Causes of inequality in life expectancy between Indigenous and non-Indigenous people in the Northern Territory, 1981–2000: a decomposition analysis

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ABSTRACT

Objective: To identify the causes of the gap in life expectancy between Indigenous and non-Indigenous populations of the Northern Territory and how the causes have evolved over time.

Design and setting: Analysis of NT death data over four 5-year periods, 1 January 1981 to 31 December 2000 inclusive. A decomposition method using discrete approximations (Vaupel and Romo) was applied to abridged life tables for the Indigenous and non-Indigenous populations of the NT.

Main outcome measures: Contribution of causes of death, grouped according to global burden of disease groups and categories, to the life expectancy gap.

Results: The gap between the life expectancy of Indigenous and non-Indigenous people in the NT did not appear to narrow over time, but there was a marked shift in the causes of the gap. In terms of disease groups, the contribution of communicable diseases, maternal, perinatal and nutritional conditions halved during the 20 years to 2000. Meanwhile, the contribution of non-communicable diseases and conditions increased markedly. The contribution of injuries remained static. In terms of disease categories, the contribution of infectious diseases, respiratory infections and respiratory diseases declined considerably; however, these gains were offset by significantly larger increases in the contribution of cardiovascular diseases and diabetes for Indigenous women and cardiovascular diseases, cancers and digestive diseases for Indigenous men.

Conclusions: The main contributors to the gap in life expectancy between the Indigenous and non-Indigenous populations were non-communicable diseases and conditions, which are more prevalent in ageing populations. With the life expectancy of Indigenous people in the NT expected to improve, it is important that public health initiatives remain focused on preventing and managing chronic diseases.

MJA 2006; 184: 490–494

Summary measures of population health can be used to assess and compare levels of health; to identify the diseases, injuries and risk factors contributing most to ill health; and to evaluate the health gains from interventions.[1] Life expectancy at birth is a useful summary measure for the mortality patterns of populations. In the 20 years between 1983 and 2003, Australians experienced a marked increase in life expectancy at birth, rising from 72 to 78 years in men and from 79 to 83 years in women.[2] However, over a similar period, the life expectancy at birth of Australia's Indigenous population was up to 20 years lower than that of the general Australian population.[3,4]

In the Northern Territory between 1981 and 2000, age-standardised mortality rates for Indigenous people were two to three times higher than those for non-Indigenous people. In some age groups, particularly between 40 and 50 years, mortality rates of Indigenous people were up to nine times higher, signifying extensive premature mortality among middle-aged Indigenous people.[3]

Causes-specific mortality and population data by Indigenous status are available for the NT population dating back to 1981. We aimed to identify the diseases or conditions contributing to the difference in life expectancy between Indigenous and non-Indigenous people in the NT, to estimate the extent of the contribution of these diseases or conditions, and to examine changes in their contributions over time.

Since the late 1970s, demographers have developed a decomposition technique to assess the factors contributing to differences in life expectancy.[5,6] The technique has been used to describe the contribution of causes of death to the change in life expectancy in Australia between 1971 and 1981,[7] and the contribution of the reduction in major cardiovascular diseases, malignant neoplasms, injuries and AIDS-related mortality to the gains in life expectancy in 1985–1994.[8]

More recently, Vaupel and Romo have summarised the decomposition method for life expectancy.[9] To our knowledge the contribution of specific causes of death to differences in life expectancy between the Indigenous and non-Indigenous population in Australia has not previously been examined.

METHODS

The period studied was the 20 years from 1 January 1981 to 31 December 2000 inclusive. NT unit record death data were extracted for causes of death by sex, age and Indigenous status on the basis of date of death and state of residence, from the Australian Bureau of Statistics (ABS) mortality dataset. The underlying causes of death were coded by the ABS using the *International classification of diseases*, 9th and 10th revisions (ICD-9 and ICD-10). It has been shown previously that the overall quality of the medical cause of death data was of a sufficiently good standard from a public health perspective to broadly inform health policy.[10] In the NT, considerable effort has been made to validate and identify Indigenous status in historical death data by using commonly used Indigenous community and family names,[11] and completeness of Indigenous death identification data was considered acceptable for trend analysis.[3,12] Under-identification of Indigenous status for the NT is reported as being the lowest in Australia, and coverage of Indigenous deaths the highest.[13,14] Constant annual death counts suggest that coverage has remained relatively stable in the NT.[14]

Population data comprising yearly estimated resident population counts for the NT by sex, Indigenous status and 5-year age group were obtained from the ABS. Annual Indigenous population counts were derived using ABS experimental estimates of the Aboriginal and Torres Strait Islander population.[15]

During the 20-year study period, 7217 Indigenous people died among an annual population of around 56 200 (estimated resident population in 2000) and 6701 non-Indigenous people died among an annual

1 Global burden of disease classification for diseases and injuries[17]

Group I — Communicable, maternal, perinatal and nutritional conditions
Infectious and parasitic diseases
Respiratory infections
Maternal conditions
Conditions arising during the perinatal period
Nutritional deficiencies
Others
Group II — Non-communicable diseases
Malignant neoplasms
Other neoplasms
Diabetes mellitus
Endocrine disorders
Neuropsychiatric conditions
Sense organ diseases
Cardiovascular diseases
Respiratory diseases
Digestive diseases
Genitourinary diseases
Skin diseases
Musculoskeletal diseases
Congenital anomalies
Oral conditions
Others
Group III — Injuries
Unintentional injuries
Intentional injuries ◆

2 The Vaupel and Romo decomposition method[9]

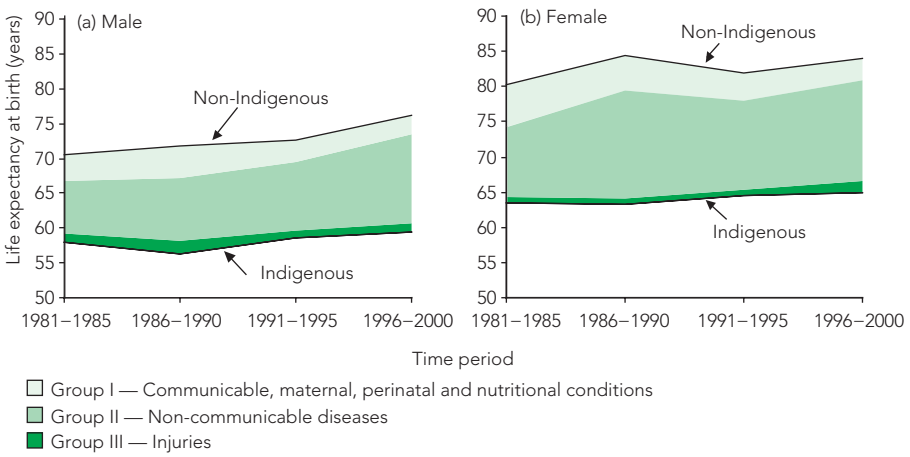
Let $\hat{e}_0$ denote the estimated life expectancy at birth for a population. The difference in estimated life expectancy at birth between the two population groups can be decomposed as n contributing factors ($i = 1, 2, \ldots, n$). (In this instance, n is the total number of global burden of disease categories.)

$$\hat{e}_0^2 - \hat{e}_0^1 = \sum_{i=1}^{n} [MI_i \cdot YLL_i + C_i] W_i$$

where $W_i = \sum_{a=0}^{\omega} w_{ai}$

- the weight w_{ai} refers to the proportion of deaths from cause i at age a, and ω is the maximum age group in the life table;
- the years of life lost YLL_i is the number of years lost through death at any given age resulting from cause i, and is given by $YLL_i = \sum_{a=0}^{\omega} \hat{e}_a w_{ai} / W_i$ with $\hat{e}_a$ being the life expectancy at age a;
- the notation MI_i represents the average rate of difference in mortality from cause i; and
- the notation C_i is the covariance between MI_i and YLL_i. ◆

3 Trends in the life expectancy gap between Indigenous and non-Indigenous people in the Northern Territory, 1981–2000, for global burden of disease groups



population of around 139 400. To increase the stability of the data, we pooled the deaths and population data into four 5-year periods. All-causes life expectancy at birth for males and females within the NT Indigenous and non-Indigenous populations over four intervals (1981–1985, 1986–1990, 1991–1995, and 1996–2000) were calculated using Chiang's method for constructing abridged life tables.[16]

Using a conversion table from the *Global burden of disease and injury (GBD) series*,[17] we mapped each cause of death into GBD groups and categories (Box 1). We chose the GBD classification because, in this system, causes of death are aggregated in a way that underpins socioeconomic development and epidemiological transition.[18] This approach differs from the conventional method, which involves aggregating causes of death into ICD chapters on the basis of body system. There are three broad groups in the GBD classification. Group I comprises communicable diseases, maternal causes, conditions arising in the perinatal period and nutritional deficiencies; Group II comprises non-communicable diseases; and Group III comprises unintentional and intentional injuries.

We then applied the Vaupel and Romo[9] decomposition method to discrete abridged life tables for the Indigenous and non-Indigenous populations of the NT as shown in Box 2.

RESULTS

The gap between the life expectancy of NT Indigenous and non-Indigenous people was large for all four periods of time and did not appear to be narrowing (Box 3). The difference in life expectancy during the last 5-year period, 1996–2000, was 16.7 years for males and 19.0 years for females (Box 4 and Box 5).

GBD groups

The major contributor to the difference in life expectancy was Group II (non-communicable diseases and conditions). The contribution of this group to the gap in life expectancy increased markedly over time. In 1981–1985, Group II was collectively responsible for 58% of the life expectancy

4 Decomposition differences in life expectancies between Indigenous and non-Indigenous populations, males, Northern Territory, 1981–2000

	$\hat{e}_0$ in years (%)				$\hat{e}_0$ 95% confidence interval			
	1981–1985	1986–1990	1991–1995	1996–2000	1981–1985	1986–1990	1991–1995	1996–2000
Cause of death*								
Cardiovascular diseases	3.5 (28%)	3.6 (25%)	4.1 (30%)	4.8 (33%)	3.1 to 3.9	3.3 to 4.0	3.8 to 4.5	4.5 to 5.2
Genitourinary diseases	0.7 (5%)	0.8 (6%)	0.5 (4%)	1.3 (9%)	0.2 to 1.1	0.4 to 1.2	0.2 to 0.8	1.0 to 1.7
Diabetes	0.8 (6%)	0.6 (4%)	0.7 (5%)	1.3 (9%)	0.4 to 1.2	0.3 to 0.9	0.3 to 1.0	1.0 to 1.7
Respiratory diseases	2.9 (23%)	1.5 (11%)	1.4 (10%)	1.3 (9%)	2.5 to 3.3	1.2 to 1.9	1.0 to 1.7	1.0 to 1.6
Unintentional injury	1.3 (10%)	1.4 (10%)	1.3 (10%)	1.1 (8%)	0.8 to 1.8	1.0 to 1.8	0.9 to 1.7	0.7 to 1.5
Respiratory infection	2.1 (16%)	1.9 (13%)	1.7 (13%)	1.0 (7%)	1.4 to 2.8	1.4 to 2.5	1.2 to 2.2	0.5 to 1.4
Infectious disease	1.5 (12%)	2.0 (14%)	0.9 (7%)	0.8 (5%)	0.8 to 2.2	1.4 to 2.6	0.3 to 1.4	0.4 to 1.2
Others	0.2 (2%)	0.5 (4%)	0.9 (7%)	0.7 (5%)	–0.4 to 0.9	0.0 to 1.1	0.3 to 1.5	0.1 to 1.2
Cancers	–0.8 (–6%)	0.4 (2%)	0.7 (5%)	0.6 (4%)	–1.1 to –0.4	0.1 to 0.6	0.4 to 1.0	0.3 to 0.9
Perinatal conditions	0.2 (2%)	0.3 (2%)	0.3 (2%)	0.6 (4%)	0.0 to 0.4	0.1 to 0.5	0.1 to 0.5	0.4 to 0.8
Mental conditions	0.4 (3%)	0.9 (6%)	0.7 (5%)	0.5 (3%)	–0.1 to 0.9	0.5 to 1.4	0.3 to 1.2	0.1 to 1.0
Digestive diseases	–0.8 (–6%)	–0.2 (–2%)	0.5 (4%)	0.4 (3%)	–1.3 to –0.4	–0.6 to 0.1	0.1 to 0.9	0.0 to 0.8
Congenital anomalies	0.2 (2%)	0.2 (1%)	0.0 (0)	0.2 (1%)	–0.2 to 0.5	–0.2 to 0.6	–0.4 to 0.5	–0.3 to 0.7
Endocrine disorders	0.3 (2%)	0.2 (1%)	0.0 (0)	0.2 (1%)	–0.2 to 0.8	–0.3 to 0.7	–0.5 to 0.4	–0.2 to 0.6
Intentional injury	0.1 (1%)	0.5 (3%)	–0.3 (–2%)	–0.1 (–1%)	–0.3 to 0.5	0.1 to 0.8	–0.6 to 0	–0.4 to 0.2
Total	**12.6 (100%)**	**14.6 (100%)**	**13.4 (100%)**	**14.7 (100%)**	**10.8 to 14.5**	**13.0 to 16.2**	**11.7 to 14.8**	**13.1 to 16.2**
Life expectancy at birth†								
Indigenous	57.9	56.2	58.6	59.4	57.0 to 58.7	55.4 to 57.0	57.7 to 59.4	58.7 to 60.2
Non-Indigenous	70.4	71.8	72.7	76.1	69.8 to 71.0	71.2 to 72.3	72.2 to 73.1	75.6 to 76.6
Actual difference	12.5	15.6	14.1	16.7	11.5 to 13.6	14.6 to 16.5	13.1 to 15.1	15.7 to 17.6

* In order of 1996–2000 data. † Source: Li SQ, Guthridge S. Mortality in the Northern Territory: 1981 to 2000.[3] $\hat{e}_0$ denotes the estimated life expectancy at birth. ◆

gap between Indigenous and non-Indigenous males and 60% of the gap between Indigenous and non-Indigenous females. By the last 5-year period of 1996–2000, the contribution of this group had increased to 77% for both males and females.

Group I (communicable diseases, maternal, perinatal and nutritional conditions) contributed far less to the life expectancy gap and, in contrast to Group II, the collective contribution of Group I diseases and conditions decreased markedly over time. In 1981–1985, Group I diseases and conditions were collectively responsible for 36% of the life expectancy gap between Indigenous and non-Indigenous males and 34% of the gap between Indigenous and non-Indigenous females. By the last 5-year period, 1996–2000, this group was only contributing to 15% of the life expectancy gap for males and 16% for females.

The collective contribution of the third group, Group III (injuries), to the life expectancy gap was considerably less than that of the other two groups, for both males and females. Over time the change in contribution of this group to the female life expectancy gap was negligible, increasing from 5% to 8%. For males the trend was the opposite, declining from 11% to 7%.

GBD categories

The extent to which each GBD category contributed to the life expectancy gap is shown in Box 4 and Box 5. For males (Box 4) during the first period, 1981–1985, there was considerable variation between the contributions of each category. Several categories, including cardiovascular diseases, respiratory diseases, respiratory infections and infectious diseases, contributed more than 10% each to the gap. In contrast, the contributions of both cancer and digestive diseases were negative, as the death rate due to these causes was lower for Indigenous males than for non-Indigenous males in the early 1980s.

With the exception of respiratory diseases, the contribution of most of the chronic disease GBD categories, including digestive diseases and cancer, to the life expectancy gap increased over the ensuing 15 years. By the last period, 1996–2000, digestive diseases and cancer were contributing positively to the gap, albeit in a small way (3% and 4%, respectively), and the contributions of cardiovascular diseases increased from 28% to 33%, genitourinary diseases from 5% to 9%, diabetes from 6% to 9% and perinatal conditions from 2% to 4%. In contrast, the contribution of respiratory diseases (this GBD category comprises asthma and chronic obstructive pulmonary disease) declined considerably over time from 23% to 9%. By the last period, 1996–2000, the contribution of this category was around a third of that in the first period.

For females (Box 5), all GBD categories except congenital anomalies contributed to the gap in life expectancy between Indigenous and non-Indigenous females during the first period, 1981–1985. The extent of their contribution ranged from 1% for several categories to 19% for infectious diseases. The contribution of cardiovascular diseases to the gap was very much less (9%) than it was for males (28%) during this period. The trend over time was very similar to that of males, with most chronic disease GBD categories, except for respiratory diseases, increasing their contribution to the life expectancy gap. By the last period, 1996–2000, cardiovascular diseases were

5 Decomposed differences in life expectancies between Indigenous and non-Indigenous populations, females, Northern Territory, 1981–2000

	$\hat{e}_0$ in years (%)				$\hat{e}_0$ 95% confidence interval			
	1981–1985	1986–1990	1991–1995	1996–2000	1981–1985	1986–1990	1991–1995	1996–2000
Cause of death*								
Cardiovascular diseases	2.2 (9%)	3.2 (13%)	4.0 (19%)	4.3 (24%)	1.6 to 2.8	2.7 to 3.7	3.6 to 4.4	3.9 to 4.8
Genitourinary diseases	2.2 (9%)	3.5 (15%)	2.3 (11%)	1.8 (10%)	1.8 to 2.6	2.9 to 4.0	1.9 to 2.7	1.4 to 2.2
Respiratory diseases	3.8 (15%)	3.4 (14%)	2.6 (12%)	1.6 (9%)	3.2 to 4.4	2.9 to 3.9	2.1 to 3.1	1.2 to 2.0
Diabetes	0.3 (1%)	2.1 (9%)	2.7 (13%)	1.6 (9%)	0.0 to 0.7	1.8 to 2.4	2.3 to 3.0	1.2 to 2.0
Infectious disease	4.7 (19%)	2.5 (10%)	1.6 (8%)	1.2 (7%)	3.8 to 5.7	1.7 to 3.2	1.0 to 2.2	0.6 to 1.8
Respiratory infection	3.2 (13%)	2.5 (11%)	2.5 (12%)	1.2 (7%)	2.4 to 4.1	1.8 to 3.2	1.9 to 3.1	0.6 to 1.8
Others	3.7 (15%)	2.4 (10%)	1.4 (7%)	1.2 (7%)	2.8 to 4.6	1.6 to 3.2	0.6 to 2.2	0.4 to 1.9
Unintentional injury	0.3 (1%)	0.5 (2%)	0.7 (3%)	1.0 (6%)	–0.5 to 1.1	–0.2 to 1.2	0.0 to 1.4	0.4 to 1.7
Cancers	0.7 (3%)	0.3 (1%)	0.9 (4%)	0.9 (5%)	0.2 to 1.3	–0.2 to 0.8	0.4 to 1.3	0.5 to 1.3
Digestive diseases	0.3 (1%)	0.5 (2%)	0.6 (3%)	0.9 (5%)	–0.3 to 1.0	0.0 to 1.1	0.0 to 1.2	0.4 to 1.3
Congenital anomalies	0.0 (0)	0.2 (1%)	0.0 (0)	0.5 (3%)	–0.1 to 0.1	–0.1 to 0.4	–0.5 to 0.5	0.2 to 0.8
Perinatal conditions	0.1 (1%)	0.3 (1%)	0.4 (2%)	0.4 (2%)	0.0 to 0.2	0.1 to 0.5	0.2 to 0.6	0.2 to 0.6
Endocrine disorders	1.0 (4%)	1.2 (5%)	0.7 (3%)	0.4 (2%)	0.4 to 1.5	0.5 to 1.9	0.1 to 1.3	–0.3 to 1.1
Intentional injury	1.1 (4%)	0.5 (2%)	0.3 (2%)	0.3 (2%)	0.8 to 1.4	0.2 to 0.7	–0.3 to 0.9	0.0 to 0.6
Mental conditions	0.8 (3%)	0.7 (3%)	0.1 (1%)	0.3 (2%)	0.0 to 1.6	–0.1 to 1.4	–0.5 to 0.7	–0.3 to 0.9
Maternal conditions	0.4 (2%)	0.2 (1%)	0.0 (0)	0.0 (0)	0.3 to 0.6	0.0 to 0.3	—	—
Total	**24.8 (100%)**	**24.0 (100%)**	**20.8 (100%)**	**17.6 (100%)**	**22.6 to 27.4**	**21.6 to 26**	**18.6 to 22.8**	**15.6 to 19.5**
Life expectancy at birth†								
Indigenous	63.5	63.2	64.4	65.0	62.6 to 64.4	62.4 to 64.0	63.6 to 65.3	64.2 to 65.7
Non-Indigenous	80.2	84.4	81.8	84.0	79.3 to 81.1	83.6 to 85.3	81.1 to 82.5	83.4 to 84.6
Actual difference	16.7	21.2	17.4	19.0	15.4 to 18.0	20.1 to 22.4	16.3 to 18.5	18.1 to 20.0

* In order of 1996–2000 data. † Source: Li SQ, Guthridge S. Mortality in the Northern Territory: 1981 to 2000.[3] $\hat{e}_0$ denotes the estimated life expectancy at birth. ◆

contributing almost three times as much to the gap (24%) compared with the first period (9%), whereas the contribution of respiratory diseases halved over time.

Sex differences were more pronounced for unintentional injuries. For males, this GBD category declined in its contribution to the gap over time, but for females the contribution of unintentional injuries increased from 1% to 6%.

The 95% confidence intervals indicate a sufficient sample size for a life expectancy difference between the NT Indigenous and non-Indigenous populations (Box 4 and Box 5).

DISCUSSION

The gap between NT Indigenous and non-Indigenous life expectancy did not appear to narrow over the 20 years between 1981 and 2000, but there was a marked shift in the causes of the gap. By using GBD groups, we showed that diseases or conditions associated with lower socioeconomic status (Group I) declined in their contribution over time, whereas diseases associated with life style factors (Group II) increased. In terms of GBD categories, the contribution of communicable diseases, particularly infectious diseases and respiratory infections, declined considerably over time. In contrast, the contribution of most chronic disease GBD categories increased, with the exception of the respiratory diseases category, which declined in contribution. The magnitude of the increase in the contribution of cardiovascular diseases and diabetes for women, and in cardiovascular diseases, cancers and digestive diseases for men, was large enough to offset the decline in contribution of GBD communicable disease categories.

The patterns demonstrated in our study are corroborated by mortality rate analyses, which have shown substantial falls in communicable disease death rates among Indigenous people over the past three decades.[12] Increased mortality due to non-communicable diseases among Indigenous Australians has also been documented.[3,19] The reasons for this are manifold, with a mix of social, economic and educational disadvantages, resulting in whole-of-life poor nutrition, systematic infections and adverse health behaviours in adulthood,[20-22] further aggravated by poor access to primary health care services.[23] The introduction of effective and sustained primary care programs to address these unmet needs for preventive, early diagnostic measures and prompt intervention is a matter of urgency.

Some underlying causes of death contributed negatively to the gap in life expectancy between Indigenous and non-Indigenous males, for example cancers, digestive diseases and intentional injury (Box 4). Li and Guthridge reported that the age-adjusted cancer death rate in NT Indigenous males was 30% below the national average in the early 1980s and became 30% above the national average by the 1990s.[3] However, there were significant differences among individual cancer sites in rate ratios comparing Indigenous and non-Indigenous cancer mortality.[24] Similarly, the age-adjusted death rate for Indigenous males due to chronic liver disease, the major digestive disease, was around 30% lower than non-Indigenous males in the early 1980s. For the intentional injury category, homicide death rates in Indigenous males dropped from around 50 per 100 000 during 1981–1985

to 35 per 100 000 in 1991–1995, and non-Indigenous males had relatively higher suicide mortality rates during the study period.[25] Within the unintentional injury category, the major cause of death is motor vehicle traffic accidents. The upward trend in the contribution of unintentional injuries to the life expectancy gap for females is likely to be due to a small increase among Indigenous women, and a considerable decline among non-Indigenous women, in the rate of motor vehicle traffic accident deaths.[25] In contrast, motor vehicle traffic accident deaths among men have declined for both Indigenous and non-Indigenous people.

Applying the decomposition technique to life expectancy data gives more exact information about health inequalities between populations. It adds another level of precision to existing health information for trend analysis, on which informed decisions can be made to guide resource allocation and direct programs for reducing the life expectancy gap between Indigenous and non-Indigenous Australians.

A limitation of our study was the use of GBD groups, which arbitrarily separate communicable and non-communicable diseases. There is evidence to suggest that infectious and non-infectious diseases are interrelated. For example, bacterial infections of the ears, nose and skin are associated with renal and heart disease.[26,27] The reverse has also been reported with non-communicable diseases such as diabetes, which has been shown to amplify the effect of infection in Indigenous communities.[28]

The introduction of ICD-10 in 1997 has resulted in some artefactual variation in disease coding rules. The comparability with ICD-9 has been assessed by the ABS.[29] The most notable variations at a code level are asthma, rheumatic fever (resulting in a 25% and 30% decrease, respectively) and dementia (50% increase). These changes have not had a significant impact on the higher order categories applied in this study.

A further limitation is that, with this method, precise decomposition of the life expectancy differentials for abridged life tables, commonly used for population health assessment, is not possible. Due to discretion and approximation errors resulting from 5-year age intervals in abridged life tables, most decomposed differentials varied slightly from the actual differentials. The difference was more apparent for females, particularly in the 1980s, due to the smaller number of deaths in this period. An increase in sample size will allow extension of the method to analysis of the life expectancy gap by both age and cause of death and warrants further investigation.

With life expectancy expected to continue to improve for both Indigenous and non-Indigenous people in the NT, the proportion of elderly people in both populations is also expected to increase. Thus improvements in life expectancy will be accompanied by an increased prevalence of chronic diseases and conditions. Narrowing the gap caused by these diseases will become more difficult and resource consuming, and public health interventions need to focus on better prevention and management of chronic diseases, particularly cardiovascular diseases and diabetes for Indigenous women and cardiovascular diseases, cancers and digestive diseases for Indigenous men.

COMPETING INTERESTS

None identified.

AUTHOR DETAILS

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(Received 13 Dec 2005, accepted 4 Apr 2006) ❑