



**Queensland  
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## Supplementary techniques to age-standardisation in Indigenous health status reporting

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### Key Findings

Crude rates depict the true magnitude of the risk as an average measure at the total population level. However, they are heavily affected by the respective age composition of the populations being compared. Once standardised for age composition, the rates become comparable. However, the standardised rates are hypothetical. In all cancer incidence for example, they are not the true level of all cancer incidence for Indigenous and non-Indigenous people in Qld. Another measure that is available to describe incidence (new cases of disease and deaths) is *lifetime cumulative rate*. Lifetime cumulative rate is more indicative of actual rates of a population and can be compared with other populations and over time. No standard population is needed to calculate lifetime cumulative rate. Cumulative rates by age groups show age differentials of risk which provide further analytical possibilities. Furthermore, cumulative rates by age groups can easily be converted to *probabilities of risk*, which can be comprehended easily by the general public.

### Introduction

Crude rates are sensitive to differences in age compositions, therefore, are not useful measures for comparison with other populations. In order to overcome the confounding impact of the differing age structures of the populations on the observed rates, application of age-standardisation is widely popular through the use of a standard population. However, the standardised rates are hypothetical values which can divert attention from actual magnitudes of risk and their variation across age groups, which may reduce the ability to correctly interpret the risks and develop appropriate policy responses. For these reasons, we attempt here to explore the use of other suitable techniques to supplement age-standardised rates.

### The need for rate standardisation

Crude rates are useful summary measures and are the true rate at which cases occur in a population during a specific period (WHO, 2007, p99). In the case of cancer incidence for example, crude rate is expressed as the average number of new cases occurring per 100,000 persons each year or 100,000 person-years. Crude rate is useful to compare similar populations of different sizes. But crude rates are sensitive to differences in age compositions and heavily confounded by the age structure of the population. Therefore, crude rates are not useful measures for comparison with other populations. For example, the crude death rate (CDR) of the Indigenous population of Queensland for the period 2002–2004 is estimated at 4.0 per 1000 population while the same rate for the non-Indigenous population of Qld is estimated at 5.9 per 1000 population implying an Indigenous to non-Indigenous crude death rate ratio of 0.7 (Please see Appendix 1 and Appendix 2). Given this, one would wrongly conclude that Indigenous people in Qld have lower mortality compared to non-Indigenous people. However, estimates of life expectancy tell us that Indigenous people in Qld have much higher mortality compared to non-Indigenous people (ABS, 2011 p39).

Therefore, when comparing rates of various jurisdictions or population sub-groups, in order to overcome the confounding impact of the differing age structures of the populations on the observed rates, application of age-standardisation is widely popular. Generally there are two

methods of standardisation, direct and indirect. In the direct method of standardisation, the age-specific rates of the study population, are applied to a standard population. In the indirect technique, the age-specific rates of the standard population are applied to the age distribution of the study population. Referring to the CDR example earlier, once the mortality rates were age-standardised, the relative Indigenous to non-Indigenous mortality rate ratios can be obtained as the following:

Indigenous Standardised Mortality Rate (per 1000)	10.9
Non-Indigenous Standardised Mortality Rate (per 1000)	5.4
Indigenous to non-Ind Standardised Mortality Rate Ratio	2.0

(Source: please refer to Appendix 3 and Appendix 4).

The direct method of standardisation is the method of choice for the Australian Institute of Health and Welfare (AIHW) and the Australian Bureau of Statistics (ABS) when comparing Indigenous and non-Indigenous mortality rates, diseases incidence and prevalence over time (AIHW, 2011, p8).

However, age-standardised rates are hypothetical, not actual measures of risk and have no intrinsic value themselves, therefore, do not measure the magnitude of the problem. Age-standardised rates are just relative indices (New Mexico Department of Health, 2010). Reliance on standardised rates may divert attention from actual magnitudes of risk and their variation across age groups and may reduce the ability to correctly interpret the risks and develop appropriate policy responses.

**Alternatives to standardisation**

An alternative or supplementary measure that is available to describe incidence (new cases of disease and deaths) is *lifetime cumulative rate*. Properties of lifetime cumulative rate include:

- shows the true magnitude of the risk and retains the intrinsic value;
- easy to compute and easy to comprehend;
- does not require the use of a standard population;
- does not hide comparative variation of the risk by age groups; and
- provides good explanatory power.

However, it needs to be pointed out that this method can not be applied in situations with multiple exposures, such as hospitalisations. Therefore it is not applicable to the measurement of prevalence which precludes its use for assessing differences in hospitalisation rates.

**Table 1: Cancer Incidence Rates by Indigenous Status, Queensland, 2005-2009**

	Indigenous	Non-Indigenous	Rate Ratios
Crude Cancer Incidence Rate (per 100,000)	206	538	0.4
Standardised Cancer Incidence Rate (per 100,000)	543	519	1.1
Lifetime Cumulative Cancer Incidence Rate: from age 0 to age 74, (per 100,000)	8762	8126	1.1
Lifetime Cancer Probability: the probability of an individual developing a lifetime cancer	43.80%	40.60%	1.1

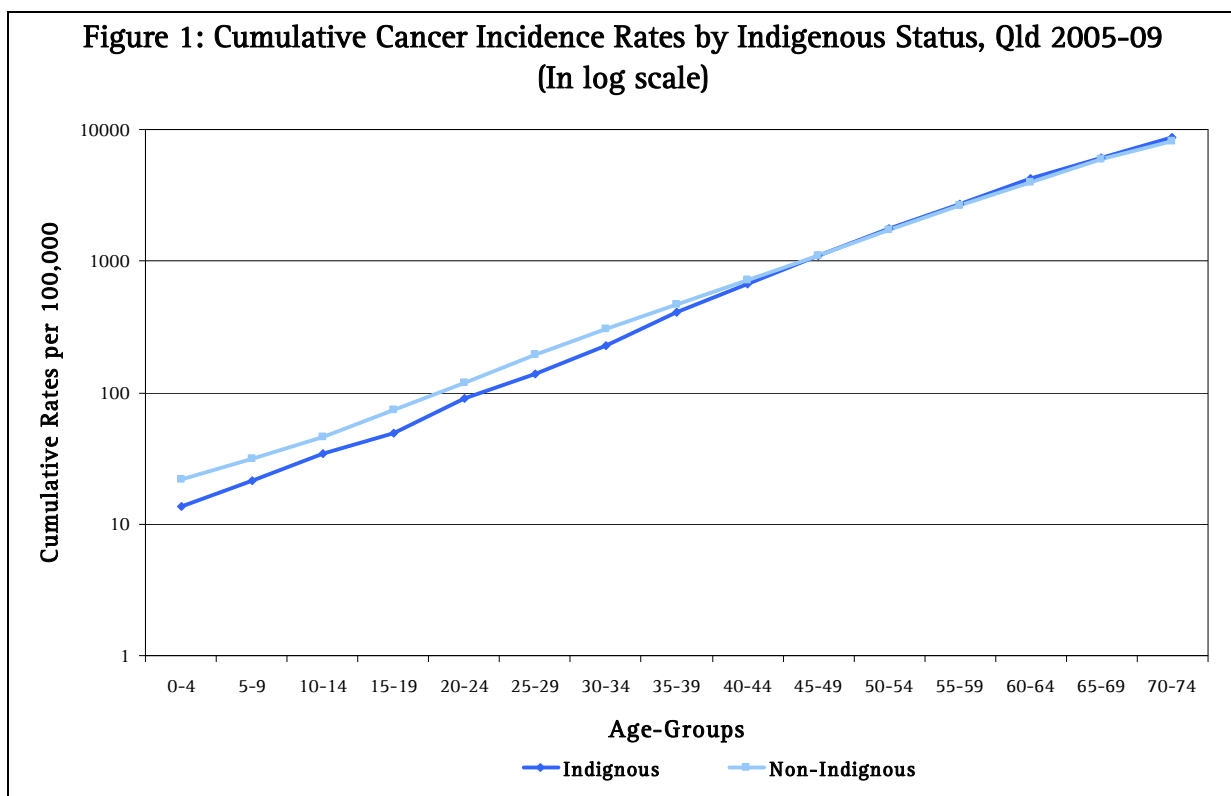
Source: Registered new cases of cancer incidence, Qld Health, Cancer Registry, (Extracted 05/04/2012)

In the example that we have used in this paper, cancer incidence, lifetime cumulative rate is defined as the probability of developing a cancer between the ages of 0-74 years. In Appendix 3, the age specific rates between ages 0-74 are summed. That is:

$$(13.54+7.61+12.85+15.16+41.75+46.42+91.51+180.49+258.34+428.14+671.02+950.59+1,490.41+1,931.75+2,622.29) = 8,761.87 \text{ per } 100,000.$$

The lifetime cumulative cancer incidence rates are shown in Table 1. This shows the magnitude of the risk of cancer for a group of 100,000 Indigenous and 100,000 non-Indigenous people during their lifetime. They show that about 8762 Indigenous and about 8126 non-Indigenous persons out of 100,000 persons will be likely to develop cancer during their lifetime if the age-specific cancer incidence rates of 2005-09 prevail throughout their life span.

Figure 1 shows age-specific cumulative cancer incidence rates by Indigenous status in Qld for the period 2005-09. It shows the accumulation of cancer risk over the age groups, from childhood to adulthood, mature ages and on to old ages. It shows that up until the age group 40-44, the non-Indigenous cancer incidence rates are higher than those of the Indigenous people. The rates converge from middle ages and continue at the same level until old ages. This information is valuable for measurement and comparison of the increments of change in the risk of cancer as people age.



Appendix 3 and Appendix 4 show the calculation steps involved in all of the measures discussed above. Crude rates are the easiest to calculate. All that is needed is the total number of incident cases for the study period and the total population for the year or total number of person years at risk for a period of time. To calculate the age standardised rate (direct method here) we needed age-specific incidence rates for both Indigenous and non-Indigenous populations and a standard population (Australian population at 30 June 2001). To calculate the lifetime cumulative cancer incidence rate we needed age-specific incidence rates.

### Lifetime risk probability

Another measure that can be derived from cumulative lifetime rate is *lifetime risk probability*. To obtain this measure, the cumulative age-specific rates are divided by 100,000 then multiplied by 5 (number of years in the age groups) and converted to a percentage to obtain the percent chance of an individual developing cancer during his or her lifetime. Hence, from the example in Appendix 3, the calculations required to convert to the probability of an individual developing cancer are:  $(8,761.87/100,000) \times 5 = 0.4381$ , 43.81%. This figure assumes that the age-specific cancer incidence rates of the study period prevail throughout their lifetime. Table 1 showed that the Lifetime Cancer Probability for Indigenous people in Qld is 43.8% compared to 40.6% for non-Indigenous Queenslanders.

### Conclusions

Lifetime cumulative rate is a useful supplementary method for describing incidence and for comparing incidence of disease and deaths in Indigenous and non-Indigenous populations. No standard population is needed to calculate lifetime cumulative rate. In addition, cumulative rates by age groups show age differentials of risk which provide further analytical possibilities. Cumulative rates by age groups can easily be converted to probabilities of risk, which can be comprehended easily by the general public.

A limitation of this method is that it is not applicable to the measurement of prevalence which precludes its use for assessing differences in hospitalisation rates.

### References

- ABS 2011, Deaths Australia, 3302.0, 2010.
- AIHW 2011, Principles on the use of direct age-standardisation in administrative data collections, Canberra.
- Queensland Health 2012, Experimental Life Tables by Remoteness, Queensland, 2002-04 and 2005-07, forthcoming Discussion Paper, HSC.
- New Mexico Department of Health 2010, Age-adjusted rates, Santa Fe.
- WHO 1994, Statistical Methods in Cancer Research Volume iv, Descriptive Epidemiology, Lyon.
- WHO 2007, Cancer Incidence in Five Continents, Volume IX / edited by M.P. Curado [et al.] International Agency for Research on Cancer (IARC Scientific Publications; 160).

Appendix 1: Indigenous Females Crude Death Rate, Age-Specific Mortality Rates, and Age-Standardised Mortality Rate, Qld, 2002-2004

Age groups	Indigenous Female Deaths*	Indigenous Female aggregated ERP(1)	Indigenous ASDRs(2)	Indigenous Standardised Rate	Australia Standard Population 30 June 01 (per 1000)
00-04	51	27,821	0.00184	0.1	66
05-09	7	27,451	0.00026	0.0	70
10-14	7	24,893	0.00029	0.0	70
15-19	11	19,350	0.00058	0.0	70
20-24	14	16,514	0.00084	0.1	67
25-29	19	15,348	0.00121	0.1	72
30-34	25	16,157	0.00157	0.1	76
35-39	38	13,646	0.00280	0.2	77
40-44	51	11,643	0.00440	0.3	76
45-49	61	9,189	0.00660	0.5	70
50-54	64	7,295	0.00872	0.6	67
55-59	68	5,066	0.01341	0.7	52
60-64	76	3,350	0.02256	1.0	42
65-69	80	2,398	0.03348	1.2	35
70-74	73	1,635	0.04489	1.5	33
75+	173	2169	0.07974	4.6	57
Grand Total	819	203925	0.004014	10.9	1000

\*Deaths Registered in Queensland, Usual Residence of Queensland by Registration year.

Observed Crude Death Rate (per 1000) 4.0

Standardised Mortality Rate (per 1000) 10.9

(1) Estimated Resident Population (ERP)

(2) Age-Specific Death Rates (ASDRs)

Appendix 2: Non-Indigenous Females Crude Death Rate, Age-Specific Mortality Rates, and Age-Standardised Mortality Rate, Qld, 2002-2004

Age groups	non-Indigenous Female Deaths*	non-Indigenous Female aggregated ERP(1)	non-Indigenous ASDRs(2)	non-Indigenous Standardised Rate	Australia Standard Population 30 June 01 per 1000
00-04	319	341,074	0.00094	0.1	66
05-09	31	363,565	0.00008	0.0	70
10-14	52	378,128	0.00014	0.0	70
15-19	76	376,623	0.00020	0.0	70
20-24	102	375,688	0.00027	0.0	67
25-29	123	373,722	0.00033	0.0	72
30-34	165	417,986	0.00039	0.0	76
35-39	247	408,146	0.00060	0.0	77
40-44	375	431,245	0.00087	0.1	76
45-49	535	395,812	0.00135	0.1	70
50-54	742	370,174	0.00201	0.1	67
55-59	965	324,737	0.00297	0.2	52
60-64	1254	243,579	0.00515	0.2	42
65-69	1729	194,499	0.00889	0.3	35
70-74	2625	170,827	0.01537	0.5	33
75+	23256	361011	0.06442	3.7	57
Grand Total	32596	5526816	0.005898	5.4	1000

\*Deaths Registered in Queensland, Usual Residence of Queensland by Registration year.

Crude Death Rate (per 1000) 5.9  
 Indigenous to non-Ind Crude Death Rate Ratio 0.7  
 Standardised Mortality Rate (per 1000) 5.4  
 Indigenous to non-Ind ASR Rate Ratio 2

(3) Estimated Resident Population (ERP)

(4) Age-Specific Death Rates (ASDRs)

Appendix 3: Indigenous Cancer Incidence by Age Group, Qld, 2005-2009

Age-groups	Registered new cases of cancer incidence	5 year aggregated Estimated Resident Populations	Age-specific incidence rates per 100,000	Cumulative Rates per 100,000	Probability of an individual developing a lifetime cancer	Australian Standard Population 30 June 2001	Age Standardised Rates
0-4	13	97,013	13.54	13.54	0.07%	6,606	0.89
5-9	7	94,339	7.61	21.15	0.11%	6,963	0.53
10-14	12	93,612	12.85	34.00	0.17%	6,970	0.90
15-19	12	80,798	15.16	49.15	0.25%	6,968	1.06
20-24	27	63,481	41.75	90.90	0.45%	6,709	2.80
25-29	25	53,688	46.42	137.32	0.69%	7,248	3.36
30-34	47	50,964	91.51	228.83	1.14%	7,555	6.91
35-39	90	49,945	180.49	409.32	2.05%	7,687	13.87
40-44	110	42,504	258.34	667.66	3.34%	7,620	19.68
45-49	149	34,896	428.14	1,095.80	5.48%	6,998	29.96
50-54	185	27,619	671.02	1,766.82	8.83%	6,700	44.96
55-59	197	20,716	950.59	2,717.42	13.59%	5,196	49.40
60-64	205	13,787	1,490.41	4,207.83	21.04%	4,234	63.11
65-69	167	8,657	1,931.75	6,139.58	30.70%	3,516	67.91
70-74	147	5,591	2,622.29	8,761.87	43.81%	3,288	86.23
75+	177	6,679	2,643.34	11,405.21		5,742	151.77
Total	1533	744,289	205.95			100,000	543.36

Source: Registered new cases of cancer incidence, Cancer Registry, Queensland Health (Extracted 05/04/2012).

Notes:

(1) New cases with unknown Indigenous status have been proportionally assigned to Indigenous and non-Indigenous.

Annex 2: Non-Indigenous Cancer Incidence by Age Group, Qld, 2005–2009

Age-groups	Registered new cases of cancer incidence	5 year aggregated Estimated Resident Populations	Age-specific incidence rates per 100,000	Cumulative Rates per 100,000	Probability of an individual developing a lifetime cancer	Australian Standard Population 30 June 2001	Age Standardised Rates
0-4	287	1,302,542	22.02	22.02	0.11%	6,606	1.45
5-9	123	1,302,264	9.43	31.45	0.16%	6,963	0.66
10-14	198	1,368,642	14.46	45.92	0.23%	6,970	1.01
15-19	385	1,386,956	27.74	73.66	0.37%	6,968	1.93
20-24	649	1,456,055	44.61	118.27	0.59%	6,709	2.99
25-29	1059	1,397,938	75.76	194.03	0.97%	7,248	5.49
30-34	1547	1,422,718	108.76	302.79	1.51%	7,555	8.22
35-39	2425	1,501,783	161.46	464.25	2.32%	7,687	12.41
40-44	3717	1,475,846	251.87	716.12	3.58%	7,620	19.19
45-49	5783	1,471,909	392.86	1,108.99	5.54%	6,998	27.49
50-54	8172	1,341,243	609.26	1,718.25	8.59%	6,700	40.82
55-59	11854	1,254,750	944.74	2,662.98	13.31%	5,196	49.09
60-64	14062	1,052,238	1,336.34	3,999.33	20.00%	4,234	56.59
65-69	14938	784,201	1,904.84	5,904.17	29.52%	3,516	66.97
70-74	13294	598,449	2,221.47	8,125.64	40.63%	3,288	73.05
75+	30433	1,153,368	2,638.66	10,764.30		5,742	151.50
Total	108963	20,270,902	537.53			100,000	518.87
Rate Ratios			0.4	1.1			1.0

Source of registered new cases of cancer incidence: Cancer Registry, Queensland Health (Extracted 05/04/2012).

Notes:

(1) New cases with unknown Indigenous status have been proportionally assigned to Indigenous and non-Indigenous.