

3 A profile of diabetes mortality

3.1 Introduction

Diabetes causes death, both as a disease in its own right and as a risk factor for microvascular and macrovascular complications, which affect organs through impairment of their blood supply. Macrovascular complications affect the large blood vessels and include diseases such as coronary heart disease, stroke, and peripheral vascular disease.

Microvascular complications affect smaller vessels leading to kidney disease, renal failure, nerve damage and loss of vision and these complications are more likely to be associated with Type 1 diabetes. Since several of these complications are life-threatening, diabetes can contribute significantly to premature mortality through these pathways. Diabetes is rarely if ever recorded alone as the underlying cause of death with no associated causes listed.

Attribution of diabetes-related mortality therefore requires an extensive analysis of diabetes as an associated cause of death as well as the underlying cause of death.

Although much of the information on the underlying causes of death has been available in Australia since the early 1900s, information on additional causes of death has become available only since 1997. The latter information, though not possible to interpret as a direct cause of death, is useful in gaining further insight into the contribution diabetes makes to mortality overall.

This chapter explores this issue in detail in three sections:

- diabetes as the underlying cause or an associated cause of death;
- diabetes as the underlying cause of death; and
- diabetes as an associated cause of death.

To allow for more detailed analysis, mortality data for 1997 and 1998 have been combined. Disaggregation by age and sex has been attempted where the numbers are sufficiently large. Interpopulation and regional differences in diabetes-related mortality are presented in chapters 4 and 5.

3.2 Diabetes as the underlying cause or an associated cause of death

Diabetes was the underlying or an associated cause of 18,982 deaths, or 7.4% of all deaths, in 1997 and 1998 (Table 3.1). In less than one-third of these cases, diabetes was recorded as the underlying cause of death. Even in these cases, diabetes was listed as the only cause in less than 2% of deaths (Table 3.4).

There were more male than female deaths with diabetes as the underlying or associated cause, even though the proportion was similar in both sexes. Age-standardised death rate comparisons clearly indicate a much higher death rate among males (57.2 per 100,000) than females (36.5 per 100,000) (Table A1).

Table 3.1: Diabetes as a cause of death, 1997 and 1998

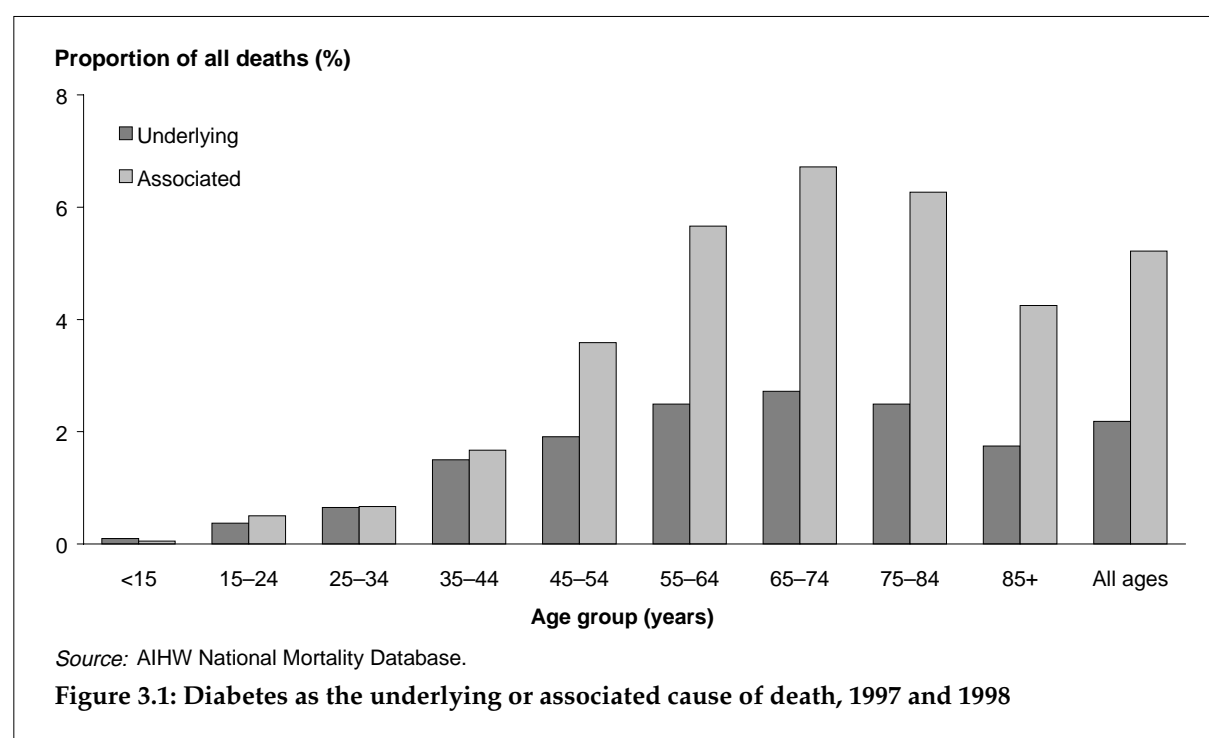
Cause of death	Proportion of all deaths (%)			Number		
	Males	Females	Persons	Males	Females	Persons
Underlying	2.1	2.3	2.2	2,849	2,747	5,596
Associated	5.3	5.1	5.2	7,187	6,199	13,386
<i>Total diabetes deaths</i>	<i>7.4</i>	<i>7.3</i>	<i>7.4</i>	<i>10,036</i>	<i>8,946</i>	<i>18,982</i>
Total deaths	100.0	100.0	100.0	134,825	121,727	256,552

Source: AIHW National Mortality Database.

A report from the Australian Bureau of Statistics (ABS) has shown that when diabetes is the underlying cause of death it was associated with one or more diseases in 98.5% of cases in 1998. In other words, diabetes was the only cause of death recorded in 1.5% of these deaths. This was a substantially smaller proportion than for other diseases such as malignant neoplasms (35.0%), stroke (19.6%), mental disorders (12.5%) and coronary heart disease (11.5%) (ABS 1999).

Diabetes-related deaths rise in proportion with increasing age. The increase is particularly rapid from age 45 years onwards. For example, in 1997 and 1998, the proportion of age-specific deaths from diabetes increased from less than 1% among 15–24-year-olds to 9.4% among those aged 65–74 years. The proportion declined thereafter to 8.8% among 75–84-year-olds and 6.0% among those aged 85 and over (Figure 3.1). Around 84% of all diabetes deaths occur among those aged 65 years and over.

In the younger age groups (less than age 45) there were no significant differences in diabetes being recorded as the underlying cause or an associated cause of death. From age 45 diabetes was progressively more likely to be recorded as an associated cause of death than as the underlying cause. In the 65 and over age groups, diabetes was 2.5 times as likely to be recorded as an associated cause of death than as the underlying cause of death (Figure 3.1).



3.3 Diabetes as the underlying cause of death

Diabetes was a leading underlying cause of death among Australians accounting for 5,596 deaths or 2.2% of all deaths in 1997 and 1998 combined. Among females the proportion of deaths where diabetes was the underlying cause was higher than that found in males (2.3% compared with 2.1%). Over the 12-year period 1987 to 1998, the age-standardised rate for diabetes as the underlying cause of death increased among males annually by 1.3%, but no such trend was noted among females (AIHW forthcoming).

The peak age group for diabetes as the underlying cause of death was 65–74 years, with a rapid increase in proportion from age 35 onwards (Figure 3.1). During 1997 and 1998, the proportion of age-specific deaths with diabetes as the underlying cause of death rose from 0.4% among 15–24 year-olds to 2.7% among those aged 65–74 years. The proportion among those aged 85 years and over declined to 1.7%.

Diabetic complications

The ICD-9 classification of diabetes as the underlying cause of death is coded, at the fourth digit level, into nine different categories (Table 3.2). This fourth digit level identifies the complications present at death when diabetes is recorded as the underlying cause of death. Of the 5,596 deaths where diabetes was listed as the underlying cause of death, no diabetic complication was listed in 71.4% of deaths, and peripheral circulatory disorders, renal manifestations and ketoacidosis were listed as specific diabetic complications in 15.7%, 6.4% and 2.3% of deaths, respectively (Table 3.2).

Table 3.2: Diabetic complications as the underlying cause of death, 1997 and 1998

Category	Males	Females	Persons
	Proportion of diabetes deaths (%)		
Diabetes mellitus without mention of complication (ICD-9 250.0)	70.6	72.3	71.4
Diabetes with ketoacidosis (ICD-9 250.1)	2.0	2.5	2.3
Diabetes with coma (ICD-9 250.2)	1.7	2.1	1.9
Diabetes with renal manifestations (ICD-9 250.3)	6.7	6.1	6.4
Diabetes with ophthalmic manifestations (ICD-9 250.4)	0.2	0.2	0.2
Diabetes with neurological manifestations (ICD-9 250.5)	0.4	0.6	0.5
Diabetes with peripheral circulatory disorders (ICD-9 250.6)	16.7	14.6	15.7
Diabetes with other specified manifestations (ICD-9 250.7)	1.6	1.6	1.6
Diabetes with unspecified complications (ICD-9 250.9)	0.1	0.0	0.1
<i>Total deaths where diabetes is the underlying cause (%)</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>
Total deaths where diabetes is the underlying cause (number)	2,849	2,747	5,596

Note: Code 250.8 has been omitted from the ICD-9 classification.

Source: AIHW National Mortality Database.

Associated causes of death where diabetes is the underlying cause of death

Number of causes of death

When diabetes is listed as the underlying cause of death it tends to be recorded with numerous associated causes. A report from the ABS highlighted that in 1998 over half of these diabetes deaths were recorded with three or more associated causes (ABS 1999). The mean number of associated causes listed on the death certificate was generally higher for diabetes (2.7 causes) than for other diseases and for all causes of death overall (1.7 causes) (Table 3.3).

Table 3.3: Mean number of associated causes for the leading underlying causes of death, 1998

Underlying causes of death	Mean number of associated causes
Diseases of the musculoskeletal system and connective tissue	2.8
Endocrine, nutritional and metabolic diseases and immunity disorders (including diabetes)	2.7
<i>Diabetes</i>	2.7
Diseases of the genito-urinary system	2.6
Diseases of the digestive system	2.5
Infectious and parasitic diseases	2.3
Diseases of the blood and blood-forming organs	2.2
Diseases of the circulatory system	1.9
Diseases of the respiratory system	1.9
Mental disorders	1.7
Diseases of the nervous system and sense organs	1.6
Neoplasms	1.3
All causes of death	1.7

Source: ABS 1999.

Clustering of associated causes of death

An analysis of the clustering of associated causes when diabetes was the underlying cause of death showed that diseases of the circulatory system, diseases of the genito-urinary system and/or diseases of the nervous system and sense organs were listed as an associated cause in over 90% of deaths in 1997 and 1998. Of these three diseases, diseases of the circulatory system was most likely to be recorded as the only associated cause when diabetes was the underlying cause of death (65.5% of deaths), while for diseases of the genito-urinary system the corresponding proportion was 7.2%, and for diseases of the nervous system and sense organs 0.6%. Diseases of the circulatory system and diseases of the genito-urinary system were the most common associated causes listed together (14% of diabetes deaths), while diseases of the circulatory system and diseases of the nervous system and sense organs were listed together as an associated cause in only 2.8% of deaths. All three associated causes were rarely listed together on death certificates when diabetes was the underlying cause of death (0.5%) (Table 3.4).

Table 3.4: Clustering of associated causes when diabetes is the underlying cause of death, 1997 and 1998

Number and type of associated causes	Number	Per cent
No associated causes	87	1.6
Causes other than diseases of the circulatory system, diseases of the genito-urinary system and diseases of the nervous system and sense organs	420	7.5
Diseases of the circulatory system	3,666	65.5
Diseases of the genito-urinary system	401	7.2
Diseases of the nervous system and sense organs	34	0.6
Diseases of the circulatory system and diseases of the genito-urinary system	786	14.0
Diseases of the circulatory system and diseases of nervous system and sense organs	158	2.8
Diseases of the nervous system and sense organs and diseases of the genito-urinary system	18	0.3
Diseases of the circulatory system and diseases of the genito-urinary system and diseases of the nervous system and sense organs	26	0.5
Total deaths where diabetes was the underlying cause	5,596	100.0

Source: AIHW National Mortality Database.

Associated causes of death

When diabetes was recorded as the underlying cause of death, diseases of the circulatory system was listed as an associated cause in 82.8% of deaths. The most prominent associated causes listed with diabetes were coronary heart disease (52.4%), hypertensive disease (22.3%), stroke (21.0%), renal failure (19.4%), diseases of the respiratory system (18.9%) and heart failure (17.4%) (Table 3.5). Renal failure accounts for the vast majority of deaths from diseases of the genito-urinary system when diabetes is the underlying cause (88%). Coronary heart disease accounts for almost two-thirds of deaths from diseases of the circulatory system, and stroke and hypertensive disease account for over one-quarter of these deaths.

Table 3.5: Deaths where diabetes is the underlying cause of death by associated causes of death, 1997 and 1998

Associated causes of death	Males	Females	Persons
	Proportion of diabetes deaths (%)		
Diseases of the circulatory system	84.1	81.6	82.8
<i>Coronary heart disease</i>	56.3	48.3	52.4
<i>Hypertensive disease</i>	20.2	24.5	22.3
<i>Stroke</i>	20.5	21.4	21.0
<i>Heart failure</i>	16.0	18.9	17.4
<i>Peripheral vascular disease</i>	1.0	0.8	0.9
Diseases of the genito-urinary system	21.2	22.8	22.0
<i>Renal failure</i>	19.3	19.5	19.4
Diseases of the respiratory system	20.4	17.4	18.9
Mental disorders	9.2	10.3	9.7
Infectious and parasitic diseases	8.9	10.4	9.6
Endocrine, nutritional and metabolic diseases and immunity disorders ^(a)	8.0	8.7	8.3
Diseases of the digestive system	5.6	5.6	5.6
Neoplasms	6.0	4.1	5.1
Injury and poisoning	4.4	4.2	4.3
Diseases of the nervous system and sense organs	4.6	3.9	4.2
Diseases of the musculoskeletal systems and connective tissue	2.2	3.4	2.8
Diseases of the blood and blood-forming organs	1.8	2.6	2.2
Other ^(b)	1.4	2.0	1.7
Total deaths where diabetes is the underlying cause (number)	2,849	2,747	5,596

(a) Excludes deaths where diabetes is an associated cause.

(b) Other includes diseases of the skin and subcutaneous tissue, congenital anomalies, complications of pregnancy, childbirth and the puerperium, certain conditions originating in the perinatal period, symptoms, signs and ill-defined conditions.

Note: Column percentages do not sum to 100, as more than one disease category may be recorded on the death certificate as an associated cause.

Source: AIHW National Mortality Database.

The pattern of associated causes in the context of diabetic complications is presented in Table 3.6. When no diabetic complication was listed as the underlying cause of death, diseases of the circulatory system as an associated cause increased from 82.8% to 88.9% of deaths, with coronary heart disease accounting for much of this increase. However, for complications relating to renal manifestations, diseases of the circulatory system was less likely to be listed as an associated cause compared with diabetes overall (72.3% compared with 82.8% of deaths respectively), while renal failure was more than twice as likely to be listed as an associated cause of death (50.6% compared with 19.4%). For complications relating to peripheral circulatory disorders, diseases of the circulatory system was less likely to be listed as an associated cause (71.7% of deaths), while infectious and parasitic diseases was 2.5 times as likely to be listed as an associated cause (24.3% compared with 9.6% of deaths overall) (Table 3.6).

Table 3.6: Deaths where diabetic complications are the underlying cause of death by associated causes of death, 1997 and 1998

Associated causes of death	Without mention of complications	Renal manifestations	Peripheral circulatory disorders
Proportion of diabetes deaths (%)			
Diseases of the circulatory system	88.9	72.3	71.7
<i>Coronary heart disease</i>	58.5	45.5	38.6
<i>Hypertensive disease</i>	25.0	22.9	14.3
<i>Stroke</i>	23.3	9.2	18.2
<i>Heart failure</i>	17.3	20.4	18.8
<i>Peripheral vascular disease</i>	0.5	2.2	2.1
Diseases of the genito-urinary system	19.1	53.1	23.1
<i>Renal</i>	16.3	50.6	21.6
Diseases of the respiratory system	19.0	19.6	17.2
Infectious and parasitic diseases	4.9	9.5	24.3
All other diseases	<10	<11	<12
Total deaths where diabetic complications are the underlying cause (number)	3,997	358	876

Note: Column percentages do not sum to 100 as more than one disease category may be recorded on the death certificate as an associated cause.

Source: AIHW National Mortality Database.

3.4 Diabetes as an associated cause of death

Diabetes was an associated cause of death in 13,386 deaths (5.2% of all deaths) in 1997 and 1998. Diabetes was twice as likely to be recorded as an associated cause of death rather than as the underlying cause of death. Among males the proportion of deaths where diabetes was an associated cause was higher than that found in females (5.3% compared with 5.1%) (Table 3.1).

The peak age group for diabetes as an associated cause of death was 65–74 years, with a rapid increase in proportion from age 35 years onwards. The proportion of age-specific deaths increased fourfold between 35–44-year-olds and 65–74-year-olds (1.7% compared with 6.7% of deaths respectively). The proportion among those aged 85 years and over declined to 4.2% (Figure 3.1).

Underlying causes of death where diabetes is an associated cause of death

The pattern of association between diabetes and the underlying causes of death can be examined in four different ways:

1. Diabetes as an associated cause of death within each underlying cause of death disease group (Table 3.7);
2. contribution of each of the underlying causes of death for diabetes as an associated cause of death (Table 3.8);
3. comparison of the contribution of each of the underlying causes of death where diabetes is an associated cause and where it is not an associated cause (Table 3.8); and

4. clustering of associated causes and underlying causes of death where diabetes is an associated cause.

Diabetes as an associated cause of death within each underlying cause of death disease group

Diabetes was more likely to be associated with endocrine, nutritional and metabolic diseases and immunity disorders, diseases of the circulatory system and diseases of the genito-urinary system (7.9%, 7.6%, and 6.8% respectively) compared with other disease groups (Table 3.7).

In the endocrine, nutritional and metabolic diseases and immunity disorders disease group, disorders of lipid metabolism (ICD-9 272) and obesity and other hyperalimentation (ICD-9 278) accounted for the majority of these deaths, with the proportion of these deaths where diabetes was an associated cause at 12.5% and 15.2% respectively. For diseases of the

Table 3.7: Deaths associated with diabetes within each underlying cause of death, 1997 and 1998

Underlying causes of death	Males	Females	Persons	Males	Females	Persons
	Per cent			Number		
Endocrine, nutritional and metabolic diseases and immunity disorders ^(a)	9.1	6.8	7.9	95	78	173
<i>Disorders of lipid metabolism</i>	11.8	13.7	12.5	34	25	59
<i>Obesity and other hyperalimentation</i>	17.3	13.0	15.2	22	16	38
Diseases of the circulatory system	8.1	7.2	7.6	4,065	3,806	7,871
<i>Coronary heart disease</i>	8.9	8.7	8.8	2,736	2,294	5,030
<i>Hypertensive disease</i>	7.8	8.8	8.4	67	124	191
<i>Stroke</i>	7.6	5.9	6.5	734	845	1,579
<i>Heart failure</i>	6.9	5.3	5.9	140	171	311
<i>Peripheral vascular disease</i>	1.9	2.0	1.9	47	36	83
Diseases of the genito-urinary system	6.7	7.0	6.8	147	195	342
<i>Renal failure</i>	8.2	7.4	7.7	107	111	218
Infectious and parasitic diseases	5.9	6.6	6.2	94	81	175
Diseases of the musculoskeletal systems and connective tissue	9.2	4.3	5.7	36	40	76
Diseases of the digestive system	5.6	4.8	5.2	224	186	410
Diseases of the blood and blood-forming organs	4.9	4.3	4.6	19	19	38
Diseases of the respiratory system	5.0	4.2	4.6	671	505	1,176
Neoplasms	3.9	3.3	3.6	1,542	998	2,540
Diseases of the nervous system and sense organs	3.4	2.9	3.1	90	84	174
Mental disorders	2.6	3.1	2.9	79	106	185
Injury and poisoning	1.0	1.9	1.2	106	87	193
Other ^(b)	0.9	0.7	0.8	19	14	33
All underlying causes of death^(a)	5.4	5.2	5.3	7,187	6,199	13,386

(a) Excludes deaths where diabetes is the underlying cause.

(b) Other includes congenital anomalies, diseases of the skin and subcutaneous tissue, complications of pregnancy, childbirth and the puerperium, certain conditions originating in the perinatal period, symptoms, signs and ill-defined conditions.

Source: AIHW National Mortality Database.

circulatory system, coronary heart disease and hypertensive disease accounted for the highest proportion of deaths associated with diabetes (8.8% and 8.4% respectively), while peripheral vascular disease accounted for less than 2% of such deaths. Renal failure also features prominently with diabetes as an associated cause, accounting for 7.7% of deaths.

The pattern of association between diabetes and the leading underlying causes of death is generally similar for males and females. The most notable difference was for diseases of the musculoskeletal systems and connective tissue, where the proportion of deaths where diabetes was an associated cause among males was more than twice that of females (9.2% compared with 4.3%) (Table 3.7).

Contribution of each of the underlying causes of death for diabetes as an associated cause

When diabetes was an associated cause, diseases of the circulatory system was listed as the underlying cause of death in 58.8% of these deaths in 1997 and 1998. Coronary heart disease accounted for almost two-thirds of these deaths and stroke one-in-five of these deaths.

Neoplasms were the second most prominent cause of death where diabetes was an associated cause (19.0%), followed by diseases of the respiratory system (8.8%) (Table 3.8).

The pattern between diabetes (as an associated cause) and the underlying causes of death shows some interesting associations when compared with associated causes present when diabetes is the underlying cause of death (Table 3.5). Diseases of the circulatory system accounted for the highest proportion of diabetes deaths when it was both the underlying cause of death and an associated cause of death. The strong association between diabetes-related deaths and diseases of the circulatory system is not surprising, given that diabetes is a known risk factor for macrovascular complications.

The most notable difference between diabetes as the underlying cause or associated cause of death occurred with neoplasms, where the proportion of such deaths increased in ranking from eighth as an associated cause to second as the underlying cause of death (i.e. neoplasms accounted for a higher proportion of deaths when it was the underlying cause of death rather than an associated cause).

However, for diseases of the genito-urinary system the pattern is reversed, with this disease more likely to be recorded as an associated cause (ranked second) than the underlying cause of death (ranked fifth). This may reflect that, the presence of diabetic complications when diabetes is the underlying cause affects the extent to which specific associated causes are listed on the death certificate. For example as shown in section 3.3, when renal manifestations are listed as a specific diabetic complication, diseases of the genito-urinary system are far more likely to be listed as an associated cause of death.

Comparison of each of the underlying causes of death where diabetes is an associated cause and where it is not an associated cause

The pattern of underlying causes of death when diabetes is an associated cause and not an associated cause is presented in Table 3.8. These proportions have not been age-standardised so the differences observed may partially reflect the different age structures of these two groups. Diabetes as an associated cause of death is composed of a slightly older population than when diabetes is not an associated cause—mean age of 75.5 compared with 73.3 years respectively.

Diseases of the circulatory system, neoplasms and diseases of the respiratory system were the three leading causes of death when diabetes was an associated cause and when it was not an associated cause in 1997 and 1998. Diseases of the digestive system and genito-urinary system ranked fourth and fifth in deaths where diabetes was an associated

cause, and injury and poisoning and diseases of the digestive system ranked fourth and fifth when diabetes was not an associated cause of death (Table 3.8).

Table 3.8: Distribution of the underlying causes of death associated and not associated with diabetes, 1997 and 1998

Underlying causes of death	Males		Females		Persons	
	Associated with diabetes	Not associated with diabetes	Associated with diabetes	Not associated with diabetes	Associated with diabetes	Not associated with diabetes
	Proportion of deaths (%)					
Diseases of the circulatory system	56.6	37.2	61.4	43.6	58.8	40.2
<i>Coronary heart disease</i>	67.3	60.0	60.3	48.8	63.9	54.3
<i>Stroke</i>	18.1	19.3	22.2	27.6	20.1	23.6
<i>Heart failure</i>	3.4	4.1	4.5	6.2	4.0	5.2
<i>Hypertensive disease</i>	1.6	1.7	3.3	2.6	2.4	2.2
<i>Peripheral vascular disease</i>	1.2	5.1	0.9	3.7	1.1	4.4
<i>Other</i>	8.4	9.8	8.8	11.1	8.6	10.4
<i>Total</i>	100.0	100.0	100.0	100.0	100.0	100.0
Neoplasms	21.5	30.4	16.1	26.2	19.0	28.4
Diseases of the respiratory system	9.3	10.3	8.1	10.3	8.8	10.3
Diseases of the digestive system	3.1	3.0	3.0	3.3	3.1	3.1
Diseases of the genito-urinary system	2.0	1.7	3.1	2.3	2.6	2.0
<i>Renal failure</i>	72.8	58.4	56.9	53.6	63.7	55.7
<i>Other</i>	27.2	41.6	43.1	46.4	36.3	44.3
<i>Total</i>	100.0	100.0	100.0	100.0	100.0	100.0
Mental disorders	1.1	2.4	1.7	2.9	1.4	2.6
Injury and poisoning	1.5	8.7	1.4	4.1	1.4	6.5
Infectious and parasitic diseases	1.3	1.2	1.3	1.0	1.3	1.1
Endocrine, nutritional and metabolic diseases and immunity disorders ^(a)	1.3	0.8	1.3	0.9	1.3	0.8
Diseases of the nervous system and sense organs	1.3	2.1	1.4	2.5	1.3	2.3
Diseases of the musculoskeletal systems and connective tissue	0.5	0.3	0.6	0.8	0.6	0.5
Diseases of the blood and blood-forming organs	0.3	0.3	0.3	0.4	0.3	0.3
Other ^(b)	0.3	1.8	0.2	1.7	0.2	1.7
<i>Total deaths (%)</i>	100.0	100.0	100.0	100.0	100.0	100.0
Total deaths (number)	7,187	124,789	6,199	112,781	13,386	237,570

(a) Excludes deaths where diabetes is the underlying cause.

(b) Other includes congenital anomalies, diseases of the skin and subcutaneous tissue, complications of pregnancy, childbirth and the puerperium, certain conditions originating in the perinatal period, symptoms, signs and ill-defined conditions.

Source: AIHW National Mortality Database.

Diseases of the circulatory system accounted for a substantially higher proportion of deaths when diabetes was an associated cause than when it was not an associated cause (58.8% compared with 40.2%). Coronary heart disease accounted for almost two-thirds of these deaths and was more prevalent among deaths associated with diabetes than not associated with diabetes (37.6% compared with 21.9%).

Diseases of the genito-urinary system accounted for a greater proportion of deaths when diabetes was an associated cause (2.6%) than when it was not an associated cause (2.0%). Renal failure accounted for nearly two-thirds of these deaths, and was more likely to be associated with diabetes than not associated with diabetes (1.6% compared with 1.1%).

However, neoplasms, diseases of the respiratory system, injury and poisoning and mental disorders accounted for a lower proportion of deaths when diabetes was an associated cause than when it was not an associated cause. Diseases of the digestive system accounted for the same proportion of deaths whether or not diabetes was the associated cause of death (Table 3.8).

A similar pattern was evident for males and females in terms of the ranking of the leading underlying causes of death. However, among females diabetes was associated with a higher proportion of deaths from diseases of the circulatory system and diseases of the genito-urinary system than among males. Neoplasms and diseases of the respiratory system were more likely to be associated with diabetes among males than females (Table 3.8).

Clustering of the underlying and associated causes of death

The analysis so far has been confined to looking at only the underlying causes of death and not any other associated causes when diabetes is an associated cause of death. As previously stated, there are a number of diseases that are known to be more prevalent among people with diabetes, i.e. diseases of the circulatory system, diseases of the genito-urinary system and diseases of the nervous system and sense organs. Table 3.9 investigates the clustering of these diseases.

When diseases of the circulatory system is the underlying cause of death and diabetes is an associated cause, in 85.9% of deaths neither diseases of the genito-urinary system nor diseases of the nervous system and sense organs were listed as associated causes in 1997 and 1998. However, when diseases of the genito-urinary system was the underlying cause of death, diseases of the circulatory system was an associated cause in almost two-thirds of these deaths. For diseases of the nervous system and sense organs as the underlying cause, in half of deaths where diabetes was an associated cause neither diseases of the circulatory system nor diseases of the genito-urinary system were listed as associated causes. Diseases of the circulatory system were, however, listed as an associated cause in 43.7% of these deaths (Table 3.9).

Table 3.9: Clustering of the underlying and associated causes when diabetes is an associated cause of death, 1997 and 1998

Underlying cause by associated cause	Number	Per cent
Diseases of the circulatory system—underlying cause	7,871	100.0
Neither diseases of the genito-urinary system nor diseases of the nervous system and sense organs as associated causes	6,765	85.9
Diseases of the genito-urinary system as associated cause	758	9.6
Diseases of the nervous system and sense organs as associated cause	319	4.1
Diseases of the genito-urinary system and diseases of the nervous system and sense organs as associated causes	29	0.4
Diseases of the genito-urinary system—underlying cause	342	100.0
Neither diseases of the circulatory system nor diseases of the nervous system and sense organs as associated causes	105	30.7
Diseases of the circulatory system as associated cause	221	64.6
Diseases of the nervous system and sense organs as associated cause	9	2.6
Diseases of the circulatory system and diseases of the nervous system and sense organs as associated causes	7	2.0
Diseases of the nervous system and sense organs—underlying cause	174	100.0
Neither diseases of the circulatory system nor diseases of the genito-urinary system as associated causes	87	50.0
Diseases of the circulatory system as associated cause	76	43.7
Diseases of the genito-urinary system as associated cause	4	2.3
Diseases of the circulatory system and diseases of the genito-urinary system as associated causes	7	4.0

Source: AIHW National Mortality Database.

3.5 Discussion

This chapter has highlighted the considerable contribution diabetes makes to all-cause mortality. In 1997 and 1998 diabetes was listed as the underlying or associated cause in 18,982 deaths or 7.4% of all deaths. Diabetes is twice as likely to be reported as an associated cause rather than the underlying cause of death. Although Australian mortality data do not allow distinction between Type 1 and Type 2 diabetes, people with Type 1 diabetes are twice as likely to have diabetes listed as the underlying cause of death than those who develop it later on in life (Geiss et al. 1995). The life expectancy of people with Type 1 diabetes is reduced by at least 15 years (Portuese & Orchard 1995), so diabetes progressively becomes more of an associated cause than the underlying cause of death as age increases. Type 1 diabetes may be relatively more common at younger ages than Type 2 diabetes.

Age distribution

Diabetes-related deaths are substantially higher among older Australians, and given the growing number of elderly Australians this mortality burden is likely to become more pronounced over the next decades. The higher mortality among older Australians is consistent with age-specific prevalence and hospitalisation rates for diabetes, which follow the same pattern. The slight decline in age-specific diabetes-related deaths among the very

old may reflect the higher rate of undiagnosed diabetes among this population which could be due to the complex array of co-morbidities often present in the very old (Glynn et al. 1999).

Strong association with diseases of the circulatory system and genito-urinary system

Diabetes is rarely listed alone as the underlying cause of death with no associated causes, and predominantly occurs with diseases of the circulatory system and to a lesser extent diseases of the genito-urinary system (particularly renal failure). Diseases of the circulatory system also reappears as the leading underlying cause of death when diabetes is an associated cause of death. The presence of diabetic complications when diabetes is the underlying cause appears to affect the extent to which specific associated causes are listed on the death certificate. For example, when renal manifestations are listed as a specific diabetic complication, diseases of the genito-urinary system is more likely to be listed as an associated cause rather than the underlying cause of death in these cases.

The strong association between diabetes and diseases of the circulatory system (predominantly coronary heart disease) and diseases of the genito-urinary system (mainly renal failure) is consistent with numerous studies. Studies in the United States have shown that 75% of the excess mortality among diabetic men and 57% among diabetic women are attributable to deaths from diseases of the circulatory system (Kleinman et al. 1988). Furthermore, the risk of death from coronary heart disease has been shown to be 2–4 times higher in people with diabetes compared with those without diabetes (Geiss et al. 1995). Persons with diabetes have also been shown to be at greater risk of mortality from renal disease (Moss et al. 1991). In Australia, diabetes ranks second behind glomerulonephritis as a cause for end-stage renal disease. Over the period 1988–1996, the incidence of end-stage renal disease in people with Type 2 diabetes increased by 22% per year, compared with 5% per year for other causes of the renal condition (Briganti et al. 1999).

Possible reasons for this strong association

The greater risk of mortality from coronary heart disease and renal disease among people with diabetes can largely be explained by the risk factor profile of this population. Obesity, physical inactivity and poor nutrition in foetal and early infant life are important factors in the development of Type 2 diabetes. The existence of diabetes is also known to magnify the effect of conventional risk factors such as hyperlipidaemia, hypertension and smoking which substantially increase the risk of diseases of the circulatory system (McCann et al. 1994). People with diabetes are also more likely to have a clustering of risk factors—an individual with a high level of one risk factor is also likely to have high levels of other risk factors. However, the excess mortality in persons with diabetes cannot be fully explained by these risk factors. Other factors such as age at onset also contribute to the excess risk of mortality in persons with diabetes (Geiss et al. 1995). It is not surprising then that the life expectancy of middle-aged persons with Type 2 diabetes is 5–10 years lower than for people without Type 2 diabetes.

Data limitations

Although data from death certificates is the most comprehensive mortality data in Australia, it is important to be aware of some of the limitations with using these data to assess the national burden of diabetes. The lack of uniform practice among medical practitioners in completing death certificates for individuals with diabetes makes it difficult to determine the

role of diabetes in specific causes of death (Knuiman et al. 1992). The causal role of diabetes in mortality may therefore be underrecognised. Selection of a single underlying cause of death may be difficult in people with multiple chronic diseases. One Australian study has shown a systematic underreporting of diabetes deaths among people with known diabetes depending on the stated cause of death and on the mode of treatment (Whittall et al. 1990). Diabetes mortality based on death certificates may underestimate the number of deaths, as the presence of diabetes is not always noted on the death certificate (Riley et al. 1995). A further limitation with death certificate data is that these data do not distinguish between Type 1 and Type 2 diabetes. Despite these limitations, the introduction of the coding of multiple causes of death in 1997 has enabled the contribution diabetes makes to all-cause mortality to be more thoroughly explored and understood.