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Australian Bureau of Statistics

Discussion Paper: Assessment of Methods for Developing Life Tables for Aboriginal and Torres Strait Islander Australians

Australia

2006

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Brian Pink
Australian Statistician

AUSTRALIAN BUREAU OF STATISTICS

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CONTENTS

ABBREVIATIONS

ABS	Australian Bureau of Statistics
ACT	Australian Capital Territory
Aust.	Australia
CDE	Census data enhancement
ERP	estimated resident population
NSW	New South Wales
NT	Northern Territory
OT	Other Territories
p.a.	per annum
PES	Census of Population and Housing Post-Enumeration Survey
Qld	Queensland
RSE	relative standard error
RTO	resident temporarily overseas
SA	South Australia
SE	standard error
Tas.	Tasmania
Vic.	Victoria
WA	Western Australia

CHAPTER 1 MAIN FEATURES

INTRODUCTION

In this discussion paper, the word "Indigenous" refers to Aboriginal and Torres Strait Islander peoples of Australia. We thank Australian Aboriginal and Torres Strait Islander peoples for their cooperation and assistance in the collection of data, without which, this analysis would not have been possible.

Life expectancy estimates for Aboriginal and Torres Strait Islander Australians are an important aspect of assessing Indigenous disadvantage. The compilation of accurate life tables to derive life expectancy estimates for Aboriginal and Torres Strait Islander (Indigenous) Australians presents particular difficulties. Specifically, the standard approach to compiling life tables and resulting life expectancies at birth requires complete and accurate data on deaths that occur in a period, and an estimate of the population exposed to those deaths at the mid-point of the period. These data are required by age and sex. In the case of Indigenous mortality estimation, this situation is far from being perfect. Both Indigenous population estimates and death registrations have limitations.

Despite these limitations, the importance of life expectancy estimates and population projections for the purposes of planning, policy and program formulation, evaluation, research, analysis, and resource distribution purposes are well recognised by the Australian Bureau of Statistics (ABS).

PURPOSE OF THIS DISCUSSION PAPER

The ABS has previously compiled experimental life tables for Indigenous Australians following the 1996 and 2001 Censuses of Population and Housing. Those estimates were compiled using different indirect demographic methods and were subject to a range of caveats. Because of these caveats, the estimates have been labelled 'experimental'. In spite of those caveats, the resulting estimates have been used extensively.

In considering the compilation of life tables for Indigenous Australians following the 2006 Census, the ABS has been investigating a range of different methodologies. These investigations have once again highlighted the sensitivity of these estimates to the underlying assumptions, input data and methods explored.

The objective of this Discussion Paper is to highlight the issues associated with compiling life tables and life expectancy estimates for Indigenous Australians. The paper discusses the different methods available, the data limitations and the resulting outcomes for the different methods. An ABS preferred approach of using a direct demographic method, by adjusting the death registration data by the undercoverage factor obtained from the Census Data Enhancement (CDE) Indigenous Mortality Quality Study, to derive Indigenous life tables is presented.

The purpose of the Discussion Paper is to give users and stakeholders the opportunity to provide feedback and to ensure all issues associated with compiling life tables and life expectancy estimates for Indigenous Australians are adequately considered before finalising the Indigenous life tables in early 2009. A consequence of this approach will be that experimental Indigenous life tables and life expectancy estimates for 2001-2006 will not be included in *Deaths, Australia, 2007* (cat. no. 3302.0) scheduled to be released on 25 November 2008. The ABS will advise on the specific timing of the release of experimental Indigenous life tables and life expectancy estimates in due course.

PURPOSE OF THIS DISCUSSION PAPER *continued*

It should be noted that the Indigenous life expectancy estimates presented in this Discussion Paper are preliminary in nature. The ABS will continue to review the estimates and the methodology used prior to publication of the final estimates.

METHODS ASSESSED

The ABS has assessed four methodologies for compiling Indigenous life tables and life expectancies. These can be broadly grouped into indirect demographic methods and direct demographic methods.

The indirect methods (Bhat with and without unexplained growth, and Hill), which are discussed in detail in Chapters 3 and 5, require Indigenous population estimates by age and sex, at two time points and the recorded Indigenous deaths in the intervening period. The methods effectively derive an estimate of undercoverage in the recorded deaths which are adjusted accordingly, with resulting life tables and life expectancies. The outcomes for life expectancy under each of these models is summarised below:

1.1 INDIGENOUS LIFE EXPECTANCY AT BIRTH, AUSTRALIA, Indirect Methods—2001–2006

	Males	*Females*
Method	years	years
Bhat without unexplained growth	62.5	71.0
Bhat with unexplained growth	61.7	69.3
Hill	63.2	71.7

The investigations undertaken by the ABS have identified two main concerns with the use of indirect methods. First, for both the Bhat and Hill methods the resulting estimates of coverage of Indigenous deaths for 2001-2006 are markedly lower (20-25 percentage points) than the coverage rates for the 1996-2001 period, implying that coverage of Indigenous deaths in death registration data has worsened considerably over the last five years. Such a result would seem implausible when compared to the observed data. Second, analyses undertaken by ABS and others (Barnes et al., 2008) have highlighted that the life expectancy estimates are very sensitive to the quality of the population estimates at the respective end points. Errors in the age distribution and level of either population estimate can result in very different life expectancy outcomes.

Based on the analysis of the 2006 data, the ABS is of the view that the indirect demographic methods are not suitable to the Australian situation and no longer recommends their use for the purpose of compiling Indigenous life expectancy estimates.

The direct demographic method is the method used for deriving life expectancy for the Australian population without any adjustment to deaths data. It takes the population at a point in time and the registered deaths around that period (e.g. the average of three years to reduce the effect of year-to-year variation) to compile life tables and life expectancy estimates. The method assumes good quality population estimates and assumes complete coverage of deaths.

METHODS ASSESSED *continued*

The direct method can also be applied with a prior adjustment to the deaths or population data based on assumptions regarding coverage. Previously the ABS only had the indirect methods for deriving coverage estimates in respect of deaths. However, in 2006 a more direct measure of coverage was possible using results from the Census Data Enhancement (CDE) Indigenous Mortality Quality Study. This study linked death records for an 11 month period to the 2006 Census records, which enabled comparison of the reporting of Indigenous status in the two records. More detail on the CDE Indigenous Mortality Quality Study is provided in Chapters 4 and 5 of the Discussion Paper. In summary, the study indicated that the coverage of Indigenous deaths in death registration data was higher than previously estimated (based on the indirect methods).

The outcomes for Indigenous life expectancy for 2005-2007 using direct methods are presented below. The first series (Unadjusted) is based on no adjustment to deaths data, i.e., it is assumed that death registration data are complete and is provided primarily for completeness of analysis. The second series (CDE adjusted) is derived by adjusting the death registration data by the undercoverage observed in the CDE Indigenous Mortality Quality Study.

1.2 INDIGENOUS LIFE EXPECTANCY AT BIRTH, AUSTRALIA, Direct Methods—2005–2007

	Males	*Females*
Method	years	years
Unadjusted	68.4	73.8
CDE adjusted	66.9	72.6

While the results using the CDE Indigenous Mortality Quality Study do result in some outcomes that are difficult to reconcile (e.g. the results for both WA and NT indicate that death registrations represent an overcoverage of Indigenous deaths relative to Indigenous status in the Census), they do represent the only direct measure of undercoverage of Indigenous deaths available.

ABS PREFERRED APPROACH

The ABS is of the view that a direct method using the CDE Indigenous Mortality Quality Study presents the best option for deriving measures of Indigenous life expectancy for 2006. The approach based on the CDE Indigenous Mortality Quality Study does have limitations. However, it is data based and does not require assumptions. Also, confidence intervals around any error in the estimates can be established. It also produces results that are considered to be more plausible, particularly in regard to the coverage of death registrations.

As indicated above, the indirect methods require extensive assumptions and produce significantly implausible results in terms of outcomes in relation to the apparent undercoverage measures over time. Furthermore, the analysis undertaken has highlighted the sensitivity of the estimates to the accuracy of the population estimates.

The preliminary results for 2006 by state/territory (for those for which estimates can be reasonably compiled) using the preferred approach are presented in the table below.

ABS PREFERRED APPROACH *continued*

1.3 INDIGENOUS LIFE EXPECTANCY AT BIRTH, CDE Indigenous Mortality Quality Study—2005–2007

State/territory	*Males* years	*Females* years
NSW	69.6	74.8
Qld	68.1	73.5
WA	64.9	70.2
NT	61.5	69.2
Aust.(a)	66.9	72.6

(a) Includes all states/territories.

COMPARISON TO NON-INDIGENOUS LIFE EXPECTANCIES

Table 1.4 presents the difference between Indigenous life expectancy by state/territory (for which data can be compiled) and the Australia level non-Indigenous life expectancy using the CDE Indigenous Mortality Quality Study to adjust Indigenous death registration data.

1.4 INDICATIVE DIFFERENCE IN LIFE EXPECTANCY BETWEEN INDIGENOUS AND NON-INDIGENOUS AUSTRALIANS—2005–2007

State/territory	*Indigenous life expectancy*(a) years	*Indicative difference*(b) years
MALES		
NSW	69.6	9.1
Qld	68.1	10.6
WA	64.9	13.8
NT	61.5	17.2
Aust.(c)	66.9	11.8
FEMALES		
NSW	74.8	7.8
Qld	73.5	9.1
WA	70.2	12.4
NT	69.2	13.4
Aust.(c)	72.6	10.0

(a) Using CDE adjusted approach.
(b) Difference between Australia level non-Indigenous life expectancies (78.7 years for males and 82.6 years for females) and state/territory level Indigenous life expectancies.
(c) Includes all states/territories.

The results indicate a difference at the Australia level of 11.8 years for males and 10.0 years for females. The estimates vary considerably at the state/territory level with NT (17.2 years for males; 13.4 years for females) being the highest, while NSW (9.1 years for males; 7.8 years for females) was the lowest of the states for which estimates could realistically be compiled. At the same time the standard errors and other limitations (see Chapter 5) associated with these estimates need to be clearly kept in mind.

COMPARISON WITH PREVIOUS PERIODS

The above Indigenous life expectancy estimates are markedly higher than the experimental estimates published for 1996-2001, which were based on an indirect method (Bhat with unexplained growth). In terms of trying to assess changes in life expectancy over time, it needs to be recognised that the above concerns identified in relation to indirect methods are equally applicable to the ABS' previously published Indigenous life expectancy estimates for the period 1996-2001. While the ABS took considerable care to explain the underlying assumptions, and that the estimates were of an experimental nature, it would seem clear now that the derived coverage rates and resulting life expectancy estimates for some states/territories are implausible. The ABS would strongly advise against any comparison of the published Indigenous life expectancies based on 1996-2001 with the estimates presented in this Discussion Paper, and in no way should those differences be interpreted as measuring changes in life expectancy over time.

While the CDE Indigenous Mortality Quality Study does not provide a basis for deriving life tables and life expectancy estimates for previous periods, a range of possible outcomes for previous periods using different assumptions regarding undercoverage of Indigenous deaths in 2000-2002 are presented in Chapter 5 of this Discussion Paper. The results would suggest that the use of indirect methods for 1996-2001 may have resulted in an understatement of Indigenous life expectancy at birth for some states/territories and at the Australian level. For example, if death coverage was 20 percentage points less for 2000-2002 relative to the CDE estimates for 2005-2007, then the life expectancy estimate using a direct adjustment method would be 1.8 years higher for males and 2.4 years higher for females than the previously published ABS estimates (59.4 years for males and 64.8 years for females). Unfortunately, it is not possible to quantify the change in death coverage over the time frame.

FUTURE DIRECTIONS

The analysis undertaken for 2006 has highlighted the complexities in compiling Indigenous life tables and life expectancy estimates. It is clear that the estimates are subject to a range of potential errors in terms of data inputs, for example, the population estimates are subject to the sampling error associated with the Post Enumeration Survey, and the estimates of undercoverage in death registration data are subject to under or over estimation. In that context it needs to be recognised that life expectancy estimates are just that, estimates based on the available information.

The analysis for 2006 has highlighted the limitations of indirect demographic methods in the compilation of Indigenous life tables and life expectancy estimates. Furthermore, it has emphasised the importance of having direct measures of the extent of undercoverage of death registrations data to provide a basis for adjustment in the compilation of these estimates. The ABS would see such measures as being integral to the compilation of future life tables and life expectancy estimates. The ABS would view a repeat of the CDE Indigenous Mortality Quality Study as critical to the compilation of Indigenous life tables and life expectancy estimates following the 2011 Census of Population and Housing.

Needless to say the difficulties associated with the compilation of life tables and life expectancy estimates are exacerbated when trying to monitor changes over time.

OUTLINE OF SUBSEQUENT CHAPTERS

The remaining chapters of the Discussion Paper cover the following aspects.

Chapter 2 describes the requirements for the compilation of accurate life tables and details the limitations of the population and death estimates for Indigenous Australians, and the need to adopt alternative methods to adjust Indigenous death registrations to account for undercoverage.

Chapter 3 presents discussion of the indirect methods considered in the compilation of life tables and life expectancy estimates. In particular, it discusses the derived coverage rates arising from the methods and the suitability of their use in the Australian context.

Chapter 4 describes a direct demographic method using information from an ABS data linkage project as the basis for adjusting for undercoverage in Indigenous death registrations.

Finally *Chapter 5* discusses the outcomes in terms of life expectancy estimates that result from the use of the different methods and presents the ABS preferred method.

ISSUES FOR CONSIDERATION

ABS would welcome comments on any aspects of this Discussion Paper but in particular would appreciate comments as to:

- whether the proposed direct method is supported given the available options,
- any suggestions to help improve the suggested method,
- any other evidence available as to the extent of undercoverage of Indigenous deaths in death registration data,
- any other aspects of the analysis presented.

Comments should be forwarded by 15 December 2008 to:

Director,
Demography Section
Australian Bureau of Statistics, Locked Bag 10
BELCONNEN ACT 2616
Phone: (02) 6252 6411

or

E-mail: demography@abs.gov.au

In addition, the ABS will be contacting key stakeholders to discuss issues identified in this paper.

CHAPTER 2 ISSUES WITH INDIGENOUS POPULATION AND DEATHS DATA

INTRODUCTION

The standard approach to the compilation of life tables and resulting life expectancy estimates requires complete and accurate data on deaths that occur in a period and an estimate of the population exposed to those deaths at the mid-point of the period. These data are required by age and sex. In the case of Indigenous mortality estimation, this situation is far from being perfect. In particular, information in respect of death registrations for Indigenous Australians has limitations. At the same time there are quality issues associated with Indigenous population estimates. These in combination present particular methodological challenges to compiling high quality life tables.

The remainder of the chapter discusses the data limitations of the ABS Indigenous population estimates and registered deaths in more detail.

POPULATION ESTIMATES OF INDIGENOUS AUSTRALIANS

The Census of Population and Housing is the principal source of information about Australia's population. It has been held on a five-yearly basis since 1961. The most recent Census was conducted in August 2006.

The Census provides the benchmark from which Australia's estimated resident population (ERP) is calculated. The Census count of the population is adjusted for:

- temporary visitors from overseas;
- Australian residents temporarily overseas (RTO) on Census night;
- estimates of the number of people missed in the Census; and
- estimates of those counted more than once in the Census.

For years between the five-yearly Censuses, the Census-based ERP is incremented by adding births and net overseas migration and subtracting deaths.

However, estimating the size and composition of the Indigenous population is more complicated. In the intercensal years the above standard approach to Indigenous population estimation cannot be used due to the lack of sufficiently reliable data on births, deaths and migration.

For the five-yearly Census there are a sufficient number of issues that make compilation of the Indigenous ERP problematic. These include:

- undercount of Indigenous population;
- non-response to Indigenous status question on the Census form; and
- unexplained growth in Indigenous Census counts relative to the previous Census.

Undercount of Indigenous population

While every effort is made to ensure full coverage of people and dwellings in the Australian Censuses, some people are still missed (undercount) and others are counted more than once (overcount). In Australia, more people are missed from the Census than are counted more than once. The net effect of overcount and undercount is called net undercount. The ABS conducts a Post Enumeration Survey (PES) about one month after each Census to measure the extent of net undercount in the Census. The net undercount estimates provide direct information on the quality of population counts in the Census, and enable the necessary adjustment or correction to be made to the raw Census counts.

Undercount of Indigenous population continued

In addition, for some people, the Indigenous status reported in the PES is different to the Indigenous status recorded in the Census. Accordingly, estimates from the PES include an adjustment for misclassification error.

The net undercount rate in the 2006 Census was estimated at 11.5% for the Indigenous population. The undercount for the total Australian population was 2.7%; however, the two estimates can not be directly compared as the Indigenous undercount includes persons who did not have an Indigenous status reported on the Census form or who had a mis-stated response - both of these groups of persons would have been counted in the total Australian population. Estimates in the 2001 Census were 6.1% for the Indigenous population and 1.8% for the total Australian population.

These undercount estimates should be compared with caution for the following reasons:

- the 2001 and earlier PES excluded remote areas and discrete Indigenous communities from their coverage, whereas the 2006 PES was extended to remote areas, and discrete Indigenous communities;
- a new and improved method of estimation was used in the 2006 PES; and
- high sampling errors are associated with the undercount estimates.

For more details on the PES and Indigenous undercount, see

- *Information Paper*: *Measuring Net Undercount in the 2006 Population Census, Australia, 2006* (cat. no. 2940.0.55.001),
- *Census of Population and Housing- Undercount, Australia, 2006* (cat. no. 2940.0),
- *Census of Population and Housing- Details of Undercount, Australia, August 2006* (cat. no. 2940.0),
- *Australian Demographic Statistics, March Quarter 2007* (cat. no. 3101.0),
- *Experimental Estimates of Aboriginal and Torres Strait Islander Australians, Jun 2006* (cat. no. 3238.0.55.001),
- *Research Paper: An Estimating Equation Approach to Census Coverage Adjustment* (cat. no. 1351.0.55.019), and
- *Population Distribution, Aboriginal and Torres Strait Islander Australians, Australia, 2006 (*cat. no. 4705.0).

Non-response to Indigenous status question on the Census form

Indigenous status is not recorded for all people counted in the Census. While some of the people with unknown Indigenous status will be of Indigenous origin and some will be non-Indigenous, the exact proportions cannot be determined from the Census data. There are two situations which result in Indigenous status being unknown:

- incomplete Census forms, with no answer to the Indigenous status question, are returned to the ABS (item non-response); and
- the ABS cannot obtain Census forms from people or dwellings believed to be occupied on Census night and as a consequence imputes basic demographic information (but not Indigenous status) for these records.

While the non-response rate to the Indigenous status question remained relatively constant at around 1.7% in the 1996 and 2006 Censuses and 2.0% in the 2001 Census, the proportion of imputed records increased from 1.3% of the total Census count in 1996 to 4.1% in 2006 [see *Population Distribution, Aboriginal and Torres Strait Islander Australians, Australia, 2006* (cat. no. 4705.0)].

Non-response to Indigenous status question on the Census form continued

The number of records with unknown Indigenous status in the 2006 Census was 1,133,446 (5.7% of the total Census count) compared with 767,757 (4.1%) in 2001. Of these, about 29% were a result of incomplete Census forms with Indigenous status question unanswered. The remaining 71% were a result of imputation by the ABS for people who were identified as residents in dwellings (both private and non-private) at the time of the Census but for whom no Census form was received. While some of the records with unknown Indigenous status will be for people of Indigenous origin and the others for non-Indigenous origin, no imputation was made for Indigenous status in the Census file. However, for compiling Indigenous ERP they are allocated as either Indigenous or non-Indigenous according to the distribution of stated responses within specific age group, sex, Census form type and geographic area. For more details on missing Indigenous status and how Indigenous ERP are derived, see *Experimental Estimates of Aboriginal and Torres Strait Islander Australians, Jun 2006* (cat. no. 3238.0.55.001) and *Population Distribution, Aboriginal and Torres Strait Islander Australians, Australia, 2006* (cat. no. 4705.0).

Unexplained growth in Indigenous Census counts

The way the Indigenous status of a person is recorded in the Census can change over time and in different situations. The recorded status of an individual may move between any of the categories of Indigenous status, including between Indigenous and non-Indigenous.

Over the past 35 years, there has been a clear upward trend in Indigenous Census counts, beginning with the 1971 Census and continuing to the 2006 Census. During this time, large increases in Indigenous Census counts have occurred on several occasions. The excess of births over deaths accounted for a proportion, but not all of these increases, while overseas migration has had an insignificant impact on the size of the Indigenous population. Between the 1991 and 1996 Censuses, the Census counts of Indigenous people increased by 88,000 (33%). The components of the Indigenous Census count increase between 1991 and 1996 were estimated to be 14% due to births and deaths, and a further 19% due to other factors, including changes in Census procedures and a difference in the identification of people in the Census as being of Indigenous origin. Comparable figures for the 1996-2001 increase were: 16% (57,000) total increase, 12% due to births and deaths, and a further 4% due to other factors. These large increases in Census counts are also reflected in the respective Census-based Indigenous ERP.

Between the 2001 and 2006 Censuses, the Census counts of Indigenous people increased by 45,000 (11%). This increase is considerably lower than that experienced during the periods 1991-1996 and 1996-2001. Registration data show that natural increase (i.e., births minus deaths) accounted for an increase of about 49,000 Indigenous people during the 2001-2006 intercensal period. This suggests that there was no unexplained growth in Indigenous population during 2001-2006 as natural increase fully explained all of the increase in the Census counts of Indigenous people during this period. Changes in the way some Indigenous people answer the Indigenous status question on Census forms may be the reason for the lower increase between the 2001 and 2006 Censuses. Many people who did not identify themselves or were not identified as Indigenous during the earlier Censuses, have possibly done so by the 2001 Census. Another reason

Unexplained growth in Indigenous Census counts continued

for this could be the inconsistent identification of Indigenous status in births and deaths registrations compared with Census responses.

INDIGENOUS ERP SIZE AND GROWTH, 1996-2001 AND 2001-2006

The ABS derives Indigenous ERP by making various adjustments to Indigenous Census counts. The adjustment process takes account of these factors: non-response to the Indigenous status question in the Census; unknown Indigenous status on Census records imputed by ABS when a form could not be obtained from persons identified in the field; net undercount of Indigenous persons; and residents temporarily overseas on Census night. The complexities associated with the compilation of ERP of Indigenous Australians are best demonstrated by analysis of the average annual growth rates by sex for the periods 1996-2001 and 2001-2006 as presented in Table 2.1 below. Some important results to note from this table are:

- The Australia level annual population growth rates for males and females for the 2001-2006 period are about one percentage point lower than for the 1996-2001 period. This is a significant change for a time span of just five years. This suggests there was an increasing propensity to identify as Indigenous in the 1996-2001 period.
- All states/territories experienced lower population growth rates in 2001-2006 than in 1996-2001 with the only exception being females in the NT with a much higher growth rate (2.7%) in 2001-2006 than in 1996-2001 when growth was 1.7%.
- There are significant variations in growth rates at the state/territory level with Victoria having the highest growth rate (3.7%) and Tasmania the lowest (1.1%) during 2001-2006.
- The 2001-2006 population growth rates have halved in SA, WA and Tasmania compared to those during 1996-2001.
- The population growth rate in NSW has declined to 2.5% in 2001-2006 from about 4% in 1996-2001. Growth rate for females in Qld has declined to 2.5% in 2001-2006 from 3.8% in 1996-2006. The ACT population growth rate has dropped significantly in the same period.

2.1 INDIGENOUS ERP AND ANNUAL EXPONENTIAL GROWTH RATE, at 30 June

	MALES				FEMALES			
	2001	*2006*	*Annual growth 2001–2006*	*Annual growth 1996–2001*	*2001*	*2006*	*Annual growth 2001–2006*	*Annual growth 1996–2001*
State/territory	no.	no.	%	%	no.	no.	%	%
NSW	67 432	76 229	2.5	4.4	67 456	76 456	2.5	3.8
Vic.	13 799	16 581	3.7	4.3	14 047	16 936	3.7	4.1
Qld	61 526	71 950	3.1	3.6	64 384	72 935	2.5	3.8
SA	12 604	13 790	1.8	3.1	12 940	14 265	1.9	2.8
WA	32 881	35 775	1.7	3.4	33 050	35 191	1.3	3.0
Tas.	8 718	9 204	1.1	2.7	8 666	9 211	1.2	2.4
NT	28 492	31 514	2.0	2.0	28 383	32 491	2.7	1.7
ACT	1 963	2 147	1.8	5.1	1 946	2 135	1.9	4.7
Aust.(a)	227 526	257 309	2.5	3.6	230 994	259 734	2.3	3.3

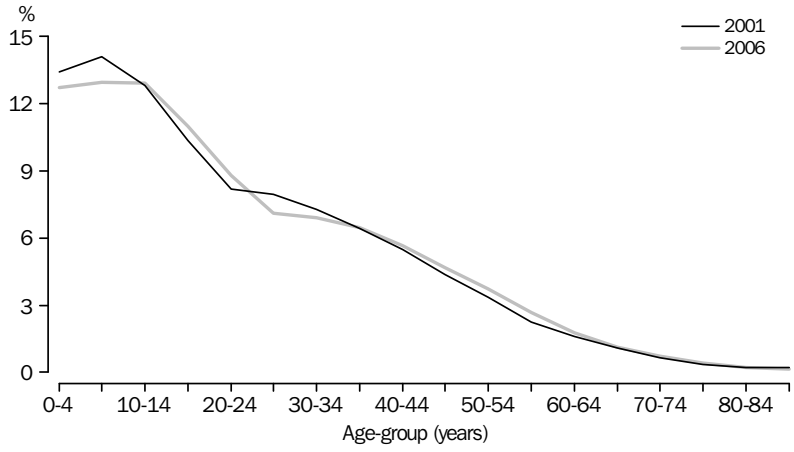
(a) Includes Other Territories.

INDIGENOUS ERP SIZE AND GROWTH, 1996-2001 AND 2001-2006 *continued*

The large variations over the two periods could reflect a number of factors including changes in the 2006 Post Enumeration Survey coverage and estimation methodology or changes in the way some Indigenous people answer the Indigenous status question on Census forms. Nevertheless, it is clear that Indigenous ERP are volatile and the estimates need to be used with caution.

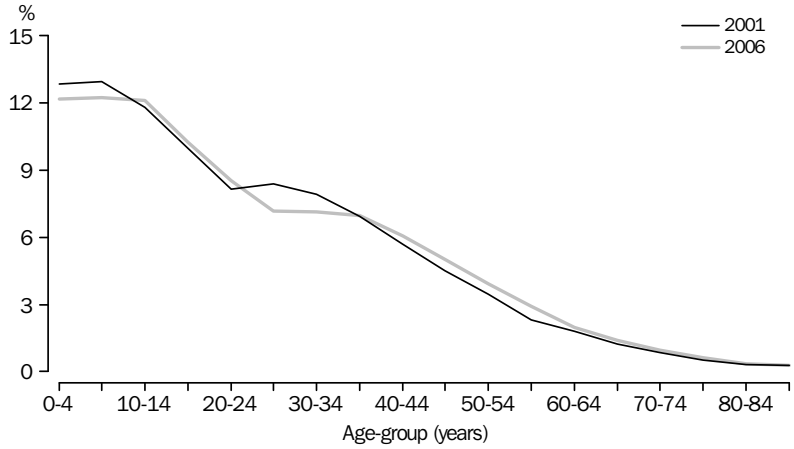
For the purposes of compiling life tables it is necessary to have accurate measures of the age-sex structure of the population. It is therefore important to make some assessment of the quality of the age-sex structure of Indigenous ERP at the Australia and state/territory levels. The age distributions of the 30 June 2001 and 2006 Indigenous ERP have remained more or less the same (Figures 2.2 and 2.3).

2.2 AGE DISTRIBUTION, INDIGENOUS MALES, AUSTRALIA



INDIGENOUS ERP SIZE AND GROWTH, 1996-2001 AND 2001-2006 *continued*

2.3 AGE DISTRIBUTION, INDIGENOUS FEMALES, AUSTRALIA



In terms of the variation in the age distribution between successive Census years, the index of dissimilarity (Shryock et al., 1976:131) showed quite low values in comparison to its theoretical range of 0 to 100. The smaller the value of index of dissimilarity, the more similar are the two age distributions. Most values of index of dissimilarity fall around or below 5 except for ACT, where the index value could be unreliable due to small numbers of the Indigenous ERP (Table 2.4).

2.4 INDEX OF DISSIMILARITY BETWEEN INDIGENOUS ERP AGE DISTRIBUTIONS—June 2001 and June 2006

State/territory	*Males*	*Females*
NSW	4.0	4.5
Vic.	4.2	3.6
Qld	3.3	3.2
SA	3.5	4.1
WA	3.5	3.6
Tas.	5.0	4.7
NT	2.9	2.4
ACT	9.4	5.6
Aust.(a)	3.4	3.4

(a) Includes Other Territories.

INDIGENOUS DEATHS

The other main component required in the compilation of life tables for Indigenous Australians is information by age and sex of all Indigenous deaths.

Quality of Indigenous status of death registrations

Birth and death registrations are collected in the form of administrative by-product data from the Registrars of Births, Deaths and Marriages in each state/territory. Census, and birth and death registration forms all use the same standard Indigenous origin question, which is consistently worded on the registration form in all states/territories. While Australia maintains a very high quality registration system of births and deaths, the level of Indigenous identification can vary across collections and over time. Response to Indigenous origin question can be influenced by a number of factors, including the perception of why such information is required, who completes the question on behalf of others, and feeling about to identifying as Indigenous.

Quality of Indigenous status of death registrations continued

While Indigenous identification in birth registration data is considered to be reasonably accurate for many purposes, less than complete Indigenous identification in death records remains a major limitation in estimating the Indigenous population between Census years and in developing Indigenous life tables.

Table 2.5 shows Indigenous deaths registered from 1991 to 2007. Not all Indigenous deaths are registered as Indigenous. This may arise from the failure to report the person's Indigenous status on the death registration form or may result from the incorrect identification of a person's Indigenous status (i.e. recording non-Indigenous instead of Indigenous) on the death certificate. Such mis-identification may occur because some Indigenous people may have non-Indigenous ancestries which can sometimes create uncertainty for those completing the death registration form as to how a deceased person should be identified.

2.5 REGISTERED INDIGENOUS DEATHS—1991 to 2007

	NSW	*Vic.*	*Qld*	*SA*	*WA*	*Tas.*	*NT*	*ACT*	*Aust.*(b)
Year(a)	no.	no.	no.	no.	no.	no.	no.	no.	no.
1991	206	50	np	135	401	np	412	—	1 208
1992	165	53	np	107	346	np	397	—	1 074
1993	194	50	np	111	386	np	376	9	1 134
1994	207	50	np	123	377	np	380	10	1 153
1995	224	50	np	121	384	np	387	9	1 182
1996	177	49	258	118	370	np	328	np	1 306
1997	88	93	531	132	351	5	458	4	1 662
1998	462	123	593	127	378	13	415	3	2 114
1999	435	130	529	116	350	11	399	6	1 976
2000	473	108	535	144	407	np	450	np	2 127
2001	481	93	565	125	345	np	429	np	2 072
2002	516	64	590	107	371	20	462	4	2 136
2003	485	82	569	137	338	23	435	9	2 079
2004	490	54	579	131	400	20	449	10	2 136
2005	507	71	519	142	406	28	454	11	2 141
2006	530	111	584	124	443	20	452	14	2 279
2007	601	95	594	138	502	24	461	6	2 421

— nil or rounded to zero (including null cells)
np not available for publication but included in totals where applicable, unless otherwise indicated
(a) Deaths are by registration year.
(b) Includes Other Territories.

In regard to the quality of the Indigenous deaths data, some observations may be made by simply looking at the annual series of counts available for each state and territory. The series looks fairly consistent for SA, WA and the NT for the entire period since 1991 (Table 2.5). However, in the other jurisdictions, especially NSW and Qld, the data for the first half of the 1990s are clearly incomplete. They show that relatively few, if any, Indigenous deaths were registered as such. Since about 1998, death counts in these states have begun to display greater consistency. For Victoria, the number of registered Indigenous deaths was higher for the 1996-2001 period than for the 2001-2006 period. At the national level, recorded Indigenous deaths have increased by over 6% in 2006 and 2007; the highest increase since 2000.

Year of registration versus year of occurrence of death

Deaths data can be classified by year of registration or by year of occurrence of death. All mortality statistics, including life expectancy estimates, published by the ABS are based on year of registration of death, although ideally they should be based on the occurrence of death. While the majority of deaths are registered in the year they occur, some of those registered in a given year in fact occurred in previous years, and some which occurred in a particular year are not registered until subsequent years. Delays in registrations can occur due to a variety of reasons and are more common among Indigenous deaths than non-Indigenous deaths. For example, Australia level data show that of all non-Indigenous deaths which occurred in 2005, about 96% were registered in 2005 (Table 2.6). The comparable figure was about 87% for Indigenous deaths.

2.6 PROPORTION OF DEATHS REGISTERED IN THE YEAR OF OCCURRENCE—1991–2006

Year of occurrence	*Indigenous*(a) %	*Non-Indigenous*(a) %
1991	85.6	94.2
1992	85.4	94.9
1993	86.2	95.4
1994	86.3	95.4
1995	87.4	95.2
1996	81.1	95.7
1997	83.6	96.2
1998	87.8	96.0
1999	86.3	95.9
2000	86.7	95.5
2001	86.7	95.3
2002	87.6	95.8
2003	87.7	96.0
2004	89.1	96.1
2005	86.7	95.6
2006	87.8	95.2

(a) Based on deaths registered up to December 2007.

While late registrations are more common among Indigenous people, there is little difference between the number of deaths registered in a given year and the number of deaths that occurred in the same year for Indigenous Australians (see Table 2.7). This is because for each year, the number of deaths that are not registered in the year they occur are compensated by deaths that occurred in previous years but were registered late [see also *The Health and Welfare of Australia's Aboriginal and Torres Strait Islander Peoples 2008* (cat. no. 4704.0)]. This indicates that year of registration as well as year of occurrence of deaths data will produce similar Indigenous death rates and life expectancy estimates.

Year of registration versus year of occurrence of death continued

2.7 INDIGENOUS DEATHS BY REGISTRATION AND OCCURRENCE—July 2001–June 2006

	MALES		FEMALES	
	Registered	*Occurred*(a)	*Registered*	*Occurred*(a)
State/territory	no.	no.	no.	no.
NSW	1 453	1 448	1 074	1 064
Vic.	218	217	149	147
Qld	1 634	1 591	1 195	1 188
SA	368	374	266	264
WA	1 086	1 080	845	846
Tas.	57	57	55	55
NT	1 303	1 307	934	940
ACT	26	27	19	20
Aust.(b)	6 150	6 106	4 542	4 529

(a) Based on deaths registered up to December 2007.
(b) Includes Other Territories.

CONCLUSION

As explained above the key inputs for compiling life tables i.e., population estimates at a point in time and the number of deaths over the relevant period of time are subject to a range of caveats.

In the main the Indigenous ERP compiled from the five yearly Census provide a sound benchmark. However, improvements in methodologies for the Post Enumeration Survey and changing propensities to identify as Indigenous make interpretation of changes in the Indigenous population estimates and reconciling the periodic estimates problematic.

In relation to Indigenous deaths statistics the non-reporting and/or incorrect reporting of a person's Indigenous status on the death registration form means that the death rate implied by the registered Indigenous deaths is an underestimate of the true death rate prevalent among Indigenous Australians. This understatement precludes the compilation of annual Indigenous ERPs without adjusting for the undercoverage as it would result in an overstatement of the population, due to the number of deaths being understated. Similarly, application of these death rates in a standard life table would result in an overestimate of Indigenous life expectancy.

For the purposes of compiling life tables some method of adjustment is therefore required to inflate the registered number of Indigenous deaths for potential undercoverage in registration data.

CHAPTER 3 USE OF INDIRECT METHODS TO ACCOUNT FOR UNDERCOVERAGE OF DEATHS

INTRODUCTION

Over the years, demographers have developed a number of indirect demographic methods which can be used to combine less than comprehensive death registrations, and population estimates at points in time, so as to estimate the extent of undercoverage of deaths in the death registration data. These undercoverage estimates can then be used to adjust the death registration data to provide improved measures for the purposes of compiling life tables and life expectancy estimates.

This chapter outlines the indirect methods considered by the ABS for compiling life tables, including the underlying assumptions and the limitations of each of the methods. Appendix provides a more detailed summary of the methodologies.

OUTLINE OF INDIRECT DEMOGRAPHIC METHODS

The General Growth Balance (GGB) Equation developed by Brass (1975) was the first approach which provided a method of 'balancing' population growth and death registrations during an intercensal period using the stable population theory and deriving an adjustment factor for the under-registration of deaths. This method has been used widely to estimate coverage of registered deaths in developing countries with limited or defective vital registration systems.

The Brass method was modified by Professor Hill in 1987 (Hill, 1987) and by Professor Bhat in 2002 (Bhat, 2002). The ABS used the Bhat method for the estimation of consistency factors and subsequent construction of Indigenous life tables for the 1996-2001 intercensal period. This was a change from the previously used Preston and Hill (1980) method, which the ABS used for the 1991-1996 intercensal estimation of Indigenous mortality.

The above methods require three basic inputs for their application:

- age distribution of the population in question at the first Census;
- age distribution of the population at the second Census; and
- age distribution of registered deaths during the intercensal period.

These distributions are generally required by sex and conventional five years age-groups (0-4, 5-9, ..., 85 + years). The Bhat method requires additional data on the age distribution of net migration or in their absence, an independent estimate of natural growth rate.

While the methods are all dependent on the same inputs, the outcomes can be markedly different. The Hill (1987) method was used by Vos and his colleagues at the University of Qld for the estimation of undercoverage of Australian Indigenous deaths for the 1996-2001 intercensal period (Vos et al., 2007). Limited Australian level estimates of undercoverage of Indigenous deaths based on the Hill method and Indigenous life expectancy at birth have also been published in a journal article (Hill et al., 2007). The estimates of Indigenous life expectancy derived by the ABS using the Bhat method were found to be significantly lower than those obtained by Vos et al. (2007) using the Hill method.

Difference between Bhat and Hill methods

The main difference between the Bhat and the Hill variants of the GGB method is that the Bhat equation allows migration to be taken into account as an independent component of population change between two time points, whereas the Hill equation does not. Both the estimating equations are very similar for a population with no migration in or out and thereby are expected to produce similar results.

All indirect demographic methods invariably involve assumptions, some of which may not be verifiable at all. The success of the methods depends on the acceptability of the assumptions involved, and how accurately they reflect the reality.

As used in this study, the Hill method is based on the following assumptions:

- completeness of death registration is constant across all age groups;
- the Census coverage of the population between the two Censuses is assumed to vary.

According to the Hill method, a change in coverage between two Censuses can be interpreted as a change in Indigenous identification.

The Bhat method is based on the same assumptions as the Hill method above except for:

- coverage of the population across the two Censuses is assumed to be constant; and
- the population is open to migration and the age/sex distribution of migration is known or can be assumed with some confidence.

Sources of error in Indirect methods

The underlying assumptions of the indirect methods are obviously critical to the methods. In particular, both the Bhat and Hill methods are heavily dependent on the quality of the end point population estimates. Sensitivity analyses undertaken by ABS indicate that the outcomes produced by the methods are highly sensitive to changes in the population and the age structure of the population. In that respect any errors in the Indigenous population estimates, particularly in respect of age structures, will be reflected in the results under the indirect methods. Details of the sensitivity analyses undertaken by the ABS are not presented in this Discussion Paper but are available on request. Similar findings have also been noted by other researchers (Barnes et al., 2008).

ABS PAST PRACTICES

For the 1991-1996 Indigenous life tables, there was limited data and limited indirect methods available. In that context, the ABS used the Preston and Hill (1980) method. This method relies on the assumption that the population is closed to migration. However, the increase in the size of the Indigenous ERP observed in that intercensal period cannot be fully explained by demographic events (namely births and deaths occurring during the intercensal period). That is, a component of growth relates to an apparent increased propensity to identify as Indigenous. The Preston and Hill assumption of demographic consistency is therefore now considered invalid when applied to the Australian Indigenous population. The Preston and Hill method has not been used by ABS subsequently and has not been considered further in this discussion paper.

ABS PAST PRACTICES *continued*

The ABS used the Bhat (2002) method with unexplained growth for the 1996-2001 intercensal period. This method offered an improvement over other indirect methods available for estimating mortality from incomplete data. The main advantage of this method over other methods was that this technique explicitly allowed for an adjustment for migration to be taken into account. The "migration" component in the Bhat method was used by the ABS to allow for an estimate of population growth mainly resulting from the apparent increased propensity to identify as Indigenous i.e., unexplained growth. For further information, see the ABS *Demography Working Paper 2004/3 - Calculating Experimental Life Tables for Use in Population Estimates and Projections of Aboriginal and Torres Strait Islander Australians, 1991 to 2001* (cat. no. 3106.0.55.003).

ANALYSIS OF INDIRECT METHODS FOR 2001-2006

For the current intercensal period (2001-2006) consistency factors/coverage estimates have been compiled using the following methods:

- consistency factors based on Bhat method, 1996-2001 and 2001-2006;
- consistency factors based on Hill method, 1996-2001 and 2001-2006; and
- coverage estimates derived from the ABS Census Data Enhancement (CDE) Indigenous Mortality Quality Study, 2006-2007.

The methods of estimation, levels and possible limitations of the first two types of coverage estimates are discussed below. A detailed description of how the coverage estimates were derived from the ABS CDE Indigenous Mortality Quality Study is provided in Chapter 4.

Estimates based on Bhat method (without unexplained growth), 1996-2001 and 2001-2006

During the current estimation cycle, the Bhat method was explored to calculate consistency factors (i.e., coverage estimates) for Indigenous death registrations for the 1996-2001 and 2001-2006 intercensal periods. There was significant unexplained growth in the Indigenous population in 1996-2001 largely due to the apparent increasing propensity to identify as an Indigenous Australian, but considerably less such growth in 2001-2006 is apparent. For the purpose of illustration, zero unexplained growth was assumed for both the periods. This will enable a good comparison of the relative coverage estimates over the two periods. The data needed for each set of calculations comprise:

- population estimates at the beginning and end of each five year period (i.e., rather than actual Census counts, 30 June population estimates based on the respective Census counts have been used); and
- intercensal deaths (i.e., deaths over the relevant five year periods).

Both the Indigenous ERP and deaths data were disaggregated by five year age groups, sex and state and territory.

Table 3.1 provides estimated consistency factors using the Bhat method for NSW, Qld, WA, NT and Australia for the periods 1996-2001 and 2001-2006. The number of Indigenous deaths registered in Vic., SA, Tas. and the ACT are insufficient to produce any reliable coverage estimates and life tables. Based on this method, consistency factors or Indigenous death coverage rates for Australia were estimated to be 95% for Indigenous males and 92% for Indigenous females for the period 1996-2001 (Table 3.1) i.e., the method indicates there was almost complete coverage of Indigenous deaths in death registration data. In contrast the comparable estimates for 2001-2006 were 70% and 80%

Estimates based on Bhat method (without unexplained growth), 1996-2001 and 2001-2006 continued

for Indigenous males and females respectively. At the state/territory level for which estimates can be compiled, the Bhat coverage rates for 1996-2001 ranged from 80% for Indigenous females in NSW to 124% for Indigenous females in WA. The latter implies an overstatement of Indigenous deaths relative to the population estimates. This in part may be explained by the apparent increased propensity to identify as Indigenous during that period. For the period 2001-2006, the coverage rates were about 20-30 percentage points lower. These consistency factors suggest that registered Indigenous deaths and the two-end Census based experimental Indigenous population estimates were less consistent for 2001-2006 than for 1996-2001.

3.1 ESTIMATED CONSISTENCY FACTORS, Bhat method without unexplained growth—1996–2001 and 2001–2006

	MALES			FEMALES		
	1996–2001	*2001–2006*	*Difference*	*1996–2001*	*2001–2006*	*Difference*
State/territory (a)	%	%	%	%	%	%
NSW	93	82	–11	80	79	–1
Qld	89	65	–24	86	72	–14
WA	107	73	–34	124	82	–42
NT	92	64	–28	105	88	–17
Aust. (b)	95	70	–25	92	80	–12

(a) Numbers of Indigenous deaths registered in Vic., SA, Tas. and ACT are insufficient to produce reliable consistency factors.

(b) Includes all state/territories.

The results highlight some apparent inconsistencies between the coverage rates for the two time periods. For 2001-2006, NSW has the highest consistency factor for males (82%), followed by WA (73%) and Qld (65%). The NT, which is generally believed to have close to complete records of Indigenous deaths, has the lowest consistency factor for males (64%) for this period. While the results presented in Table 3.1 do not necessarily provide a basis for assessing the level of completeness in the deaths data, they do inform that the registered intercensal Indigenous male deaths and the two end Census-based population estimates do not accord well with each other. However, the male consistency factors for NT were much higher for the 1996-2001 period (92%) than for the 2001-2006 period (64%). These results are not very plausible suggesting that the assumptions underlying this application of the Bhat method without unexplained growth do not hold.

Estimates based on Bhat method (with unexplained growth) 1996-2001 and 2001-2006

As described in Chapter 2, the apparent Indigenous population growth in the period 1996-2001 (3.6% p.a. for males and 3.3% p.a. for females) was well above the bounds of demographic factors (i.e., births and deaths). In other words, there was a significant unexplained growth, which may have been due to an increasing propensity to identify as Indigenous or inaccuracies in either or both of the ERPs. For the purposes of compiling life tables for 1996-2001, the ABS made the assumption that growth above 2.0% p.a. was unexplained growth. The resulting consistency factors from using the Bhat method with unexplained growth are presented in Table 3.2 below. For the purposes of comparison to 2001-2006, the consistency factors derived from the Bhat method with unexplained growth are also presented (using the same assumption, i.e., growth over and above 2.0%

Estimates based on Bhat method (with unexplained growth) 1996-2001 and 2001-2006 continued

p.a. is unexplained). However, the impact of using unexplained growth is less marked as except for females in NT the Indigenous population growth in the period is largely within the bounds of demographic factors.

3.2 ESTIMATED CONSISTENCY FACTORS, Bhat method with unexplained growth—1996–2001 and 2001–2006

	MALES			FEMALES		
	1996–2001	*2001–2006*	*Difference*	*1996–2001*	*2001–2006*	*Difference*
State/territory (a)	%	%	%	%	%	%
NSW	55	78	23	45	65	20
Qld	65	57	–8	52	60	8
WA	81	(b) 73	–8	86	(b) 82	–4
NT	(b) 92	(b) 64	–28	(b) 105	69	–36
Aust. (c)	67	66	–1	60	70	10

(a) Numbers of Indigenous deaths registered in Vic., SA, Tas. and ACT are insufficient to produce reliable consistency factors.
(b) As the growth rate is less than 2%, consistency factor is the same as for Bhat without unexplained growth.
(c) Includes all state/territories.

Estimates based on Hill method, 1996-2001 and 2001-2006

The Bhat method without unexplained growth or migration component and Hill method produce similar consistency factors for both intercensal periods (see Tables 3.1 and 3.3). This is expected since without an unexplained growth or migration component, the Bhat and Hill estimating equations are similar. Such results had also been noted by other researchers (Vos et al., 2007; Barnes et al., 2008) for Indigenous Australians. In general, Hill consistency factors are slightly higher than the Bhat consistency factors. This is true for both Indigenous males and females and for both intercensal periods. Like the Bhat estimates, Hill estimates also show a poor consistency between registered Indigenous deaths and the two end Census-based population estimates for the period 2001-2006.

3.3 ESTIMATED CONSISTENCY FACTORS, Hill method—1996–2001 and 2001–2006

	MALES			FEMALES		
	1996–2001	*2001–2006*	*Difference*	*1996–2001*	*2001–2006*	*Difference*
State/territory (a)	%	%	%	%	%	%
NSW	92	88	–4	90	85	–5
Qld	98	69	–29	90	77	–13
WA	112	75	–37	118	82	–36
NT	93	71	–22	110	92	–18
Aust. (b)	99	74	–25	95	85	–10

(a) Numbers of Indigenous deaths registered in Vic., SA, Tas. and ACT are insufficient to produce reliable consistency factors.
(b) Includes all state/territories.

DISCUSSION

Both Bhat and Hill methods produced highly implausible results which showed that coverage of Indigenous deaths in the deaths registration data has declined by as much as 25 percentage points at the national level and over 30 percentage points in WA for the 2001-2006 period. It is also worth noting that the methods indicate that for 1996-2001 there was overcoverage of Indigenous deaths recorded in WA and for Indigenous females in NT.

Specifically, for the Bhat method (without unexplained growth) the outcomes indicate a decline of 25 percentage points in the coverage of Indigenous male deaths and 12 percentage points for Indigenous female deaths at the national level. In particular, they indicate an implausible and significant fall in the coverage of Indigenous deaths in WA and NT, both of which are generally accepted as jurisdictions that have almost complete records of Indigenous deaths.

Bhat method (with unexplained growth) produced coverage estimates which are implausibly low for NT for 2001-2006. The Hill method produces similar outcomes to the Bhat method although the size of the reduction in coverage is less pronounced. The results indicate that during 2001-2006, NT has the second lowest coverage of Indigenous male deaths (71%).

CONCLUSION

The implied significant decline in the coverage of deaths between 1996-2001 and 2001-2006 is not consistent with the available data on Indigenous deaths (see Chapter 2) which indicated a steady increase in the number of recorded Indigenous deaths over time. While that in itself is not evidence of improving coverage rates, it indicates that the magnitude of the reduction, if any, in the coverage of Indigenous deaths is likely to be small, which contradicts the results from the use of these indirect methods. In particular, the results for NT where coverage of Indigenous deaths is known from other independent studies to be of a high standard are implausible.

These results in combination with the sensitivity analysis undertaken in respect of the end populations indicate that these methods have significant limitations in the Australian context.

CHAPTER 4 USE OF DATA LINKAGE METHOD TO DERIVE COVERAGE ESTIMATES OF DEATHS

INTRODUCTION

Chapter 2 described the data inputs to derive Indigenous life tables and life expectancy estimates. It also highlighted the data quality issues associated with the reporting of Indigenous status in death registrations. Chapter 3 presented a range of indirect demographic methods for adjusting for undercoverage of Indigenous deaths in death registration data. This chapter considers the use of data linkage techniques to derive coverage measures for Indigenous deaths. Specifically, it describes the CDE Indigenous Mortality Quality Study, discusses the analyses undertaken and presents the results. To calculate estimates of life expectancy using direct methods, it is important to ensure that the classification of records as Indigenous occurs in a consistent manner in the numerator (deaths) and the denominator (population).

BACKGROUND

The Indigenous Mortality Quality Study was conducted as part of the ABS Census Data Enhancement (CDE) project. The CDE project consisted of a number of quality studies which brought together data from the 2006 Census of Population and Housing and other specified datasets.

For more information on the CDE project, see the following papers:

- *Research Paper: Methodology of Evaluating the Quality of Probabilistic Linking* (cat. no. 1351.0.55.018);
- *Research Paper: Exploring Methods for Creating a Longitudinal Census Dataset* (cat. no. 1352.0.55.076);
- *Discussion Paper: Enhancing the Population Census: Developing a Longitudinal View 2006* (cat. no. 2060.0); and
- *Information Paper: Census Data Enhancement Project: An Update, Australia* (cat. no. 2062.0).

The CDE Indigenous Mortality Quality Study involved linking Census records with death registration records to examine differences in reporting of Indigenous status across the two datasets. Specifically the study linked 2006 Census records with deaths registered from 9 August 2006 to 30 June 2007, for all states and territories except for Victoria where death registration records were only available through till mid-March 2007. After Census processing was completed, all names and addresses held by the ABS on Census records were destroyed. The linked file never contained name and address and it was destroyed after the analysis was completed.

Internationally, similar record linkage studies have been conducted in New Zealand where the 1981, 1986, 1991 and 1996 Censuses were each anonymously and probabilistically linked to three years of subsequent deaths data, allowing a comparison of ethnicity recording (Ajwani et al., 2003; Blakely et al., 2002a; Blakely et al., 2002b). Large nationally representative studies based on linked Census and deaths data were also conducted in the United Kingdom, France, Sweden and Netherlands. The results from these studies have been used in various ways including the provision of evidence for policy decisions and the setting of policy targets for special intervention programs.

CDE INDIGENOUS MORTALITY QUALITY STUDY

The aims of the CDE Indigenous Mortality Quality Study were to:

- assist in understanding the differences in recording of Indigenous status between death registration and Census data; and
- assess the undercoverage of Indigenous deaths in death registration records.

CDE INDIGENOUS MORTALITY QUALITY STUDY *continued*

In the absence of any unique identifier in the Census and deaths datasets, linking was performed using probabilistic methods. Three groups of variables, name (first name and surname), personal characteristics (date of birth, age, sex, place of birth, year of arrival and marital status), and geographic information (meshblock, statistical local area, street number, street name, suburb and postcode), were used to link deaths data to Census data. To ensure comparability, variables common to both datasets were coded and formatted consistently. The two datasets were linked in a way that was independent of reported Indigenous status so that any future analysis would not be affected by bias introduced in the linking process. For this reason, Indigenous status was not used as a linking variable.

SUMMARY RESULTS OF THE CDE STUDY

The number of Census and death records eligible for linking and percentage of death records linked are presented in Table 4.1. The linking process used 106,945 death records and 19,046,302 Census records. These Census counts are different from the Indigenous ERP, which includes adjustments for (i) net undercount in the Census, (ii) residents temporarily overseas on Census night, and (iii) backdating from Census night to the estimated resident population reference date of 30 June 2006 using data on births, deaths, and interstate and overseas migration.

Of the 106,945 death records, 98,898 (92.5%) records were linked to one of 19,046,302 eligible Census records. Of the total linked death records, about 1,200 records (1.2%) were estimated to be false links (i.e. record pairs do not belong to the same person). This estimate of false links was obtained by clerically reviewing a sample of linked record pairs and observing the percentage of presumed false links. However, given the small level of potential false links no attempt was made to adjust the results.

SUMMARY RESULTS OF THE CDE STUDY *continued*

4.1 CENSUS AND DEATH RECORDS, Australia

Description	*Records*
Number	
Census records eligible for linking(a)	19 046 302
Indigenous Census records	454 993
Records on death file(b)	106 945
Death records linked	98 898
Death records not linked	8 047
Indigenous records on death file(c)	1 800
Indigenous death records linked(c)	1 327
Estimated false links(d)	1 202
Percent	
All death records linked	92.5
Indigenous death records linked	73.7
False links	1.2
True links	98.8

(a) Excludes residents temporarily overseas on Census night, imputed records and Census net undercount adjustment.
(b) Deaths occurred between 9 Aug 2006 and 30 June 2007. For Victoria deaths which occurred until 15 March 2007 were included.
(c) According to Indigenous status reported on death registration form.
(d) With a 95% upper confidence level of 1,617.

The number and percentage of death records linked to Census records by selected characteristics of deceased persons are presented in Table 4.2. A slightly higher linkage was achieved for females (93.8%) compared with males (91.2%). The linkage rate varied considerably by age being lowest for 25-44 year olds (76.5%). This may be due to the high Census undercount rate in this age group. The linkage rate was highest for 75 years and older decedents (94.5%). Age and sex interacted as predictors of linkage such that 25-64 year old male decedents were less likely to be linked than 25-64 year female decedents, whereas there was little difference by sex for other age groups.

SUMMARY RESULTS OF THE CDE STUDY *continued*

4.2 DEATH RECORDS LINKED TO CENSUS RECORDS BY SELECTED CHARACTERISTICS, Australia

Reported characteristics in death registration	*Total death records* no.	*Linked records* no.	*Linked records* %
Sex			
Males	54 904	50 075	91.2
Females	52 041	48 823	93.8
Age (years)			
0–14	539	450	83.5
15–24	1 053	835	79.3
25–44	4 153	3 176	76.5
45–64	15 626	13 810	88.4
65–74	16 578	15 402	92.9
75 and over	68 996	65 225	94.5
Indigenous status			
Indigenous	1 800	1 327	73.7
Non-Indigenous	103 987	96 531	92.8
Not stated	1 158	1 040	89.8
State/territory of usual residence			
NSW	40 116	37 064	92.4
Vic.	19 351	17 940	92.7
Qld	20 915	19 346	92.5
SA	10 409	9 768	93.8
WA	10 467	9 628	92.0
Tas.	3 534	3 314	93.8
NT	797	589	73.9
ACT	1 350	1 245	92.2
Aust.(a)	106 945	98 898	92.5
Marital status			
Never married	10 536	8 898	84.5
Married	44 331	41 845	94.4
Widow	39 819	37 552	94.3
Divorced	8 792	7 736	88.0
Not applicable (<15 years)	2 899	2 390	82.4
Time elapsed between Census and death			
Within 6 months of Census	63 747	58 767	92.2
Within 7–11 months of Census	43 198	40 131	92.9

(a) Includes all states/territories.

The linkage success varied by Indigenous status recorded on the death registration form. People of non-Indigenous origin had a considerably increased linkage success (92.8%) compared with people of Indigenous origin (73.7%). The linkage success also varied by state of usual residence as reported on the death registration form. The rate was highest for Tasmania and SA (93.8%), and lowest for NT (73.9%). All other states and the ACT have a linkage rate of about 92%. The low linkage rate for NT reflects the relatively high proportion of Indigenous Australians in the Territory's population. The linkage rate was similar for married and widowed persons (about 94%). The linkage rate was slightly lower for deaths which occurred within six months of the Census (92.2%) than those which occurred within 7-11 months after the Census (92.9%).

Other aspects of the CDE Indigenous Mortality Quality Study data were analysed by the ABS and results released in *Information Paper : Census Data Enhancement - Indigenous Mortality Quality Study, 2006-07* (cat. no. 4723.0) on 17 November 2008.

USE OF THE CDE STUDY TO DERIVE COVERAGE ESTIMATES FOR INDIGENOUS DEATHS

Table 4.3 presents the outcomes of the CDE study for Indigenous deaths in NSW. It provides a cross-classification of the linked death registrations and Census records by the Indigenous status recorded in the respective records. This allows a direct comparison of Indigenous status recorded on the death and the Census data for what is highly likely to be the same individual. It enables estimation of the undercoverage of Indigenous deaths in the death registration system. Similar tables for other states/territories where there are sufficient deaths are available on request.

4.3 SUMMARY OF LINKED DEATHS BY INDIGENOUS STATUS, NSW—2006–2007

	DEATH REGISTRATION CLASSIFICATION			
Census classification	*Indigenous*	*Non-Indigenous*	*Not stated*	*Total*
	no.	no.	no.	no.
Indigenous	273	131	12	416
Non-Indigenous	87	34 460	196	34 743
Not stated	12	1 881	12	1 905
Total	372	36 472	220	37 064

The table highlights a number of features:

- of the 416 records identified as Indigenous in the Census only 273 (66%) were identified as Indigenous on the death registration.
- the 273 records identified as Indigenous in both datasets represented 73% of linked deaths identified as Indigenous in death registration.
- there is considerable misidentification of Indigenous status between the Census and death registrations (for example, Indigenous in death registration but non-Indigenous in Census and vice versa).
- the overall coverage, indicated by these statistics, is 89% [i.e. (372/416)*100].

The above suggests that while there would seem to be considerable misidentification of Indigenous status between the Census and the death registrations, the overall coverage rate in the death registrations is quite high (89%).

At the same time, it needs to be recognised that at the national level, 26% of Indigenous deaths as recorded on the death registration could not be linked to a Census record. This would occur due to failures in the linking process (i.e., inadequate name and/or address information to enable a match) and also under-enumeration of the Indigenous population in the Census counts - which was estimated to be 11.5%. Despite these issues, it is considered that the linked data provide reasonable estimates of Indigenous deaths coverage.

For the purpose of compiling Indigenous life tables the experimental Indigenous ERP used is derived from the Census counts adjusted by the results of the Post Enumeration Survey (PES). The PES, which is a large household survey conducted about one month after the Census, provides an independent check on Census coverage and also identifies key demographic characteristics of the population that have been missed or overcounted in the Census. In compiling experimental Indigenous ERP, Indigenous status reported in PES was considered more reliable than that recorded in Census.

USE OF THE CDE STUDY TO DERIVE COVERAGE ESTIMATES FOR INDIGENOUS DEATHS *continued*

Therefore, to be consistent with Indigenous ERP calculations, the number of deaths reported as Indigenous in Census in the linked data need to be adjusted to a PES basis. It should be noted that these adjustments are only in respect of misclassifications of Indigenous status in the linked file. No attempt has been, or can be, made for undercount identified in the PES; this is reflected in the non-matched death registrations.

Thus, coverage of Indigenous deaths using the linked data was derived by:

- calculating the propensities, from PES, of being Indigenous in PES given Census Indigenous status (this will align the PES Indigenous status with the Census Indigenous status);
- applying the propensities to counts from the CDE linked data to obtain the expected number of deaths in Census; and
- taking the ratio of the number of deaths reported as Indigenous in death registrations to that reported in Census to calculate coverage estimate.

The following step by step example illustrates the calculation of coverage of Indigenous deaths for NSW:

Step 1: Calculation of propensities from PES data given in Table 4.4

The propensities are calculated for persons who matched to Census and responded as Indigenous in the PES to the Census Indigenous question. They are estimated by the three response classes for the Census Indigenous question : Indigenous, non-Indigenous and not stated.

4.4 CLASSIFICATION OF 'INDIGENOUS STATUS' REPORTED IN 2006 PES AND 2006 CENSUS, NSW

	PES RESPONSE		
Census response	*Indigenous*	*Non-Indigenous*	*Total*
	no.	no.	no.
Indigenous	275	75	350
Non-Indigenous	31	17 160	17 191
Not stated	5	278	283
Total	311	17 513	17 824

Data in Table 4.4 gives,

- P(I/I) = Propensity of being Indigenous in PES given Census Indigenous status = "Indigenous" is 275/350 = 0.7857.
- P(I/NI) = Propensity of being Indigenous in PES given Census Indigenous status = "non-Indigenous" is 31/17,191 = 0.0018.
- P(I/NS) = Propensity of being Indigenous in PES given Census Indigenous status = "not stated" is 5/283 = 0.0177.

The propensities P(I/NI) and P(I/NS) calculated above for NSW are based on small numbers of PES responses (i.e., 31 and 5 respectively in this example) and hence could be unreliable. To overcome this problem, P(I/NI) and P(I/NS) are estimated from the Australian level PES data which gives P(I/NI) = 0.0015 and P(I/NS) = 0.0303.

Step 2: Estimation of expected number of deaths in Census in linked data given in Table 4.3 using PES Indigenous propensities

Expected number of deaths in Census in linked data using PES Indigenous propensities

- = 416 * P(I/I) + 34,743 * P(I/NI) + 1,905 * P(I/NS), where P(I/I) is based on NSW PES data, and P(I/NI) and P(I/NS) are based on Australian level PES data
- = 416 * 0.7857 + 34,743 * 0.0015 + 1,905 * 0.0303 = 438.

Step 3: Calculation of coverage of Indigenous deaths

Indigenous deaths coverage estimate is then calculated by taking the ratio of the number of deaths reported as Indigenous in death registration to the number of deaths expected to be recorded as Indigenous in Census using the PES Indigenous propensities

= 372/438 = 0.85.

Step 4: Calculation of adjustment factor

Adjustment factor = reciprocal of coverage of Indigenous deaths = 1 / 0.85 = 1.18

In the linked data, 372 records were reported as Indigenous on the death registration form (Table 4.3). Of the deaths linked to the Census, 438 were recorded as Indigenous, after adjustment for classifying indigeneity in the way that PES does. This means that fewer deaths were identified as Indigenous in death registration data than were expected in Census data. Therefore, the number of Indigenous deaths according to deaths data needed multiplying by an adjustment factor of 1/0.85 = 1.18 to be comparable to the Indigenous deaths expected to be recorded in the Census.

The procedure described above was used to derive coverage of Indigenous deaths for NSW, Qld, WA, and NT, although for the states and NT the individual P(I/NI) and P(I/NS) were based on very small numbers and the Australian propensities were used instead. Due to the relatively small number of Indigenous deaths in Victoria, SA, Tasmania and ACT, it was not feasible to derive separate coverage estimates for these states/territory. Therefore, a single coverage estimate was derived by grouping these states/territory.

This method was not used to derive expected number of deaths for Australia. Instead, they were obtained by summing up the expected number of deaths for NSW, Qld, WA, NT, and the states/territory group mentioned above. This ensures the consistency of estimating expected deaths and hence coverage of deaths between state/territory and Australia.

There is considerable variation in coverage estimates at the state/territory level (Table 4.5). The estimate is less than 1.0 for NSW, Qld and the aggregate of Victoria, SA, Tasmania and the ACT which indicates a level of undercoverage of Indigenous deaths in death registrations relative to the Census for linked records. The situation is the opposite for WA and NT indicating an over representation of Indigenous deaths in deaths registration relative to the Census for linked records, i.e., persons who are identified as Indigenous in the death registrations exceed those identified as Indigenous in the Census. There is no clear reason as to why this might be the case, although there is evidence that some Indigenous deaths have a state of usual residence on the death registration that is different to the Census. It should be noted that both WA and NT had high levels of unlinked Indigenous death records (35% and 40% respectively) which in part is a reflection of the high undercount for those jurisdictions in the Census counts.

Step 4: Calculation of adjustment factor continued

This may indicate that the matched records may not be representative of all death records.

4.5 COVERAGE OF INDIGENOUS DEATHS, State/territory and Australia—2006–2007

State/territory	Number of Indigenous deaths according to death registration	Expected number of Indigenous deaths(a)	Coverage estimate	Adjustment factor(b)
NSW	372	438	0.85	1.18
Qld	351	379	0.93	1.08
WA	254	231	1.10	0.91
NT	204	187	1.09	0.92
Vic., SA, Tas. , ACT, OT	146	253	0.58	1.72
Aust.(c)	1 327	1 488	0.89	1.12

(a) In Census if PES Indigenous propensities are used.
(b) Calculated by taking the reciprocal of coverage estimate.
(c) Includes all states/territories.

DISCUSSION

The use of the CDE Indigenous Mortality Quality Study to assess coverage of Indigenous deaths in death registration data has a number of benefits but at the same time it has limitations. First, the obvious and most substantial benefit is that it enables for the first time direct calculation of coverage rates. That is, they are derived by directly comparing the Indigenous status reported on death and Census data for linked records, as opposed to the indirect and modelled estimates that have been used previously. No other coverage estimates derived by the ABS in the past were produced by a direct comparison of an individual's Indigenous status reported in two separate collections.

Second, no assumption was made to derive the coverage estimates from the CDE study, whereas a number of subjective judgements and assumptions were necessary to produce the ABS' previously published implied coverage estimates.

The limitations of the CDE Indigenous Mortality Study relate to two main factors.

First, the derived coverage rates relate to a very restricted time frame i.e. the 11 months from early August 2006 to the end of June 2007 that the study was conducted. It is not possible to accurately judge the appropriateness or otherwise of the derived coverage rates for past or future periods. In that regard it should be noted that the number of Indigenous deaths recorded in 2006-07 represented a 4% increase over 2005-06 indicating a possible improvement in coverage in 2006-07.

Second, there remains a relatively high level (26%) of unlinked Indigenous death records, particularly in WA (35%) and NT (40%). While not unexpected, given the relatively high Census undercount for Indigenous Australians, there may be features or characteristics of the unlinked records that are quite different to the linked records and therefore, may introduce some bias to the results, although sensitivity analysis indicates this is likely to be small.

DISCUSSION *continued*

In spite of these limitations, the CDE Indigenous Mortality Study clearly indicates that the coverage of Indigenous deaths in the deaths registration data is markedly higher, at least in 2006-07, than previous estimates. In particular, the ABS previously published implied coverage rates in *Deaths, Australia*, *2006* (cat. no. 3302.0) indicated a coverage rate of 55% nationally. The estimates of NSW (45%) and Qld (51%) were the significant contributors to that low coverage estimate.

Those implied coverage rates were derived using population projections based on assumptions regarding future fertility, mortality, migration and unexplained growth. However, there was a significant degree of circularity in the way the published implied coverage estimates were derived. The Bhat method (with unexplained growth) was used to estimate the completeness of Indigenous deaths registration and to produce Indigenous life tables for the period 1996-2001. Age-specific death rates obtained from these life tables were then used to formulate mortality assumptions for Indigenous projections, which produced projected number of deaths. Therefore, the accuracy of the projected number of Indigenous deaths and the implied coverage estimates obtained this way were dependent on the accuracy of the Indigenous life tables this method produced in the first place. To the extent that the Bhat (with unexplained growth) coverage estimates and the resulting life expectancies were flawed, then the implied death coverage estimates would have been highly unreliable.

CHAPTER 5 LIFE EXPECTANCY ESTIMATES USING DIFFERENT METHODS

INTRODUCTION

The previous chapters have described a number of different approaches that can be adopted to construct experimental Indigenous life tables and the resulting life expectancy estimates. This chapter presents the life expectancy outcomes using the different approaches, an assessment of each of the approaches and a preferred ABS method.

DIRECT METHOD USING THE REGISTERED NUMBER OF INDIGENOUS DEATHS

The standard approach to deriving life tables and life expectancy estimates for a population is to use deaths registered in a particular year together with mid-point population of the same year. Both deaths and population data are required by age and sex. However, three years of deaths data can be used to reduce the impact of year-to-year statistical variations, particularly at younger ages where there are small numbers of deaths and at very old ages where the population at risk is small.

For the Indigenous Australian population such a method cannot be used as the population estimates for Indigenous Australians are only available for Census years, and the coverage of deaths is known to be deficient.

However, for completeness and to provide some context to the results presented later in this chapter, life expectancy estimates using the direct method are given below. Two sets of estimates are presented.

The first set is life expectancy estimates using the number of Indigenous deaths registered during the 1996-2001 and 2001-2006 intercensal periods, and the 1996, 2001 and 2006 Census-based experimental Indigenous ERPs. The average of 1996 and 2001 Indigenous ERPs, and of 2001 and 2006 Indigenous ERPs, have been used to derive the 1996-2001 and 2001-2006 Indigenous life tables respectively.

For the purposes of constructing the life tables and compiling life expectancy estimates, it is assumed that all Indigenous deaths are registered as such in the death registration data (i.e., coverage is 100%) and therefore no adjustment to registered Indigenous deaths is required for potential undercoverage. Resultant life expectancy at birth estimates are presented in Table 5.1 below. These life expectancy estimates are presented primarily to provide some context and comparison to the life expectancy estimates derived from the indirect methods (described in Chapter 3) presented later in this chapter.

5.1 LIFE EXPECTANCY ASSUMING 100% COVERAGE OF REGISTERED DEATHS—1996–2001 & 2001–2006

	MALES			FEMALES		
	1996–2001	*2001–2006*	*Difference*	*1996–2001*	*2001–2006*	*Difference*
State/territory	years	years	years	years	years	years
NSW	68.6	70.8	2.2	75.3	76.3	1.0
Qld	65.3	67.5	2.2	71.2	73.6	2.4
WA	62.0	64.6	2.6	69.1	70.1	1.0
NT	59.0	59.2	0.2	64.5	66.9	2.4
Aust.(a)	65.3	67.7	2.4	71.6	73.6	2.0

(a) Includes all states/territories.

DIRECT METHOD USING THE REGISTERED NUMBER OF INDIGENOUS DEATHS *continued*

Using this approach, life expectancy at birth was estimated to be 65.3 years for Indigenous males and 71.6 years for Indigenous females for Australia for the 1996-2001 intercensal period (Table 5.1). This compares with life expectancy of 67.7 years and 73.6 years for Indigenous males and females respectively for 2001-2006. This suggests an improvement of 2.4 years for males and 2.0 years for females at the Australia level between 1996-2001 and 2001-2006. At the state/territory level, the improvement in Indigenous male life expectancy was highest in WA (2.6 years) and lowest in NT (0.2 years), whereas the improvement in Indigenous female life expectancy was highest in Qld and NT (2.4 years each) and lowest in NSW and WA (1.0 year each). As shown by the CDE study, Indigenous deaths are understated to some extent in most states/territories, therefore these figures overestimate the true life expectancies. To the extent that the level of undercoverage of Indigenous deaths has changed over time then this will impact the apparent change in life expectancies over time. For example, if coverage of Indigenous deaths has been improving then the improvement in life expectancy will be understated and vice versa.

Therefore these estimates and their apparent improvements over time should be interpreted with considerable caution.

The second set of life expectancy estimates compiled using the direct method involves using a population estimate at a single point and the three years of deaths data centred on that population point. The population points used are Indigenous ERPs at June 2001 and June 2006 derived from the corresponding Censuses. The deaths data relate to the three years 2000-2002 and 2005-2007 respectively. Again, it is assumed that all Indigenous deaths are registered as such in the death registration data (i.e. coverage is 100%) and therefore no adjustment to registered Indigenous deaths is required for potential undercoverage. Resultant life expectancy at birth estimates are presented in Table 5.2 below. As in Table 5.1 above, these are presented to provide some context and comparison to the life expectancy estimates derived from using the results of the CDE Indigenous Mortality Quality Study (described in Chapter 4) presented later in this chapter.

5.2 LIFE EXPECTANCY ASSUMING 100% COVERAGE OF REGISTERED DEATHS—2000–2002 & 2005–2007

	MALES			FEMALES		
	2000–2002	*2005–2007*	*Difference*	*2000–2002*	*2005–2007*	*Difference*
State/territory	years	years	years	years	years	years
NSW	69.7	71.6	1.9	75.0	76.4	1.4
Qld	66.7	69.1	2.4	71.9	74.3	2.4
WA	63.7	63.5	–0.2	69.4	69.0	–0.4
NT	58.5	60.1	1.6	64.9	68.0	3.1
Aust.(a)	66.6	68.4	1.8	72.0	73.8	1.8

(a) Includes all states/territories.

DIRECT METHOD USING THE REGISTERED NUMBER OF INDIGENOUS DEATHS *continued*

Using this approach, life expectancy at birth was estimated to be 66.6 years for Indigenous males and 72.0 years for Indigenous females for Australia for 2000-2002 (Table 5.2). This compares with life expectancy of 68.4 years and 73.8 years for Indigenous males and females respectively for 2005-2007. This indicates an improvement of 1.8 years for both males and females at the Australia level between 2000-2002 and 2005-2007. At the state/territory level, the improvement in Indigenous male life expectancy was highest in Qld (2.4 years) and lowest in NT (1.6 years), whereas the improvement in Indigenous female life expectancy was highest in NT (3.1 years) and lowest in NSW (1.4 years). Of the states/territory for which estimates were produced, WA was the only state which showed a decline in life expectancy. As noted above, and as demonstrated in the CDE Indigenous Mortality Quality Study, Indigenous deaths are understated to some extent in most states/territories. Therefore, these figures generally overestimate the true life expectancies. To the extent that the level of undercoverage of Indigenous deaths has changed over time then this will impact the apparent change in life expectancies over time. For example, if coverage of Indigenous deaths has been improving then the improvement in Indigenous life expectancy will be understated and vice versa.

Therefore these direct estimates of life expectancy without any adjustment for deaths coverage and the apparent changes over time should be interpreted with considerable caution.

BHAT METHOD (WITHOUT UNEXPLAINED GROWTH)

Under the assumption of no unexplained growth in the Indigenous population, coverage of Indigenous deaths was estimated using the Bhat method. An adjustment factor (the reciprocal of coverage estimate), assumed to be constant at each age group, was applied to the registered Indigenous death counts. The adjusted deaths were then used for the calculation of Indigenous life tables for the periods 1996-2001 and 2001-2006. As discussed in Chapter 3 and presented in Table 5.3 below, this method produced highly implausible results which show that coverage of Indigenous male deaths has declined by as much as 25 percentage points in Australia, 24 percentage points in Qld, 34 percentage points in WA, and 27 percentage points in NT. The method indicates that the coverage of Indigenous female deaths has declined by 17 percentage points in NT and over 40 percentage points in WA. As expected, these inconsistencies in coverage estimates have been reflected in life expectancy estimates. For example, using this methodology, life expectancy has declined by 3.3 years and 4.4 years for Indigenous males and females respectively in WA. The decline was even more pronounced for Indigenous males in NT (5.8 years). These are very significant and implausible declines in life expectancy in a time span of just five years.

BHAT METHOD (WITHOUT UNEXPLAINED GROWTH) *continued*

5.3 DEATH COVERAGE AND LIFE EXPECTANCY, Bhat method without unexplained growth—1996–2001 and 2001–2006

	DEATH COVERAGE			LIFE EXPECTANCY		
	1996–2001	*2001–06*	*Difference*	*1996–2001*	*2001–06*	*Difference*
State/territory	%	%	%	years	years	years
			MALES			
NSW	93	82	–11	67.6	68.3	0.7
Qld	89	65	–24	63.6	61.4	–2.2
WA	107	73	–34	63.1	59.8	–3.3
NT	92	64	–28	57.6	51.8	–5.8
Aust.(a)	95	70	–25	64.6	62.5	–2.1
			FEMALES			
NSW	80	79	–1	72.8	73.9	1.1
Qld	86	72	–14	69.2	69.7	0.5
WA	124	82	–42	71.9	67.5	–4.4
NT	105	88	–17	65.2	65.0	–0.2
Aust.(a)	92	80	–12	70.5	71.0	0.5

(a) Includes all states/territories.

Furthermore, a male life expectancy of 51.8 years and a female life expectancy of 65.0 years for NT for 2001-2006 is not consistent with other available estimates for the territory. Life expectancy at birth estimates using a longitudinal mortality dataset resulted in life expectancies of 60 years for Indigenous males and 68 years for Indigenous females for the period 2000-2004 (Wilson et al., 2007).

Given the obvious inconsistencies in these estimates it is suggested that these estimates should similarly be interpreted with considerable caution.

BHAT METHOD (WITH UNEXPLAINED GROWTH)

As explained in Chapter 3, the ABS used the Bhat method for 1996-2001. However, given the large growth rate between the 1996 Indigenous ERP and the 2001 Indigenous ERP, the ABS made the assumption that growth over 2.0% per annum at the state/territory by sex level was categorised as unexplained growth mainly resulting from an increasing propensity for people to identify as Indigenous Australians. The inclusion of a migration factor in the Bhat method provided the mechanism to accommodate this unexplained growth in the model. To enable comparison, estimates for 2001-2006 have been compiled using the same assumption i.e. growth over 2.0% per annum at the state/territory by sex level was categorised as unexplained growth, mainly resulting from an increasing propensity for people to identify as Indigenous Australians. The results are presented in Table 5.4.

BHAT METHOD (WITH UNEXPLAINED GROWTH) *continued*

5.4 DEATH COVERAGE AND LIFE EXPECTANCY, Bhat method with unexplained growth—1996–2001 and 2001–2006

	DEATH COVERAGE			LIFE EXPECTANCY		
	1996–2001	*2001–06*	*Difference*	*1996–2001*	*2001–06*	*Difference*
State/territory	%	%	%	years	years	years
			MALES			
NSW	55	78	23	60.2	67.7	7.5
Qld	65	57	–8	58.9	59.5	0.6
WA	81	(a)73	–8	58.6	59.8	1.2
NT	(a)92	(a)64	–28	57.6	51.8	–5.8
Aust.(b)	67	66	–1	59.4	61.7	2.3
			FEMALES			
NSW	45	65	20	65.4	71.9	6.5
Qld	52	60	8	62.6	67.5	4.9
WA	86	(a)82	–4	66.9	67.5	0.6
NT	(a)105	69	–36	65.2	61.4	–3.8
Aust.(b)	60	70	10	64.8	69.3	4.5

(a) As the growth rate is less than 2%, consistency factor is the same as for Bhat without unexplained growth.

(b) Includes all states/territories.

Life expectancy at birth estimates are lower when Bhat method with unexplained growth is used. Due to large unexplained growth in the 1996-2001 period, the impact of the assumptions is more pronounced for 1996-2001 than 2001-2006. One of the criticisms of the ABS' published estimates for 1996-2001 period was the use of non-biological or unexplained change in the Indigenous population as a separate component in the Bhat estimating equation. For further information, see the ABS *Demography Working Paper 2004/3 - Calculating Experimental Life Tables for Use in Population Estimates and Projections of Aboriginal and Torres Strait Islander Australians, 1991 to 2001* (cat. no. 3106.0.55.003).

The Hill method treats change in unexplained growth (including change in identification) as a change in Census coverage. Hill argues that by correcting again for migration is essentially double adjusting (cited in Vos et al., 2007). Because of this over-adjustment, life expectancy estimates based on this approach may underestimate the true life expectancy.

The other significant limitation of the Bhat method is that it requires a subjective assumption regarding unexplained growth. As indicated by a comparison of results using Bhat method with and without unexplained growth, that assumption has a significant influence on the outcome.

HILL METHOD

The coverage of Indigenous deaths was estimated using the Hill method. As for the Bhat method an adjustment factor (the reciprocal of coverage estimate), assumed to be constant at each age group, was applied to the registered Indigenous death counts. The adjusted deaths were then used for the calculation of Indigenous life tables for the periods 1996-2001 and 2001-2006. As discussed in Chapter 3 and presented in Table 5.5,

this method produced highly implausible results which show that coverage of Indigenous male deaths has declined by as much as 25 percentage points in Australia, 29 percentage points in Qld and 37 percentage points in WA. Coverage of Indigenous female deaths has declined by 18 percentage points in NT and 36 percentage points in WA.

5.5 DEATH COVERAGE AND LIFE EXPECTANCY, Hill method—1996–2001 and 2001–2006

	DEATH COVERAGE			LIFE EXPECTANCY		
	1996–2001	*2001–06*	*Difference*	*1996–2001*	*2001–06*	*Difference*
State/territory	%	%	%	years	years	years
			MALES			
NSW	92	88	–4	66.6	69.3	2.7
Qld	98	69	–29	64.6	61.9	–2.7
WA	112	75	–37	63.3	60.2	–3.1
NT	93	71	–22	57.6	53.2	–4.4
Aust.(a)	99	74	–25	64.7	63.2	–1.5
			FEMALES			
NSW	90	85	–5	73.7	74.6	0.9
Qld	90	77	–13	69.3	70.5	1.2
WA	118	82	–36	71.0	67.6	–3.4
NT	110	92	–18	66.0	65.4	–0.6
Aust.(a)	95	85	–10	70.5	71.7	1.2

(a) Includes all states/territories.

As for the Bhat method these large declines in coverage have resulted in declines in Indigenous male life expectancy, with the estimate for life expectancy for Indigenous Australian in NT and WA both declining markedly (4.4 years and 3.1 years respectively). Given the obvious inconsistencies in these data, it is suggested that these data should be interpreted with considerable caution.

CDE INDIGENOUS MORTALITY QUALITY STUDY

The CDE Indigenous Mortality Quality Study (see Chapter 4) provides a sound basis for adjusting recorded Indigenous death registrations to account for apparent under and overcoverage. Therefore, a direct demographic method, with up-front adjustments using the CDE based coverage estimates for incomplete identification of Indigenous deaths in death registrations, can be used to derive Indigenous life tables.

The data used for the compilation of the life tables were the experimental population estimates for Indigenous Australians as at 30 June 2006 and the average annual number of Indigenous deaths registered in 2005-2007 adjusted by the coverage rates from the CDE Indigenous Mortality Quality Study. Deaths were averaged over the three year period to smooth out the year-to-year irregularities in the number of registered deaths.

The results are presented in Table 5.6.

CDE INDIGENOUS MORTALITY QUALITY STUDY *continued*

5.6 ESTIMATED INDIGENOUS LIFE EXPECTANCY, CDE Indigenous Mortality Quality Study—2005–2007

State/territory	Estimated coverage %	Male life expectancy years	Female life expectancy years
NSW	85	69.6	74.8
Qld	93	68.1	73.5
WA	110	64.9	70.2
NT	109	61.5	69.2
Vic, SA, Tas, ACT & OT	58	np	np
Aust.	(a) 89	(b) 66.9	(b) 72.6

np not available for publication but included in totals where applicable, unless otherwise indicated
(a) Not used to derive Indigenous life expectancies for Australia presented in this table.
(b) Based on NSW, Qld, WA, NT and balance of Australia level adjustment factors (see Table 4.5).

A number of observations can be made regarding the above estimates. First, in terms of assumptions, the key assumption is that the undercoverage adjustment factors derived from this CDE study are applicable over the three years of death registrations used. Second, the implied overcoverage of Indigenous deaths in WA and NT is counter intuitive. While the general view would be that coverage of Indigenous deaths in these jurisdictions is very high, the apparent overcoverage would indicate that deaths data overcounted Indigenous status compared with Census data. Finally, the major limitation with the use of the CDE Indigenous Mortality Quality Study is that data are only available for 2007 and some assumptions need to be made for the purpose of compiling Indigenous life tables and life expectancies for 2000-2002.

It is possible to simulate the outcomes for 2000-2002 by making assumptions as to the improvement in coverage of Indigenous deaths over the period from 2001 to 2006. The intention is to provide indicative outcomes under a range of assumptions. On the basis that coverage of Indigenous deaths is unlikely to have declined in recent years three scenarios are presented below:

- coverage has improved 20% over the period i.e., it was 20% less in 2001 than in 2006;
- coverage has improved 10% over the period i.e. it was 10% less in 2001 than in 2006;
- coverage is unchanged over the period.

The other assumption made is that changes in coverage are uniform across states/territories and age and sex. The outcomes are presented in Table 5.7.

CDE INDIGENOUS MORTALITY QUALITY STUDY *continued*

5.7 ESTIMATED INDIGENOUS LIFE EXPECTANCY, Different death coverage assumptions—2000–2002

	ASSUMPTION		
	If death coverage is 20% less	*If death coverage is 10% less*	*If death coverage is unchanged*
State/territory	years	years	years
	MALES		
NSW	64.1	66.0	67.6
Qld	62.1	64.0	65.6
WA	62.1	63.7	65.1
NT	56.6	58.3	59.9
Aust.(a)	61.2	63.4	65.1
	FEMALES		
NSW	70.0	71.7	73.2
Qld	67.9	69.5	71.0
WA	67.9	69.4	70.7
NT	63.1	64.7	66.2
Aust.(a)	67.2	69.1	70.7

(a) Includes all states/territories.

The key aspect in relation to the simulations is that even under the scenario where the coverage of Indigenous deaths is 20% less than the coverage derived from the CDE Indigenous Mortality Quality Study in respect of 2007, then the life expectancies derived are higher than those derived using the Bhat (with unexplained growth) method which was the method used at the time.

Errors in life expectancy estimates

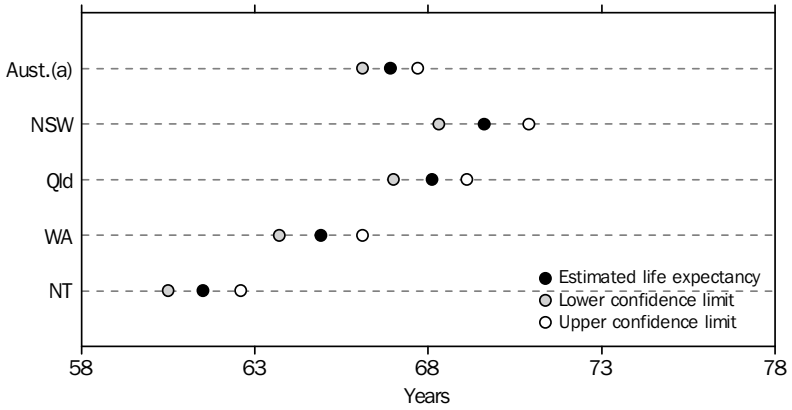
A number of factors may lead to errors in life expectancy at birth estimates using the CDE Indigenous Mortality Quality Study. These include errors in linking death registrations to the Census, errors in converting death registrations to the same basis as ERP, and sampling errors in estimating ERP using the PES undercount estimates.

Sampling error from the PES

Standard Errors (SEs) for Indigenous life expectancy at birth estimates were generated by sex and states/territory and Australia using a replication approach by reflecting PES sampling error. A 95% confidence interval for life expectancy at birth estimate was then calculated based on the standard error estimates. The interval is narrow for Australia relative to those for states/territory (Figures 5.8 and 5.9), this suggests that life expectancy at birth estimate is more robust for Australia than for the states/territory. While the state/territory estimates presented are robust, NSW and WA estimates are less accurate than the Qld and NT estimates. This is true for both males and females.

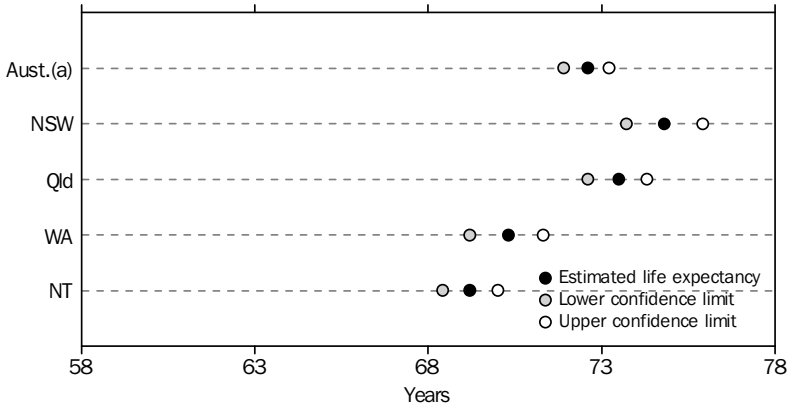
Sampling error from the PES continued

5.8 LIFE EXPECTANCY WITH 95% CONFIDENCE INTERVAL, Indigenous males, 2005-07



(a) Estimates derived by summing components for 4 states/territory shown and balance of Australia

5.9 LIFE EXPECTANCY WITH 95% CONFIDENCE INTERVAL, Indigenous females, 2005-07



(a) Estimates derived by summing components for 4 states/territory shown and balance of Australia

Error from non-linking in the CDE study

One other main source of error relates to the variation in the undercoverage rate of registered deaths that were unable to be linked to the Census. A sensitivity analysis was undertaken to determine the possible effect of this error on life expectancy at birth estimates, within a plus or minus 5% variation of the undercoverage of Indigenous deaths obtained from the CDE study. The spread of estimates based on this sensitivity analysis suggest that life expectancies are fairly robust against this type of error, increasing the spread of estimates by 0.2 years.

SUMMARY

There are a number of methodologies available to address the issue of incomplete coverage of deaths for a population or a population subgroup. In assessing these methodologies ABS has explored a range of indirect methods and direct methods.

SUMMARY *continued*

The assessment of the indirect methods, Bhat with unexplained growth and the Hill method, is that they result in implausible outcomes in terms of changes in the apparent undercoverage rates over time. The other aspect of the indirect methods that has emerged in the analysis to date is the sensitivity of the outcomes to the population estimates at the end points. Small changes in the age/sex structure of the population estimates result in quite markedly different outcomes in life expectancies. Given the quality issues associated with the Indigenous population estimates, this result becomes an important factor in assessing the relative merits of the indirect methods. Based on these findings, ABS would no longer propose the use of indirect methods to estimate the completeness of Indigenous death registration in Australia.

The ABS view is that indirect methods are not suitable in the Australian context. For the purpose of applying direct methods the CDE Indigenous Mortality Quality Study provides the only basis for developing assumptions as to the extent of undercoverage in the recording of Indigenous deaths in death registration information and making appropriate adjustments, and is the ABS preferred approach.

The limitation of the CDE Indigenous Mortality Quality Study is that it only provides a measure for a single year (i.e. 2006-07). The assumption that these coverage rates are applicable for other years is questionable. The other concerning aspect of the results from the CDE Indigenous Mortality Quality Study is the derived outcomes for NT and WA i.e., there is apparent overcoverage of Indigenous deaths in the death registrations relative to the Indigenous identification in the Census. Notwithstanding these issues, the ABS is of the view that these provide the best basis for compiling current life tables and in turn experimental Indigenous life expectancy estimates as at 2006.

Results using the CDE Indigenous Mortality Quality Study are presented in Table 5.10 which also presents the difference between Indigenous life expectancy and non-Indigenous life expectancy for 2005-2007.

SUMMARY *continued*

5.10 INDICATIVE DIFFERENCE IN LIFE EXPECTANCY BETWEEN INDIGENOUS AND NON-INDIGENOUS AUSTRALIANS—2005–2007

State/territory	*Indigenous life expectancy*(a) years	*Indicative difference*(b) years
MALES		
NSW	69.6	9.1
Qld	68.1	10.6
WA	64.9	13.8
NT	61.5	17.2
Aust.(c)	66.9	11.8
FEMALES		
NSW	74.8	7.8
Qld	73.5	9.1
WA	70.2	12.4
NT	69.2	13.4
Aust.(c)	72.6	10.0

(a) Using CDE adjusted approach.
(b) Difference between Australia level non-Indigenous life expectancies (78.7 years for males and 82.6 years for females) and state/territory level Indigenous life expectancies.
(c) Includes all states/territories.

The indicative difference in life expectancy at birth estimates between Indigenous and non-Indigenous Australians at the national level is approximately 12 years for Indigenous males and 10 years for Indigenous females. Results vary across states/territory, with NSW having the lowest difference (9 years for males and 8 years for females) while NT has the highest difference with 17 years for males and 13 years for females.

In terms of trying to assess changes in life expectancy over time, it needs to be recognised that the above concerns identified in relation to indirect methods are equally applicable to the ABS' published Indigenous life expectancy estimates for the period 1996-2001. While the ABS took considerable care to explain the underlying assumptions, and that the estimates were of an experimental nature, it would seem clear now that the derived coverage rates and resulting life expectancy estimates for some states/territories are implausible. The ABS would strongly advise against any comparison of the published Indigenous life expectancies based on 1996-2001 with the estimates presented in this Discussion Paper, and in no way should those differences be interpreted as measuring changes in life expectancy over time.

While the CDE Indigenous Mortality Quality Study does not provide a basis for deriving life tables and life expectancy estimates for previous periods, the simulations of possible outcomes would clearly indicate that the use of indirect methods for 1996- 2001 has resulted in an understatement of life expectancies for some states/territories and at the Australian level.

BRASS'S ORIGINAL METHOD

This method is based on the simple fact that in a stable and closed population, the birth rate should be equal to the death rate plus the rate of growth of the population. Brass (1975) defined the following equation for a population aged 'a' and over,

$$\frac{N_a}{N_{a+}} = r_{a+} + \frac{D_{a+}}{N_{a+}}$$

where:

N_a = Number of persons at exact age 'a',

N_{a+} = Number of persons at age 'a' and over

D_{a+} = Number of deaths occurring to persons aged 'a' and over, and

r_{a+} = Growth rate of population aged 'a' and over.

If D^*_{a+} be the number of deaths registered and is related to D_{a+} with the following relationship,

$$D^*_{a+} = C_{a+}.D_{a+}$$

where C_{a+} is the coverage of deaths (i.e. a ratio of registered deaths to actual number of deaths) aged 'a' and over, then the above equation can be re-written as

$$\frac{N_a}{N_{a+}} = r_{a+} + \frac{1}{C_{a+}}\frac{D^*_{a+}}{N_{a+}}$$

Assuming that the growth rate and coverage of deaths do not vary across ages (i.e. $r_{a+}=r$, $C_{a+}=C$), the equation finally takes the form,

$$\frac{N_a}{N_{a+}} = r + \frac{1}{C}\cdot\frac{D^*_{a+}}{N_{a+}}$$

or,

$$b_{a+} = r + \frac{1}{C_{a+}}d^*_{a+}$$

Since N_a may be thought of as being the number of persons in a year entering the group of those aged 'a' and over, the ratio N_a/N_{a+} can be interpreted as a birth rate (b_{a+}) for the population aged 'a' and over, while D^*_{a+}/N_{a+} is the death rate (d^*_{a+}) corresponding to the same population. Accordingly, the relationship between N_a/N_{a+} and D^*_{a+}/N_{a+} is a linear relation of the form Y= A + B X where A (=r) is the intercept and B(=1/C) is the slope of the straight line. Fitting such a line with observed data can provide a reasonable estimate of r, the rate of growth of the population and C, the consistency factor. The reciprocal of the consistency factor can then be used as a correction factor for registered Indigenous deaths so that the age distribution of the two Census based population estimates and the reported intercensal deaths are consistent with each other.

Brass method assumes that there are no severe age misreporting errors in deaths and population data. Therefore no allowance is made for age misreporting in the above equation, although deaths and population data based on cumulative ages such as 0+, 5+, 10+ years and so on, are likely to smooth out some of the effects of age misreporting. The advantage of using cumulative ages is that the population and deaths data relating to older age groups are repeatedly included within successively younger age groups and thus smooth out age related irregularities in population and deaths data.

HILL (1987) METHOD

Recognising the fact that, apart from deaths data, Census counts are also subject to errors, Professor Kenneth Hill has re-formulated the GGB method in 1987 so that the method can simultaneously estimate the relative correction factors of deaths and the Census counts.

The Hill variant of Brass estimating equation is of the form,

HILL (1987) METHOD *continued*

$$\frac{N_a}{N_{a+}} - r_{a+} = \frac{1}{t}\log\left(\frac{K_1}{K_2}\right) + \frac{\sqrt{K_1K_2}}{K_3}.\frac{D^*_{a+}}{N_{a+}}$$

where,

N_a is the number of people having 'a'-th birthday during the intercensal period,

N_{a+} is the person-years lived beyond age 'a' and above,

r_{a+} is the growth rate beyond age 'a' and above,

t is the length of duration between two Census dates,

K_1 and K_2 are the coverage rates associated with the first and the second Censuses respectively,

K_3 is the coverage of intercensal deaths and finally,

D^*_{a+} is the number of deaths registered during the intercensal period among people aged 'a' and above.

The Equation can be re-written in the following simple form,

$$b_{a+} - r_{a+} = A + B.d^*_{a+}$$

where $b_{a+} = \frac{N_a}{N_{a+}}$ is rate of entry into the population at age 'a' and over, $d^*_{a+} = \frac{D^*_{a+}}{N_{a+}}$ is rate of exit from the population at age 'a' and over, and finally A and B are constants where $A = \frac{1}{t}\log\left(\frac{K_1}{K_2}\right)$ and $B = \frac{\sqrt{K_1K_2}}{K_3}$.

It is apparent that the observed entry rate minus the observed growth rate is linearly related to the observed death rate with an intercept determined by K_1 and K_2 and a slope determined by the value of K_3 relative to an average of K_1 and K_2. The slope of the line therefore estimates the correction factor needed to adjust the observed count of deaths relative to the recorded population. A variable growth rate, r_{a+}, across age-groups in the above equation means that, under the Hill (1987) method, the population in question does not need to be a stable population, but it requires to be closed against migration in or out.

BHAT (2002) METHOD

The 2002 re-formulation of the GGB method by Professor Bhat was to relax the assumption of a closed population with no or negligible migration. Bhat also started with the basic GGB equation, and generalised it to include a migration component.

The Bhat formulation of the equation is of the form,

$$b_{a+} - u_{a+} + v_{a+} = n + \frac{1}{C}.d^*_{a+}$$

where b_{a+} is the entry rate into the population at age 'a' and over,

$u_{a+} = r_{a+} - r_{0+}$, is the partial growth difference at age 'a' and over [r_{a+} and r_{0+} being growth rates at age 'a+' and '0+' respectively],

$v_{a+} = m_{a+} - m_{0+}$, is the partial migration difference at age 'a' and over [m_{a+} and m_{0+} being net migration rates at age 'a+' and '0+' respectively],

'C' is the consistency factor ('1/C' can be used as a correction factor for registered Indigenous deaths so that the age distribution of the two Census based population estimates and the reported intercensal deaths are consistent with each other) and finally,

'n' is a constant measuring natural increase (difference between the birth and death rates) of the population.

Under the assumption that the population in question is closed to migration, the equation takes the form,

$$b_{a+} - u_{a+} = n + \frac{1}{C}.d^*_{a+}$$

BHAT (2002) METHOD
continued

which represents a linear equation of the form Y = A + B X, where A (=n) is the intercept and B (=1/C) is the slope of the line passing through the points [b_{a+} - u_{a+}, d^*_{a+}]. Fitting such a line with observed data can determine 'n' (the rate of growth of the population) and 1/C, the factor to adjust the registered deaths.

GLOSSARY

Age-specific death rates Age-specific death rates are the number of deaths (occurred or registered) during the calendar year at a specified age per 1,000 of the estimated resident population of the same age at the mid-point of the year (30 June). Pro rata adjustment is made in respect of deaths for which the age of the deceased is not given.

Census The complete enumeration of a population or groups at a point in time with respect to well-defined characteristics (eg Population, Manufacturing, etc.). In this paper the word 'Census' refers to the ABS Census of Population and Housing.

Death Death is the permanent disappearance of all evidence of life after birth has taken place. The definition excludes deaths prior to live birth. For the purposes of the Deaths and Causes of Death collections conducted by the Australian Bureau of Statistics (ABS), a death refers to any death which occurs in, or en route to Australia and is registered with a state or territory Registry of Births, Deaths and Marriages.

Discrete Indigenous Community A discrete Indigenous community is defined as a geographic location, bounded by physical or legal boundaries, and inhabited or intended to be inhabited predominantly by Indigenous people, with housing or infrastructure that is either owned or managed on a community basis.

Estimated Resident Population (ERP) The official measure of the population of Australia is based on the concept of usual residence. It refers to all people, regardless of nationality or citizenship, who usually live in Australia, with the exception of foreign diplomatic personnel and their families. It includes usual residents who are overseas for less than 12 months. It excludes overseas visitors who are in Australia for less than 12 months.

Estimates of the Australian resident population are generated on a quarterly basis by adding natural increase (the excess of births over deaths) and net overseas migration (NOM) occurring during the period to the population at the beginning of each period. For state and territory population estimates, an additional term is added to the equation representing net interstate migration.

Exponential growth rate A measure of growth of a population, defined by $r=(1/t)\ \log_e (P_t/P_0)$, where P_0 and P_t are population size at time '0' and 't' respectively, and 't' is the distance between the two time points.

Implied coverage The ratio of observed to expected deaths.

Imputation A statistical process for predicting values where no response was provided to a question and a response could not be derived.

Indigenous death The death of a person who is identified as being of Aboriginal or Torres Strait Islander origin on the death registration form.

Indigenous people People who identified themselves, or were identified by another household member, as being of Aboriginal and/or Torres Strait Islander origin.

Life table A life table is a statistical model used to show the life expectancy and hence levels of mortality at different ages. It depicts the mortality experience of a hypothetical group of newborn babies throughout their lifetimes. Life tables may be complete or abridged, depending on the age interval used in their compilation. Complete life tables such as those for the Australian population contain data by single years of age, while abridged life tables, such as those for the Indigenous population, contain data for five-year age groups. Life tables are presented separately for males and females.

Life expectancy Life expectancy refers to the average number of additional years a person of a given age and sex might expect to live if the age-specific death rates of the given period continued throughout his/her lifetime.

Natural increase Excess of births over deaths.

Net undercount The difference between the actual Census count (including imputations) and an estimate of the number of people who should have been counted in the Census. This estimate is based on the PES conducted after each Census. For a category of person (e.g. based on age, sex and state of usual residence), net undercount is the resultant of Census undercount, overcount, misclassification and imputation error.

Non-sampling error Non-sampling error arises from inaccuracies in collecting, recording and processing the data. Every effort is made to minimise non-sampling error by the careful design of questionnaires, intensive training and supervision of interviewers, and efficient data processing procedures. Non-sampling error also arises because information cannot be obtained from all people selected in the survey.

Other Territories Following the 1992 amendments to the Acts Interpretation Act to include the Indian Ocean Territories of Christmas Island and the Cocos (Keeling) Islands as part of geographic Australia, another category of the state and territory level has been created, known as Other Territories. Other Territories include Jervis Bay Territory, previously included with the Australian Capital Territory, as well as Christmas Island and the Cocos (Keeling) Islands.

Overcount The number of people in the Census who should not have been counted, either because they had already been counted or because they were overseas and should not have been counted at all. If a person was counted in the Census three times, for example, they would contribute two counts to the gross overcount (assuming they should have been counted in the Census).

Sampling error Sampling error occurs because a sample, rather than the entire population, is surveyed. One measure of the likely difference resulting from not including all dwellings in the survey is given by the standard error.

Standard error A measure of the spread of the difference between the true value and an estimate. There are about two chances in three that a sample estimate will differ by less than one standard error from the figure that would have been obtained if all dwellings had been included in the survey, and about nineteen chances in twenty that the difference will be less than two standard errors.

Undercount The number of people who should have been counted in the Census but were not.

Year of occurrence Data presented on year of occurrence basis relate to the date the death occurred.

Year of registration Data presented on year of registration basis relate to the date the death was registered.

BIBLIOGRAPHY

ABS PUBLICATIONS

Australian Demographic Statistics, *March Quarter 2007*, (cat. no. 3101.0).

Census of Population and Housing - Undercount, Australia, 2006, (cat. no. 2940.0).

Census of Population and Housing- Details of Undercount, Australia, August 2006 (cat. no. 2940.0).

Deaths, Australia, 2006 (cat. no. 3302.0).

*Demography Working Paper 2004/3- Calculating Experimental Life Tables for Use in Population Estimates and Projections of Aboriginal and Torres Strait Islander Australians, 1991 to 2001 (*cat. no. 3106.0.55.003).

Discussion Paper: Enhancing the Population Census: Developing a Longitudinal View (cat. no. 2060.0).

Experimental Estimates of Aboriginal and Torres Strait Islander Australians, Jun 2006 (cat. no. 3238.0.55.001).

Experimental Estimates and Projections of Aboriginal and Torres Strait Islander Australians, 1991-2009 (cat. no. 3238.0).

Information Paper: Census Data Enhancement Project: An Update, *Australia, June 2006* (cat. no. 2062.0).

Information Paper: Census Data Enhancement - Indigenous Mortality Quality Study, 2006-07 (cat. no. 4723.0).

*Information Paper: Measuring net undercount in the 2006 Population Census, Australia, 2006 (*cat. no. 2940.0.55.001).

Population Distribution, Aboriginal and Torres Strait Islander Australians, Australia, 2006 (cat. no. 4705.0).

Research Paper: An Estimating Equation Approach to Census Coverage Adjustment (cat. no. 1351.0.55.019).

Research Paper: Exploring Methods for Creating a Longitudinal Census Dataset (cat. no. 1352.0.55.076).

Research Paper: Methodology of Evaluating the Quality of Probabilistic Linking (cat. no. 1351.0.55.018).

The Health and Welfare of Australia's Aboriginal and Torres Strait Islander Peoples 2008 (cat. no. 4704.0).

OTHER PUBLICATIONS

Ajwani S, Blakely T, Robson B, Atkinson J and Kiro C (2003). 'Unlocking the numerator-denominator bias III: adjustment ratios by ethnicity for 1981-1999 mortality data. The New Zealand Census-Mortality Study', *New Zealand Medical Journal*, Vol. 116 (1175), pp. 1-12.

Barnes T, Smith L, Zhao Y and Guthridge S (2008). *A comparative analysis of indirect methodologies for estimating Indigenous life expectancy*, A report commissioned by the National Advisory Group on Aboriginal and Torres Strait Islander Health Information and Data: Charles Darwin University.

Bhat, P (2002). 'General growth balance method: A reformulation for populations open to migration', *Population Studies*, Vol. 56, pp. 23-34.

Blakely T, Robson B, Atkinson J, Sporle A and Kiro C (2002a). 'Unlocking the numerator-denominator bias I: adjustment ratios by ethnicity for 1991-94 mortality data. The New Zealand Census-Mortality Study', *New Zealand Medical Journal,* Vol. 115, pp. 39-43.

OTHER PUBLICATIONS *continued*

Blakely T, Kiro C, and Woodward A (2002b). 'Unlocking the numerator-denominator bias II: adjustment to mortality rates by ethnicity and deprivation during 1991-94. The New Zealand Census-Mortality Study', *New Zealand Medical Journal*, Vol. 115, pp. 43-48.

Brass, W (1975). *Methods of Estimating Fertility and Mortality from Limited and Defective Data*, Laboratories for Population Studies, Carolina Population Centre, Chapel Hill, North Carolina.

Hill, K (1987). 'Estimating Census and Death Registration Completeness', *Asia and Pacific Population Forum*,Vol. 1(3), pp. 8-15.

Hill K, Barker B, Vos T (2007). 'Excess Indigenous mortality: are Indigenous Australians more severely disadvantaged than other Indigenous populations?', *International Journal of Epidemiology*,Vol. 36, pp 580-589.

Preston, S and Hill, K(1980). Estimating the completeness of death registration, *Population Studies*, Vol. 34, pp. 349-366.

Shryock H, Siegel J and Associates (1976). *The Methods and Materials of Demography*, Condensed Edition, Academic Press, New York.

Vos T, Barker B, Stanley L & Lopez A (2007). *The Burden of Disease and Injury in Aboriginal and Torres Strait Islander Peoples 2003,* The University of Queensland, Brisbane.

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