Disparities in prostate cancer outcomes between First Nations and Non-First Nations men in Canada—Cohort study

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The Lancet Regional Health - Americas 2025;■: 101331

Published Online XXX https://doi.org/10.1016/j.lana.2025.101331

Summary

Background First Nations men in Canada, one of the three distinct Indigenous groups along with Inuit and Métis, have been reported to present with more aggressive prostate cancers than non-First Nations men. However, the long-term impact on prostate cancer-specific survival remains unclear. This study examines disparities in prostate cancer outcomes between First Nations and non-First Nations men in Alberta.

Methods Data from the Alberta Cancer Registry (1995–2022) were analyzed for all men aged 18 and above diagnosed with prostate cancer. First Nations status was determined using the Alberta Health Care Insurance Plan registry. The primary outcome was age-standardized prostate cancer mortality; secondary outcomes included age at death and prostate cancer-specific survival. Statistical analyses included t-tests, Chi-squared tests, Kaplan–Meier survival curves, log-rank tests, and Cox proportional hazards models. Data on socioeconomic deprivation were not available, and analyses could not be adjusted for this potential confounder.

Findings The dataset comprised 1,323,333 person-years for First Nations men and 37,820,148 for non-First Nations men. First Nations men were diagnosed younger (65.8 vs. 67.8 years, $p < 0.0001$) and died earlier (74.4 vs. 78.9 years, $p < 0.0001$) across both rural and urban settings. Age-adjusted prostate cancer mortality was higher (41.5 vs. 30.1 per 100,000, $p < 0.0001$), and Stage IV disease was more common (17.8% vs. 12.2%, $p < 0.0001$). Prostate cancer-specific survival was worse (HR 1.67, 95% CI 1.43–1.96, $p < 0.0001$). After adjusting for age, stage, location, and number of malignancies, overall survival was similar (HR 1.06, 95% CI 0.57–1.89, $p = 0.84$).

Interpretation First Nations men in Alberta are diagnosed with prostate cancer at a younger age and later stage, leading to higher overall mortality. After adjustment, disease-specific survival is similar to non-First Nations men. These findings indicate disparities may arise from delayed diagnosis, underscoring the need for culturally safe, community-informed initiatives promoting earlier presentation and detection.

Funding Movember, Alberta Cancer Foundation, Bird Dogs, University Hospital Foundation.

Keywords: Disparities in health; Prostate cancer; First nations

Introduction

Prostate cancer is one of the most commonly diagnosed cancers in men worldwide and remains a significant contributor to cancer-related mortality.[1] Although advances in screening and treatment have improved outcomes, many individuals remain undiagnosed until later stages of disease, particularly within populations facing barriers to healthcare access.[1–3] In Alberta,

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Research in context

Evidence before this study

We searched PubMed for studies in English using the search terms "Prostate Cancer" AND ("First Nations" OR "Indigenous" OR "Native American") on April 3, 2025. This generated 103 results, with 61 results in the last 10 years. Only 1 study, assessed Indigenous men in Canada, and showed worse prostate cancer metastasis-free survival for Indigenous men compared to non-Indigenous men as well as lower rates of PSA testing. The majority of the other studies assessed Indigenous men in New Zealand, who represent a distinct population from Canadian Indigenous men. One study using the SEER database from the USA, found that while Native American men in the USA had higher risk disease at presentation, their prostate cancer specific mortality was similar.

Added value of this study

This study provides a comprehensive, population-based analysis of prostate cancer outcomes among First Nations men in Alberta, Canada, a group often underrepresented in cancer research. By examining a large dataset (>39 million person-years) and spanning 27 years (from 1995 to 2022), the research demonstrates significant disparities in age at diagnosis, age at death, prostate cancer specific survival and stage at diagnosis compared to non-First Nations men. The study's finding that First Nations men are diagnosed at a younger age and die from prostate cancer significantly younger, irrespective of rural or urban residence, underscores the complexity of the issue and suggests that factors beyond geographical location are driving these inequities. Furthermore, the study highlights the higher percentage of Stage IV diagnoses among First Nations men, indicating a critical need for improved early detection strategies within this population.

Implications of all the available evidence

The collective evidence, including this study and prior research, points to a systemic problem of prostate cancer disparities affecting First Nations men in Alberta. The consistent finding of diagnosis at later stages and shorter survival times necessitates urgent, culturally safe, Indigenous-led interventions that are rooted in Indigenous knowledge systems. The implications extend beyond simply increasing screening rates; they call for addressing the underlying social determinants of health, historical mistrust of the healthcare system, and systemic inequities that contribute to these disparities. Ultimately, achieving equitable prostate cancer outcomes for First Nations men requires a multi-faceted approach encompassing improved access to care, culturally appropriate healthcare services, and policies that address the broader social and economic factors impacting their health.

Canada, and despite the presence of a universal healthcare system designed to provide equitable access to care, significant heterogeneity in presentation and outcomes remains.[4–6] Specifically, First Nations men–who are one of the three constitutionally recognized Indigenous groups in Canada, distinct from the Métis and Inuit peoples–experience disparities in prostate cancer diagnoses, with a pressing need to examine differences in prostate cancer specific mortality rates compared to non-First Nations men.[4,7] These disparities are often rooted in a complex interplay of socioeconomic factors, barriers to accessing healthcare services, and historical and ongoing impacts of colonization, which can significantly affect health-seeking behaviors and trust in the healthcare system.[8–11]

Existing literature suggests that Indigenous Peoples in Canada face disproportionate burdens of various cancers, often presenting at later stages and experiencing poorer survival rates compared to non-Indigenous populations.[12–15] These disparities are significantly influenced by the social determinants of health, including poverty, inadequate housing, food insecurity, and limited access to culturally appropriate healthcare.[12–16] Systemic racism and discrimination within the healthcare system can further exacerbate these challenges, leading to delayed diagnoses and suboptimal treatment.[9,17,18]

This study aims to determine disparities in meaningful endpoints of prostate cancer outcomes with primary outcome of age-standardized prostate cancer mortality rates, with secondary outcomes including age at diagnosis, age at death from prostate cancer, and prostate cancer specific survival between First Nations men and non-First Nations men in Alberta, using data from the Alberta Cancer Registry.

Methods

Population

Patient data was extracted from the Alberta Cancer Registry (ACR), which is a database that was established in 1942 and records data on all cancer diagnoses and deaths in the province of Alberta.[19] All men diagnosed with prostate cancer aged 18 years and above between 1995 and 2022 were included. A total of 60,376 prostate cancers were identified in ACR during that period among 60,302 unique patients. Alberta First Nations populations were identified using data available through the Alberta Health Care Insurance Plan (AHCIP) registry. First Nations identifying data was available in the AHCIP registry until 2009. Any person identified as First Nations at this point remained on the registry, but any First Nations who moved to Alberta after this point would be misclassified as non-First

Nations people. The use of the AHCIP registry identifiers has been used extensively in previous studies.[8,9,18] First Nations are one of the three distinct Indigenous Peoples in Canada, along with Inuit and Métis.[7]

Variables

In addition to cancer-specific data, demographic details such as date of birth, date of death, cause of death, postal code at the time of diagnosis were collected from the ACR. Age at diagnosis was calculated from ACR data and treated as a continuous variable. Additionally, cancer staging information was derived from the registry as well. The American Joint Committee on Cancer (AJCC) 6th edition cancer staging was used prior to 2018. The AJCC 8th edition (pathological TNM staging) was used for 2018 to 2022. In case of missing pathological staging, clinical staging was used to determine the cancer staging. Because staging information prior to 2005 was limited, staging analyses were restricted to cases diagnosed between 2005 and 2022.

Starting from 2018, ACR updated the staging collection system and shifted from the collaborative stage to the TNM staging system. According to ACR, this transition led to an increase in cases with missing or unknown stage information. The TNM system requires complete clinical or pathological information for the T (tumor), N (nodes) and/or M (metastasis) categories to assign an overall stage. As a result, staging data is incomplete/missing for a notable proportion of cases diagnosed.[20]

Geographic location (urban or rural) was determined based on the postal code of the patient's residence at the time of diagnosis. Ethnicity (First Nations or non-First Nations) were identified using the Alberta Health Care Insurance Plan (AHCIP) registry which is maintained by the Government of Alberta. Cause of death was obtained from the ACR. Deaths were classified as prostate cancer-specific if prostate cancer was identified as the underlying cause; all remaining deaths were considered as non–prostate cancer deaths. Patients with multiple cancer diagnoses were classified as having 'multiple malignancies'.

Statistical analyses

Continuous variables (e.g., age at diagnosis, age at death, time from diagnosis to prostate cancer-specific death) were summarized using means, standard deviations, and medians. Categorical variables were summarized using frequencies. Initial comparisons between First Nations and non-First Nations individuals were made using independent samples t-tests for continuous variables and chi-square tests for categorical variables.

Age-standardized rates were calculated between First Nations and non-First Nations, and all age-adjusted rates were standardized to the 2011 Canadian standard population.

Survival analysis considered prostate cancer-specific death as the event of interest. Survival time was defined as the time from diagnosis to prostate cancer death. Patients who died of other causes were censored at their date of death, and living patients were censored at the end of follow-up (December, 31, 2022).

Kaplan–Meier curves were plotted to visualize survival differences by subgroup, and log-rank tests were used to compare survival distributions. Median survival times and 95% confidence intervals were reported where applicable.

Cox proportional hazards models were used to assess associations between covariates and survival time, both unadjusted and adjusted. The proportional hazards (PH) assumption was evaluated using Schoenfeld residuals for individual covariates and a global test, following the method of Grambsch and Therneau. A significance level of 0.05 was used for all tests.

Although age at diagnosis violated the PH assumption in univariate analysis, it was retained in the multivariable model due to clinical importance. To address the violation, a time-dependent coefficient model was implemented, splitting the follow-up period at 0.7 years, allowing the effect of age to vary over two intervals: (0, 0.7) years and (0.7 years to study end). In the final adjusted model, all covariates, including age, satisfied the PH assumption based on Schoenfeld residual testing. The final multivariable model included the following covariates: age at diagnosis, cancer stage, geographic location, number of malignancies, and ethnicity.

Statistical analyses were performed using R version 4.4.1 (Posit Team, 2024) with RStudio: Integrated Development Environment for R (Posit Software, PBC, Boston, MA; http://www.posit.co/) and SPSS version 29.0.2.0 (IBM Corp., 2023; IBM SPSS Statistics for Windows, Armonk, NY). The STROBE reporting guidelines were followed for cohort studies.

Ethical approval

This study protocol was approved by the Health Research Ethics Board of Alberta (HREBA.CC-23-0100).

Role of the funding source

None.

Results

From 1995 to 2022 there were 1,323,333 and 37,820,148 person-years of data available for First Nations and non-First Nations men, respectively (Table 1). Patient demographics are shown in Table 2. First Nations men had a significantly higher age-adjusted prostate cancer mortality rate compared to non-First Nations men (41.5 vs 30.1 deaths per 100,000, $p < 0.0001$, Table 1). Urban First Nations men had a similar age adjusted mortality

	First Nations (n = 1,323,333 person years, n = 827 diagnosed with prostate cancer)	Non-First Nations (n = 37,820,148 person years, n = 59,533 diagnosed with prostate cancer)	p value
Age at diagnosis, mean (95% CI)	65.8 (65.2–66.4)	67.8 (67.7–67.9)	**<0.0001**
Urban	63.3 (62.4–64.3)	67.3 (67.2–67.4)	**<0.0001**
Rural	67.2 (66.4–68.0)	69.4 (69.2–69.5)	**<0.0001**
Age at death due to prostate cancer, mean (95% CI)	74.4 (72.8–76.0)	78.9 (78.7–79.1)	**<0.0001**
Urban	73.0 (70.3–75.8)	78.7 (78.4–79.0)	**<0.0001**
Rural	75.0 (73.1–76.9)	79.3 (78.9–79.7)	**<0.0001**
Age-Adjusted Prostate Cancer Mortality Rate (95% CI)	41.5 (33.5–49.4)	30.1 (29.4–30.7)	**0.0022**
Urban	28.2 (16.9–39.4)	27.9 (27.1–28.6)	0.97
Rural	47.4 (37.2–57.5)	36.0 (34.7–37.3)	**0.012**

CI – confidence interval. Bold indicates p < 0.05.

Table 1: **Prostate cancer demographics and mortality rates.**

compared to urban non-First Nations men (28.2 vs 27.9 deaths per 100,000, p = 0.97, Table 1). Rural First Nations men had a significantly higher age adjusted mortality compared to rural non-First Nations men (47.4 vs 36.0 deaths per 100,000, p = 0.01, Table 1).

First Nations men were diagnosed with prostate cancer at a younger age (65.8 vs 67.8, p < 0.0001, Table 1) and with a higher proportion of stage IV cancer compared to non-First Nations men (17.8% vs 12.2%, p < 0.0001, Fig. 1, Supplementary Table S1). This trend was seen throughout the dataset with First Nations men diagnosed with Stage IV at a higher proportion than non-First Nations men (Supplementary Figure S1). There is no significant different in stage at diagnosis between urban and rural First Nations men (p = 0.06, Supplementary Table S1). There was a significant difference in age at death due to prostate cancer, with First Nations men dying 4.5 years earlier than non-First Nations men (74.4 vs 78.9, p < 0.0001). This observation was consistent when stratifying men by geographical location (i.e., living in rural areas vs urban areas). Urban First Nations men die significantly younger than urban non-First nations men (73.0 vs 78.7, p < 0.0001, Table 1). Similarly, rural First Nations men die younger than rural non-First Nations men (75.0 vs 79.3, p < 0.0001, Table 1).

Prostate cancer specific survival was significantly worse for First Nations men compared to non-First Nations men (HR 1.67, 95% CI 1.43–1.96, p < 0.0001) (Fig. 2). Overall survival was also significantly worse for First Nations men (HR 1.32, 95% CI 1.19–1.47, p < 0.0001) (Fig. 3). When stratified by prostate cancer stage, a significant difference in survival was observed for stage II between First Nations and non-First Nations (p = 0.0043). However, no statistically significant differences were observed in the survival curves for stages I (p = 0.92) III (p = 0.81), and IV (p = 0.22) between the two groups (Supplementary Figure S2).

A multivariable Cox regression analysis was performed, adjusting for age at diagnosis, cancer stage, race (First Nations vs. non-First Nations), rural or urban and number of concomitant malignancies. Results are presented in Supplementary Tables S2 and S3. Although the study period spanned 1995–2022, staging data were incomplete prior to 2005. The Alberta Cancer Registry adopted the TNM staging system in 2018, whereas earlier years used various editions of the AJCC system. To ensure staging consistency, the multivariable analyses were restricted to cases diagnosed between 2018 and 2022, when TNM staging was applied uniformly. In this adjusted model, age at diagnosis and cancer stage emerged as significant predictors of prostate cancer-specific survival, while other covariates were not statistically significant.

Discussion

This study reveals significant disparities in prostate cancer outcomes between First Nations and non-First Nations men in Alberta, Canada. First Nations men die at an earlier age than non-First Nations men from prostate cancer (4.5 years). This substantial difference in age at death was also observed in both populations when stratifying for living rural and urban areas. Age adjusted prostate cancer mortality was significantly worse for First Nations men compared to non-First Nations men, though the difference was minimal when comparing urban First Nations men to urban non-First Nations men. When adjusting for age at diagnosis, stage, rurality, number of concurrent malignancies and ethnicity, only stage and age were significant predictors of prostate cancer mortality. The significantly higher percentage of First Nations men diagnosed with Stage IV prostate cancer would therefore help explain why First Nations men are more likely to die from prostate cancer and underscores the poor prognosis of late detection and more aggressive disease at diagnosis.

This study does indicate that geographic location plays a role in the disparities noted in the prostate

Characteristics	1995 to 2017			2018 to 2022		
	Overall (%)	First Nations (%)	Non-First Nations (%)	Overall (%)	First Nations (%)	Non-First Nations (%)
Number of cases	46,959	596 (1.3)	46,363 (98.7)	13,417	231 (1.7)	13,186 (98.3)
Number of patients	46,922	595 (1.3)	46,327 (98.7)	13,406	231 (1.7)	13,175 (98.3)
Age at diagnosis (years)						
Mean (SD)	67.8 (9.86)	65.7 (9.59)	67.8 (9.86)	68.0 (9.35)	66.1 (9.11)	68.0 (9.36)
Median	67.0	65.0	67.0	67.0	66.0	67.0
Minimum	32.0	41.0	32.0	35.0	42.0	35.0
Maximum	100.0	92.0	100.0	102.0	99.0	102.0
Geographical location						
Rural	12,816 (27.3)	384 (64.5)	12,432 (26.8)	3324 (24.8)	132 (57.1)	3192 (24.2)
Urban	34,091 (72.7)	211 (35.5)	33,880 (73.2)	10,081 (75.2)	99 (42.9)	9982 (75.8)
Stage[a]						
I	310 (1.1)	2 (0.5)	308 (1.1)	1278 (9.5)	13 (5.7)	1265 (9.6)
II	21,316 (72.8)	300 (68.6)	21,016 (72.8)	3116 (23.2)	44 (19.0)	3072 (23.3)
III	2959 (10.1)	37 (8.5)	2922 (10.1)	2248 (16.8)	37 (16.0)	2211 (16.8)
IV	3269 (11.1)	72 (16.5)	3197 (11.1)	1974 (14.7)	47 (20.3)	1927 (14.6)
NA/Unknown	1443 (4.9)	26 (5.9)	1417 (4.9)	4801 (35.8)	90 (39.0)	4711 (35.7)
Number of malignancies[b]						
Single	38,015 (81.0)	550 (92.3)	37,465 (80.8)	10,646 (79.3)	207 (89.6)	10,439 (79.2)
Multiple	8944 (19.0)	46 (7.7)	8898 (19.2)	2771 (20.7)	24 (10.4)	2747 (20.8)
Vital statistics						
Alive	29,629 (63.1)	367 (61.7)	29,262 (63.2)	12,097 (90.2)	201 (87.0)	11,896 (90.3)
Dead	17,293 (36.9)	228 (38.3)	17,065 (36.8)	1309 (9.8)	30 (13.0)	1279 (9.7)
Cause of death						
Prostate	5928 (34.3)	103 (45.2)	5825 (34.1)	685 (52.3)	20 (66.7)	665 (52.0)
Other	11,365 (65.7)	125 (54.8)	11,240 (65.9)	624 (47.7)	10 (33.3)	614 (48.0)
Age at death from prostate cancer (years)						
Mean (SD)	78.4 (9.88)	73.7 (10.30)	78.7 (9.86)	79.1 (10.53)	76.0 (11.30)	79.2 (10.50)
Median	79.5	74.4	79.6	80.4	78.5	80.6
Minimum	37.3	49.7	37.3	45.1	55.7	45.1
Maximum	102.8	93.6	102.8	100.3	99.9	100.3
Time from diagnosis to prostate cancer-specific death (years)						
Mean (SD)	4.6 (4.27)	3.2 (3.18)	4.6 (4.29)	1.3 (1.10)	1.5 (1.07)	1.3 (1.10)
Median	3.1	1.9	3.15	1.0	1.7	1.0
Minimum	0.0	0.1	0.0	0.0	0.1	0.0
Maximum	21.6	14.5	21.6	4.6	3.6	4.6

SD—Standard Deviation. [a]Diagnosed in 2005 or later. [b]Patients with prostate cancer and at least one other malignancy, excluding non-melanoma skin cancers (NMSC).

Table 2: **Summary of patients diagnosed with prostate cancer in Alberta from 1995 to 2022.**

cancer outcomes between First Nations and non-First Nations men, which was seen in earlier studies.[21] While urban First Nations men and urban non-First Nations men had similar age-adjusted prostate cancer mortality rates, the analysis included relatively few urban First Nations men. In contrast, age-adjusted prostate cancer mortality was significantly higher among rural men compared to urban men for both First Nations and non-First Nations populations, although rural First Nations men exhibited higher mortality than rural non-First Nations men. This indicates that factors beyond rurality, such as unequal access to culturally appropriate healthcare, systemic inequities, and ongoing impacts of colonialism and systemic racism in healthcare, which has resulted in deep rooted structural inequities that may have a more substantial impact on prostate cancer outcomes for First Nations men. These findings may be used to inform healthcare policies designed to promote earlier detection, improve access to care, and ultimately aim to reduce prostate cancer mortality among First Nations men in Canada, addressing potential inequities within the existing healthcare framework.

The combination of younger age at diagnosis and higher proportion of advanced prostate cancer among First Nations men suggests that genetic or other biological differences may also play a role in disease development and progression. Poor access to healthcare and diagnostic disparities would typically result in an older age at diagnosis, implying that biology might be an underlying factor. However, there is limited research to date investigating genetic contributions to prostate

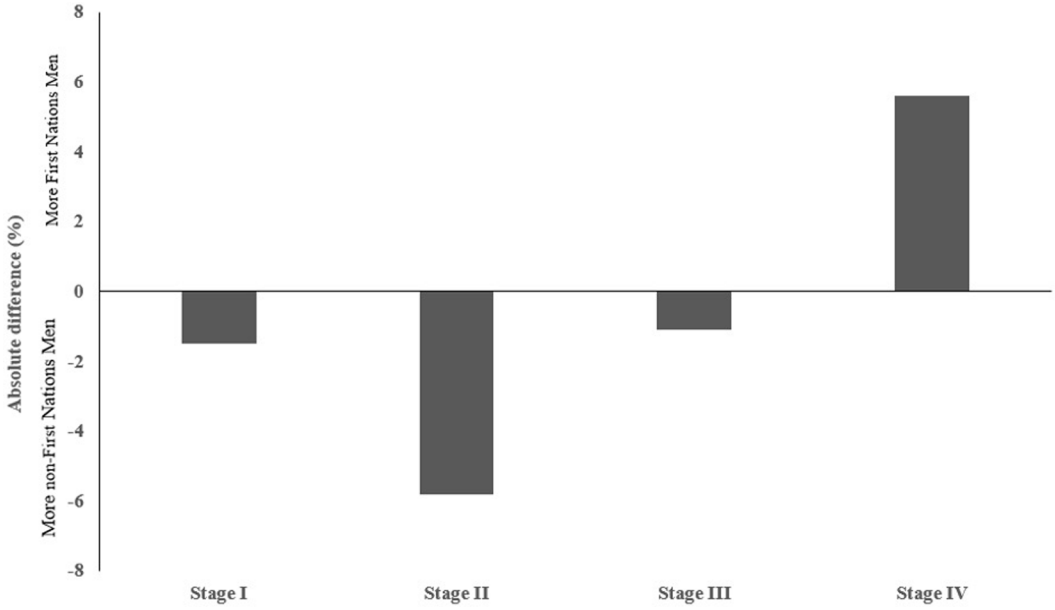

Fig. 1: Absolute difference in proportion of men at prostate cancer diagnosis for First Nations and non-First Nations. P < 0.0001.

cancer risk and outcomes specifically in First Nations men, highlighting a critical gap in the literature. Future studies incorporating genetic analyses are needed to better understand these potential differences and improve tailored prevention and treatment strategies for this population.

Unequal access to healthcare and screening programs is a well-documented issue affecting Indigenous Peoples in Canada, contributing significantly to the observed disparities in prostate cancer outcomes.[4,16,22,23] Previous studies have consistently shown that Indigenous Peoples often face barriers such as geographical remoteness, socioeconomic disadvantages, cultural differences, and historical mistrust of the healthcare system.[8–11,16,22–25] These factors can lead to delayed diagnoses, presentation at more advanced stages of the

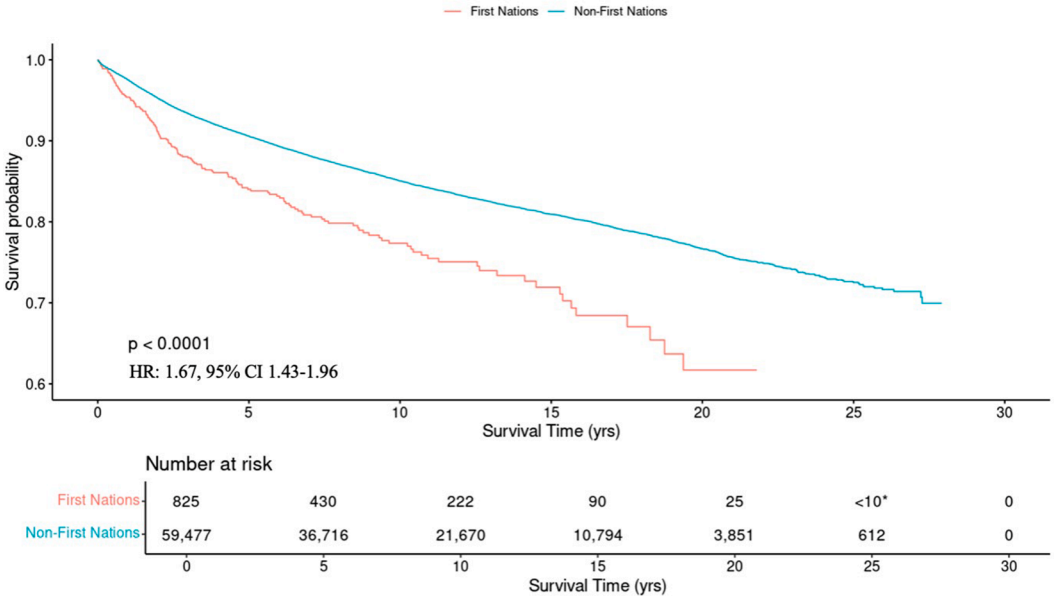

Fig. 2: Kaplan Meier curve for prostate cancer specific survival (Note—patients censored if < 10 in a group due to patient confidentiality).

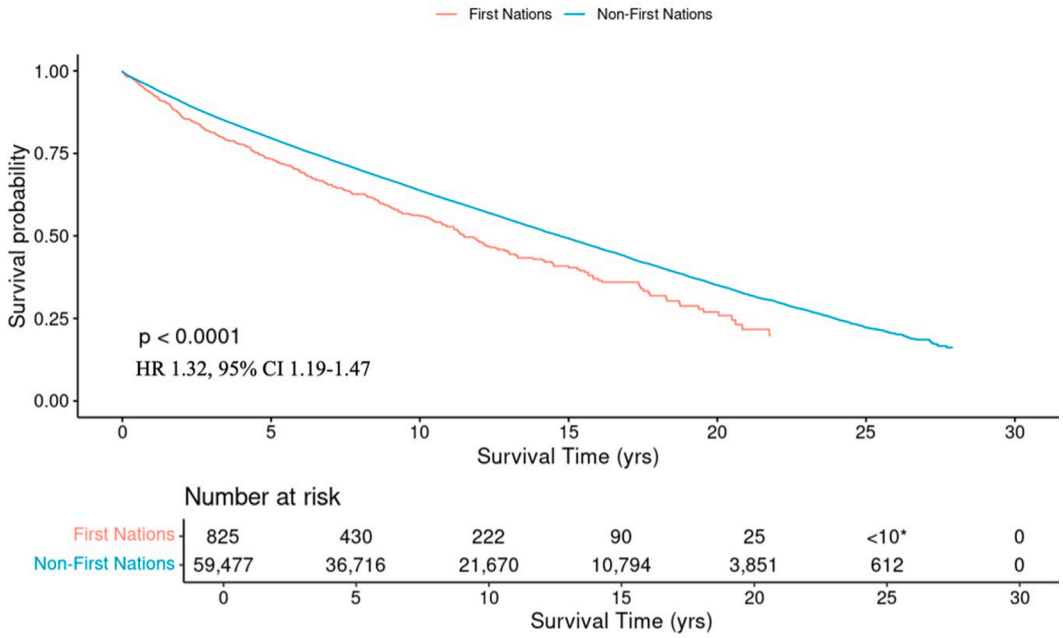

Fig. 3: Kaplan Meier curve for overall survival (Note—patients censored if < 10 in a group due to patient confidentiality).

disease, and ultimately, poorer survival rates. The higher percentage of Stage IV diagnoses among First Nations men in this study strongly suggests that lack of access to early detection is a significant contributing factor to the observed mortality differences. Furthermore, in our adjusted survival analysis, only stage and age were found to be significant predictors of prostate cancer mortality. These findings are a call to action for addressing systemic inequities and improving the accessibility and cultural appropriateness of prostate cancer screening programs for First Nations communities.

One method to attempt to reduce this gap is with mobile screening platforms for First Nations communities, such as the MAN VAN® initiative, which represents a potentially transformative step towards addressing these disparities in Canada.[26] A recent grant from Movember is being used to help fund this initiative.[27] By bringing prostate cancer screening directly to remote and underserved communities, this initiative can help overcome geographical barriers and reduce the burden on individuals seeking care. Crucially, any programs must be implemented in a culturally appropriate manner, incorporating Indigenous knowledge and practices, and building trust with community members. While the long-term impact of such an initiative remains to be seen, their potential to improve early detection rates, reduce late-stage diagnoses, and ultimately improve prostate cancer outcomes for First Nations men is significant, offering a tangible pathway towards achieving health equity within this population.

One of the limitations of this study is the use of the Alberta Health Care Insurance Plan registry for identifying First Nations men. The extent of misclassification is unknown, but First Nations individuals who migrated to Alberta after 2009 without prior residency are classified as non-First Nations. Second, our study does not account for potential confounding factors such as socioeconomic status, comorbidities, lifestyle factors, and genetic predispositions that may contribute to these differences. Third, access to healthcare services, including screening programs and treatment options, was not directly measured, making it difficult to determine whether disparities are driven primarily by healthcare access or other systemic barriers. Fourth, data on prostate cancer treatment types were not available, which could influence survival differences.

Conclusion

First Nations men in Alberta are diagnosed with and die from prostate cancer younger than non-First Nations men, highlighting the urgent need for culturally safe, Indigenous-led interventions that are rooted in Indigenous knowledge systems to address this inequity in prostate cancer outcomes.

Contributors

Conceptualization, AL, WC, AC, LB, AK.
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The decision to submit the manuscript was made by Adam Kinnaird.

Data sharing statement

All data is available through Cancer Care Alberta, and researchers interested can request with appropriate ethical approval.

Declaration of interests

We have no financial conflicts of interest to disclose.

Acknowledgements

Movember, Alberta Cancer Foundation, Bird Dogs, University Hospital Foundation.

Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lana.2025.101331.

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