Some limitations of the mortality data presented in this bulletin should be noted. The lack of uniform practice among medical practitioners in completing death certificates for individuals with diabetes makes it difficult to determine the causal role of diabetes in specific causes of death (Knuiman et al. 1992) and it is possible that the role of diabetes in mortality is under-recognised. Selection of a single underlying cause of death is also likely to be difficult in people with multiple chronic diseases as is often the case in people with diabetes. Finally, differences in methods of counting deaths from diabetes mean that some of the data presented here are not directly comparable with previously published estimates. For example, Mathur et al. (2000) defined diabetes-related deaths as deaths where diabetes was the underlying or an associated cause of death (irrespective of the underlying cause).

Conclusion

This analysis has taken steps toward more accurately quantifying the extent to which diabetes and its complications contribute to deaths in Australia. The findings also provide valuable information on key predictors of diabetes mortality in the population. Diabetes-related deaths are disproportionately high among elderly Australians, men, Australians living in lower socioeconomic and remote areas, and Aboriginal and Torres Strait Islander Australians.

Appendix 1: Statistical methods

Data classification and limitations

Identification of diabetes-related deaths

As described in Box 1 (see p. 5), this bulletin defines a diabetes-related death to be a death where either diabetes was recorded as the underlying cause of death, or where the underlying cause of death was one of a defined list of diabetes complications and diabetes was recorded as an associated cause of death. The ICD-10 codes used to identify these deaths are listed in Table A1.

A limitation of this definition is that it may capture some deaths that are unrelated to diabetes.

Table A1: ICD-10 codes used to identify diabetes-related deaths

Condition	ICD-10 code
Diabetes	E10–E14
Myocardial infarction	I21–I22
Ischaemic heart disease	I20, I24, I25
Stroke	I60–I64
Sequelae of stroke	I69.0–I69.4
Heart failure	I50
Sudden cardiac death	I46
Peripheral vascular disease	I70–I74
Kidney disease	N01–N28
Hypoglycaemia	E16.1–E16.2
Hyperglycaemia	R73

Aboriginal and Torres Strait Islander people

For the period 2001–2003, the Indigenous identifier on the AIHW National Mortality Database was considered usable only for deaths registered in the Northern Territory, South Australia, Western Australia, and Queensland. Identification of Indigenous status in death records is not of sufficient quality for use in New South Wales, Victoria, Tasmania, or the Australian Capital Territory. This makes it difficult to get accurate national estimates of Indigenous mortality rates, make comparisons with the non-Indigenous population, and examine geographical variation. Trends in Indigenous mortality need to be interpreted with caution as differences may reflect changes in data quality, coverage, or collection methods rather than real changes in Indigenous health. The reliability of Indigenous status as reported by another person is also uncertain.

In this analysis, only persons specifically identified as being of Aboriginal and/or Torres Strait Islander origin were classified as Indigenous. All other persons were classified as non-Indigenous. The non-Indigenous group therefore includes deaths where the person's Indigenous status was unknown or not recorded.

Overseas-born Australians

Country of birth of the deceased is recorded in the AIHW National Mortality Database and is encoded using Australian standard classification systems. For 2001 and 2002 the Australian Standard Classification of Countries for Social Statistics (ASCCSS) was used (ABS 1990). For 2003 the Standard Australian Classification of Countries (SACC) was used (ABS 1998). The SACC coding system was used to group countries into regions for this analysis. The SACC publication contains a map relating the ASCCSS and SACC codes, and this has been used to ensure consistency in country groupings over the 3 years.

Limitations of the country of birth data are similar to those concerning Indigenous status, in that the accuracy of country of birth information when reported by another person may be questionable, or indeed the country of birth may be unknown. Further, the quality and method of collection of country of birth data, and country boundaries, may change over time, making it difficult to interpret long-term trends. Records where the country of birth was unknown or not recorded (157 deaths, 0.7%) were excluded from the region of birth analysis in this bulletin.

Diabetes type

The accuracy of identification of the type of diabetes a person had also presents difficulties for those certifying deaths. In ICD-10, diabetes is split into 'insulin-dependent' and 'non-insulin-dependent' diabetes rather than Types 1 and 2. Although the former terms should map directly to the latter, the use of the word 'insulin' may cause confusion and lead to classification based on treatment type rather than disease type. The accuracy of the classification of deceased persons into these two groups of diabetes is uncertain. Therefore, in this bulletin deaths from both types of diabetes have been combined.

Area of usual residence

In the AIHW National Mortality Database, area of usual residence is recorded at the Statistical Local Area (SLA) level. Since SLA boundaries may change from year to year, concordance files supplied by the ABS were used to map all data used in this analysis to the 2001 SLA boundaries. Geographical areas were therefore able to be defined consistently over time.

For this bulletin, three major geographical regions were defined: major cities, regional Australia, and remote Australia. SLAs are classified into these three regions based on their score on the Accessibility/Remoteness Index of Australia (DoHA & University of Adelaide 1999). This index is calculated based on how distant a place is by road from urban centres of different sizes, and therefore provides a relative indication of how difficult it might be for residents to access certain services such as health care and education. In 2001–2003, 65 deaths (0.3%) could not be mapped to one of the three regions. These records were excluded from the analysis.

Socioeconomic status

In this report, the Index of Disadvantage was used to determine socioeconomic status (ABS 2004c). This index is one of several socioeconomic indexes derived by the Australian Bureau of Statistics from information collected in the Census of Population and Housing. The Index of Disadvantage is an area-based measure which represents the average level of disadvantage across a geographic area, in this case the SLA. It is derived from social and economic characteristics of the SLA such as low income, low educational attainment, high levels of public sector housing, high unemployment, and jobs in relatively less skilled occupations.

In this analysis, individual death records were classified into quintiles of socioeconomic disadvantage based on the Index of Disadvantage value of the SLA of the deceased person's usual residence. SLAs were grouped into quintiles so that each quintile contained approximately 20% of the total Australian population. Quintile 1 includes the most disadvantaged households and Quintile 5 the least disadvantaged households. In 2001–2003, 59 deaths (0.3%) could not be mapped to an Index of Disadvantage value. These records were excluded from the analysis.

It is important to note that the Index of Disadvantage is an area-based measure of disadvantage. It will therefore tend to understate the true inequality in health at an individual level.

Statistical methods

Age-specific rates

Age-specific death rates were calculated by dividing the number of deaths occurring in a particular age group by the mid-year estimated resident population for that age group.

Age-standardised rates

Age standardisation is used to remove the influence of age when comparing populations with different age structures. This is done by applying age-specific rates

to a standard population. In this analysis the 2001 Australian population was used as the standard population.

Direct age standardisation

This is the most common method of age standardisation, and is used in this report for all analyses except analysis by Indigenous status and region of birth for which indirect age standardisation has been used (see below). Direct age standardisation is used when the populations of interest are large and the age-specific rates are reliable. Direct age-standardised rates are calculated as follows:

Step 1: Calculate the age-specific death rate for each age group in the population of interest.

Step 2: Calculate the expected number of deaths in each age group by multiplying the age-specific rate by the corresponding standard population for each age group.

Step 3: Add together the expected number of deaths in each age group and divide the total by the total standard population. This is the age-standardised death rate.

Indirect age standardisation

This method of age standardisation is used when the populations of interest are small or when the age-specific rates may not be stable. In this report, indirect age standardisation is used to examine deaths in the Indigenous population and among overseas-born Australians.

Indirect age standardisation removes the effect of age but does not provide a result in terms of a rate. Instead the summary measure is a comparison of the number of deaths observed compared to the number expected if the age-specific death rates of the standard population applied in the population of interest. The method used is as follows:

Step 1: Calculate the age-specific death rate for each age group in the standard population.

Step 2: Multiply these age-specific rates by the number of people in each age group of the population of interest and sum to calculate the expected number of deaths in the population of interest.

Step 3: Add together the number of deaths observed in the population of interest and divide this number by the expected number of deaths derived in Step 2. This is the Standardised Mortality Ratio (SMR).

An SMR of 1 indicates the same number of deaths occurred as were expected (suggesting death rates in the population of interest were similar to those in the standard population). An SMR greater than one indicates more deaths than were expected, while an SMR less than one indicates fewer deaths than were expected. For example, if there were twice as many deaths as were expected (SMR of 2.0) then the rate of death in the population of interest can be assumed to be twice that of the standard population.

Significance testing

Significance testing is a way of detecting differences between different population groups. In this report significance tests for differences in death rates between two population groups were performed by examining confidence intervals. The difference between the two rates was calculated and a 95% confidence interval was constructed around this value. Adjustments were made for multiple comparisons using the Bonferroni adjustment. If the confidence interval did not contain zero, the two rates were considered to be significantly different. The standard pooled variance formula was used to calculate confidence intervals (see Armitage & Berry 1994).

Appendix 2: Statistical tables

Tables presented here give estimates for males, females and persons.

Table A2: Selected underlying causes of death listed with diabetes as an associated cause of death, 2003

Underlying cause of death	Number of deaths		
	Males	Females	Persons
Acute myocardial infarction*	813	600	1,413
Ischaemic heart disease*	620	489	1,109
Stroke or sequelae of stroke*	321	391	712
Heart failure*	65	73	138
Peripheral vascular disease*	39	31	70
Sudden death (cardiac arrest)*	—	1	1
Circulatory disorder subtotal*	*1,858*	*1,585*	*3,443*
Neoplasms	1,121	799	1,920
Respiratory disease	346	290	636
Kidney disease*	94	95	189
Infectious/parasitic diseases	76	74	150
External causes (e.g. accidents)	64	51	115
Hyper/Hypoglycaemia*	—	1	1
Other	703	854	1,557
Total	**6,069**	**5,331**	**8,011**

* Common complications of diabetes.

Source: AIHW National Mortality Database.

Table A3: Diabetes-related deaths and diabetes as an underlying cause of death, 1998 to 2003

	Year					
	1998	1999	2000	2001	2002	2003
	Rate per 100,000 population (95% confidence interval)					
Males						
Diabetes-related	68.8 (66.4–71.2)	68.4 (66.1–70.8)	67.2 (64.9–69.5)	67.7 (65.5–69.9))	70.0 (67.8–72.3)	66.5 (64.3–68.6)
Underlying only	30.6 (29.0–32.2)	29.5 (28.0–31.0)	30.9 (29.3–32.4)	30.7 (29.2–32.2)	32.1 (30.6–33.6)	31.8 (30.3–33.3)
Females						
Diabetes-related	45.5 (43.9–47.1)	43.9 (42.3–45.4)	42.9 (41.4–44.4)	41.5 (40.0–43.0)	42.3 (40.8–43.7)	40.4 (39.0–41.7)
Underlying only	20.5 (19.4–21.6)	20.8 (19.7–21.9)	19.5 (18.5–20.5)	19.1 (18.1–20.1)	19.9 (18.9–20.9)	19.6 (18.6–20.6)
Persons						
Diabetes-related	55.5 (54.2–56.9)	54.6 (53.2–55.9)	53.4 (52.1–54.7)	52.8 (51.6–54.1)	54.3 (53.0–55.5)	51.7 (50.5–52.9)
Underlying only	24.8 (23.9–25.7)	24.6 (23.8–25.5)	24.3 (23.4–25.2)	24.1 (23.2–24.9)	25.2 (24.3–26.0)	25.0 (24.1–25.8)

Notes

1. Age-standardised to the 2001 Australian population.

2. Data for people aged 25 years and over.

Source: AIHW National Mortality Database.

Table A4: Number of diabetes-related deaths, by age group, 2001 to 2003

	Males			Females			Persons		
	2001	2002	2003	2001	2002	2003	2001	2002	2003
Age (years)	Number								
<25	2	4	2	4	5	6	6	9	8
25–34	14	7	15	5	9	7	19	16	22
35–44	58	52	48	28	20	21	86	72	69
45–54	174	164	135	82	71	64	256	235	199
55–64	438	442	401	208	185	168	646	627	569
65–74	946	999	979	562	593	547	1,508	1,592	1,526
75–84	1,323	1,414	1,416	1,207	1,267	1,227	2,530	2,681	2,643
85+	654	760	763	1,046	1,167	1,222	1,700	1,927	1,985
All ages	**3,609**	**3,847**	**3,759**	**3,142**	**3,319**	**3,262**	**6,751**	**7,166**	**7,021**
25 and over	**3,607**	**3,838**	**3,757**	**3,138**	**3,312**	**3,256**	**6,745**	**7,150**	**7,013**
All ages (ASR)	**44.6**	**46.1**	**43.7**	**27.3**	**27.9**	**26.6**	**34.8**	**35.7**	**34.1**
25 and over (ASR)	**67.7**	**70.0**	**66.5**	**41.5**	**42.3**	**40.4**	**52.8**	**54.3**	**51.7**

Note: Age-standardised to the 2001 Australian population.

Source: AIHW National Mortality Database.

Diabetes-related deaths in Australia, 2001–2003

Table A5: Diabetes-related deaths, by age group, 2001–2003

	Number			Age-specific rate per 100,000 population		
	Males	**Females**	**Persons**	**Males**	**Females**	**Persons**
Age (years)						
<25	8	15	23	0.1	0.2	0.1
25–34	36	21	57	0.8	0.5	0.7
35–44	158	69	227	3.5	1.5	2.5
45–54	473	217	690	11.8	5.4	8.6
55–64	1,281	561	1,842	43.7	19.6	31.8
65–74	2,924	1,702	4,626	150.2	82.4	115.3
75–84	4,153	3,701	7,854	373.2	243.5	298.4
85+	2,177	3,435	5,612	843.3	602.2	677.3
All ages	**11,215**	**9,723**	**20,938**	**38.3**	**32.8**	**35.5**
25 and over	**11,202**	**9,706**	**20,908**	**58.9**	**48.8**	**53.7**
All ages (ASR)	..	..	..	**44.8 (44.0–45.6)**	**27.3 (26.7–27.8)**	**34.9 (34.4–35.3)**
25 and over (ASR)	..	..	..	**68.1 (69.3–66.8)**	**41.4 (40.5–42.2)**	**52.9 (52.2–53.6)**

. . not applicable

Notes

1. Age-standardised to the 2001 Australian population.

2. Data for 2001, 2002 and 2003 are combined.

Source: AIHW National Mortality Database.

Table A6: Diabetes-related deaths by state/territory, 2001–2003

	State/territory								
	New South Wales	**Victoria**	**Queensland**	**Western Australia**	**South Australia**	**Tasmania**	**Australian Capital Territory**	**Northern Territory**	**Australia**
	Age-standardised rate per 100,000 population (95% confidence interval)								
Males	66.6 (64.5–68.8)	72.9 (70.3–75.5)	62.2 (59.4–65.1)	63.7 (59.5–67.8)	71.7 (67.3–76.0)	75.6 (67.3–84.0)	51.2 (40.2–62.1)	128.4 (99.6–157.2)	68.1 (66.8–69.3)
Females	38.3 (36.9–39.6)	44.7 (43.0–46.4)	40.1 (38.2–42.1)	41.4 (38.5–44.2)	42.2 (39.4–45.0)	47.1 (41.7–52.5)	29.9 (23.3–36.5)	102.1 (77.9–126.4)	41.4 (40.6–42.2)
Persons	50.6 (49.4–51.7)	56.8 (55.3–58.3)	49.8 (48.2–51.5)	51.2 (48.8–53.6)	54.6 (52.2–57.1)	59.4 (54.7–64.1)	38.8 (33.0–44.7)	113.8 (95.5–132.1)	52.9 (52.2–53.6)

Notes

1. Age-standardised to the 2001 Australian population.

2. Data for 2001, 2002 and 2003 are combined.

3. Data for people aged 25 years and over.

Source: AIHW National Mortality Database.

Table A7: Diabetes-related deaths by region, 2001–2003

	Region		
	Major cities of Australia	**Regional Australia**	**Remote Australia**
	Age-specific rate per 100,000 population (95% confidence interval)		
Males	64.9 (63.3–66.5)	71.6 (69.3–73.8)	97.8 (86.8–108.9)
Females	38.6 (37.6–39.6)	44.2 (42.7–45.7)	90.2 (79.8–100.5)
Persons	49.8 (48.9–50.7)	56.3 (55.0–57.6)	94.0 (86.5–101.5)

Notes

1. Age-standardised to the 2001 Australian population.

2. Data for 2001, 2002 and 2003 are combined.

3. Data for people aged 25 years and over.

Source: AIHW National Mortality Database.

Table A8: Diabetes-related deaths by quintile of socioeconomic disadvantage (SEIFA), 2001–2003

	SEIFA quintile				
	First (most disadvantaged)	**Second**	**Third**	**Fourth**	**Fifth (least disadvantaged)**
	Age-specific rate per 100,000 population (95% confidence interval)				
Males	84.4 (81.3–87.6)	71.5 (68.6–74.3)	70.0 (67.1–72.9)	61.8 (58.8–64.8)	51.6 (49.2–54.0)
Females	55.3 (53.2–57.5)	45.5 (43.6–47.4)	42.6 (40.7–44.5)	37.1 (35.2–39.0)	27.5 (26.1–28.8)
Persons	68.0 (66.2–69.8)	57.0 (55.3–58.6)	54.7 (53.0–56.3)	48.0 (46.4–49.7)	37.3 (36.1–38.6)

Notes

1. Age-standardised to the 2001 Australian population.

2. Data for 2001, 2002 and 2003 are combined.

3. Data for people aged 25 years and over.

4. Socioeconomic Indexes for Areas (SEIFA). The Index of Disadvantage is used in this analysis. The first quintile corresponds to the most disadvantaged group and the fifth to the least disadvantaged group.

Source: AIHW National Mortality Database.

Table A9: Diabetes-related deaths by region of birth, 2001–2003

	Region of birth						
	New Zealand	**South Pacific**	**UK & Ireland**	**Southern Europe**	**Northern & Western Europe**	**South Eastern Europe**	**Eastern Europe**
	Standardised mortality ratio (95% confidence interval)						
Males	0.8 (0.6–1.0)	2.6 (1.8–3.5)	0.9 (0.8–1.0)	1.5 (1.3–1.6)	1.0 (0.9–1.2)	1.4 (1.3–1.6)	1.4 (1.3–1.6)
Females	0.8 (0.6–1.1)	3.0 (2.1–4.2)	1.0 (0.9–1.1)	2.1 (1.8–2.3)	1.2 (1.1–1.4)	2.0 (1.8–2.3)	1.3 (1.1–1.5)
Persons	0.8 (0.6–1.0)	2.7 (2.1–3.5)	0.9 (0.9–1.0)	1.7 (1.6–1.8)	1.1 (1.0–1.2)	1.6 (1.5–1.8)	1.4 (1.2–1.5)

Table A9 (continued): Diabetes-related deaths by region of birth, 2001–2003

	Region of birth					
	Middle East & North Africa	Southeast Asia	Northeast Asia	Southern & Central Asia	Americas & Caribbean	Sub-Saharan Africa
	Standardised mortality ratio (95% confidence interval)					
Males	1.9 (1.6–2.3)	0.8 (0.6–1.1)	0.8 (0.6–1.0)	1.2 (0.9–1.5)	0.6 (0.4–0.9)	0.9 (0.6–1.3)
Females	2.6 (2.1–3.2)	1.2 (0.9–1.4)	0.7 (0.5–1.0)	1.4 (1.0–1.8)	0.9 (0.6–1.3)	0.9 (0.6–1.4)
Persons	2.2 (1.9–2.5)	1.0 (0.8–1.2)	0.8 (0.6–0.9)	1.3 (1.0–1.5)	0.7 (0.5–1.0)	0.9 (0.7–1.2)

Notes

1. By definition, the SMR for Australian-born is equal to 1.00.

2. SMR (Standardised mortality ratio) is the ratio of the observed number of deaths to the number of expected deaths if Australians born overseas had experienced the same age–sex-specific death rates as Australian-born Australians.

3. Data for 2001, 2002 and 2003 are combined.

4. Data for people aged 25 years and over.

Source: AIHW National Mortality Database.

Acknowledgments

Glossary

angina	Temporary chest pain or discomfort when the heart's own blood supply is inadequate to meet extra needs, as in exercise.
associated cause of death	All morbid conditions, disease and injuries (other than the underlying cause of death) contributing to death.
cardiac arrest	The complete cessation of activity of the heart.
cardiovascular disease	Any disease of the heart or blood vessels, for example heart attack, stroke, angina, or peripheral vascular disease.
coronary heart disease (CHD)	Heart attack and angina. Also known as ischaemic heart disease.
diabetes-related death	Any death with an underlying cause of death of diabetes, or where the underlying cause was one of a specific list of common complications of diabetes and diabetes was recorded as an associated cause of death. See Box 1, p. 5.
glucose	A type of sugar the body uses for energy. The main source of glucose is carbohydrates in the diet.
heart attack	A life-threatening emergency that occurs when a vessel supplying blood to the heart muscle is suddenly blocked completely. The event may lead to the death of a part of the heart muscle. The medical term commonly used for a heart attack is myocardial infarction.
heart failure	When the heart cannot pump strongly enough to keep the blood circulating around the body at an adequate rate.
hyperglycaemia	High blood glucose levels.
hypoglycaemia	Low blood glucose levels.
ischaemic heart disease	See *coronary heart disease.*
mortality	Death.
myocardial infarction	See *heart attack*.
peripheral vascular disease	Refers to diseases of arteries outside the heart and brain. It occurs when fatty deposits build up in the inner walls of these arteries and affect blood circulation.
sequelae	A condition following as a consequence of a disease.
stroke	An event in which an artery supplying blood to the brain suddenly becomes blocked or bleeds.
sudden death	Sudden (unexpected) death caused by cardiac arrest.
underlying cause of death	The main disease or injury initiating the sequence of events leading directly to death.

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