

Cancer diagnosis, treatment, and survival in Indigenous and non-Indigenous Australians: a matched cohort study

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Summary

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Background Indigenous Australians do not have the high standard of health that Australians in general have, and have worse outcomes for several diseases such as cancer. However, few comparative data exist to prove this disparity. We assessed differences in disease stage at cancer diagnosis, treatment, and survival between these two populations in Queensland.

Methods Indigenous people diagnosed with cancer between 1997 and 2002 were identified through the cancer registry and compared with randomly selected non-Indigenous patients who were frequency-matched for age, sex, place of residence, cancer site, and year of diagnosis. We obtained details of treatment from hospital medical records. We restricted analyses to patients treated in the public sector, since less than 5% of Indigenous cases were treated privately. We used multivariate models, mainly Cox regression analyses, to assess differences.

Findings We studied 815 Indigenous and 810 non-Indigenous cancer patients. Stage at diagnosis differed significantly ($p=0\cdot007$): 47% of Indigenous versus 53% of non-Indigenous patients had localised cancer, 22% versus 21% had distant metastases, and 12% versus 7% had no information on stage in the medical chart examined. Comorbidities such as diabetes mellitus or chronic renal disease were more common in Indigenous patients. These individuals were less likely to have had treatment for cancer (surgery, chemotherapy, radiotherapy), and waited longer for surgery (hazard ratio=0·84, 95% CI 0·72–0·97) than non-Indigenous patients. After adjustment for stage at diagnosis, treatment, and comorbidities, non-Indigenous patients had better survival than Indigenous ones (hazard ratio=1·3, 95% CI 1·1–1·5).

Interpretation Non-Indigenous cancer patients survive longer than Indigenous ones, even after adjustment for stage at diagnosis, cancer treatment, and greater comorbidity in Indigenous cases. We believe that better understanding of cultural differences in attitudes to cancer and its treatment could translate into meaningful public-health and clinical interventions to improve cancer survival in Indigenous Australians.

Introduction

The Aboriginal and Torres Strait Islander population of Australia (referred to in this article as Indigenous) account for 2·4% of the total population.¹ Like other such groups, their history has been a powerful determinant of socioeconomic status.² Since colonisation, Indigenous Australians have lost some of their cultural expression and practices.³ This disempowerment manifests in their poor education and low levels of employment. They are on average younger, live more remotely, and have poorer health than other Australians. Their life expectancy at birth is also 20 years shorter, with much of the excess mortality attributable to heart disease, injury, diabetes, chronic renal failure, smoking-related lung disease, and suicide.¹

This disparity also exists for cancer. In Australia, the reported incidence of cancer in Indigenous people is lower than or equivalent to that in the general population,¹⁴ but the mortality rate is higher.⁵ Indigenous Australians have a high incidence of rapidly fatal cancers such as cancers of the lung and liver, and a very low incidence of cancers with better survival, particularly melanoma (one of the most common cancers in white Australians).⁶ However, studies that have allowed for differences in cancer types and stage at diagnosis showed that case-fatality rates in Indigenous

Australians with cancer were twice that of their non-Indigenous counterparts.^{7,8} Little is known about why this should be so, although possible reasons include less access to high-quality treatment and a higher prevalence of comorbidities that might limit treatment options—such as diabetes, acute coronary conditions, and chronic renal failure.

In a study done in the Northern Territory of Australia,⁹ stage-adjusted survival rates were lower for Indigenous people than for non-Indigenous people with cancers of the colon and rectum, breast, cervix, and for non-Hodgkin lymphoma. Cancer survival was also strongly associated with a patient's first language. For Indigenous people whose first language was English, lower cancer survival was entirely explained by more advanced cancer at diagnosis; for those whose first language was an Indigenous language, incomplete treatment and other unidentified factors were also associated with lower cancer survival.

The difficulty in comparing health outcomes of Indigenous and non-Indigenous people is that these groups are so highly disparate that it is not easy to distinguish the factors that cause the health differential. We therefore decided to investigate this issue in relation to cancer survival with a new approach. By matching

Indigenous and non-Indigenous cancer patients to create groups with similar age distributions and types of cancer, and living in similar regions, we could explore the roles of stage at diagnosis, treatment uptake, and comorbidities in the survival rates of these two populations. In view of the matched design, we postulated that equal access to public-health services in Queensland would result in similar cancer survival rates in the Indigenous and non-Indigenous cancer patients studied.

Methods

Participants

The study was done in Queensland, the north-eastern state of Australia, which constitutes 23% of the continental land mass and has a population of 3.9 million, around 126 000 of whom identify themselves as Indigenous (28% of the total Indigenous population of Australia). All Indigenous people residing in Queensland and diagnosed with cancer between 1997 and 2002 were identified through Queensland public hospitals or the Queensland Cancer Registry, and were eligible for inclusion. Indigenous status has been routinely recorded in Queensland public hospitals' patient administration

systems since 1996. The cancer registry obtains information about Indigenous status through the process of cancer notification from Queensland hospitals. We linked administrative data obtained from all public hospitals in Queensland with data obtained from the Queensland Cancer Registry. Also, data for all persons who die of cancer or cancer patients who die from other causes were abstracted from the Register of Deaths and linked to Queensland Cancer Registry files.

From the cancer registry, we ascertained all Indigenous cancer patients and an equal number of non-Indigenous cancer patients for comparison. The sample of the non-Indigenous patients was selected by frequency-matching with computer-generated random numbers within the following strata: 5-year age groups, sex, cancer site, and place of residence. Place of residence was frequency-matched according to categories of the accessibility/remoteness index of Australia.¹⁰ We were able to match 83% of cases by these criteria. The remaining patients were matched with broader criteria for three of the categories: 15-year age groups, reducing the cancer types from 20 groups to 12 groups, and decreasing the measure of rurality from five to two categories (urban and rural). To

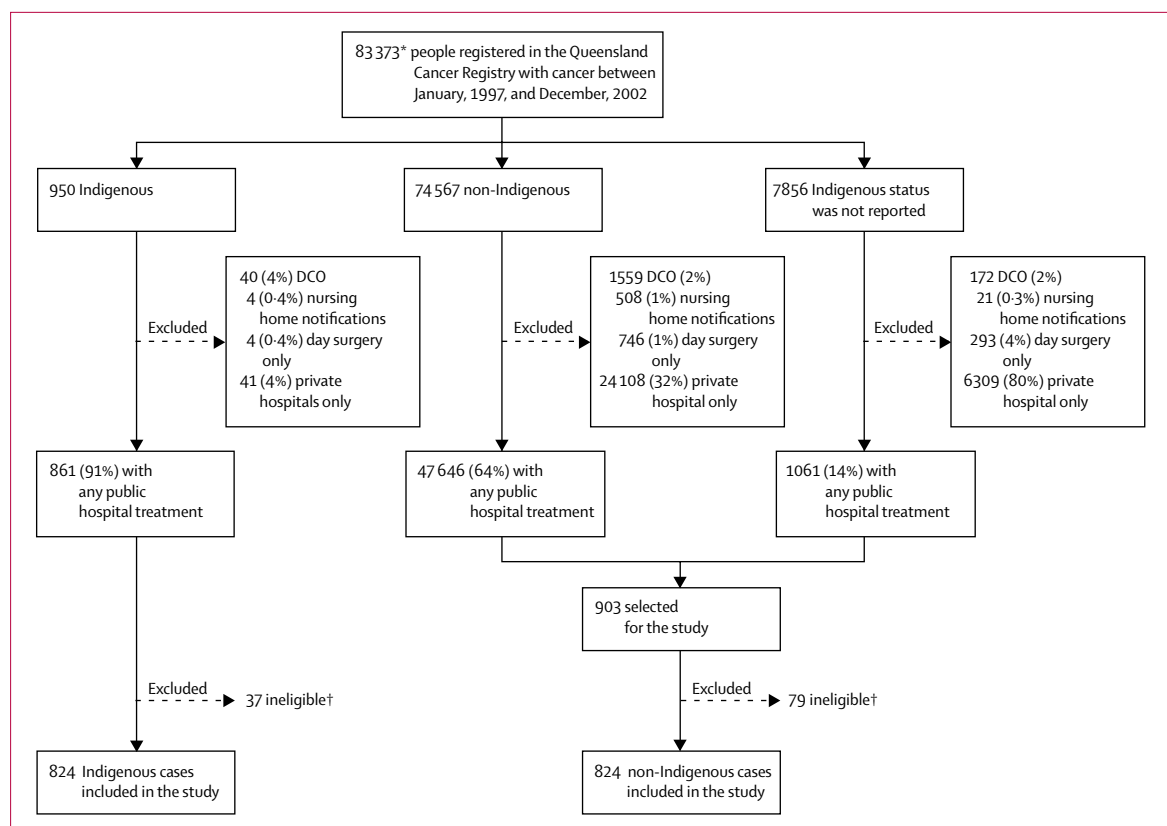


Figure 1: Flow chart for case selection

DCO=notification by death certificate only. *11 063 excluded (pathology only notifications). †Data in the Queensland Cancer Registry were cross-checked and updated, when necessary, with that in the hospital medical record. There were several changes to Indigenous status (eg, because of data entry error by hospital or Queensland Cancer Registry staff, or both), diagnosis (due to extra information obtained from the chart which confirmed a different diagnosis or confirmed a non-cancer diagnosis) and date of diagnosis, which eliminated some cases from the original sample selected (some non-Indigenous cases were excluded after rechecking the Indigenous/non-Indigenous matching).

be included in the study sample, patients had to have been admitted to a public hospital at least once for diagnosis or treatment of their cancer. Cancer patients registered on the basis of diagnosis of a pathology report (biopsy) only, death certificate only, nursing home notifications, or day surgery only were excluded from the study (figure 1).

In Queensland, as in the rest of Australia, all residents have free access to public-health care, but can also get private-health care if they are privately insured or willing to pay. More than a third of cancer patients in Queensland are treated exclusively in the private sector, but more than 95% of these are non-Indigenous (figure 1). Because there were only 41 Indigenous cases treated exclusively in the private sector compared with more than 30 000 non-Indigenous, we restricted our analysis to public-sector patients.

Throughout the study, the Queensland Aboriginal and Islander Health Forum acted as a community resource to provide community consultation and support. Ethics approval was obtained from the ethics committees of the Queensland Institute of Medical Research, the Queensland Health Department, and all hospitals who assisted in the data collection.

Procedures

Since the cancer registry does not record details about disease stage at diagnosis, treatment, or comorbidities, we obtained this information from hospital administrative data and hospital medical records. If a patient went to more than one public hospital, we investigated their

medical chart from the largest public hospital. Data were directly abstracted from records of 23 major public hospitals and nine smaller hospitals by a former Registrar of the Queensland Cancer Registry (1492 charts, 91.9% of Indigenous cases, and 91.7% of non-Indigenous cases). The information was extracted on a standard form that also verified Indigenous status.

Demographic information and all data from the cancer registry were cross-checked and updated where necessary from the hospital medical record. Summary staging at diagnosis was recorded for all cases with existing coding rules¹¹ so that degree of cancer spread was classified as localised, regional (spread to adjacent organs or regional lymph nodes), distant (spread beyond the organ of origin and neighbouring tissues), or unknown. Basic information for cancer treatment such as surgery (yes or no, date, and type of major surgery), chemotherapy (yes or no), and radiotherapy (yes or no) was also obtained. For surgery there were no missing data: if the medical chart did not contain sufficient information about surgery, we ascertained details of surgery through electronic hospital records. Information on comorbidities was obtained from computerised discharge abstracts held by the Queensland Health Department. Date of death and cause of death were obtained from the Queensland Cancer Registry. All cases were followed-up with respect to surgery and survival until Dec 31, 2003 (median follow-up 42 months, range 12–84). One small hospital denied access to medical charts. There were 15 Indigenous patients treated for cancer at this hospital, but information for 13 was available from other hospitals and only two had to be excluded from final analysis. Medical records personnel from each of the remaining 52 hospitals extracted and provided requested information through standard forms (133 charts, 8.1% Indigenous cases, and 8.3% non-Indigenous cases).

Statistical analysis

Cox regression analysis was used to assess the differences between Indigenous and non-Indigenous cases with respect to timing of surgical treatment of cancer and cancer survival. We built one model for time to surgery for cancer, and one for time to death from cancer. The methods of purposeful selection of covariates and likelihood ratio tests were used to choose covariates to be included in the models.¹² Age group, sex, year of diagnosis, remoteness index, and type of cancer were included in both core models since perfect matching was not possible, and we purposely included cancer stage at diagnosis. In the time to surgery model, seven more variables were added: cancer stage at diagnosis, diabetes, chronic renal disease, respiratory disease, hypertension, acute coronary conditions, and total number of comorbidities. In the final model for time to death from cancer, four more variables were added: time to surgery, type of surgery (intention to treat vs palliative), chemotherapy, and radiotherapy. Relative risk (RR) estimation, 95% CI, and two-sided p values were calculated with modified Poisson regression

	Indigenous N=815, n (%)	Non-Indigenous N=810, n (%)	Cancers treated in public hospitals in Queensland*
Bronchus and lung	158 (19.4%)	152 (18.8%)	13.4
Breast	82 (10.1%)	83 (10.2%)	11.7
Head and neck	66 (8.1%)	68 (8.4%)	3.9
Colorectal	60 (7.4%)	64 (7.9%)	13.8
Other	52 (6.4%)	55 (6.8%)	4.9
Lymphomas and leukaemias	50 (6.1%)	55 (6.8%)	9.9
Cervix	48 (5.9%)	48 (5.9%)	1.2
Renal tract	42 (5.2%)	41 (5.1%)	6.7
Corpus uteri	38 (4.7%)	34 (4.2%)	1.8
Oesophagus	20 (2.5%)	15 (1.9%)	1.5
Ovary	28 (3.4%)	29 (3.6%)	1.8
Unknown primary	28 (3.4%)	29 (3.6%)	3.9
Liver	25 (3.1%)	16 (2.0%)	1.0
Stomach	23 (2.8%)	23 (2.8%)	2.4
Prostate	23 (2.8%)	24 (3.0%)	7.5
CNS	20 (2.5%)	20 (2.5%)	2.5
Thyroid	19 (2.3%)	21 (2.6%)	2.3
Pancreas	19 (2.3%)	20 (2.5%)	2.2
Testis	9 (1.1%)	8 (1.0%)	0.9
Melanoma	5 (0.6%)	5 (0.6%)	6.7

*Data obtained from Queensland Health, Queensland Government.

Table 1: Frequency of type of cancer by Indigenous status, and distribution of cancers treated in public hospitals in Queensland

in which a robust error variance procedure was used to avoid over-estimation of the standard error of the relative risk.¹³ Unless specified, models used to calculate p values and estimates were adjusted for age, sex, year of diagnosis, remoteness index of residence, and cancer type (matching factors in the design). Calculations were done with the SPSS statistical software package (version 11.5) and STATA (version 8).

Role of the funding source

The funding sources had no role in the study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to the data in the study and had final responsibility for the decision to submit for publication.

Results

We identified 824 eligible Indigenous cancer patients and an equal number of eligible non-Indigenous patients. Information from medical charts was available for 815 Indigenous people (610 Aboriginal patients, 158 Torres Strait Islanders, and 47 who identified themselves as both Aboriginal and Torres Strait Islander). Overall, 4% of Indigenous cases were children (0–14 years), 11% were aged 15–39 years, 40% aged 40–59 years, and the remaining 45% were 60 years or older. For Indigenous people in Queensland, the leading cancers were bronchial and lung (19%), breast (10%), head and neck (8%, including larynx, oropharynx, tongue, palate), colorectal (7%), lymphomas and leukaemias (6%), and cervical cancer (6%; table 1). The leading cancers treated at public hospitals in Queensland overall (information obtained from the Queensland Health Department) were colorectal (14%), bronchial and lung (13%), breast (12%), lymphomas and leukaemias (10%), prostate (8%), renal tract (8%), and melanoma (7%).

We could not perfectly match our study cohorts according to place of residence. In our study sample, we had a higher proportion of Indigenous cancer patients who lived in “very remote” areas (20% vs 11% of non-Indigenous patients) and a smaller proportion of Indigenous patients living in “highly accessible” areas (19% vs 22%). A higher proportion of Indigenous cases lived in “most disadvantaged” areas (social-economic disadvantage index)¹⁴ than in “most affluent” or “affluent” areas, compared with non-Indigenous cases (39% vs 28%); 4–5% of Indigenous and 4% of non-Indigenous cases lived in areas classified as “most affluent”.

Of 1625 medical records, 1365 (84%) had the stage of cancer recorded in the hospital medical chart—for 114 (7%) summary stage was not applicable (eg, leukaemias and lymphomas) and for 146 (9%) this information was missing. Overall, Indigenous cases were less likely to have cancer stage recorded (Indigenous 12% vs non-Indigenous 7%; adjusted p value=0.002). The two groups differed significantly in stage of cancer at diagnosis (p=0.007) taking into account the missing information; fewer

	Indigenous n (%)	Non-Indigenous n (%)	RR (95% CI)	p value
Chemotherapy*				
No	515 (64.4%)	435 (54.4%)	1.0	<0.0001
Yes	285 (35.6%)	365 (45.6%)	0.80 (0.7–0.9)	
Radiotherapy†				
No	437 (54.8%)	390 (49.1%)	1.0	0.039
Yes	361 (45.2%)	405 (50.9%)	0.91 (0.8–1.0)	
Surgery (any)				
No	427 (52.4%)	341 (42.1%)	1.0	<0.0001
Yes	388 (47.6%)	469 (57.9%)	0.76 (0.7–0.9)	
“Intention to treat” surgery‡				
No	457 (59.8%)	362 (49.1%)	1.0	<0.0001
Yes	307 (40.2%)	375 (50.9%)	0.76 (0.7–0.9)	

RR=relative risk. *Data unavailable for 15 Indigenous and ten non-Indigenous patients. †Data unavailable for 17 Indigenous and 15 non-Indigenous patients. ‡Data unavailable for 51 Indigenous and 73 non-Indigenous patients.

Table 2: Frequency of use of cancer treatments in Indigenous and non-Indigenous patients

Indigenous cases had localised cancers. After adjustment for place of residence, age and year of diagnosis, and cancer type, Indigenous cases were 1.2 times more likely (95% CI 1.0–1.3) to have distant metastases at diagnosis, 1.1 times more likely (0.9–1.3) to have regional cancers, and 1.3 times more likely (1.1–1.6) to have cancer stage missing from their chart than to have localised cancers, compared with non-Indigenous cases.

About two-thirds (63%) of Indigenous cancer patients and 72% of non-Indigenous cases had no comorbidities; 21% of both Indigenous and non-Indigenous cases had one comorbidity, 12% of Indigenous and 5% of non-Indigenous had two, and 4% of Indigenous and 1% of non-Indigenous cases had three or more. Indigenous cases were 1.7 times (95% CI 1.4–2.1) more likely to have three comorbidities or more, than zero, compared with non-Indigenous cases. Several comorbidities were

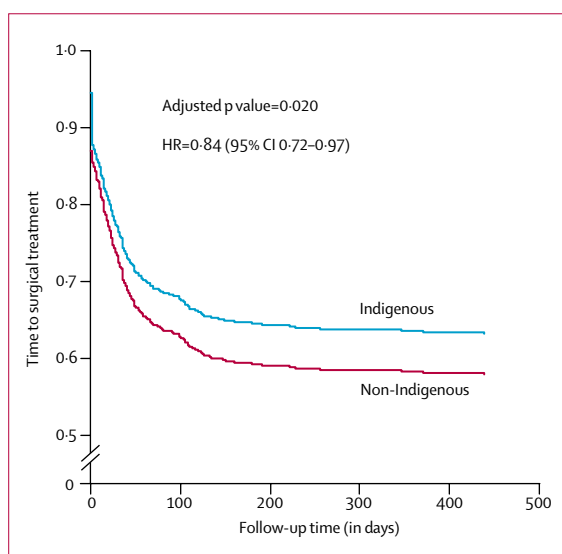


Figure 2: Time to surgical treatment of cancer by Indigenous status

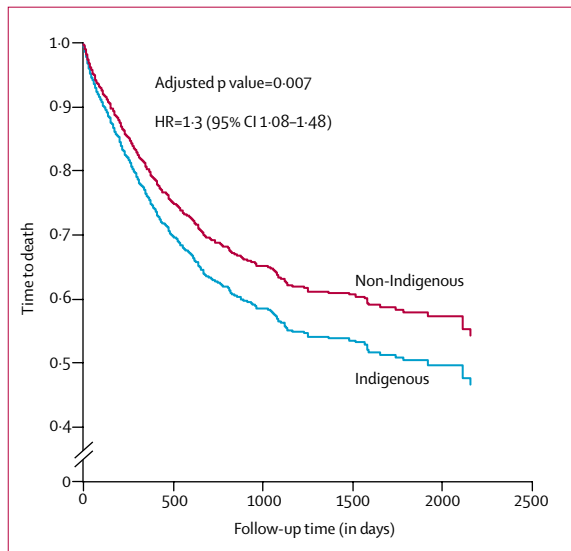


Figure 3: Time to death due to cancer by Indigenous status

more common in Indigenous cases than their non-Indigenous counterparts, such as diabetes mellitus (17% vs 6%), hypertension (12% vs 9%), acute coronary conditions (9% vs 5%), chronic renal disease (4% vs 1%) and respiratory disease (16% vs 12%). Of the 192 cases with diabetes mellitus, 12 had diabetes mellitus type 1, of which seven were Indigenous and four non-Indigenous. The two groups did not differ significantly in the prevalence of chronic respiratory disease (specifically chronic obstructive pulmonary disease), heart failure, chronic liver disease, dementia, chronic rheumatic heart disease, or stroke.

Indigenous cancer patients were less likely to undergo cancer treatment (table 2). 857 patients underwent surgical treatment of cancer in the study sample, 48% of Indigenous and 58% of non-Indigenous patients. 650 patients were treated with chemotherapy and 766 with radiotherapy; Indigenous people were less likely to receive these treatments. Indigenous individuals also waited longer to have surgery (figure 2; hazard ratio=0.84, 95% CI 0.72–0.97) than their non-Indigenous counterparts. About half of Indigenous and of non-Indigenous cases had surgery close to registration of diagnosis (median time to surgery was 1 day for both Indigenous and non-Indigenous cases). Removing comorbidities from the model made little difference to the hazard ratio for time to surgery (hazard ratio=0.81, 95% CI 0.70–0.94).

After adjustment for age, sex, year of diagnosis, remoteness index, and type of cancer (matching factors), Indigenous people were 1.5 times more likely (95% CI 1.3–1.7) to die from cancer than were non-Indigenous cases. Further adjustment for stage reduced the hazard ratio to 1.4 (1.2–1.6), and still further adjustment for time to surgery, type of surgery (intention-to-treat vs palliative), chemotherapy, and radiotherapy reduced it further to 1.3 (1.1–1.5). Further adjustments for comorbidities had no

	n (%)	HR (95% CI)
Indigenous status		
Non-Indigenous	810 (49.8%)	1.0
Indigenous	815 (50.2%)	1.3 (1.1–1.5)
Summary stage at diagnosis*		
Localised	757 (49.8%)	1.0
Regional	293 (19.3%)	1.7 (1.3–2.2)
Distant	323 (21.2%)	3.7 (2.9–4.7)
Stage not recorded	147 (9.7%)	1.8 (1.3–2.4)
Time to surgery†		
At diagnosis	381 (24.1%)	1.0
Within 30 days of diagnosis	250 (15.8%)	1.4 (0.9–2.1)
Within 31–100 days of diagnosis	131 (8.3%)	1.8 (1.1–2.9)
Within over 100 days of diagnosis	52 (3.3%)	1.6 (0.9–3.0)
No surgery	768 (48.5%)	1.9 (1.2–2.8)
"Intention to treat" surgery‡		
Yes	682 (45.4%)	1.0
No	819 (54.6%)	3.5 (2.2–5.4)
Radiotherapy§		
Yes	766 (48.1%)	1.0
No	827 (51.9%)	1.3 (1.1–1.6)
Chemotherapy¶		
Yes	650 (40.6%)	1.0
No	950 (59.4%)	1.0 (0.8–1.2)
Total number of comorbidities		
Nil	1100 (67.7%)	1.0
1	342 (21%)	1.3 (0.5–3.1)
2	141 (8.7%)	1.7 (0.7–3.0)
3 or more	42 (2.6%)	1.5 (0.8–2.8)
Respiratory disease		
No	1397 (86)	1.0
Yes	228 (14%)	1.4 (1.1–1.9)
Acute coronary conditions		
No	1507 (92.7%)	1.0
Yes	118 (7.3%)	1.3 (0.9–2.0)
Diabetes		
No	1433 (88.2%)	1.0 (0.7–1.4)
Yes	192 (11.8%)	1.0
Chronic renal disease		
No	1586 (97.6%)	1.0
Yes	39 (2.4%)	1.2 (0.6–2.2)
Hypertension		
No	1455 (89.5%)	1.0
Yes	170 (10.5%)	0.9 (0.6–1.3)

HR=hazard ratio. *50 Indigenous and 55 non-Indigenous excluded (cancer not included in this classification—eg, lymphomas and leukaemias). †Data unavailable for 72 Indigenous and 79 non-Indigenous cases. ‡Data unavailable for 51 Indigenous and 73 non-Indigenous cases. §Data unavailable for 17 Indigenous and 15 non-Indigenous cases. ¶Data unavailable for 15 Indigenous and ten non-Indigenous cases.

Table 3: Hazard ratios of selected variables for overall survival

effect. The likelihood of death from cancer during follow-up for Indigenous cancer patients, after adjusting for the matching variables, cancer stage, treatment, and comorbidities, was higher than for non-Indigenous cases (figure 3, table 3; hazard ratio=1.3, 95% CI 1.1–1.5).

Death from cancer took longer for non-Indigenous cases (mean=383 days, median=255 days) than for Indigenous cases (mean=251 days, median=135 days). There was also an increase in likelihood of death from cancer if cases had more advanced disease, no radiotherapy, or no surgery (particularly “intention-to-treat” surgery; table 3).

Discussion

Compared with non-Indigenous Australian cancer patients, Indigenous patients of a similar age, sex, place of residence, type of cancer, and public-health care in Queensland, fared worse. The likelihood of death from cancer was about 30% higher for Indigenous than for non-Indigenous cases, after taking into account cancer stage at diagnosis, cancer treatment, and higher rates of comorbidities in Indigenous individuals.

In Australia, as in most other countries, ethnicity (as recorded in population-based data systems such as the Queensland Cancer Registry and the Queensland public hospitals) is defined by self-assessment.¹⁵ Since our study relied on self-identification of Indigenous status, not all Indigenous cases might have been identified. In Australia, there is some evidence that, occasionally, an Indigenous patient might be reluctant to identify themselves as such, or that hospital staff might not ask or might make an educated guess.^{16,17} This potential misclassification could mean that some Indigenous cancer patients were not included in our cohort. However, we believe our case ascertainment was sufficiently complete since Indigenous status has been routinely recorded in the Queensland hospital patient administration system since 1996. We also believe the Indigenous to non-Indigenous comparison to be internally valid, with little, if any, misclassification of Indigenous status in the study sample, since medical charts were consulted to verify Indigenous status and discrepant cases were excluded. Information about cancer stage and treatment was obtained retrospectively from the hospital medical charts (one per patient) and therefore was subject to coding and interpretative uncertainties, but was not differentially biased. In view of the imperfect matching, especially for place of residence (about 20% of participants), some residual confounding affecting our results might have happened, despite adjustments of estimates by the matching variables.

Indigenous Australians with cancer tend to have higher mortality rates than their non-Indigenous counterparts.¹⁸ This could partly be due to a higher relative incidence of cancers with high fatality rates, particularly lung cancer.¹⁹ Several researchers have tried to explain this finding. A similar study done in the Northern Territory of Australia²⁰ has shown that advanced disease at diagnosis was more common for Indigenous (70%) than for non-Indigenous people (51%) with cancers of the colon and rectum, breast, cervix, and non-Hodgkin lymphoma, and for those diseases, cancer survival was strongly associated with a patient's first language.⁹ Because of demographic and cultural differences between Indigenous peoples in the

Northern Territory and in Queensland, we cannot easily generalise these findings. In the Northern Territory, 81% of Indigenous people live in remote areas, whereas in Queensland, 76% of Indigenous people live in major cities or regional areas. Indigenous people living in remote areas of Australia are more likely to report an Indigenous language as their main language at home (39%) than those living in regional and metropolitan areas (2%), and thus around three-quarters of Indigenous people living in the Northern Territory have an Indigenous language as their main language.¹

Also, unlike the present study, the Northern Territory study included cancer patients treated in private hospitals. A record linkage study done in Western Australia²¹ has shown that, compared with non-Indigenous cases, Indigenous people were about 36% less likely to have surgery for their lung cancer, and Indigenous men were less likely to have radical prostatectomy. Whether these differences were related to treatment choice or cultural barriers to care was unknown. In a retrospective surgical audit of breast cancer in the far north of Queensland,²² Indigenous women presented with more advanced cancer but received similar rates of breast conservation surgery to non-Indigenous women. O'Brien and co-workers²³ showed that the risk of death from cervical cancer for Indigenous women was four times higher for Indigenous women in the metropolitan areas and 18 times higher in remote areas than for non-Indigenous women. Indigenous women living in metropolitan areas compared with Indigenous women living in rural or remote areas had twice the risk of dying from their cancer.

Besides differences in demographic characteristics and cultural values, health inequalities would also play a part in the observed survival disparity. Socioeconomic inequalities are due to several factors such as poverty, low education, and poor access to health services.²⁴ Indigenous Australians,²⁵ like Indigenous populations in comparable countries,²⁶ are over-represented in low socioeconomic strata. Disparities in cancer survival have been reported in other disadvantaged groups in Australia and abroad. Hall and colleagues²⁷ reported that economically and locationally disadvantaged (remote) groups in Australia were less likely to receive surgery for their lung cancer. Jong and co-workers²⁸ reported that cancer survival varies by remoteness of residence for all cancers and some cancers (cervix and prostate). A cross-sectional analysis of UK cancer registry data²⁹ has identified strong socioeconomic trends in the chance of being diagnosed with advanced breast cancer. Ethnic and racial health disparities for cancer have also been shown within comparable countries.^{30,31}

The reasons underlying the disparities in cancer outcomes between Indigenous and non-Indigenous Australians are multifactorial and not yet fully explained. Advanced cancer at diagnosis, reduced uptake of cancer treatment, and higher rates of comorbidities in Indigenous cases are some of the factors leading to the poorer cancer

outcomes we recorded. However, we believe differences in socioeconomic status, access to health care (including both screening and treatment services), and lifestyle factors exist.¹ There are cultural differences and religious barriers between patients and health-care providers.⁴ Differences in patients' views of cancer (eg, a fatalistic view among Indigenous women)³² and of cancer treatment ("What can be done about it? It can't be cured can it? No one can stop it", a quote about breast cancer from a Queensland Aboriginal woman)³² that ultimately relate to treatment compliance are plausible barriers to optimal cancer management. High rates of comorbidities in Indigenous patients could lead to lower rates of surgical treatment of or chemotherapy for their cancers. Clinical under-staging or non-staging of cancer could be linked to socioeconomic factors or lack of access to care as well as to possible physician bias. We need to identify the specific sociodemographic and cultural factors contributing to the patterns of survival in the Aboriginal and Torres Strait Islander population of Australia. The interplay of access to care, differences in patient preferences for treatment and in patients' clinical understanding require a holistic and culturally respectful approach. Modification of some of these factors could well translate into meaningful public-health and clinical interventions to ultimately improve cancer survival.

Contributors

Initial concept and design: P Valery, J Stirling, A Green. All contributed to its further development; P Valery conducted the data analysis; P Valery drafted the manuscript and all authors contributed subsequently; all authors have seen and approved the final revised version.

Conflict of interest statement

We declare that we have no conflict of interest.

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References

- 1 Australian Bureau of Statistics. The health and welfare of Aboriginal and Torres Strait Islander peoples. Canberra: Australia Bureau of Statistics, 2005.
- 2 Freeman HP. Poverty, culture, and social injustice: determinants of cancer disparities. *CA Cancer J Clin* 2004; **54**: 72–77.
- 3 Eckerman A, Dowd T, Martin M, et al. Bina[ng] goonj: bridging cultures in Aboriginal health. Armidale, NSW: Dept of Aboriginal and Multicultural Studies, University of New England, 1992.
- 4 Coory M, Thompson A, Ganguly I. Cancer among people living in rural and remote Indigenous communities in Queensland. *MJA* 2000; **173**: 301–04.
- 5 Zhao Y, Guthridge S, Magnus A, et al. Burden of disease and injury in Aboriginal and non-Aboriginal populations in the Northern Territory. *Med J Aust* 2004; **180**: 498–502.
- 6 Condon JR, Armstrong BK, Barnes A, et al. Cancer in Indigenous Australians: a review. *Cancer Causes Control* 2003; **14**: 109–21.
- 7 Condon JR, Armstrong BK, Barnes T, et al. Cancer incidence and survival for indigenous Australians in the Northern Territory. *Aust N Z J Public Health* 2005; **29**: 123–28.
- 8 South Australian Cancer Registry. Cancer incidence, mortality and case survival in the South Australian Aboriginal Population. *Epidemiology of Cancer in South Australia*. Adelaide: South Australian Cancer Registry, 1997: 13–19.
- 9 Condon J. Cancer and Indigenous Australians in the Northern Territory. PhD thesis: Charles Darwin University, 2004.
- 10 Department of Health and Aged Care. Measuring Remoteness: Accessibility/Remoteness Index of Australia (ARIA). Canberra (ACT): Department of Health and Aged Care, 2000.
- 11 SEER. Summary Staging Manual – 2000: Codes and Coding Instructions. Bethesda, MD: National Cancer Institute, 2001.
- 12 Hosmer D, Lemeshow S. Model development. *Applied Survival Analysis: Regression modeling of time to event data*. New York: John Wiley and Sons, 1999: 158–95.
- 13 Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004; **159**: 702–06.
- 14 Australian Bureau of Statistics. Census of population and housing: Socio-Economic Indexes for Areas (SEIFA), Australia, 2001. Canberra: Australian Bureau of Statistics, 2004.
- 15 Paradies Y, Cunningham J. Placing Aboriginal and Torres Strait Islander mortality in an international context. *Aust N Z J Public Health* 2002; **26**: 11–16.
- 16 Robertson H, Lumley J, Berg S. How midwives identify women as aboriginal or Torres Strait Islanders. *Aust Coll Midwives Inc J* 1995; **8**: 26–29.
- 17 Young M. Assessing the quality of identification of Aboriginal and Torres Strait Islander people in Western Australian hospital data, 2000. Perth: Health Department of Western Australia, 2001.
- 18 Australian Bureau of Statistics. Causes of death 2002. Canberra: Australian Bureau of Statistics, 2003.
- 19 Threlfall T, Thompson J. Cancer incidence and mortality in Western Australia, 1999 and 2000. Perth: Department of Health, 2002.
- 20 Condon JR, Barnes T, Armstrong BK, et al. Stage at diagnosis and cancer survival for Indigenous Australians in the Northern Territory. *Med J Aust* 2005; **182**: 277–80.
- 21 Hall SE, Bulsara CE, Bulsara MK, et al. Treatment patterns for cancer in Western Australia: does being Indigenous make a difference? *Med J Aust* 2004; **181**: 191–94.
- 22 Shaw IM, Elston TJ. Retrospective, 5-year surgical audit comparing breast cancer in indigenous and non-indigenous women in Far North Queensland. *ANZ J Surg* 2003; **73**: 758–60.
- 23 O'Brien ED, Bailie RS, Jelfs PL. Cervical cancer mortality in Australia: contrasting risk by Aboriginality, age and rurality. *Int J Epidemiol* 2000; **29**: 813–16.
- 24 Harris E, Sainsbury P, Nutbeam D. Perspectives on health inequity. Sydney: National Centre for Health Promotion, 1999.
- 25 Glover J, Harris K, Tennant S. A social health atlas of Australia (2nd edn). Adelaide: Public Health Information Development Unit, 1999.
- 26 US Bureau Census. Poverty: 1999. Census 2000 Brief. May 2003. Available at: <http://www.census.gov/prod/2003pubs/c2kbr-19.pdf> (accessed December, 2005).
- 27 Hall SE, Holman CD, Sheiner H. The influence of socio-economic and locational disadvantage on patterns of surgical care for lung cancer in Western Australia 1982–2001. *Aust Health Rev* 2004; **27**: 68–79.
- 28 Jong KE, Smith DP, Yu XQ, et al. Remoteness of residence and survival from cancer in New South Wales. *Med J Aust* 2004; **180**: 618–22.
- 29 Adams J, White M, Forman D. Are there socioeconomic gradients in stage and grade of breast cancer at diagnosis? Cross sectional analysis of UK cancer registry data. *BMJ* 2004; **329**: 142.
- 30 Baquet CR, Commiskey P. Colorectal cancer epidemiology in minorities: a review. *J Assoc Acad Minor Phys* 1999; **10**: 51–58.
- 31 Bramley D, Hebert P, Tuzzio L, et al. Disparities in indigenous health: a cross-country comparison between New Zealand and the United States. *Am J Public Health* 2005; **95**: 844–50.
- 32 Prior D. Cultural strengths and social needs of Aboriginal women with cancer: take away the cancer but leave me whole. PhD: University of Queensland, 2005.