Postoperative outcomes for Indigenous Peoples in Canada: a systematic review

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ABSTRACT

Background: Substantial health inequities exist for Indigenous Peoples in Canada. The remote and distributed population of Canada presents unique challenges for access to and use of surgery. To date, the surgical outcome data for Indigenous Peoples in Canada have not been synthesized.

Methods: We searched 4 databases to identify studies comparing surgical outcomes and utilization rates of adults of First Nations, Inuit or Métis identity with non-Indigenous people in Canada. Independent reviewers completed all stages in duplicate. Our primary outcome was mortality; secondary outcomes included utilization rates of surgical procedures, complications and hospital length of stay. We performed meta-analysis of the primary outcome using random effects models. We assessed risk of bias using the ROBINS-I tool.

Results: Twenty-eight studies were reviewed involving 1 976 258 participants (10.2% Indigenous). No studies specifically addressed Inuit or Métis populations. Four studies, including 7 cohorts, contributed adjusted mortality data for 7135 participants (5.2% Indigenous); Indigenous Peoples had a 30% higher rate of death after surgery than non-Indigenous patients (pooled hazard ratio 1.30, 95% CI 1.09–1.54; $I^2 = 81\%$). Complications were also higher for Indigenous Peoples, including infectious complications (adjusted OR 1.63, 95% CI 1.13–2.34) and pneumonia (OR 2.24, 95% CI 1.58–3.19). Rates of various surgical procedures were lower, including rates of renal transplant, joint replacement, cardiac surgery and cesarean delivery.

Interpretation: The currently available data on postoperative outcomes and surgery utilization rates for Indigenous Peoples in Canada are limited and of poor quality. Available data suggest that Indigenous Peoples have higher rates of death and adverse events after surgery, while also encountering barriers accessing surgical procedures. These findings suggest a need for substantial re-evaluation of surgical care for Indigenous Peoples in Canada to ensure equitable access and to improve outcomes. **Protocol registration:** PROSPERO- CRD42018098757

Safe, timely and affordable access to surgical care is essential to overall population health, as conditions amenable to surgical intervention account for one-third of the global burden of disease.[1,2] Surgery is responsible for 65% of cancer cure and control, it is key to trauma management, and access to cesarean delivery reduces neonatal deaths by up to 70%.[1] The magnitude and ubiquity of surgical conditions makes tracking their prevalence and treatment within local and national monitoring systems essential to fully capture the health and welfare of populations in Canada, including Indigenous Peoples.

About 1.67 million people in Canada are Indigenous, representing 4.9% of the total population (58% First Nations, 4% Inuit, 35% Métis).[3] Health inequities exist for the Indigenous population; life expectancy at birth is 5–11 years shorter than for non-Indigenous Peoples[4,5] and higher rates of communicable and noncommunicable diseases, unintentional injury and suicide are well documented.[4,6–14] These health inequities are direct impacts of the social determinants of health, which are in turn effects of colonialism and government policies, including the Indian residential school system.[8,11] People living in remote regions have less access to publicly funded health care than other people in Canada, with worse outcomes.[15]

Given the substantial impact of surgical disease on population health and the recognized disparities in health care access for Indigenous Peoples in Canada, understanding access to surgical services and subsequent outcomes is a key step to addressing health inequities. To date, limited research has been conducted on surgical and postoperative care involving Indigenous Peoples in Canada and the available literature has not been synthesized. Our objective was to systematically review studies comparing postoperative outcomes between Indigenous and non-Indigenous Peoples in Canada.

Methods

Following protocol registration with the International Prospective Register of Systematic Reviews (CRD42018098757), we conducted a systematic review in accordance with the Cochrane Collaboration and Meta-analysis Of Observational Studies in Epidemiology (MOOSE) guidelines.[16] We report our findings according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement.[17]

Search strategy

We constructed a comprehensive and peer-reviewed[18] search strategy, in collaboration with an information specialist, using terms related to surgery and identification of Indigenous Peoples in Canada. We applied our search strategy to MEDLINE, Embase, Cochrane and the Cumulative Index to Nursing & Allied Health Literature without language restriction, from inception to Apr. 12, 2019 (Appendix 1, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.191682/tab-related-content). We reviewed the reference lists of included articles. We included all languages; however, we did not search the grey literature because of variability of quality, high risk of bias and limited ability to verify methods. We contacted when clarification was required.

Outcomes

Our primary outcome was all-cause postoperative mortality; we did not limit the window of outcome ascertainment. Secondary outcomes included complications, length of stay, wait times and rates of surgery, resource use, satisfaction and quality of life.

Inclusion and exclusion criteria

We included studies if they addressed adults having surgery or cesarean deliveries in Canada, identified Indigenous Peoples by any method (e.g., an explicit measurement technique or through self-identification) and provided quantitative data making a comparison between a group with Indigenous identity and one without Indigenous identity or the general population with respect to primary or secondary outcomes. We excluded studies that addressed non-Canadian or non-Indigenous Peoples and case reports or series.

Study selection and data extraction

Two independent reviewers (A.P. and N.A.) performed all stages of study selection in duplicate using Covidence systematic review software (Veritas Health Innovation). Reviewers first screened titles and abstracts. We specified that both reviewers must agree to exclude a study; any disagreements or uncertainties were advanced to full text review where disagreements were resolved by consensus (A.P., N.A., J.M., D.M.). Two independent reviewers (A.P. and N.A.) extracted data of studies included after full text review using a form specifically designed and piloted for this study. We extracted publication details, study population characteristics, design and outcomes data (number, proportion, central measures of tendency and variance), as well as rates of outcomes and unadjusted and adjusted effect sizes (i.e., odds ratios [ORs], risk ratios [RRs] and hazard ratios [HRs]). We also extracted data on key confounders including age, comorbidities, rural or urban residence and income. For obstetric studies, we extracted data on maternal outcomes only.

Data analysis

We summarized study characteristics descriptively. Primary outcome data, adjusted for prespecified confounders (procedure, age, and comorbidity), were meta-analyzed using models weighted for random effects inverse variance to account for pooling across heterogenous surgical procedures (Comprehensive Meta-Analysis software, Biostat). We assessed heterogeneity using the I^2 statistic. We performed a narrative synthesis of other outcome data.

Two independent reviewers (D.M. and J.M.) assessed risk of bias using the Risk Of Bias In Non-Randomized Studies of Interventions (ROBINS-I) tool.[19] We particularly focused on study definitions of exposure status, as described in Appendix 2, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.191682/tab-related-content.

Results

We identified 707 titles and abstracts, reviewed 118 full-text articles and included 28 studies (Figure 1, Table 1) published in English from 1989 to 2016. Surgical specialties included urologic ($n = 8$, 29%),[25,34,40–43,45,46] obstetric ($n = 5$, 18%),[29,33,35,38] orthopedic ($n = 3$, 11%),[21,28,30,32] general ($n = 3$, 11%),[24,27,47] cardiac ($n = 3$, 11%),[22,39,44] ophthalmologic ($n = 1$, 4%), plastic ($n = 1$, 4%) and vascular ($n = 1$, 4%) surgery.[23,26,37] Three studies (11%) included a mix of surgical specialties.[31,36] All studies used observational designs (26 retrospective cohorts, 1 case–control, 1 cross-sectional). Of 1 976 258 participants from all included studies, 202 056 (10.2%) identified as Indigenous. Studies used a variety of methods to identify Indigenous identity (Appendix 3, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.191682/tab-related-content).

Outcomes

Eight studies reported mortality rates (Table 2),[22,23,26–28,39,43,47] including 4 studies that reported crude mortality data.[22,23,26,47] Overall, 47 (16.1%) of 292 people of Indigenous identity died, compared with 1209 (21.4%) of 5647 people of non-Indigenous identity; however, inadequate description of unadjusted data precluded meta-analysis. Meta-analysis of adjusted data estimated a pooled HR of 1.30 (95% confidence interval [CI] 1.09–1.54, $I^2 = 81\%$), where an HR > 1 indicates a higher risk of death for Indigenous Peoples (Figure 2). One study reported increased mortality for the Indigenous cohort using adjusted ORs (OR 1.15, 95% CI 0.63–2.08), but the trend was not statistically significant.[39] We explored possible sources of heterogeneity in our pooled effect by surgery type (orthopedic, transplant and cardiovascular). The percentage of variation attributed to heterogeneity across studies was 0% for orthopedic and cardiovascular surgeries and 89% for transplant surgeries. When we pooled cardiovascular and orthopedic surgeries, the pooled HR estimate was 1.33 (95% CI 1.16–1.54, $I^2 = 37\%$); pooled transplant studies had an HR of 1.41 (95% CI 0.81–2.46, $I^2 = 89\%$). A sensitivity analysis explored

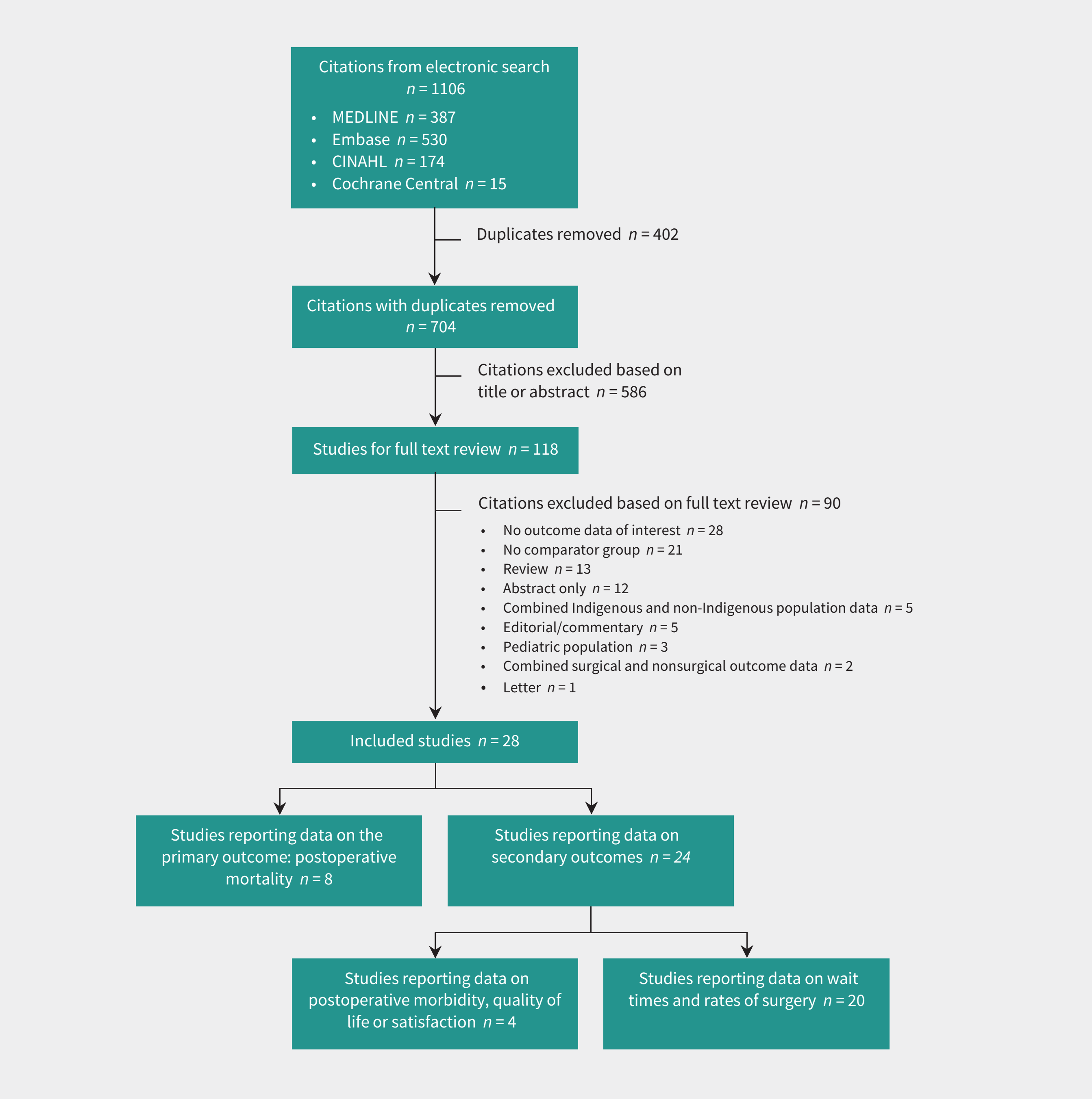

Figure 1: Flow diagram of study selection. CINAHL = Cumulative Index to Nursing & Allied Health Literature.

the role of follow-up time as an effect modifier using metaregression; we found no evidence of effect modification ($p = 0.317$).

Twenty-four studies reported on secondary outcomes. The wide range of secondary outcomes is described in Appendix 4, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.191682/tab-related-content. Complications were routinely reported and were higher for Indigenous Peoples. After cardiac surgery, we found higher adjusted rates of infectious complications among First Nations Peoples (infection-adjusted OR 1.63, 95% CI 1.13–2.34; pneumonia OR 2.24, 95% CI 1.58–3.19); a composite of major cardiac and renal events did not differ.[39] Living kidney donors who were First Nations or Métis had higher rates of long-term complications, such as new hypertension (adjusted OR 6.3, 95% CI 1.8–22.1), and diabetes (19.4% v. 1.6%, $p = 0.005$).[40] Kidney transplant recipients (HR 1.53, 95% CI 1.20–1.95) were more likely to experience graft failure.[25] After cholecystectomy, First Nations identity was associated with an adjusted 1.5-fold increase in the odds of hospital readmission (95% CI 1.17–1.81).[24] We assessed quality of life after diabetic limb amputation and noted no difference between patients of First Nations or Métis identity and the rest of the study participants (decreased in both groups).[32]

Table 1 (part 1 of 2): Characteristics of included studies

Study	Study design	Surgical specialty	Sample size	No. Indigenous	No. non-Indigenous	Indigenous population	Identification of Indigenous population	Outcome of interest
Aljohani et al.[20]	Retrospective cohort study	Obstetric	165 969	20 414	145 555	First Nations	First Nations status	Rates of cesarean delivery
Barnabe et al.[21]	Retrospective cohort study	Orthopedic	300 673	10 745	289 928	First Nations, Inuit and Métis	Payment through the First Nations and Inuit Health Branch (Health Canada)	Rates of hip or knee arthroplasty for osteoarthritis
Bresee et al.[22]	Retrospective cohort study	Cardiac	22 171	489	21 682	First Nations	First Nations status	Rates of coronary revascularization after acute myocardial infarction; death after coronary revascularization for acute myocardial infarction
Callegari et al.[23]	Retrospective cohort study	Plastic	1598	125	1473	First Nations and Métis	Unknown	Rates of surgical treatment for burns
Cohen et al. 1989[24]	Retrospective cohort study	General	37 383	1327	36 056	First Nations	First Nations status	Readmission rate after cholecystectomy
Dyck[25]	Retrospective cohort study	Urologic	645	89	556	Not specified	First Nations status	Rates of renal transplant
Goulet et al.[26]	Retrospective cohort study	Vascular	678	84	594	First Nations, Inuit, Métis	First Nations status or ethnicity referenced in medical record	Death after revascularization for peripheral vascular disease
Hong et al.[27]	Retrospective cohort study	General	1164	Unknown	Unknown	Not specified	Canadian Organ Replacement Register	Death after liver transplant
Leslie et al.[28]	Retrospective case control	Orthopedic	104 292	1069	103 223	First Nations	First Nations status	Death after surgery for nontraumatic hip, wrist or spine fracture
Liu et al.[29]	Retrospective cohort study	Obstetric	29 216	253	28 963	First Nations	On reserve First Nations residence	Rates of cesarean delivery
Martens et al.[30]	Cross-sectional study	Orthopedic	Unknown	116 071	Unknown	First Nations	First Nations status	Rates of amputation in patients with diabetes
McIntyre et al.[31]	Retrospective cohort study	Orthopedic, vascular	127	64	63	First Nations, Métis	Self-identified	Rates of amputation or vascular bypass in patients on dialysis
Meatherall[32]	Retrospective cohort study	Orthopedic	44	21	23	First Nations, Métis	Unknown	Disability and quality of life after lower limb amputation
Oster et al.[33]	Retrospective cohort study	Obstetric	427 058	28 306	398 752	First Nations	First Nations status	Rates of cesarean delivery
Promislow et al.[34]	Retrospective cohort study	Urologic	30 688	2361	28 327	Not specified	Canadian Organ Replacement Register	Rates of renal transplantation
Riddell et al.[35]	Retrospective cohort study	Obstetric	215 993	9152	206 841	First Nations	First Nations status	Rates of cesarean delivery
Rose et al.[36]	Retrospective cohort study	Orthopedic, vascular	325	224	101	First Nations, Métis	Unknown	Rates of amputation in patients with diabetes
Roy et al.[37]	Retrospective cohort study	Ophthalmologic	88	43	45	First Nations	Unknown	Rates of surgical treatment for uveitis
Shen et al.[38]	Retrospective cohort study	Obstetric	214 028	Unknown	Unknown	First Nations	First Nations status	Rates of cesarean delivery

Table 1 (part 2 of 2): Characteristics of included studies

Study	Study design	Surgical specialty	Sample size	No. Indigenous	No. non-Indigenous	Indigenous population	Identification of Indigenous population	Outcome of interest
Sood et al.[39]	Retrospective cohort study	Cardiac	12 170	574	11 596	First Nations, Inuit, Métis	Self-identified	Rates of cardiac surgery; Morbidity after cardiac surgery; death after cardiac surgery
Storsely et al.[40]	Retrospective cohort study	Urologic	114	38	76	First Nations, Métis	Self-identified	Morbidity after kidney donation; death after kidney donation
Tonelli[41]	Retrospective cohort study	Urologic	9905	495	9410	First Nations, Inuit, or Métis	Canadian Organ Replacement Register	Rates of renal transplant
Tonelli et al.[42]	Retrospective cohort study	Urologic	4840	685	4155	First Nations, Inuit, or Métis	Canadian Organ Replacement Register	Rates of renal transplant
Weber et al.[43]	Retrospective cohort study	Urologic	705	126	579	First Nation, Inuit or Métis	Self-identified	Death after renal transplant
Wei-Randall et al.[44]	Retrospective cohort study	Cardiac	353 688	6560	347 128	First Nations	Areas with high percentage of residents of First Nations identity	Rates of coronary revascularization after acute myocardial infarction
Yeates et al.[45]	Retrospective cohort study	Urologic	24 561	1071	23 490	Not Specified	Canadian Organ Replacement Register	Rates of renal transplant
Yeates et al.[46]	Retrospective cohort study	Urologic	17 986	1650	16 336	First Nations, Métis, Inuit	Canadian Organ Replacement Register	Rates of renal transplant
Zhang et al.[47]	Retrospective cohort study	General	149	20	129	First Nations	First Nations status or self-identification	Death after liver transplant

Twenty studies compared rates of surgery and wait times for Indigenous and non-Indigenous populations[20–23,25,29–31,33–39,41,42,44–46] (Appendix 5, available at www.cmaj.ca/lookup/doi/10.1503/cmaj.191682/tab-related-content). Six studies evaluating rates of renal transplantation found that Indigenous Peoples with end-stage renal disease were less likely to receive a transplant (HR 0.34–0.54).[25,34,41,42,45,46] Two studies found that Indigenous kidney transplant recipients experienced longer wait times by 3–7 months,[43,46] and 4 of 5 studies evaluating rates of cesarean delivery found rates 3%–5% lower among First Nations women.[20,29,33,35,38] In people with cardiovascular disease, 2 studies found lower rates of angiography (OR 0.73, 95% CI 0.62–0.87), but similar rates of coronary bypass procedures for Indigenous Peoples, although another study found lower rates of any cardiac surgery for Indigenous Peoples, including among those living in urban areas (0.31 v. 1.04 per 1000 people).[22,39,44] Three studies of amputation for diabetic complications found rates of amputation to be higher for First Nations and Métis Peoples.[30,31,36] Among patients with osteoarthritis, Indigenous Peoples had half the rates of hip or knee arthroplasty than non-Indigenous patients.[21]

Risk of bias

Overall, 5 studies were considered to have low risk of bias, 9 studies were moderate, 2 studies were serious and 12 studies had an unclear risk of bias (Table 3). In most studies considered to have moderate or serious risk of bias, the method used to determine Indigenous identity introduced bias. Most studies attempted to adjust for potential confounders, such as area of residence, severity of disease and comorbidities, and as a result, had a low to moderate risk of bias within these categories.

Interpretation

In this systematic review of studies estimating the association between Indigenous identity and surgical rates or outcomes in Canada, we identified evidence of inequities for Indigenous Peoples. We identified few studies that directly addressed postoperative outcomes and our ability to draw conclusions on mortality and complications was limited by risk of bias, heterogeneity and the substantial underrepresentation of Inuit and Métis peoples. In the 4 studies (7 cohorts) suitable for meta-analysis, we identified an adjusted 30% higher risk of postoperative death

Table 2 (part 1 of 2): Characteristics of studies that reported mortality outcomes

Study	Surgical specialty	Sample size	Mortality as primary outcome?	Mortality length of follow-up	Adjusted HR (95% CI)*	Variables used in adjustments	Crude mortality rate	Unadjusted HR (95% CI)*
Bresee et al.[22]	Cardiac	4287	No	Variable, follow-up to Mar. 31, 2009	0.91 (0.56–1.47)	Age, sex, diabetes, hypertension, year of acute MI, ejection fraction, smoking status, coronary anatomy, income quintiles, distance to closest cardiac catheterization laboratory, comorbidities (cerebrovascular disease, heart failure, COPD, dementia, HIV/AIDS, metastatic cancer, mild liver disease, moderate/severe liver disease, paraplegia/hemiplegia, peptic ulcer disease, peripheral vascular disease, renal disease, rheumatologic disease)	Indigenous 17/108; non-Indigenous 997/4179	0.67 (0.42–1.07)
Leslie et al.[28]	Orthopedics (hip fracture)	4145	Yes	Unknown	1.37 (1.16–1.62)	Age (within 5 yr), sex, diabetes, area of residence, ADGs (none, 1–2, 3–5, > 5)	NR	NR
	Orthopedics (wrist fracture)	8216	Yes	Unknown	1.53 (1.31–1.79)	Age (within 5 yr), sex, diabetes, area of residence, ADGs (none, 1–2, 3–5, > 5)	NR	NR
	Orthopedics (vertebral fracture)	3431	Yes	Unknown	1.30 (1.01–1.67)	Age (within 5 yr), sex, diabetes, area of residence, ADGs (none, 1–2, 3–5, > 5)	NR	NR
	Orthopedics (hip fracture)	10 367	Yes	12 mo	(OR) 0.77 (0.53–1.12)	Age (within 5 yr), sex, diabetes, area of residence, ADGs (none, 1–2, 3–5, > 5)	NR	NR
Sood et al.[39]	Cardiac (mixed)	12 170	Yes	In hospital	(OR) 1.15 (0.63–2.08)	Age, sex, body mass index, distance from centre, comorbidities (smoking, family history, diabetes, lipids, chronic kidney disease, dialysis, hypertension, pulmonary hypertension, cerebrovascular accident, COPD, peripheral vascular disease, CHF, arrhythmia, ACS, previous cardiac procedure, functional status (CCS class, NYHA class) procedure type and urgency, and medications (angiotensin-converting enzyme inhibitors, β-blockers, ASA, steroids, inotropic agents)	NR	(OR) 1.11 (0.66–1.86)
Zhang et al.[47]	General (Liver transplant)	149	Not stated	22 yr	NR	NA	Indigenous 6/20; non-Indigenous 26/129	NR
Goulet et al.[26]	Vascular (revascularization for peripheral vascular disease)	678	Not stated	5 yr	1.00 (0.6–1.6)	Unknown	Indigenous 20/84; non-Indigenous 160/594	1.00 (0.6–1.6)

Table 2 (part 2 of 2): Characteristics of studies that reported mortality outcomes

Study	Surgical specialty	Sample size	Mortality as primary outcome?	Mortality length of follow-up	Adjusted HR (95% CI)*	Variables used in adjustments	Crude mortality rate	Unadjusted HR (95% CI)*
Hong et al.[27]	General (liver transplant)	1164	Described as "survival and determinants of survival"	1 yr	1.09 (1.04–1.15)	Age, gender, ethnicity, ABO blood group, donor type, medical status before transplantation, and hepatitis B virus infection status	NR	NR
Weber et al.[43]	Urology (Kidney transplant)	705	Not stated	10 yr	1.93 (1.34–2.76)	Donor age > 45 yr (v. < 45), recipient age, recipient gender, diabetes pretransplant, deceased donor (v. living donor), delayed graft function, immunosuppressive era, maximum peak PRA, PTDM, HLA disparity and nonadherence post-transplant.	NR	NR
Callegari et al.[23]	Plastics (burn treatment)	825	Not stated	In hospital	NR	NA	Indigenous 4/80; non-Indigenous 26/745	NR

Note: ACS = acute coronary syndrome, ADG = Aggregated Diagnosis Groups, ASA = acetylsalicylic acid, CCS = Canadian Cardiovascular Society angina grading scale, CHF = congestive heart failure, CI = confidence interval, COPD = chronic obstructive pulmonary disease, HLA = human leukocyte antigen, HR = hazard ratio, MI = myocardial infarction, NA = not applicable, NYHA = New York Heart Association classification of heart failure, NR = not reported, OR = odds ratio, PRA = panel reactive antibody, PTDM = posttransplantion diabetes mellitus.
*Unless indicated otherwise.

Study	HR	95% CI	Weight, %
Bresee et al.[22]	0.91	(0.56–1.47)	8.1
Leslie et al. (wrist)[28]	1.53	(1.31–1.79)	18.5
Leslie et al. (vertebral)[28]	1.30	(1.01–1.67)	14.9
Leslie et al. (hip)[28]	1.37	(1.16–1.62)	18.1
Goulet et al.[26]	1.00	(0.61–1.63)	7.9
Hong et al.[27]	1.09	(1.04–1.14)	21.4
Weber et al.[43]	1.93	(1.34–2.77)	11.1
Random effects model	**1.30**	**(1.09–1.54)**	**100.0**

Heterogeneity: $I^2 = 81\%$, $\tau^2 = 0.0357$, $p < 0.01$

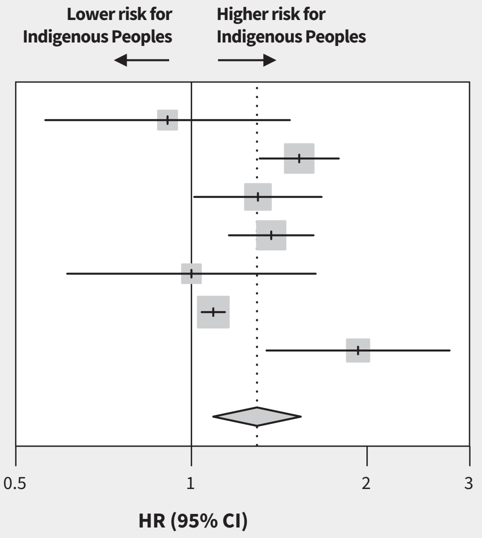

Figure 2: Forest plot of hazard ratios (HRs) and 95% confidence intervals (CIs) of adjusted association of Indigenous identity with postoperative survival.

for Indigenous Peoples, as well as higher rates of complications, including postoperative infection and hospital readmission. Indigenous Peoples also appeared to have lower utilization rates of both elective surgeries aimed at improving quality of life, such as joint replacement, as well as potentially life-saving procedures, such as cardiac surgery, transplant and cesarean delivery.

Our findings are consistent with inequities in surgical outcomes for Indigenous Peoples observed in other high income countries.[48–51] Although part of this effect may be attributable to the burden of chronic disease in Indigenous populations, our findings emerged by pooling results from studies that adjusted for important confounders, such as comorbidity status, which suggests that other factors may contribute.

Table 3: Risk of bias

Study	Bias from confounding	Bias from selection of participants	Bias from measurement of outcomes	Bias from measurement of exposure	Bias from selection of reported result	Bias from missing data	Overall risk of bias
Aljohani et al.[20]	Low	Low	Low	Moderate	Low	Unclear	Unclear
Barnabe et al.[21]	Moderate	Low	Low	Moderate	Low	Unclear	Unclear
Bresee et al.[22]	Low	Low	Low	Moderate	Low	Low	Moderate
Callegari et al.[23]	Serious	Low	Low	Unclear	Low	Unclear	Unclear
Cohen et al.[24]	Moderate	Low	Low	Moderate	Low	Unclear	Unclear
Dyck et al.[25]	Serious	Low	Serious	Moderate	Low	Unclear	Unclear
Goulet et al.[26]	Moderate	Low	Low	Moderate	Low	Unclear	Unclear
Hong et al.[27]	Moderate	Low	Low	Low	Low	Low	Moderate
Leslie et al.[28]	Low	Low	Low	Moderate	Low	Low	Moderate
Liu et al.[29]	Low	Moderate	Low	Serious	Low	Unclear	Unclear
Martens et al.[30]	Low	Moderate	Low	Moderate	Low	Unclear	Unclear
McIntyre et al.[31]	Low	Moderate	Low	Low	Low	Low	Moderate
Meatherall,[32]	Serious	Unclear	Serious	Unclear	Low	Unclear	Unclear
Oster et al.[33]	Moderate	Low	Low	Moderate	Low	Low	Moderate
Promislow et al.[34]	Low	Low	Low	Low	Low	Low	Low
Riddell et al.[35]	Low	Low	Low	Moderate	Low	Low	Moderate
Rose et al.[36]	Low	Moderate	Low	Unclear	Low	Unclear	Unclear
Roy et al.[37]	Serious	Moderate	Low	Unclear	Low	Unclear	Unclear
Shen et al.[38]	Moderate	Serious	Low	Moderate	Low	Low	Serious
Sood et al.[39]	Low	Low	Low	Low	Low	Low	Low
Storsely et al.[40]	Moderate	Low	Low	Low	Low	Low	Moderate
Tonelli[41]	Low	Low	Moderate	Low	Low	Moderate	Moderate
Tonelli et al.[42]	Moderate	Low	Low	Low	Low	Low	Moderate
Weber et al.[43]	Low	Low	Low	Low	Low	Low	Low
Wei-Randall et al.[44]	Serious	Low	Low	Serious	Low	Moderate	Serious
Yeates[45]	Low	Low	Low	Low	Low	Low	Low
Yeates[46]	Low	Low	Low	Low	Low	Low	Low
Zhang et al.[47]	Serious	Low	Low	Low	Low	Unclear	Unclear

Although access to surgical care is an essential element of a high-functioning health care system, the assessment of surgical need and provision of access to appropriate surgical services is complex. Currently, the literature provides limited data on wait times and rates of surgical procedures, which are proxy measures of access. The studies included in this review documented lower rates of common surgeries that can substantially affect health for both geographically isolated and urban Indigenous Peoples, but the results also raise questions about differences in disease stage at initial presentation and referral patterns. For example, access to intermediate types of care, including management of risk factors, could delay life-altering outcomes, such as limb amputations or the development of complications in living kidney donors.

It is essential to develop standardized national monitoring of surgical access and outcomes for Indigenous Peoples through culturally appropriate methods. Indigenous Peoples in Canada are diverse, and any pan-Indigenous research must consider the unique historic, geographic and cultural differences of First Nations, Inuit and Métis communities, as well as the heterogeneity within each of these distinct populations. The effective management of surgical diseases requires successful screening, diagnosis, timely access to surgical facilities and an appropriate transition to follow-up care. The inherent complexities in providing quality surgical care to a culturally diverse and geographically distributed population with higher rates of adverse outcomes highlights the urgent need for high quality, culturally aligned research across surgical specialties. Such research should assess access to and use of surgical care for Indigenous Peoples and the potential geographical, cultural, physical and systemic barriers to appropriate access.

The health of communities requires investment in the social determinants of health that, in addition to the availability of health services, include quality early childhood development, investment in culture and language, improved income distribution, quality housing and access to personal safety and security, education, food security, mental wellness and a healthy environment. To address the differences in outcomes identified in this study, there is a need to recognize the colonial conditions in which the Canadian health care system was established and continues to operate. The current system of health care delivery in Canada creates systemic barriers to care and limits the ability to describe national patterns in Indigenous health outcomes.[52] A comprehensive national plan must be developed to improve access to surgical services and to measure, monitor and improve surgical, obstetric and anesthesia outcomes for all Canadians, with a focus on Indigenous Peoples and those that live in rural and remote locations.[53] Indigenous leaders and community voices should be at the centre of this discussion.

Limitations

Some studies included in this review date back to 1989, when postoperative care may have been different from today. The oldest study included in the meta-analysis was published in 2006, however. No studies specifically addressed postoperative outcomes in patients who identified as Inuit or Métis. Most studies were retrospective and many were biased. The methods for determining Indigenous identity were heterogeneous, with the potential for misclassification. This denominator bias likely underestimates the disparities shown in this study.[54] The severity or stage of surgical disease was not known at presentation. We recognize, for example, that death attributed to wrist surgery is unusual, and we believe this to reflect unmeasured confounding and the lower baseline health status of Indigenous patients. Unfortunately, many studies did not report unadjusted mortality rates or effect measures including the majority of the studies included in our primary adjusted meta-analysis. Therefore, there were few data and little overlap among studies to support an unadjusted meta-analysis. A pooled, unadjusted effect measure for mortality or secondary outcomes was not provided, given the incomplete reporting in included studies, which precluded estimation of the impact of confounder adjustment on estimated effect sizes and limited part of our analysis to a narrative synthesis. Our meta-analysis pooled studies with variable windows of outcome ascertainment, although previous research suggests consistency in postoperative effect measures over time.[55] We also identified heterogeneity in our pooled estimate that appears to be attributable to data from studies of transplantation surgery. In studies of non-transplant surgery, heterogeneity was low and the pooled non-transplant effect size was similar to the overall pooled effect. We recognize that utilization rates are not a direct measure of access to surgical care as they fail to fully describe the various barriers faced by patients and do not account for personal choices made by Indigenous patients in response to their well-known lack of trust and cultural safety in the health care system.

Conclusion

In a systematic review of surgical care utilization and outcomes, we found that Canadian Indigenous Peoples had higher rates of mortality and adverse events, with lower rates of surgical utilization. First Nations, Inuit and Métis communities are increasingly prepared to direct Indigenous population health research and policy. The rights and benefits of research to Indigenous communities, colonial policies and anti-Indigenous racism should be considered in any analysis of health policy and outcomes research.

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