March 2020	Age, gender, urbanity & 5 covariates	**AOR = 1.26** (1.05, 1.52)
	AI/AN vs White All ages	Survey/retrospective cohort CDC Vital Statistics System	Incidence per 100,000 594 vs 169
	23 states	9,072 & 138,960 cases	**RR = 3.50** (1.20, 10.10)
Hatcher et al., 2020	January to July 2020	None	New Mexico RR = 14.90*
	AI/AN vs general population All ages	Retrospective cohort County-level analysis	Normalized
	22 states (79 county hotspots)	CDC Wonder & US Census	Incidence disparity
Moore et al., 2020	February to June 2020	Population size	**NID = 4.20** (1.91, 9.20)
	NHAI/AN vs non-Hispanic White All ages	Survey HRSA Health Center Program	Positive test
	USA	36,837 & 941,017 tests	3.4% vs 6.4%
Romero et al., 2020	June to October 2020	None	**PR = 0.53** (0.50, 0.56)
	AI/AN vs White 18 or older	Survey Providence Health System	Positive test
	USA	465 & 24,799 tests	2.8% vs 5.6%
Rozenfeld et al., 2020	February to April 2020	Age, gender, education & 10 covariates	**OR = 0.63** (0.36, 1.12)

	Indigenous vs English/European 18 or older Canada	Online survey Angus Reid Forum 226 & 3,567	Present with symptoms 8.5% vs 4.4%
Wu et al., 2020	March 2020	Age, gender, education & 3 covariates	**AOR = 1.34** (0.96, 2.24)
	AI/AN vs White 18 or older USA, Veterans Health Administration	Survey VHA Laboratory Database 8,036 & 562,562 tests	Positive test 9.2% vs 9.5%
Ferguson et al., 2021	February to December 2020	Age, gender, urbanity & 3 covariates	**RR = 1.05** (0.97, 1.14)
	Indigenous vs non-Indigenous Chronically ill or disabled 15 or older, Canada	Survey Impacts of COVID-19 on Canadians approximately 600 & > 13,000	Tested or sought care for COVID-19 12.0% vs 8.0%
Hahmann, 2021	June to July 2020	None	**PR = 1.50** (1.20, 1.88)
	NHAI/AN vs non-Hispanic White All ages 22 states & DC	Survey/retrospective cohort CDC Vital Statistics System 19,259 & 657,259 cases	Positive cases 2,274 vs 935
Hollis et al., 2021	January to October 2020	Age & gender	**CIR = 2.43** (2.40, 2.47)
	NHAI/AN vs non-Hispanic White All ages California	Retrospective cohort California Department of Public Health 191 & 18,046 cases	Confirmed cases per 100,000 < 50 RR = 1.55 (1.02, 2.35) 50+ RR = 0.95 (0.91, 0.99)
Hsu & Hayes-Bautista, 2021	Till June 2020	Age	**RR_{pooled} = 0.96** (0.94, 0.98)
	Indigenous vs English/European 18 or older Canada	Survey Angus Reid Forum 738 & 7,205	Seroprevalence 1.73% vs 1.81%
Jha et al., 2021	May to June 2020	Age, gender, education & 6 covariates	**OR = 0.89** (0.43, 1.83)

	North American Indigenous vs others		Survey, Public Health	
	All ages		Information Management System	
	Manitoba		2,694 & 13,154 cases	Positive cases
Manitoba Health, 2021a	May to December 2020		None	**PR = 1.31** (1.24, 1.42)
	North American Indigenous vs	White	Survey/retrospective cohort	
	All ages		Public Health Info Manage System	Confirmed cases per 1,000
	Manitoba		2,402 & 5,105 cases	10.7 vs 4.8
Manitoba Health, 2021b	March to June 2021		Age	**RR = 2.10** (1.80, 2.45)
	NHAI/AN vs Non-Hispanic W	hite	Retrospective cohort	
	Less than 25		CDC Vital Statistics System	Confirmed cases per 100,000
	15 states & DC		15,651 & 390,797 cases	4,754 vs 2,787
Van Dyke et al., 2021	2020		Age & gender	**RR = 1.71** (1.68, 1.73)
	AI/AN vs	White	Retrospective cohort	
	All ages		Dept Public Health & Human Services	Confirmed cases per 100,000
	Montana		7,069 & 39,040 cases	9,060 vs 4,033
Williamson et al., 2021	2020		Age & gender	**RR = 2.20** (2.10, 2.50)
	AI/AN vs non-Hispanic	White	Retrospective cohort	
	All ages		VHA National Database	
	USA, Veterans Health Administration		4,860 & 436,022 cases	Incidence
Wong et al., 2021	March to November 2020		Age, gender & 8 comorbidities	**RR = 1.46** (1.38, 1.55)

Severe COVID-19 Illness

	American Indian vs W	hite	Survey, CDC Behavioral	2 or more risk factors
	18 to 64		Risk Factor Surveillance System	for severe illness
Raifman &	USA		6,713 & 96,384	18.0% vs 8.0%
Raifman, 2020	2018		Age	**RR = 2.15** (1.84, 2.50)

			Survey/retrospective cohort	
	NHAI/AN vs non-Hispanic	White	Natl Syndromic Surveillance Program	ER visits
	All ages		& National Center for Health Statistics	COVID-related per 100,000
	13 states		3,739 & 166,212 COVID-related visits	570 vs 333
Smith et al., 2020	October to December 2020		Age	**RR = 1.71** (1.66, 1.77)
	North American Indigenous vs	White	Survey/retrospective cohort	
	All ages		Public Health Info Manage	Hospitalized RR = 3.50 (3.09, 3.97)
	Manitoba		2,402 & 5,105 cases	ICU RR = 4.70 (4.42, 5.00)
Manitoba Health, 2021b	March to June 2021		Age	**RR_{pooled} = 4.57** (4.50, 4.64)
	NHAI/AN vs non-Hispanic	White	Retrospective cohort	Hospitalized RR = 1.21 (1.03, 1.43)
	All ages		Cener COVID-19 Data Cohort	LOS RR = 1.32 (1.16, 1.51)
	USA, 62 health systems		1,070 & 15,048 patients	Ventilated RR = 3.49 (2.87, 4.25)
Qeadan et al., 2021	January to June 2020		Age, gender, HI & comorbidities	**RR_{pooled} = 1.67** (1.60, 1.74)
		COVID-19 Mortality		
				Deaths per 100,000
	NHAI/AN vs non-Hispanic	White	Retrospective cohort	108.9 vs 49.9
	All ages		CDC WONDER & National Center for	**RR = 2.20** (1.80, 2.60)
	USA		Health Statistics: 1,143 & 68,377 deaths	< 65: 57.1 vs 9.5
Bassett et al., 2020	February to July 2020		Age	RR = 6.00 (4.70, 7.60)
	Indigenous vs	White Americans	Retrospective cohort	
	All ages		Covid Tracking Project & US Census	Deaths per 100,000
	43 states & DC		5,477 & 299,915 deaths	401.3 vs 121.4
APM Research Lab, 2021	Till March 2021		Age	**RR = 3.31** (3.24, 3.41)
	AI/AN vs	White	Retrospective cohort	
	20 or older		CDC COVID-19 Trial Support Unit &	Deaths per 100,000
	18 states		US Census: 1,134 & 18,815 deaths	55.8 vs 30.3
Arrazola et al., 2021	January to June 2020		Age & gender	**RR = 1.84** (1.74, 2.06)

	AI/AN vs all others	Retrospective cohort	
	All ages	CDC Vital Statistics System	Deaths per 100,000
	USA	4,504 & 373,379 deaths	187.8 vs 91.5
Ahmad et al., 2021	2020	Age & gender	**RR = 2.05** (1.96, 2.14)
	NHAI/AN vs non-Hispanic White	Retrospective cohort	
	All ages	Cener COVID-19 Data Cohort	
	USA, 62 health systems	1,070 & 15,048 patients	Death
Qeadan et al., 2021	January to June 2020	Age, gender, HI & comorbidities	**RR = 2.06** (1.70, 2.50)
	AI/AN vs White	Retrospective cohort	
	All ages	MDPHHS	Deaths per 100,000
	Montana	208 & 664 deaths	267 vs 71
Williamson et al., 2021	2020	Age & gender	**RR = 3.80** (3.20, 4.40)
	AI/AN vs non-Hispanic White	Retrospective cohort	
	All ages	VHA National Database	
	USA, Veterans Health Administration	4,860 & 436,022 cases	Death
Wong et al., 2021	March to November 2020	Age, gender & 8 comorbidities	**RR = 1.64** (1.41, 1.92)
	AI/AN vs White	Retrospective cohort	
	All ages	Covid Tracking Project &	Normalized
	New Mexico	US Census	Mortality disparity
Xian et al., 2021	Till September 2020	Population size	**NMD = 5.00** (3.62, 6.90)

Notes. AI/AN, American Indian or Alaskan Native; AI/AN/PI, or Pacific Islander; AOR, adjusted odds ratio; CDC, Center for Disease Control and Prevention; CIR, cumulative incidence cases; DC, District of Columbia; HI, health insurance; HRSA, Health Resources and Services Administration; ICU, intensive care unit; Montana Department of Public Health and Human Services; NHAI/AN, non-Hispanic American Indian or Alaskan Native; NID, normalized incidence disparity; NMD, normalized mortality disparity; OR, odds ratio; PHAC, Public Health Agency of Canada; PR, prevalence ratio, RR, rate ratio; VHA, Veterans Health Administration; WONDER, Wide-Ranging Online Data for Epidemiologic Research. [a] Potential confounds that were accounted for by standardization, sample restriction and or mathematical modeling. [*] $p < .05$

Table 2.
Summary of Study Outcomes

Number of Pooled Risk Ratios	Number of Study Participants			
Study Outcomes	**Indigenous**	**Non-Indigenous**	**RR**	**95% CI**
	Overall population comparisons			
33	291,597	8,945,643		1.65
1.34, 2.04				
	COVID-19 vaccinations			
5	147,770[a]	4,143,613[a]		1.02[d]
0.96, 1.07				
3 Canada	886[a]	4,014[a]		1.06[e]
0.98, 1.15		2 USA		146,884
4,139,599	0.96[e]	0.76, 1.21		
	COVID-19 infections			
16	111,508[c]	3,308,060[c]		1.40[d]
1.09, 1.80				
5 Canada	6,659	42,031		1.47[f]
1.15, 1.89				
11 USA	104,849[c]	3,266,029[c]		1.40[f]
1.03, 1.89				
	Severe COVID-19 illness or death[b]			
12	32,319[c]	1,494,970[c]		2.45[d]
1.84, 3.27				
1 Canada	2,401	5,105		4.57[g]
4.50, 4.64				
11 USA	29,918[c]	1,489,865[c]		2.30[g]
1.86, 2.85				

Notes. CI, confidence interval. Pooled risk ratios with the same superscripts were compared.
[a] One study reported an additional disaggregated sample of 20,000.
[b] Reported together as Indigenous associations with illness severity and death did not differ significantly; χ^2 (1) = 0.06, p = .81. [c] One study did not report sample sizes. [d] χ^2 (2) = 58.17, $p < .05$, [e] χ^2 (1) = 0.64, p = .42, [f] χ^2 (1) = 0.07, p = .79. [g] χ^2 (1) = 39.70, $p < 0.05$