Comorbidity of cardiovascular disease, diabetes and chronic kidney disease in Australia

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CARDIOVASCULAR DISEASE SERIES
28

Comorbidity of cardiovascular disease, diabetes and chronic kidney disease in Australia

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August 2007

Australian Institute of Health and Welfare
Canberra
AIHW cat. no. CVD 37

This publication is part of the Australian Institute of Health and Welfare's Cardiovascular Disease Series. A complete list of the Institute's publications is available from the Institute's website <www.aihw.gov.au>.

ISSN1323-9236

ISBN 978 1 74024 705 4

Suggested citation

AIHW: Tong B & Stevenson C 2007. Comorbidity of cardiovascular disease, diabetes and chronic kidney disease in Australia. Cardiovascular Disease Series no. 28. Cat. no. CVD 37.Canberra: AIHW.

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Published by the Australian Institute of Health and Welfare

Contents

Acknowledgments

This report was prepared and written by Bin Tong and Chris Stevenson.

Susana Senes, Anne-Marie Waters and Sharon Leigh made a significant contribution to the report. Other members of the National Centre for Monitoring Cardiovascular Disease and the National Centre for Monitoring Diabetes also provided valuable advice and comments. These include: Lynelle Moon, Elizabeth Penm, Therese Bourke, Tiffany Lamb, Louise Catanzariti and Sandra Ofei.

The authors particularly wish to thank the National Heart, Stroke and Vascular Health Data Working Group and the National Diabetes Data Working Group for advice and assistance, which were critical to the completion of this report.

Advice and comments from the following people are greatly appreciated:

Alan Cass	The George Institute for International Health
Andrew Boyden	National Heart Foundation of Australia
Annette Dobson	University of Queensland
Jeff Flack	Diabetes Centre, Bankstown–Lidcombe Hospital
Mark Harris	University of New South Wales
Mike Langan	Australian Bureau of Statistics
Timothy Mathew	Kidney Health Australia
Ian Ring	University of Wollongong
Mandy Thrift	Baker Heart Research Institute

Valuable comments were also received from staff of the Australian Government Department of Health and Ageing.

Our appreciation extends to other colleagues at AIHW for their valuable input and helpful comments. These include: George Bodilsen, Ilona Brockway, Paul Magnus, Robert Van der Hoek and Xingyan Wen.

Funding from the Australian Government Department of Health and Ageing contributed to the production of this report.

Abbreviations

ABS	Australian Bureau of Statistics
ANZDATA	Australian and New Zealand Dialysis and Transplant Registry
CHD	Coronary heart disease
CKD	Chronic kidney disease
CVD	Cardiovascular disease
GP	General Practitioner
ICD	International Classification of Diseases
ICD-10	International Classification of Diseases, 10th Revision
ICD-10 AM	International Classification of Diseases, 10th Revision Australian Modification
NCDS	National Chronic Disease Strategy
NHS	National Health Survey
SDAC	Survey of Disability, Ageing and Carers
TIA	Transient cerebral ischaemic attack

Summary

About this report

This is the first report of a projected series regarding the comorbidity of cardiovascular disease (CVD), diabetes and chronic kidney disease (CKD) in Australia. Comorbidity refers to any two or more of these diseases that occur in one person at the same time. The questions to be answered in this report include:

1. How many Australians have comorbidity of CVD, diabetes and CKD?
2. What is the proportion of hospitalisations with these comorbidities?
3. How much do these comorbidities contribute to deaths?
4. What is the magnitude of comorbidity in the context of each individual disease?
5. Are there differences in the distribution of these comorbidities among age groups and sexes?

Key findings

1. In 2004–05, 417,563 (2.9%) adults not living in institutions had comorbidity of CVD and diabetes. In 2003, 14,722 (8.1%) people in institutions, such as nursing homes and aged care hostels, had this comorbidity.
2. Comorbidities of CVD, diabetes and CKD were found in 365,245 (6.6%) non-dialysis hospital separations for adults in 2004–05.
3. Comorbidities of CVD, diabetes and CKD were recorded as causes of death for 17,239 (13.2%) people who died in 2004.
4. The observed rates of these comorbidities exceeded the rates expected if conditions only occurred together by chance.
5. CVD was very common among people with diabetes and CKD. In turn, both diabetes and CKD contribute to many cases of CVD.
6. Older people were more likely to have these comorbidities than younger people. Males were more likely to have these comorbidities than females.

Messages

1. Comorbidity of CVD, diabetes and CKD is mainly caused by complex interrelationships between these conditions and shared risk factors. There is potential to reduce the associated burden by controlling common risk factors and improving disease management.
2. These comorbidities mainly affect older people. With a rapidly ageing population, comorbidity will rise. Australian health systems need to be prepared to meet an increasing demand on health services from people with comorbidities.

1 Introduction

Cardiovascular disease (CVD), diabetes and chronic kidney disease (CKD) are serious illnesses that contribute significantly to deaths and levels of ill health in the Australian population. CVD, diabetes and CKD share many risk factors, such as obesity and old age. There are also complex causal relationships between these diseases, and each of them may be caused by, or be a complication of, one or both of the other diseases. As a result, they are more likely to occur together—this is known as *comorbidity*. The presence of comorbidity is often regarded as an indicator of severity and poorer prognosis of these diseases. The clinical management for people with comorbidity is much more complex and time consuming than for those with single diseases.

Because of the ageing Australian population and the high prevalence of CVD, diabetes and CKD, comorbidity of these diseases is expected to rise. Although comorbidity of these diseases is receiving increased attention, most studies focus on one disease at a time and there are relatively few studies that include investigations of the relationship of multiple chronic diseases (Walker 2005). The extent of comorbidity in Australia and its impact on people's health and on the health system are not clear. The National Centre for Monitoring Cardiovascular Disease and the National Centre for Monitoring Diabetes have therefore collaborated to investigate the association of these diseases and their impact on the Australian population.

What are cardiovascular disease, diabetes and chronic kidney disease?

Cardiovascular disease

CVD is any disease of the heart (cardio) or blood vessels (vascular). Some forms of CVD are very common in Australia, including hypertension (high blood pressure), coronary heart disease (CHD), heart failure and cerebrovascular disease.

CVD is one of the leading causes of disability and death in Australia. Combining both the burden from premature deaths and extent of associated disability, cardiovascular disease was estimated to account for 17% of the overall disease burden in Australia in 2003 (AIHW 2006a). CVD is the most expensive disease group in terms of direct health care expenditure, at over $5.5 billion, which represents 11% of Australia's total allocated health system expenditure in 2000–01 (AIHW 2004a).

Diabetes

Diabetes mellitus (in this report referred to as diabetes) is a chronic condition in which blood glucose levels become too high as a result of the body producing insufficient insulin, or being unable to use insulin properly. Diabetes can lead to a range of complications, including coronary heart disease and stroke, as well as kidney disease and retinopathy (loss of vision).

Self-reported data in the 2004–05 National Health Survey (NHS) showed that about 699,600 Australians (3.5% of the population) had been diagnosed with diabetes

(AIHW 2006a). Diabetes accounted for 5.8% of the overall disease burden in Australia in 2003 (AIHW 2006a). In 2004, 11,735 deaths in Australia were associated with diabetes (AIHW 2006a).

Chronic kidney disease

CKD is the occurrence of kidney damage and/or reduced kidney function, lasting for at least three months. It is classified into five stages from stage 1 (least severe) to stage 5 (most severe) where patients may need to undergo kidney replacement therapy (dialysis or transplant), as kidney function is not sufficient to sustain life (AIHW 2005).

How many Australians are affected by CKD is unknown. Some investigators have suggested that about 7.5% to 11.2% of Australian adults have signs of kidney damage or reduced kidney function (Chadban et al. 2003, The Australasian Creatinine Consensus Working Group 2005). CKD imposes a substantial burden of disease in Australia. In 2004, CKD was recorded as the underlying cause of death in 2,361 cases (2% of all deaths). CKD was an associated cause of death in 9,609 cases—43% of these were recorded with cardiovascular disease as the underlying cause of death and 9% with diabetes (AIHW 2006a). For an explanation of underlying and associated causes of death see page 30.

What is comorbidity and how does it happen?

What is comorbidity?

Comorbidity refers to any two or more diseases that occur in one person at the same time. In this report comorbidity refers to the presence of CVD, diabetes or CKD in combination with one or both of the other diseases.

Causes of comorbidity

Co-occurrence of diseases can happen by chance. Some diseases can coexist in one person by coincidence, and there is no pathological association between them. However, more often than not, diseases occur together because there are some associations between them. These associations can be summarised into two main groups: direct and indirect causal relationships between the diseases and shared risk factors. The direct and indirect causal relationships between CVD, diabetes and CKD have been demonstrated by substantial evidence from pathological and epidemiological studies.

Diabetes is a well known risk factor for CVD. The reasons why diabetes increases the risk of CVD are only partially understood. One established explanation is that diabetes increases atherosclerosis (thickening of the wall of a blood vessel with deposits of plaque), which is the underlying cause of most CVD in Australia. It is also established that people with diabetes tend to have higher levels of blood pressure and abnormal cholesterol level, both of which are factors that increase the risk of atherosclerosis and CVDs (AIHW 2002a).

Diabetes can also lead to kidney damage—a complication known as diabetic nephropathy. Diabetic nephropathy results from high blood glucose levels damaging the blood-filtering capillaries in the kidneys. Moreover, diabetes also increases the risk of kidney damage and

accelerates the reduction of kidney function by increasing the risk of hypertension (AIHW 2005).

CKD has been found to independently increase the risk of hypertension and other cardiovascular diseases, including heart attack, angina, coronary artery disease, stroke and heart failure. The risks of a cardiovascular event, such as heart attack or stroke, are greater in those with poorer kidney function (Go et al. 2004). The reasons for excess risk of CVD among people with CKD are not clearly understood. However, some established risk factors of CVD, such as obesity, abnormal lipid levels and diabetes, are also common among people with CKD. In addition, CKD complications, such as anemia and disturbed mineral metabolism, also contribute to increased risk of CVD (Levin et al. 2002).

CVD, especially hypertension, is one of the major causes of CKD. Untreated high blood pressure can damage the blood vessels in the kidneys. The walls of these blood vessels become thick and the internal diameter narrowed, leading to reduced blood supply and decreased kidney function. Among people with CKD, the presence of CVD is associated with a faster decline of kidney function and the need for dialysis (Levin et al. 2001).

Furthermore, shared risk factors of these diseases also promote co-occurrence of these diseases and strengthen the association between them. These risk factors do not just affect the onset of CVD, diabetes and CKD, but also affect their progression and increase the risk of complications. These risk factors include ageing, gender, overweight or obesity, lifestyle and socioeconomic conditions (Table 1.1). Other factors, such as genetic background and environmental factors, also play some role in the co-occurrence of these diseases.

Because of these complex interactions, the risk of developing these diseases and their comorbidities is even greater among those with multiple risk factors. This is especially true for people with metabolic syndrome. Metabolic syndrome is a cluster of risk factors comprising excess abdominal weight, insulin resistance, hypertension (high blood pressure) and/or lipid abnormalities. The risk of having CVD, diabetes and CKD among people with metabolic syndrome is three times as high as for those without (Dekker et al. 2005; Stern et al. 2004). People with Type 2 diabetes who also have this syndrome are more likely to develop CVD complications and have kidney problems (Isomaa et al. 2001).

Table 1.1: Known risk factors for cardiovascular disease, diabetes and chronic kidney disease

Diseases	Non-modifiable risk factors	Modifiable risk factors
Diabetes	Age, genetic factors, pregnancy, low birth weight	Overweight and obesity, poor nutrition, impaired glucose tolerance, physical inactivity.
Cardiovascular disease	Age, genetic factors, male sex, family history	Overweight and obesity, poor nutrition, impaired glucose tolerance, physical inactivity, smoking, high blood pressure, diabetes, chronic kidney disease, atrial fibrillation, heavy alcohol consumption.
Chronic kidney disease	Age, genetic factors, family history, ethnicity	Overweight and obesity, poor nutrition, impaired glucose tolerance, physical inactivity, smoking, high blood pressure, diabetes, urinary tract infections, kidney and urinary stones, glomerulonephritis, streptococcal infections, drug toxicity.

Sources: AIHW 2002a, 2004b, 2005.

Ageing is another factor that has a particularly strong association with many forms of comorbidity, including comorbidity of CVD, diabetes and CKD. Although such an association is widely accepted as 'common wisdom', the causes of the association have not been well studied. However, there are several possible explanations. Firstly, there is

concordance between the natural course of these diseases and people's age. All of these diseases are more likely to first arise among middle aged to old people. Complications of these diseases may develop over a considerable period (about 10–20 years) after the onset of the original disease. By the time comorbidity presents, most of these people are at an old or very old age. The period between onset of the disease and its comorbidity is extremely important for the prevention and management of comorbidity, as early detection and better management of the original disease can effectively reduce the risk of comorbidity and/or delay its occurrence. Secondly, increased life expectancy in recent years in Australia is largely attributed to a reduction in death rates among older Australians, especially from diseases such as coronary heart disease and stroke (AIHW 2002b). Longer survival with chronic conditions allows the complications of these conditions to develop. Thirdly, the functions of organs gradually decline with age after middle age. Thus, older people are usually more vulnerable to the onset of diseases and their complications than younger people.

Consequences of comorbidity

The presence of these comorbidities in patients with CVD, diabetes and CKD often indicates more severe disease and poorer prognosis. These comorbidities have strong negative effects on health status and health services. Although the exact extent of the negative effects has not been well studied, it is widely recognised that such effects may go beyond the bare sum of the effects of each single disease.

An excess risk of being hospitalised or dying has been documented in people with some combinations of these diseases, compared with people with only one of these diseases. It was found that CVD mortality among people without a previous heart attack was 7.5 times higher among those with Type 2 diabetes than in those without diabetes (Haffner et al. 1998). People with comorbidity of CVD and CKD were 35% more likely to have recurrent cardiovascular events or die than people with CVD alone (Weiner et al. 2004). People with comorbidity also have an increased risk of impaired functional status or quality of life (Gijsen et al. 2001). Apart from the individual human suffering, comorbidity also increases the burden on health care services. Comorbidity is associated with greater health care utilisation, including more hospital admissions, longer stays in hospital (Gijsen et al. 2001), and greater frequency of visits to GPs and specialists (Starfield et al. 2003, Struijs et al. 2006).

Furthermore, clinical treatment for people with comorbidity is much more complex and time consuming than for those with a single condition. Health care for people with comorbidity needs to focus on a number of conditions at the same time. Multiple medications and therapies are required in almost all cases. The risk of dangerous interactions of multiple drugs is increased. People with comorbidity are also more likely to have complications after receiving common procedures, including some lifesaving procedures. Because of this, doctors may be reluctant to arrange such procedures for them (Levin et al. 2002).

Higher health care usage and complex treatments have led to higher health care costs. A study conducted in Canada estimated that about 26.4% of health expenditure for diabetes was attributed to CVD-related services and 7.5% was attributed to kidney-related services. It also found that as the number of major complications increased, expenditure grew significantly (Simpson et al. 2003).

Implications for disease prevention, management and health policy

Although comorbidity increases the health burden for individuals and society, there is substantial evidence that a large improvement in health can be achieved by prevention, early recognition and adequate treatment of comorbid diseases (Gijsen et al. 2001, Nilsson & Berglund 2000).

Better understanding and regular monitoring of comorbidity of these diseases are critical to recognising the health burden of these diseases, developing strategies and formulating health care policy, and evaluating progress in disease prevention and management.

Purpose, scope and structure of this report

This report is designed to examine the current extent of comorbidity of these diseases among Australian adults from three perspectives: prevalence, hospitalisation and mortality. It focuses on analysing the distribution of comorbidity by age and sex. The actual occurrence of comorbidity is compared with the statistically expected occurrence to determine if these diseases coexist by chance. The distribution of comorbidity is also presented separately in the context of each individual disease. Further and more detailed investigations of other characteristics of these comorbidities, such as the differences between the Indigenous and non-Indigenous populations, are planned for future reports in this series.

Although CVD, diabetes and CKD can occur among people at any age, they are mainly prevalent among the adult population, especially older people. Comorbidities from these diseases are rarely seen before the age of 18 years. Therefore, the analyses presented in this report focus on Australians aged 18 years or over.

Besides this introduction, the main body of the report consists of the following chapters:

- Chapter 2 focuses on the prevalence of comorbidity of CVD and diabetes in the Australian population. It includes analysis of data from the ABS 2004–2005 National Health Survey (NHS) and 2003 Survey of Disability, Ageing and Carers (SDAC).
- Chapter 3 investigates the proportion of hospitalisations with comorbidity of CVD, diabetes and CKD in 2004–05.
- Chapter 4 presents analysis of deaths associated with comorbidity of CVD, diabetes and CKD based on data from the AIHW National Mortality Database for 2004.
- The main findings and implications are discussed in Chapter 5.

The appendixes contain details of the methods, disease classifications, and data sources used in this report.

2 Prevalence

To examine the extent of the problem of comorbidity in the population, the most critical questions to be answered are:

- how many people have two conditions?
- what is their distribution among age groups and sexes?

This chapter focuses on these questions.

The results shown in this chapter were drawn from the 2004–05 NHS and the 2003 SDAC. Both surveys were conducted by the Australian Bureau of Statistics (ABS).

The NHS was designed to obtain national information on the health status of Australians, their use of health services and facilities, and health-related aspects of their lifestyle. The most recent NHS was conducted in 2004–05, and it included 25,906 people of all ages across urban and rural areas of Australia. Questions regarding long-term health conditions, including cardiovascular conditions and diabetes, were asked of the respondents at interview. Because it focussed on the non-institutionalised population, non-private dwellings (such as hospitals, nursing homes, hotels and boarding houses) were excluded (ABS 2006b).

In the SDAC, national information was collected on the disability levels of Australians, their current and future care needs and the role of carers. The most recent SDAC was conducted in 2003, with 41,233 Australians participating. The survey included people in both private and non-private dwellings, such as hotels, motels, boarding houses, retirement villages, hospitals and nursing homes (ABS 2005). All survey participants were asked questions regarding their long-term health conditions. However, because the survey was designed to obtain information related to disability, participants were more likely to report long-term conditions related to their disability, rather than all long-term conditions. Nevertheless, it is a unique source of health information regarding long-term conditions among the institutionalised population.

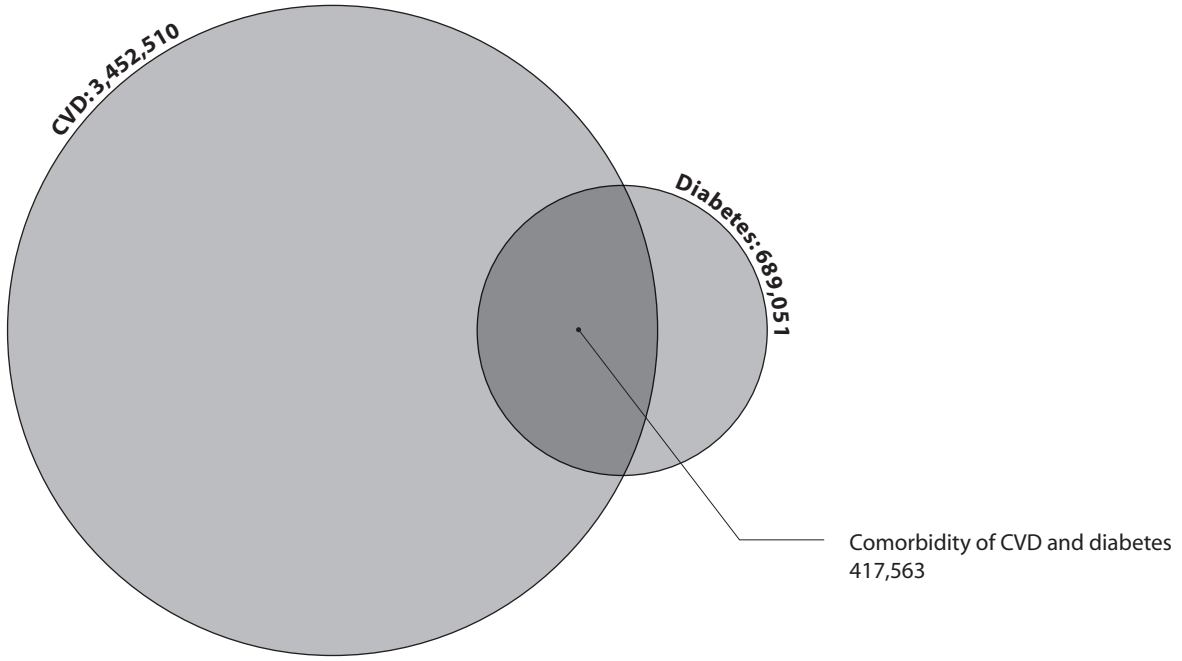
Because both were self-reported surveys, the results were influenced by the questionnaires used, and knowledge and awareness of specific conditions in the population. There is evidence that self-reported surveys are likely to underestimate the prevalence of diabetes, as some people were not aware that they had diabetes (Dunstan et al. 2001), and therefore would not report the condition.

The prevalence of CKD is not available from either survey. Thus the analysis here is limited to comorbidity of CVD and diabetes.

Due to constraints of the data sources, the analysis was restricted to people aged 20 years and older. The sub-categories of CVD were not consistent between the non-institutionalised and institutionalised populations for the same reason (Table A2 and A3).

Comorbidity of CVD and diabetes in the non-institutionalised population

Based on the 2004–05 NHS, it was estimated that 3,452,510 (23.9%) of the non-institutionalised population aged 20 years and over had CVD, 689,051 (4.8%) had diabetes, and 417,563 (2.9%) had both CVD and diabetes (Figure 2.1). In total, 25.8% of this population had at least one of these conditions.



Note: People aged 20 years and over only are included.

Source: AIHW analysis of 2004–05 ABS National Health Survey Confidentialised Unit Record File.

Figure 2.1: Prevalence of CVD and diabetes and their comorbidity in the non-institutionalised adult population, 2004–05

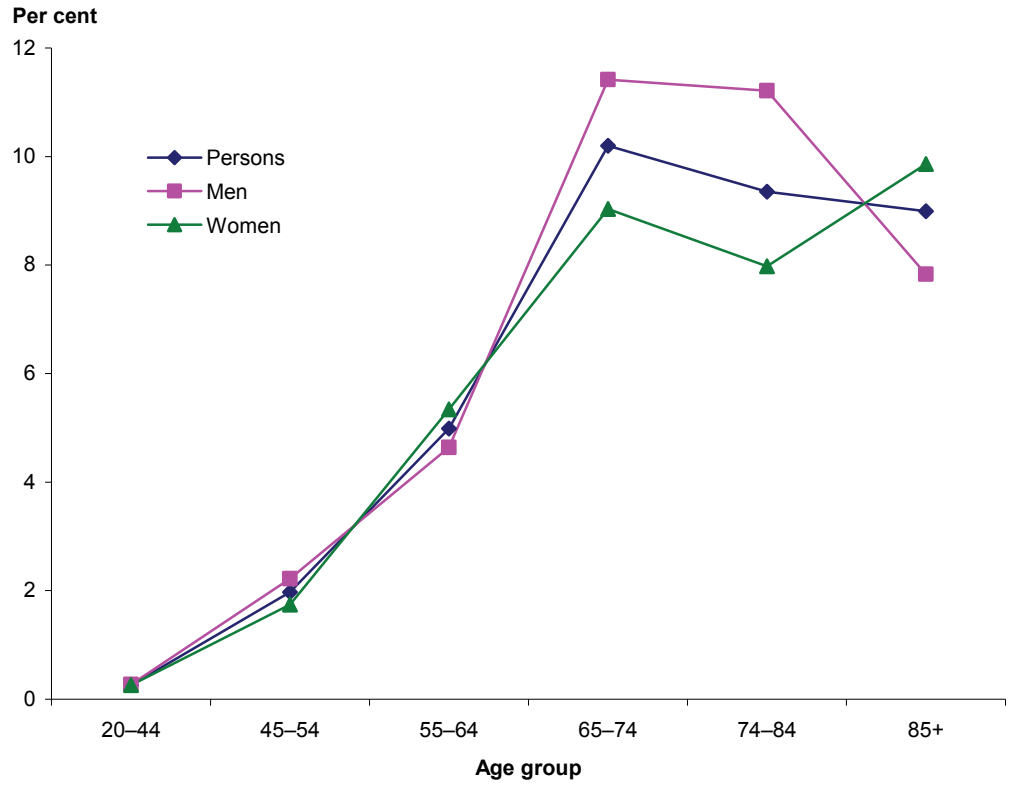
Age

There was a strong association between age and the presence of comorbidity of CVD and diabetes. The age-specific prevalence rate increased sharply with age from less than 1% in the 20–44 years age group to 10.2% in the 65–74 years age group, and then decreased slightly to about 9.0% in those aged 85 years and over (Figure 2.2—detailed data can be found in Table A4). After adjusting for sex, older people (aged 65 years and over) were 7.2 times as likely as younger people (under 65 years) to have both diseases (Table 2.1).

Sex

It was estimated that 213,150 (3.0%) men and 204,414 (2.8%) women had both CVD and diabetes in 2004–05. While the prevalence rate was nearly the same for men and women before the age of 65 years, it was much higher among men than women aged 65–84 years (11.4% versus 8.0%, respectively). However, the rates were reversed between men and

women after they reached 85 years (7.8% versus 9.9%) (Figure 2.2). After adjusting for age, men were 1.2 times as likely as women to have both diseases (Table 2.1).



Note: People aged 20 years and over only are included. Due to small sample size, those aged 20–44 years were grouped for analysis.
Source: AIHW analysis of 2004–05 ABS National Health Survey Confidentialised Unit Record File.

Figure 2.2: Age-specific rate of comorbidity of CVD and diabetes in the non-institutionalised adult population, by sex, 2004–05

Table 2.1: Prevalence of comorbidity of CVD and diabetes in the non-institutionalised adult population, by sex and age group, 2004–05

Comorbidty	Men	Women	Odds ratio men to women (95% CI)	Under 65 years	65 years and over	Odds ratio 65 years and over to under 65 years (95% CI)
CVD and diabetes	213,150	204,414	1.16	178,690	238,871	7.22
	(3.0%)	(2.8%)	(1.15–1.16)	(1.5%)	(9.8%)	(7.18–7.27)
Total estimated non-institutionalised population	**7,099,402**	**7,333,436**	**—**	**11,992,786**	**2,440,052**	**—**

CI Confidence interval

Notes

1. Odds ratio is calculated using logistic regression model, and all *p* values are less than 0.001 See Appendix for explanation of logistic regression.
2. People aged 20 years and over only are included.

Source: AIHW analysis of ABS 2004–05 National Health Survey Confidentialised Unit Record File

Observed and expected comorbidity in the non-institutionalised adult population

CVD and diabetes may occur together by chance. The expected comorbidity prevalence rate is the rate that we would expect if the comorbidity arose purely from chance. The ratio of the observed to the expected rate is a measure of how much more comorbidity has occurred in the population than would have been expected purely by chance (see Appendix for a full discussion of the expected and observed rates).

In 2004–05, the actual prevalence rate of comorbidity of CVD and diabetes observed in the Australian non-institutionalised population was 2.6 times as high as the rate expected (Table 2.2). This suggests that the high prevalence of comorbidity of CVD and diabetes is attributable to a strong association between two conditions. Because of this association, the existence of one disease causes or promotes the onset of the other disease. If all the factors that lead to this association, such as shared risk factors and a causal relationship, could be prevented, the prevalence of this comorbidity in this population could potentially be greatly reduced.

Table 2.2: Expected and observed prevalence of comorbidity of CVD and diabetes in the non-institutionalised adult population, 2004–05

Comorbidity	Expected prevalence rate	Observed prevalence rate	Ratio observed to expected (95% CI)
CVD and diabetes	1.1%	2.9%	2.64 (2.37–2.89)

CI Confidence interval

*Note*s

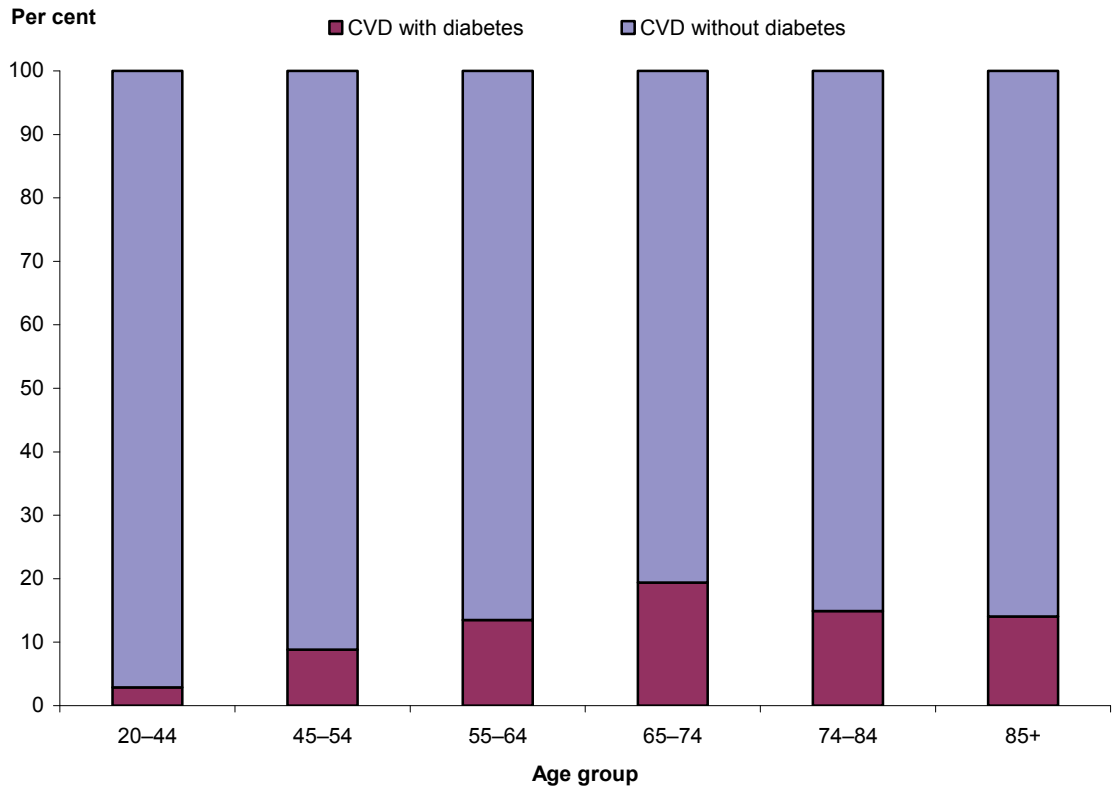
1. People aged 20 years and over only are included.
2. Expected rate based on 23.9% with CVD and 4.8% with diabetes (23.9% × 4.8% = 1.1%).

Source: AIHW analysis of ABS 2004–05 National Health Survey Confidentialised Unit Record File.

Comorbidity among people with CVD

On average, almost 1 in 8 people (12.1%) with CVD also had diabetes. It was estimated that about 21.8% of people with CHD had diabetes, followed by heart failure (21.6%), cerebrovascular disease (17.4%, mainly stroke) and hypertensive disease (15.2%) (Table 2.3).

Among people who reported CVD, those with diabetes increased from less than 2.9% in the 20–44 years group to over 19.4% in the 65–74 years group, and then declined to about 14.0% in the 85 years and over group (Figure 2.3).



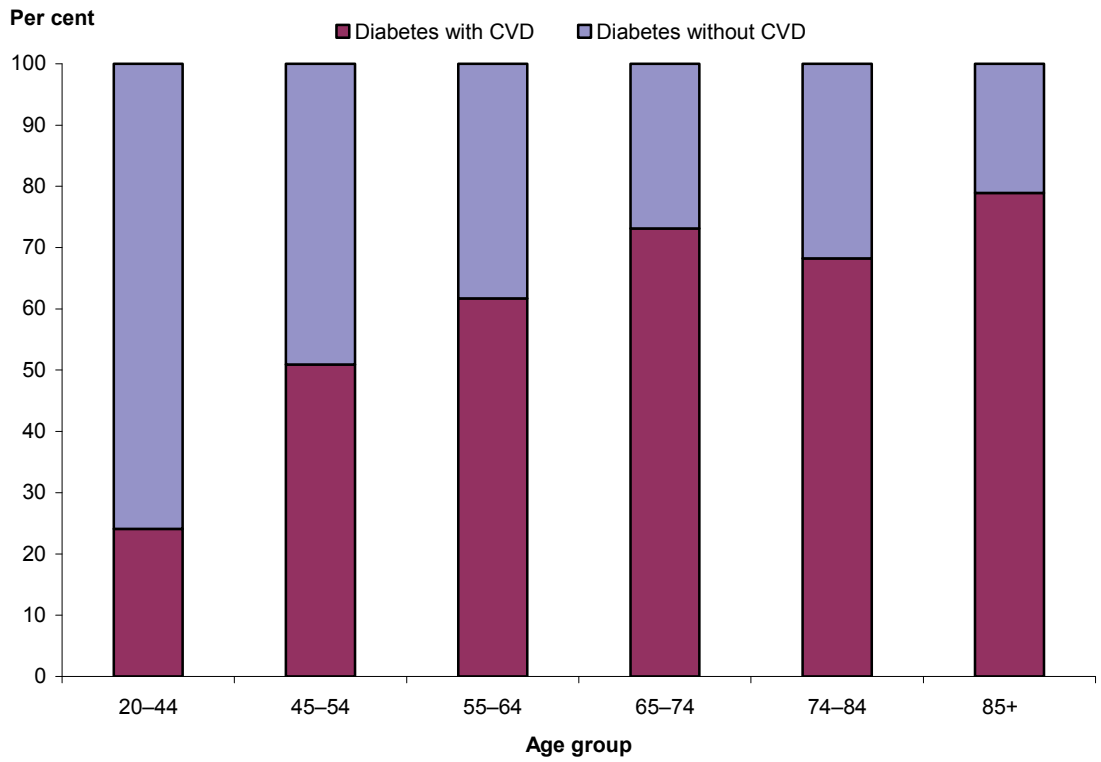
Note: People aged 20 years and over only are included. Due to the small sample size, people aged 20–44 years were grouped for analysis.
Source: AIHW analysis of 2004–05 ABS National Health Survey Confidentialised Unit Record File.

Figure 2.3: Comorbidity of CVD and diabetes among people with CVD in the non-institutionalised adult population, by age group, 2004–05

Comorbidity among people with diabetes

According to the 2004–05 NHS, more than 60% of people with diabetes had at least one form of CVD. It was estimated that about 46.1% of them had hypertensive disease, 10.6% had CHD, 8.2% had heart failure and 2.3% had cerebrovascular disease. The prevalence rates of these conditions were 3 to 5 times as high as in the general population (Table 2.3).

The prevalence rate of comorbidity increased progressively with age, and the age-specific rate increased from 24.1% in the 20–44 years group to around 70% among people aged 65 years and over (Figure 2.4).



Note: People aged 20 years and over only are included. Due to the small sample size, people aged 20–44 years were grouped for analysis.
Source: AIHW analysis of 2004–05 ABS National Health Survey Confidentialised Unit Record File.

Figure 2.4: Comorbidity of CVD and diabetes among people with diabetes in the non-institutionalised adult population, by age group, 2004–05

Table 2.3: Australians with comorbidity of CVD and diabetes in the non-institutionalised adult population by disease category, 2004–05

Index conditions	Number of people with conditions (%)	Comorbidity						
		All CVD	Cerebrovascular disease	CHD	Hypertensive disease	Heart failure	Other CVD	Diabetes
					Per cent			
All CVD	3,452,510 (23.9)	—	—	—	—	—	—	12.1
Cerebrovascular disease (mainly stroke)	89,164 (0.6)	—	—	16.7	50.2	17.1	33.9	17.4
CHD	336,098 (2.3)	—	4.4	—	46.2	13.2	40.2	21.8
Hypertensive disease	2,096,041 (14.5)	—	2.1	7.4	—	6.2	21.1	15.2
Heart failure	262,229 (1.8)	—	5.8	16.9	49.6	—	50.3	21.6
Other CVD	1,596,723 (11.1)	—	1.9	8.5	27.7	8.3	—	9.4
Diabetes	689,051 (4.8)	60.6	2.3	10.6	46.1	8.2	21.8	—
CVD and diabetes	417,563 (2.9)	—	—	—	—	—	—	—
Total population with CVD or diabetes	3,723,998 (25.8)	—	—	—	—	—	—	—
Total estimated non-institutionalised adult population	**14,432,838**	—	—	—	—	—	—	—

Notes

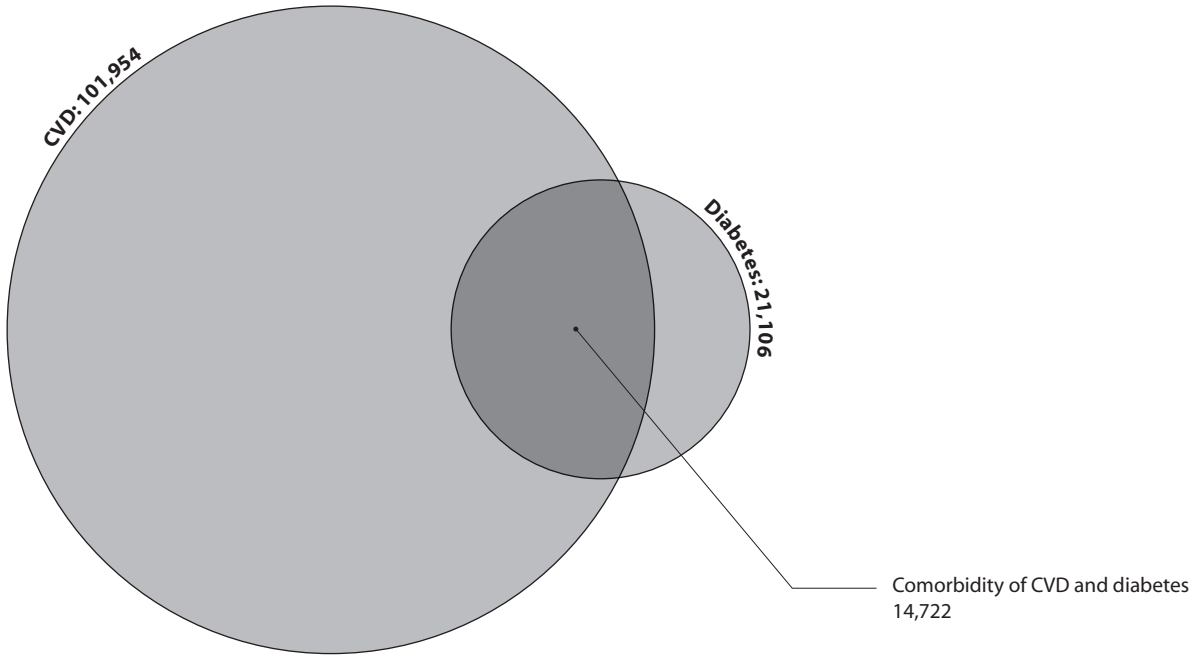
1. The number and percentage of population with CVD and diabetes do not add up to total CVD because more than one of form of CVD can be recorded. The number and percentage with individual index conditions also do not add up to total population with index conditions for the same reason.
2. People aged 20 years and over only are included.

Source: AIHW analysis of 2004–05 ABS National Health Survey Confidentialised Unit Record File.

Comorbidity of CVD and diabetes in the institutionalised population

The institutionalised adult population consists of people who can not continue to live at home due to disability or age-related frailty. Old people, especially those aged 85 years and over, are more likely to be institutionalised. In 2003, it was estimated that about 31% of those aged 85 years and over were institutionalised (ABS 2006a). Both CVD and diabetes are more common among older people. Therefore, the prevalence of CVD, diabetes and their comorbidity in the non-institutionalised population may understate the true prevalence in the whole population. This section focuses on reporting the prevalence of comorbidity of CVD and diabetes among the institutionalised adult population based on the 2003 ABS SDAC. The institutionalised adult population in this report refers to people aged 20 years or over and living in cared accommodation as residents. Cared accommodation comprises health establishments, such as hospitals, nursing homes, aged care hostels, hostels for people with disabilities and some cared parts of retirement villages. People living in cared accommodation are those who had been, or were expected to be, living there for three months or more (ABS 2005).

According to this survey, an estimated 182,061 Australians aged 20 years and over were institutionalised in 2003. The majority were older people, with about 89.8% aged 65 years and over (Table A8).



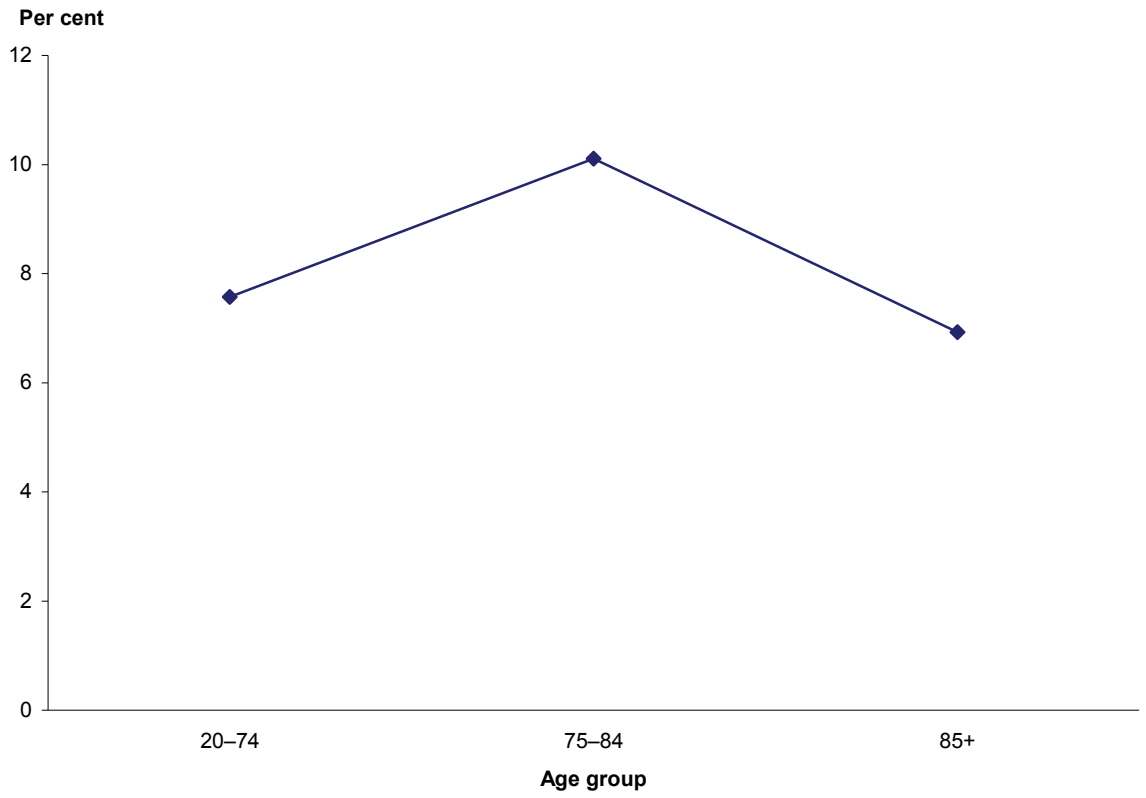
Note: People aged 20 years and over only are included.

Source: AIHW analysis of 2003 ABS Survey of Disability, Ageing and Carers Confidentialised Unit Record File.

Figure 2.5: Prevalence of CVD and diabetes and their comorbidity in the institutionalised adult population, 2003

Around 101,954 (56.0%) people had CVD and 21,106 (11.6%) had diabetes in this population. About 14,722 (8.1%) of them were estimated to have both CVD and diabetes (Figure 2.5). The prevalence rate of comorbidity of these two conditions varied with age, increasing from 7.6% in the 20–74 years age group to 10.1% in the 75–84 years age group, and then decreasing to about 6.9% in those aged 85 years and over (Figure 2.6).

Overall, men were more likely to have this type of comorbidity than women (8.6% versus 7.8%, respectively). However, because of the small sample sizes, the differences between sexes can not be compared for each age group separately. Detailed data can be found in Table A4.



Note: People aged 20 years and over only are included. Due to the small sample size, people aged 20–74 years were grouped for analysis. Analysis can not be done by sex separately for the same reason.

Source: AIHW analysis of 2003 ABS Survey of Disability, Ageing and Carers Confidentialised Unit Record File.

Figure 2.6: Age-specific rate of comorbidity of CVD and diabetes in the institutionalised adult population, 2003

Observed and expected comorbidity in the institutionalised adult population

The prevalence rate of comorbidity of CVD and diabetes observed in the institutionalised adult population was 1.2 times as high as the rate that would be expected by chance (Table 2.4), but this difference is not statistically significant.

Table 2.4: Expected and observed comorbidity of CVD and diabetes in the institutionalised adult population, 2003

Comorbidity	Expected prevalence rate	Observed prevalence rate	Ratio observed to expected (95% CI)
CVD and diabetes	6.5%	8.1%	1.24 (0.73–1.75)

CI Confidence interval

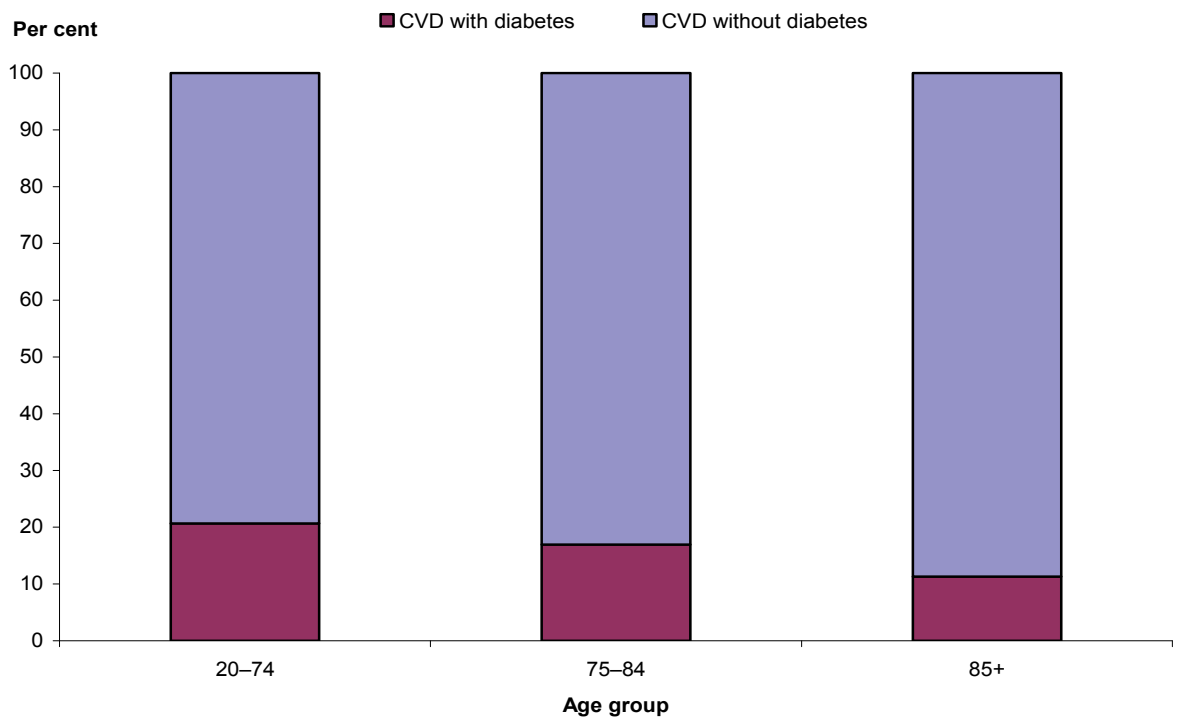
Notes

1. People aged 20 years and over only are included.
2. Expected rate based on 56.0% with CVD and 11.6% with diabetes (56.0% × 11.6% = 6.5%).

Source: AIHW analysis of 2003 ABS Survey of Disability, Ageing and Carers Confidentialised Unit Record File.

Comorbidity among people with CVD

Among people with CVD in the institutionalised population, 14.4% also had diabetes (Table 2.5). Stroke was the form of CVD most likely to coexist with diabetes (16.6%). This was followed by heart disease (15.4%) and hypertension (15.0%). About 13.9% of those with other forms of CVD also had diabetes. The prevalence rate of comorbidity of CVD and diabetes also varied with age, decreasing from 20.6% in the 20–74 years group to around 16.9% in the 75–84 years group, and then further declining to about 11.3% in the 85 years and over group (Figure 2.7).



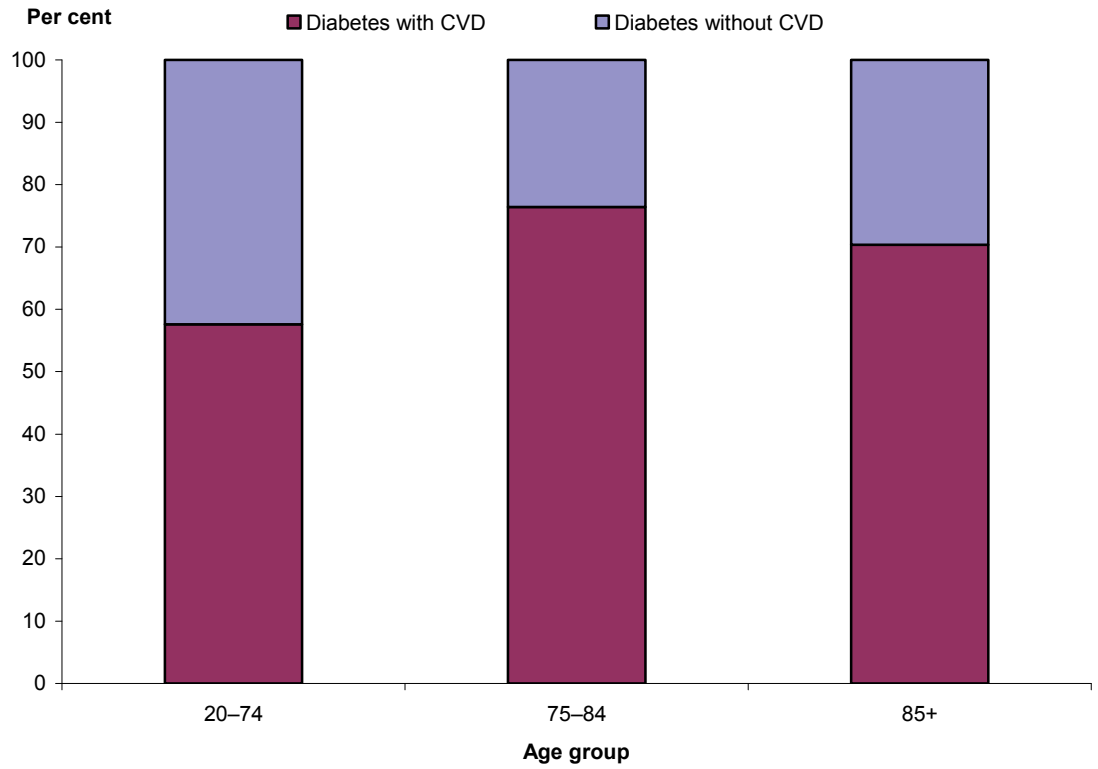
Note: People aged 20 years and over only are included. Due to the small sample size, people aged 20–74 years were grouped for analysis.
Source: AIHW analysis of 2003 ABS Survey of Disability, Ageing and Carers Confidentialised Unit Record File.

Figure 2.7: Comorbidity of CVD and diabetes among people with CVD in the institutionalised adult population, by age group, 2003

Comorbidity among people with diabetes

CVD was also common among people with diabetes in the institutionalised population. It was estimated that 69.8% of people who had diabetes also had at least one form of CVD. About 34.6% of these people had heart disease, 34.1% had stroke and 31.5% had hypertension. Around 8.6% of them also had other forms of CVD (Table 2.5).

The prevalence rate of comorbidity of CVD and diabetes increased from 57.6% in the 20–74 years group to around 76.4% among people aged 75–84 years, and then decreased to 70.4% at ages 85 years and over among people with diabetes (Figure 2.8).



Note: People aged 20 years and over only are included. Due to the small sample size, people aged 20–74 years were grouped for analysis.
Source: AIHW analysis of 2003 ABS Survey of Disability, Ageing and Carers Confidentialised Unit Record File.

Figure 2.8: Comorbidity of CVD and diabetes among people with diabetes in the institutionalised adult population, by age group, 2003

Table 2.5: Australians with comorbidity of CVD and diabetes in the institutionalised adult population by disease category, 2003

Index conditions	Number of people with conditions (%)	Comorbidity					
		All CVD	Heart disease	Hypertension	Stroke	Other CVD	Diabetes
				Per cent			
All CVD	101,954 (56.0)	—	—	—	—	—	14.4
Heart disease	47,439 (26.1)	—	—	30.3	28.3	9.9	15.4
Hypertension	44,200 (24.3)	—	32.5	—	32.7	6.2	15.0
Stroke	43,360 (23.8)	—	31.0	33.4	—	10.6	16.6
Other CVD	13,098 (7.2)	—	36.0	20.9	35.1	—	13.9
Diabetes	21,106 (11.6)	69.8	34.6	31.5	34.1	8.6	—
CVD and diabetes	14,722 (8.1)	—	—	—	—	—	—
Total population with CVD or diabetes	*108,337(59.5)*	—	—	—	—	—	—
Total estimated institutionalised adult population	**182,061**	—	—	—	—	—	—

Notes

1. The number and percentage of population with CVD and diabetes do not add up to total CVD because more than one of form of CVD can be recorded. The number and percentage with individual index conditions also do not add up to total population with index conditions for the same reason.
2. People aged 20 years and over only are included.

Source: AIHW analysis of 2003 ABS Survey of Disability, Ageing and Carers Confidentialised Unit Record File.

3 Hospitalisations

People with comorbidity have been found to use considerably more health resources, such as hospital services, GP visits and specialist consultations, than those without comorbidity (Westert et al. 2001). In this chapter, we examine the extent of comorbidity of CVD, diabetes and CKD in hospitalisations in 2004–05. We focus on presenting the number of hospital separations with any diagnosis (principal diagnosis and/or additional diagnoses) of two or three of the index conditions (CVD, diabetes and CKD), and the distribution of these hospital separations by age group and sex. Analysis was limited to separations for people aged 18 years and over.

The data presented in this chapter are drawn from the AIHW National Hospital Morbidity Database. This database includes data on virtually all hospital admissions in Australia, in both public and private hospitals. Data are collected for each episode of hospital care (called hospital separation), which starts when a patient is admitted to hospital and ends when the hospital stay ends, or there is a change in the type of care (for example, from acute care to rehabilitation hospital care).

Most diseases or conditions (including CVD and CKD) are recorded as a diagnosis following these criteria:

- diseases are recorded as principal diagnosis when they are considered to be the primary reason for the patient being hospitalised
- diseases that coexist with the principal diagnosis, or arise during the episode of care, are recorded as additional diagnoses when they affect the management of patients in terms of requiring therapeutic treatment, diagnostic procedures, or increased nursing care and/or monitoring (NCCH 2002).

In other words, a disease is not recorded as a diagnosis in hospital separations if it does not meet these criteria, even if patients had this disease when they were admitted to hospital. However, diabetes, along with a few other conditions, is treated as an exception—it is recorded as a diagnosis if people have this disease when they are hospitalised, regardless of the above criteria. As a consequence, the results of this analysis may underestimate the number of hospital separations with comorbidity of CVD, CKD or both.

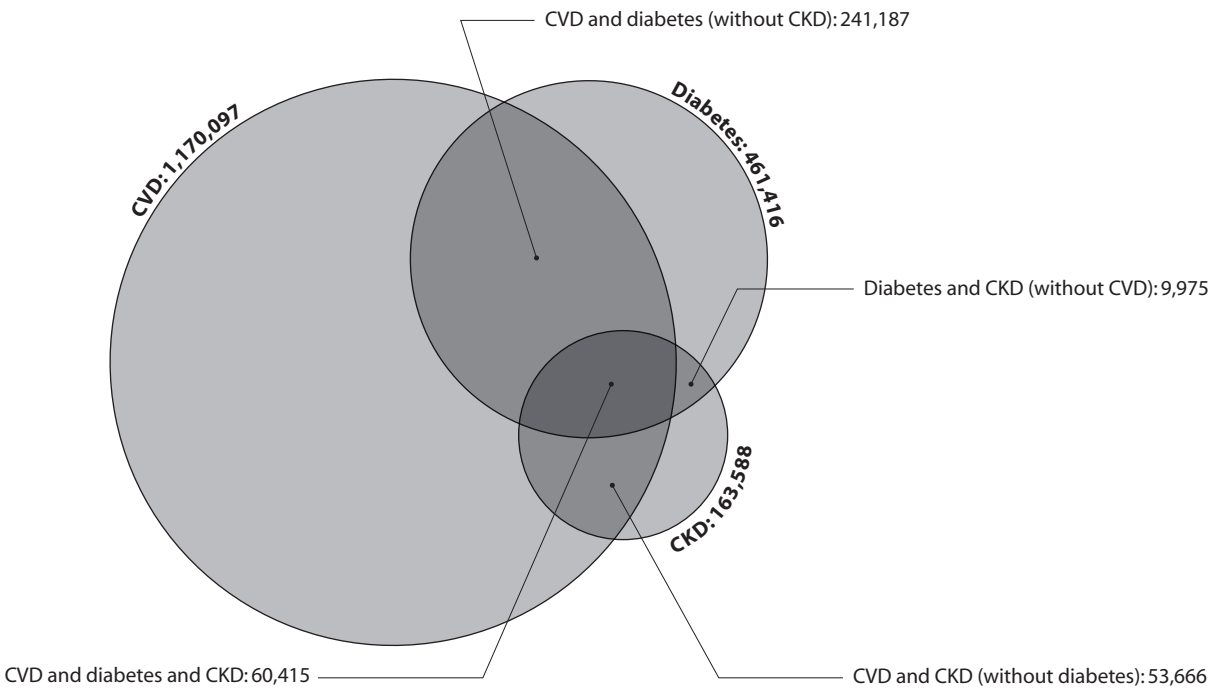
In addition, there may be some variations in coding practice between states and territories, particularly in the way comorbidity is recorded, which may also affect the results of the analyses in this report.

It is also important to note that because hospital records are based on hospital separations, rather than individual patients, it is impossible to track patients between admissions. Therefore, the analyses presented here cannot identify whether different hospital separations relate to different patients or to a single patient with more than one episode of hospital care.

In 2004–05, around 83% of adult hospitalisations with a diagnosis of CKD were attributed to regular dialysis in which 'Care involving dialysis' was recorded as the principal diagnosis. Because the characteristics of these hospital separations are very different from others, and because of the large number of them, they have been analysed separately in this chapter.

Hospitalisations with comorbidity of CVD, diabetes and CKD (excluding regular dialysis)

There was a total of 5,573,327 hospital separations (excluding regular dialysis) among people aged 18 years and over in 2004–05. This type of hospitalisation is referred to as non-dialysis adult hospitalisation in the following section. The index condition with the largest number of separations was CVD (21.0% of all separations), followed by diabetes (8.3%) and CKD (2.9%) (Figure 3.1). In total, 24.6% of hospitalisations had at least one of the three conditions as a diagnosis.



Notes

1. Hospital separations for regular dialysis were excluded from this analysis.
2. Hospital separations for people aged 18 years and over only are included.

Source: AIHW National Hospital Morbidity Database.

Figure 3.1: Non-dialysis adult hospitalisations with diagnoses of CVD, diabetes, CKD and their comorbidity, 2004–05

There were 365,243 separations with diagnoses of two or more index conditions, representing 6.6% of non-dialysis adult hospitalisations.

The most common combination between index conditions was CVD and diabetes. There were 241,187 adult separations that recorded this type of comorbidity in 2004–05, accounting for 4.3% of all non-dialysis adult separations. This was followed by the combination of CVD and CKD (53,666 separations, 1.0%), and diabetes and CKD (9,975 separations, 0.2%). There were 60,415 (1.1%) separations with all three index conditions recorded (Table 3.1 and Table 3.3).

Table 3.1: Non-dialysis adult hospitalisations with comorbidity of CVD, diabetes and CKD, by sex and age group, 2004–05

Comorbidity	Men	Women	Odds ratio men to women (95% CI)	Under 65 years	65 years and over	Odds ratio 65 years and over to under 65 years (95% CII)
CVD and diabetes	128,315	112,872	1.32	76,377	164,810	3.79
(without CKD)	(5.2%)	(3.6%)	(1.31–1.33)	(2.2%)	(8.0%)	(3.76–3.82)
CVD and CKD	30,349	23,317	1.43	10,760	42,906	6.66
(without diabetes)	(1.2%)	(0.8%)	(1.41–1.46)	(0.3%)	(2.1%)	(6.52–6.80)
Diabetes and CKD	5,509	4,466	1.46	4,218	5,757	2.24
(without CVD)	(0.2%)	(0.1%)	(1.40–1.52)	(0.1%)	(0.3%)	(2.15–2.33)
CVD and diabetes	35,146	25,269	1.59	17,791	42,624	3.96
and CKD	(1.4%)	(0.8%)	(1.56–1.61)	(0.5%)	(2.1%)	(3.89–4.03)
All hospital separations	**2,460,242**	**3,113,085**	**—**	**3,501,157**	**2,072,170**	—

CI Confidence interval

Notes

1. Hospital separations for regular dialysis were excluded from this analysis.
2. Hospital separations for people aged 18 years and over only are included.

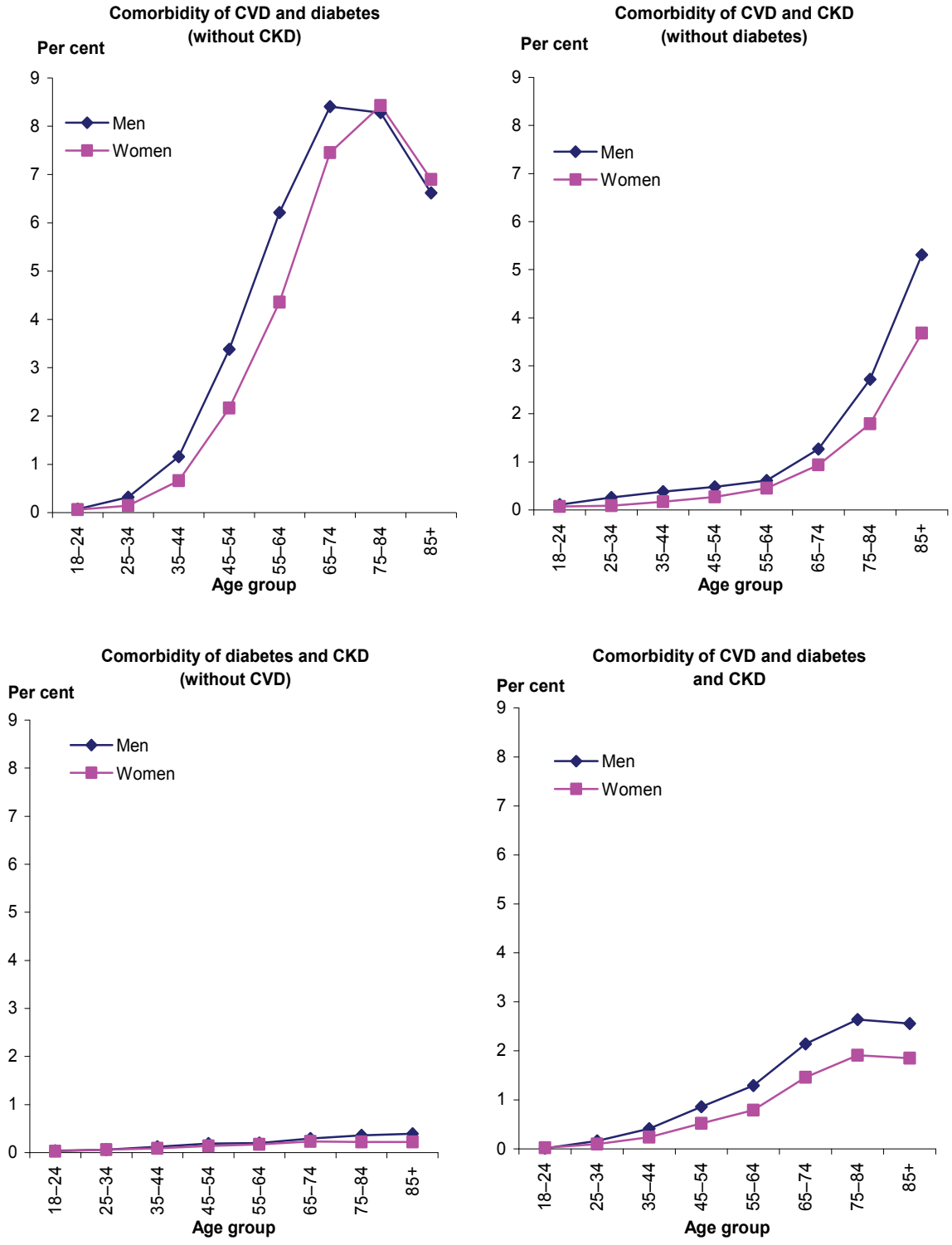
Source: AIHW National Hospital Morbidity Database.

Age and sex

The overall proportion of hospital separations with comorbidities increased with age. After adjusting for sex, separations for older people (aged 65 years and over) were around 2 to 7 times as likely to have two index conditions recorded and around 4 times as likely to have all three conditions recorded as separations for younger people (aged under 65 years) (Table 3.1).

After adjusting for age, separations for men were more likely to have these comorbidities recorded than those for women—men were 32–46% more likely to have two of the conditions recorded and 59% more likely to have all three conditions recorded (Table 3.1).

Figure 3.2 illustrates the distribution of non-dialysis adult hospitalisations with each combination of comorbidity by age and sex. Detailed data can be found in Table A5.



Notes

1. Hospital separations for regular dialysis were excluded from this analysis.
2. Hospital separations for people aged 18 years and over only are included.
3. Per cent in the figures is the percentage of total hospitalisations in corresponding age group.

Source: AIHW National Hospital Morbidity Database.

Figure 3.2: Age-specific rate of non-dialysis adult hospitalisations with comorbidity of CVD, diabetes and CKD, by sex, 2004–05

Observed and expected comorbidity in hospitalisations

Combinations of these conditions may occur by chance in the same hospital separation. Table 3.2 lists the proportion of such combinations that would be expected by chance, along with the observed proportions in adult hospital separations in 2004–05. Combinations between two conditions only were observed around 3 to 5 times as often as expected by chance, while comorbidity of all three index conditions was observed around 22 times as often (Table 3.2).

These findings were similar to the prevalence of comorbidity in the non-institutionalised and institutionalised populations. They suggest that coexistence of these diseases in hospitalisations is mainly attributed to the associations between the diseases. A large proportion of these hospitalisations could be reduced if the causes of such associations could be prevented.

Table 3.2: Expected and observed non-dialysis adult hospitalisations with comorbidity of CVD, diabetes and CKD, 2004–05

Comorbidities	Expected hospitalisation rate (per cent)	Observed hospitalisation rate (per cent)	Ratio observed to expected (95% CI)
CVD and diabetes (with and without CKD)	1.74	5.4	3.10 (3.09–3.11)
CVD and CKD (with and without diabetes)	0.61	2.1	3.44 (2.42–3.46)
Diabetes and CKD (with and without CVD)	0.24	1.3	5.41(5.38–5.46)
CVD and diabetes and CKD	0.05	1.1	22.00 (21.83–22.17)

CI Confidence interval

Notes

1. Hospital separations for regular dialysis were excluded from this analysis.
2. Hospital separations for people aged 18 years and over only are included.
3. Per cent in the table is the percentage of total hospital separations.
4. See Appendix for an explanation of calculations of observed and expected hospitalisation rates.

Source: AIHW National Hospital Morbidity Database.

Comorbidity in the context of each disease

The proportion of hospital separations with comorbidity was different for each of the three conditions. The largest was CKD, with 75.8% of CKD separations also having a diagnosis of another index condition. This was followed by diabetes (67.5%) and CVD (30.4%) (Table 3.3).

Table 3.3: Non-dialysis adult hospitalisations with index conditions and comorbidities, 2004–05

Comorbidities	Number of hospital separations	Index condition			Total hospital separations
		CVD	Diabetes	CKD	
		Per cent			
CVD and diabetes (without CKD)	241,187	20.6	52.3	—	4.3
CVD and CKD (without diabetes)	53,666	4.6	—	32.8	1.0
Diabetes and CKD (without CVD)	9,975	—	2.2	6.1	0.2
CVD and diabetes and CKD	60,415	5.2	13.1	36.9	1.1
Proportion of hospital separations with index conditions that have comorbidities from other index conditions	—	30.4	67.5	75.8	—
Total hospital separations with comorbidity of index conditions	**365,243**	**—**	**—**	**—**	**6.6**

Notes

1. Hospital separations for regular dialysis were excluded from this analysis.
2. Hospital separations for people aged 18 years and over only are included.
3. Per cent in the table is the proportion of index condition hospitalisations with each comorbidity. Example: 52.3% of diabetes hospitalisations had comorbidity of CVD without CKD.

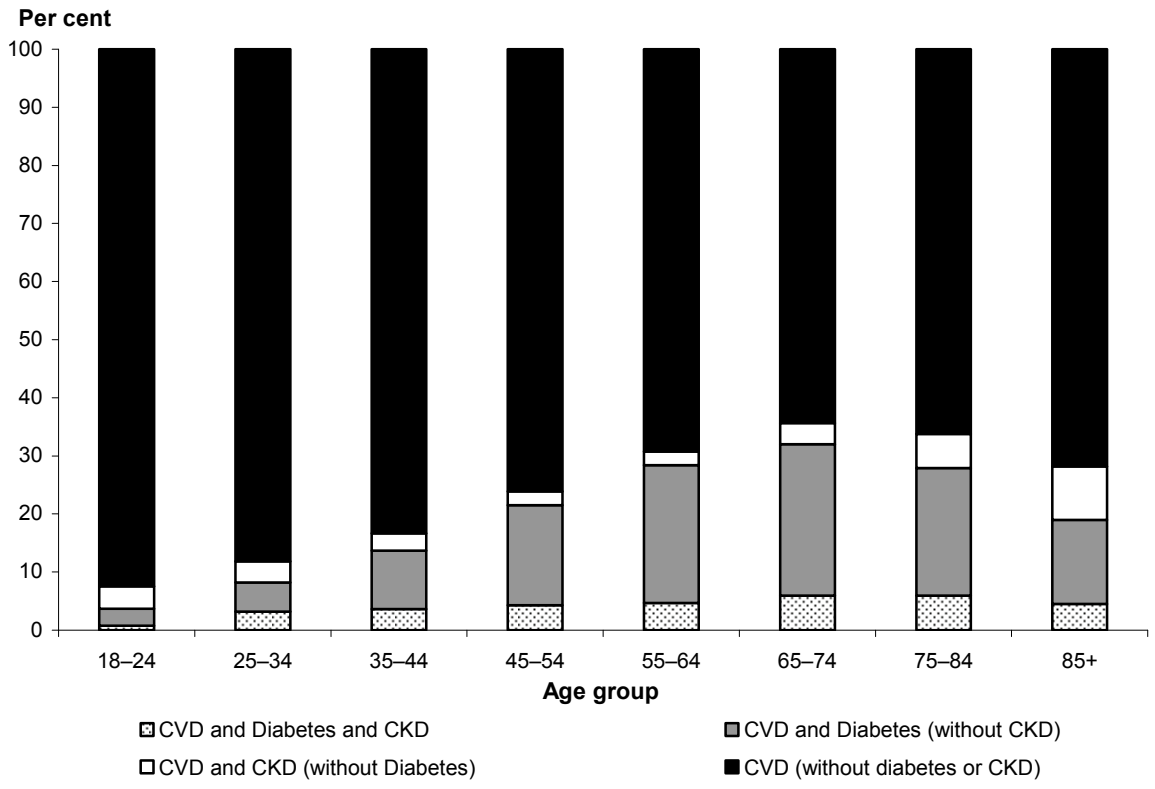
Source: AIHW National Hospital Morbidity Database.

Comorbidity in hospitalisations with a diagnosis of CVD

Of the hospital separations with a diagnosis of any form of CVD, more than 1 in 4 (25.8%) also had a diagnosis of diabetes. For some forms of CVD, the proportion of separations with diabetes was even higher than this average—hypertension (40.4%), heart failure (29.0%), CHD (25.1%), cerebrovascular disease (21.3%) and transient ischaemic attack (TIA) (16.7%). About 20.1% of hospital separations with other forms of CVD also recorded diabetes (Table 3.4).

CKD was recorded as comorbidity in 9.7% of separations with CVD (Table 3.4). Heart failure occurred most frequently with CKD (23.5%), followed by hypertension (12.9%), CHD (11.2%), cerebrovascular disease (8.4%) and TIA (5.1%). About 11.3% of hospital separations with other forms of CVD also recorded CKD (Table 3.4).

Hospitalisations with a diagnosis of CVD along with diabetes and/or CKD gradually increased from about 8% in the age group 18–24 to about 36% in the age group 65–74, before decreasing slightly in the older age groups (Figure 3.3).



Notes

1. Hospital separations for regular dialysis were excluded from this analysis.
2. Hospital separations for people aged 18 years and over only are included.

Source: AIHW National Hospital Morbidity Database.

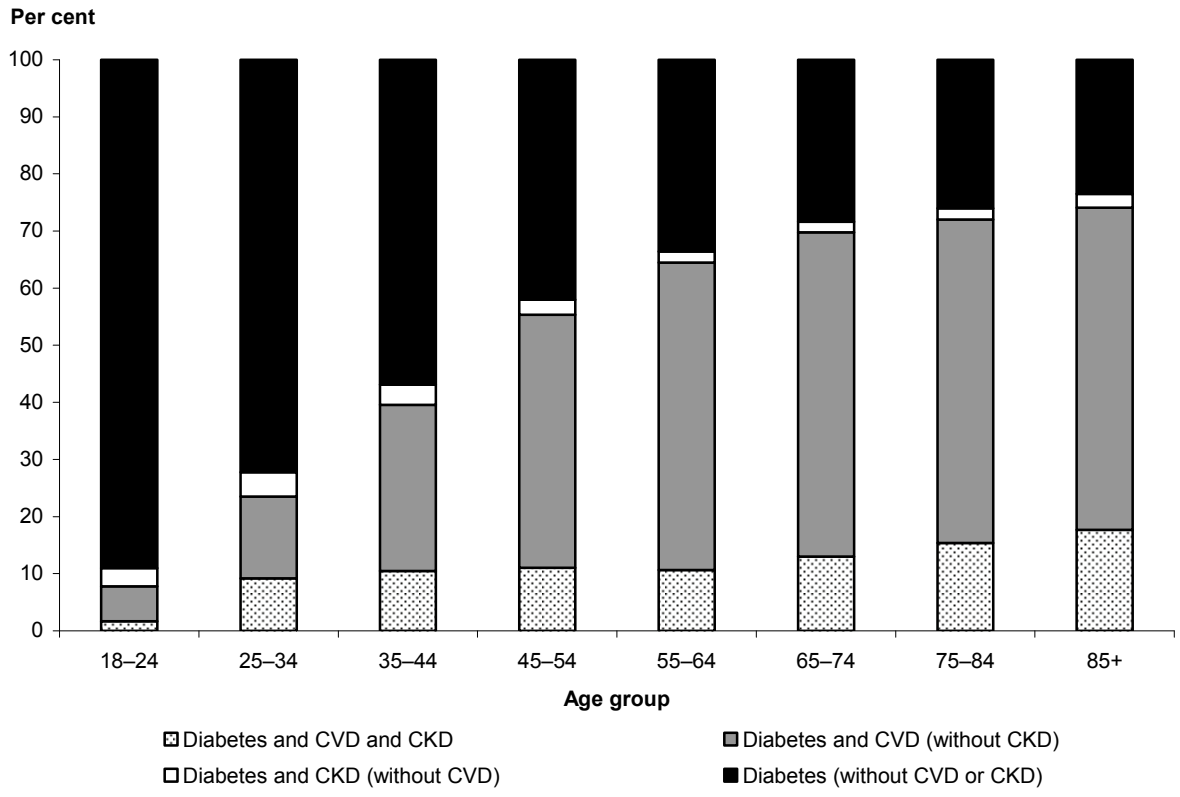
Figure 3.3: Comorbidity in non-dialysis adult hospitalisations with a diagnosis of CVD, by age group, 2004–05

Comorbidity in hospitalisations with a diagnosis of diabetes

There were 461,416 non-dialysis adult hospital separations with a diagnosis of diabetes. About 65.4% of these separations also had a diagnosis of CVD. Nearly half (49.6%) had comorbidity of hypertension, followed by CHD (17.3%), heart failure (8.9%), cerebrovascular disease (4.9%) and TIA (0.6%). About 25.6% of these separations also recorded other forms of CVD (Table 3.4).

Around 15.3% of the diabetes hospital separations recorded CKD as a comorbidity (Table 3.4). However, diabetes rarely coexists with CKD alone. Most separations with the comorbidity of diabetes and CKD also had at least one form of CVD (Table 3.3).

Among hospital separations with a diagnosis of diabetes, the proportion of separations that also recorded CVD and/or CKD increased progressively with age, mainly due to an increase across age groups in the proportion with CVD (Figure 3.4).



Notes

1. Hospital separations for regular dialysis were excluded from this analysis.
2. Hospital separations for people aged 18 years and over only are included.

Source: AIHW National Hospital Morbidity Database.

Figure 3.4: Comorbidity in non-dialysis adult hospitalisations with a diagnosis of diabetes, by age group, 2004–05

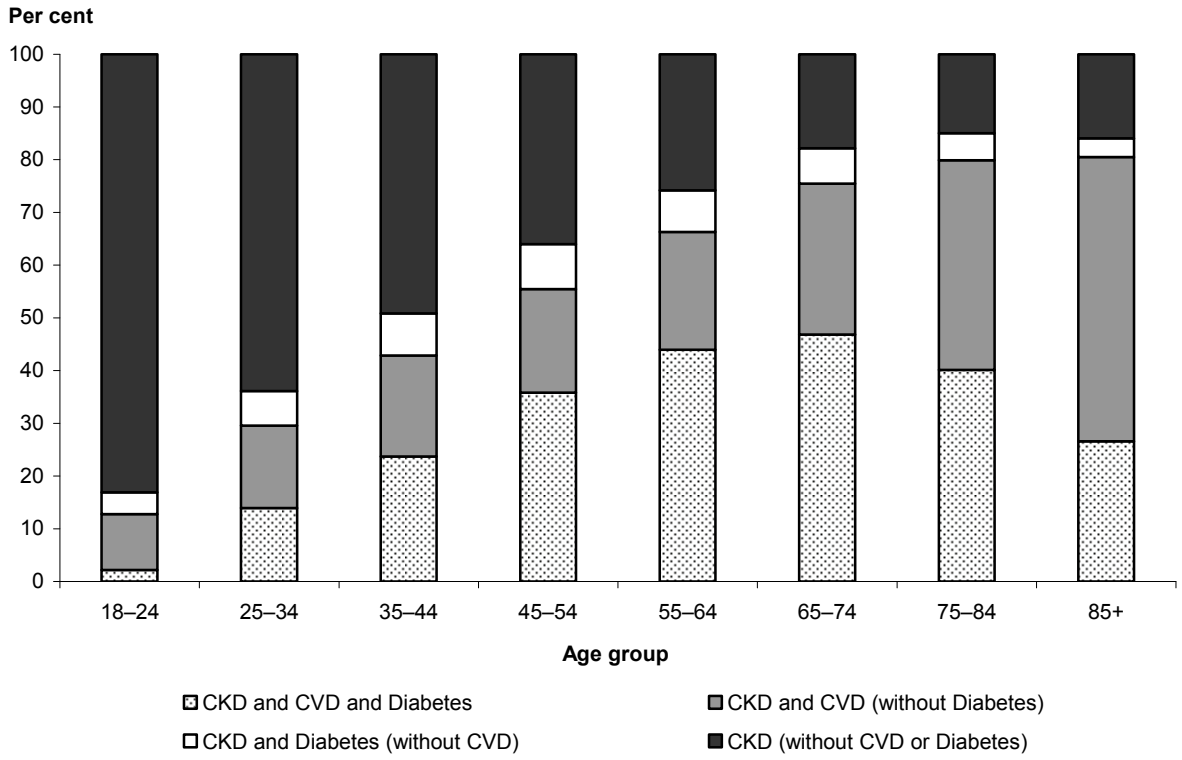
Comorbidity in hospitalisations with a diagnosis of CKD

Excluding hospital separations for regular dialysis, there were 163,588 hospital separations with a diagnosis of CKD in 2004–05. Nearly 70% of these separations also involved CVD, with hypertension (44.6%), CHD (21.8%) and heart failure (20.5%) commonly recorded. About 40.6% of these separations also recorded other forms of CVD (Table 3.4).

Diabetes was recorded in around 43% of hospital separations with CKD, and most of them also had at least one diagnosis of CVD (Table 3.3 and 3.4).

Among hospital separations with a diagnosis of CKD, the proportion of comorbidity with CVD and/or diabetes also increased progressively with age, mainly due to an increase across age groups in the proportion with CVD (Figure 3.5).

Although CKD (excluding dialysis) accounted for a small proportion of hospital separations compared with CVD and diabetes, it had the greatest proportion of comorbidity across all age groups, and it also had the greatest proportion of comorbidity with both other index conditions (Figure 3.5).



Notes

1. Hospital separations for regular dialysis were excluded from this analysis.
2. Hospital separations for people aged 18 years and over only are included.

Source: AIHW National Hospital Morbidity Database.

Figure 3.5: Comorbidity in non-dialysis adult hospitalisations with a diagnosis of CKD, by age group, 2004–05

Table 3.4: Non-dialysis adult hospitalisations with comorbidity of CVD, diabetes and CKD by disease category

Index conditions	Number of hospital separations (%)	Comorbidity								
		All CVD	Cerebrovascular disease	CHD	Heart failure	Hypertension	TIA	Other CVD	Diabetes	CKD
		Per cent								
All CVD	1,170,097 (21.0)	—	—	—	—	—	—	—	25.8	9.7
Cerebrovascular disease	105,485 (1.9)	—	—	15.0	7.6	46.6	2.2	29.5	21.3	8.4
CHD	317,991 (5.7)	—	5.0	—	15.9	48.7	0.6	36.3	25.1	11.2
Heart failure	142,337 (2.6)	—	5.6	35.5	—	38.3	0.6	55.9	29.0	23.5
Hypertension	566,699 (10.2)	—	8.7	27.3	9.6	—	1.1	30.3	40.4	12.9
TIA	16,980 (0.3)	—	13.9	11.6	4.7	36.9	—	22.8	16.7	5.1
Other CVD	587,456 (10.5)	—	5.3	19.7	13.5	29.3	0.7	—	20.1	11.3
Diabetes	461,416 (8.3)	65.4	4.9	17.3	8.9	49.6	0.6	25.6	—	15.3
CKD	163,588 (2.9)	69.7	5.4	21.8	20.5	44.6	0.5	40.6	43.0	—
Total hospital separations with index conditions	*1,369,443 (24.6)*	—	—	—	—	—	—	—	—	—
Total non-dialysis adult hospital separations	**5,573,327**	—	—	—	—	—	—	—	—	—

Notes

1. Hospital separations for regular dialysis were excluded from this analysis.
2. Hospital separations for people aged 18 years and over only are included.
3. The number and percentage of hospital separations with individual forms of CVD do not add up to total separations of all CVD because more than one of form of CVD can be recorded. The number and percentage of hospital separations with individual index conditions also do not add up to total separations with index conditions for the same reason.

Source: AIHW National Hospital Morbidity Database.

Hospitalisations for regular dialysis

There were 808,917 adult hospital separations in which 'Care involving dialysis' was recorded as the principal diagnosis in 2004–05, representing 83.2% of adult hospital separations with a diagnosis of CKD and 12.7% of all adult hospital separations. As people with end-stage kidney disease go to hospital for day-stay admissions for regular dialysis 3 times per week, these hospital separations represent a large number of hospital re-admissions for a relatively small population.

Among these separations, 64,328 (8.0%) had an additional diagnosis of diabetes and 41,543 (5.1%) had an additional diagnosis of CVD. The two forms of CVD most often recorded as an additional diagnosis were hypertension (4.4%) and CHD (0.1%). Around 1.4% of these separations also recorded other forms of CVD. Furthermore, 18,590 (2.3%) dialysis separations had both diabetes and CVD among their additional diagnoses (Table 3.5).

There are differences between the proportion of comorbidities recorded in the AIHW National Hospital Morbidity Database and in other data sources. For example, about 5.1% of dialysis separations recorded CVD as an additional diagnosis, but the Australia and New Zealand Dialysis and Transplant Registry (ANZDATA) reported that about 28% of new patients had coronary artery disease in 2004 (McDonald et al. 2005).

There are two possible reasons that may lead to this disparity. First, although a considerable proportion of people who were receiving dialysis had CVD, CVD might not affect regular dialysis, and therefore it is not recorded. Second, as the same patients attend the same dialysis unit or clinic a number of times, their medical records may be automatically repeated at each separation, rather than being re-recorded to reflect the comorbidities that they had, or were treated for, during each episode of hospital care.

Table 3.5: Adult hospitalisations for regular dialysis, 2004–05

Diagnosis	Number	Per cent
Diabetes	64,328	8.0
CVD	41,543	5.1
Cerebrovascular disease	543	0.1
CHD	927	0.1
Heart failure	623	0.1
Hypertension	35,279	4.4
TIA	1	0.0
Other CVD	11,663	1.4
Comorbidity of CVD and diabetes	18,590	2.3
Total adult hospitalisations for regular dialysis	**808,917**	**100**

Note: Hospital separations for people aged 18 years and over only are included.

Source: AIHW National Hospital Morbidity Database.

4 Deaths

In this chapter, we examine the extent of comorbidity of CVD, diabetes and CKD in deaths registered in Australia in 2004. The data presented here are drawn from the AIHW National Mortality Database. These data are collected by the Registrars of Births, Deaths and Marriages in each state and territory and compiled nationally by the ABS, which codes the causes of death according to the International Classification of Diseases (ICD).

Deaths registered in Australia may have more than one cause of death recorded on the death certificate. The disease or injury that initiated the train of events leading directly to death is defined as the 'underlying cause of death'. In addition, any other condition or event that is not the underlying cause of death but is considered to have contributed to the death is known as an associated cause. This chapter focuses on those deaths where two or more of the index conditions were recorded among the underlying and associated causes listed on the death certificate.

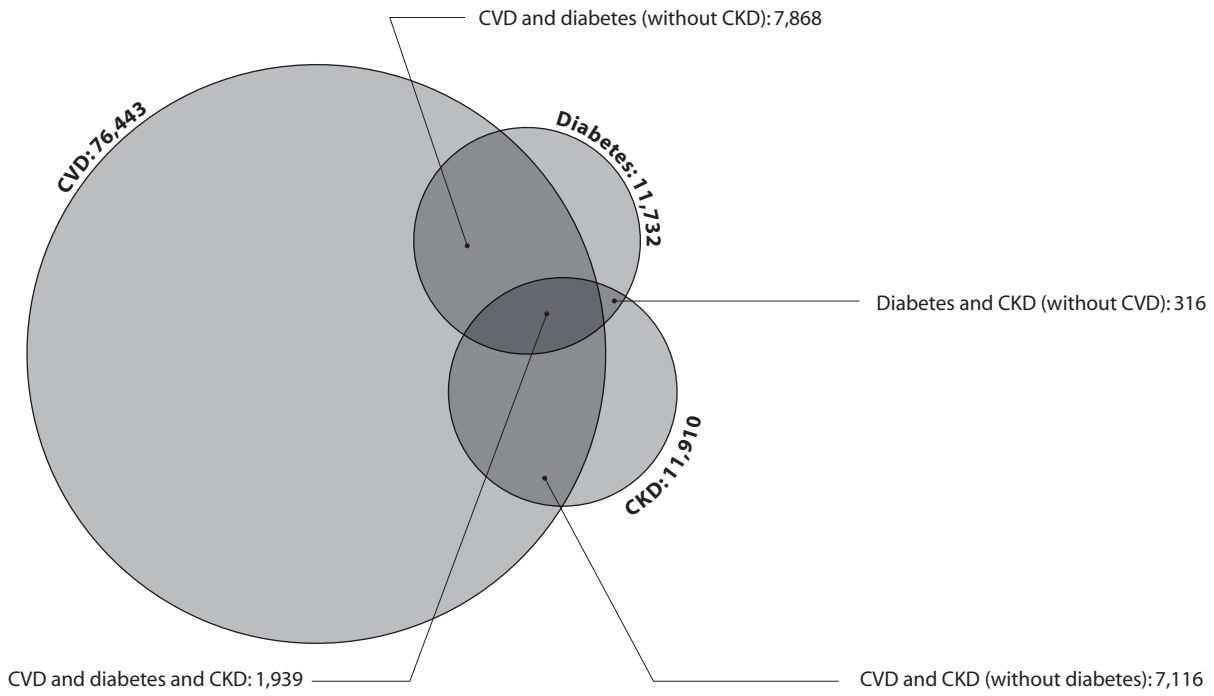
However, it is important to note that a condition is recorded as a cause of death only if it is judged to have contributed to the death. A disease will not be recorded in the death certificate if it does not meet this criterion even if people have this disease when they die. Therefore, results in this chapter represent the extent of comorbidity of the index condition *as a cause of death* (described here as 'death with index conditions or comorbidity'), rather than the prevalence of these comorbidities among people who died.

As with previous chapters, analysis here was limited to mortality records for people aged 18 years and over.

Deaths with comorbidity of CVD, diabetes and CKD

There were 130,521 deaths registered among people aged 18 years and over in Australia in 2004. CVD, diabetes and CKD contributed largely to these deaths. CVD was recorded as a cause of death in 58.6%, while CKD and diabetes were each associated with about 9% (Figure 4.1). In total, 62% of deaths were associated with at least one of these conditions.

At least two of CVD, diabetes and CKD were found in 17,239 death certificates, representing 13.2% of all adult deaths. Comorbidity of CVD and diabetes contributed to 7,868 (6%), while comorbidity of CVD and CKD was associated with 7,116 (5.5%) deaths. Comorbidity of diabetes and CKD accounted for only 0.2% of adult deaths. About 1.5% of adult deaths had all three index conditions recorded.



Note: Deaths for people aged 18 years and over only are included.
Source: AIHW National Mortality Database.

Figure 4.1: Adult deaths with CVD, diabetes, CKD and their comorbidity, 2004

Age and sex

The age-specific death rate increased with age for all combinations of these conditions. After adjusting for sex, the risk of having comorbidity was significantly greater among people aged 65 years and over than in younger people for all combinations of the index conditions, except for comorbidity of diabetes and CKD (Table 4.1).

The overall proportion of deaths with comorbidity was greater for men than for women (Table 4.1). After adjusting for age, the differences between men and women were significant for comorbidity of CVD and diabetes, CVD and CKD and all three index conditions, but not significant for a combination of diabetes and CKD (Table 4.1).

The distribution of comorbidity among age groups and sexes is presented separately for each combination in Figure 4.2. Detailed data can be found in Table A6.

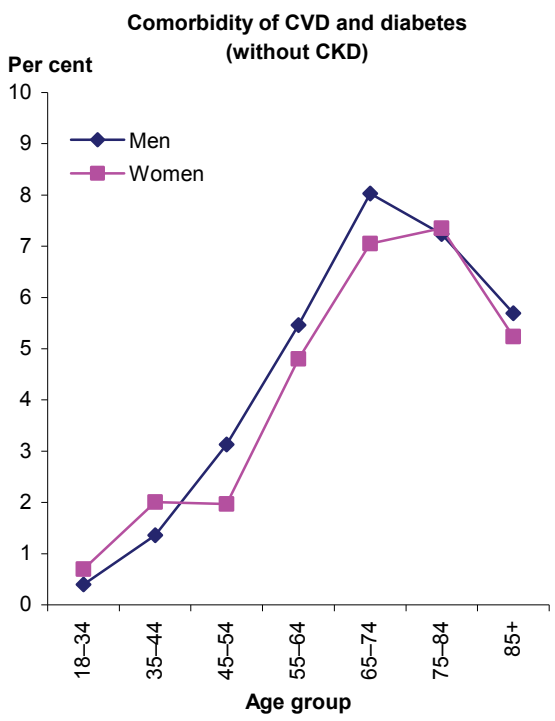
Table 4.1: Adult deaths with comorbidity of CVD, diabetes and CKD by sex and age group in 2004

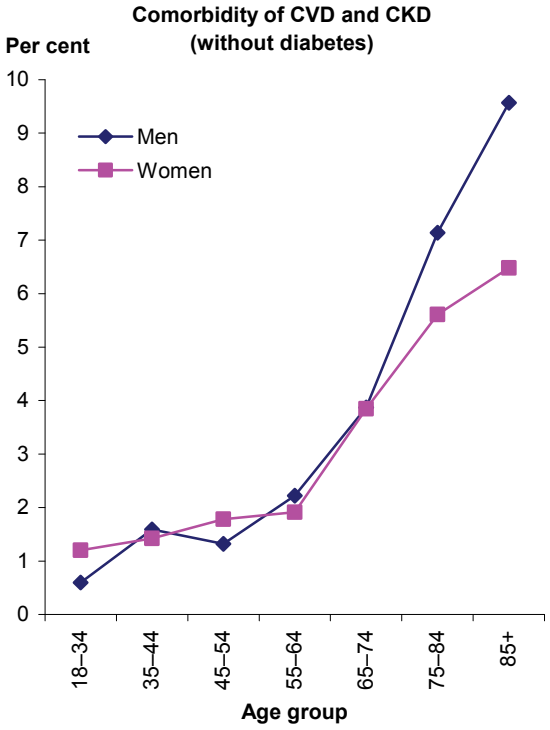
Comorbidity	Men	Women	Odds ratio men to women (95% CI)	Under 65 years	65 years and over	Odds ratio 65 years and over to under 65 years (95% CI)
CVD and diabetes (without CKD)	4,163 (6.2%)	3,705 (5.9%)	1.12 (1.07–1.17)	870 (3.5%)	6,998 (6.6%)	2.02 (1.88–2.17)
CVD and CKD (without diabetes)	3,832 (5.7%)	3,284 (5.2%)	1.21 (1.15–1.27)	427 (1.7%)	6,689 (6.4%)	4.03 (3.65–4.46)
Diabetes and CKD (without CVD)	161 (0.2%)	155 (0.2%)	0.97 (0.77–1.21)	67 (0.3%)	249 (0.2%)	0.88 (0.67–1.16)
CVD and diabetes and CKD	1,081 (1.6%)	858 (1.4%)	1.24 (1.13–1.35)	259 (1.0%)	1,680 (1.6%)	1.61 (1.41–1.83)
All deaths	**67,238**	**63,283**	**—**	**25,121**	**105,400**	—

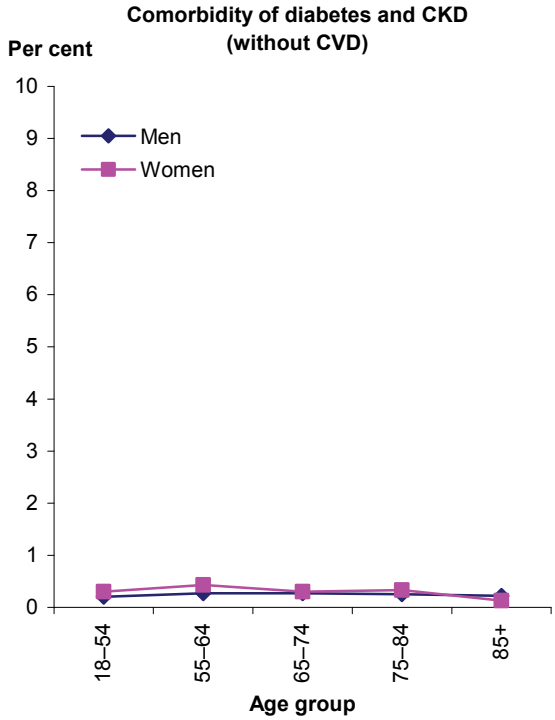
CI Confidence interval

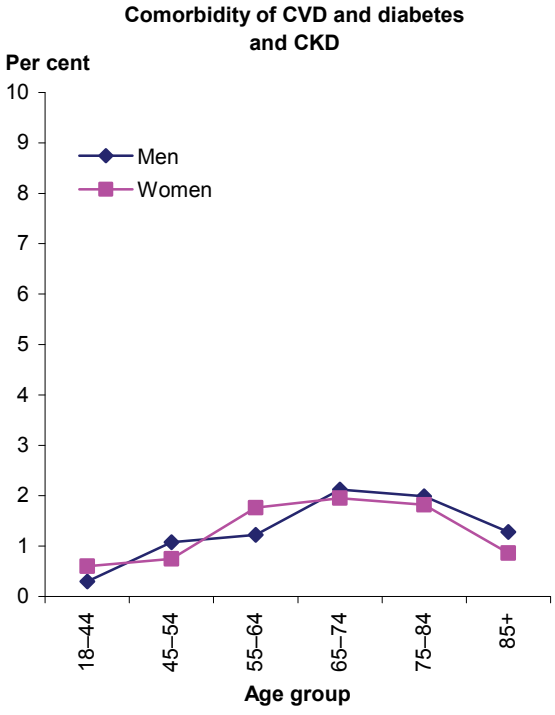
Note: Deaths for people aged 18 years and over only are included.

Source: AIHW National Mortality Database.









Notes

1. Deaths for people aged 18 years and over only are included. Due to the small numbers, some age groups were merged for analysis.
2. Per cent in the figures is the percentage of total deaths in corresponding age group.

Source: AIHW National Mortality Database

Figure 4.2: Age-specific rate of deaths with comorbidity of CVD, diabetes and CKD, by sex, 2004

Observed and expected comorbidity among deaths

Table 4.2 lists the proportion of such combinations that would be expected by chance alone, and the observed proportions among death records for adults in 2004. Combinations between CVD and diabetes, and CVD and CKD were observed 40% and 30% more often than would be expected by chance, respectively. The combination of diabetes and CKD was observed twice as often as expected and the combination of all three index conditions was observed 3 times as often (Table 4.2).

The excess observed rate of comorbidity in deaths suggests that the coexistence of these diseases is caused by associations between these diseases. Thus, a considerable proportion of these deaths could potentially be prevented by reducing the factors that lead to such associations.

Table 4.2: Expected and observed comorbidity among deaths for adults, 2004

Comorbidity	Expected death rate (per cent)	Observed death rate (per cent)	Ratio observed to expected (95% CI)
CVD and diabetes (with and without CKD)	5.3	7.5	1.42 (1.39–1.44)
CVD and CKD (with and without diabetes)	5.4	6.9	1.28 (1.28–1.33)
Diabetes and CKD (with and without CVD)	0.8	1.7	2.13 (2.04–2.22)
CVD and diabetes and CKD	0.5	1.5	3.00 (2.87–3.14)

CI Confidence interval

Notes

1. Deaths for people aged 18 years and over only are included.
2. Per cent in the table is percentage of total deaths.

Source: AIHW National Mortality Database.

Comorbidity in the context of each disease

The proportion of deaths with comorbidity was different for each condition. About 86.3% of deaths with diabetes have another one or two diseases recorded. This was followed by CKD (78.7%) and CVD (22.1%) (Table 4.3).

Table 4.3: Adult deaths with index conditions and comorbidities, 2004

Comorbidity	Number of deaths	Index condition			Proportion of total deaths
		CVD	Diabetes	CKD	
		Per cent			
CVD and diabetes (without CKD)	7,868	10.3	67.1	—	6.0
CVD and CKD (without diabetes)	7,116	9.3	—	59.7	5.5
Diabetes and CKD (without CVD)	316	—	2.7	2.7	0.2
CVD and diabetes and CKD	1,939	2.5	16.5	16.3	1.5
Proportion of deaths with index conditions that have comorbidity of other index conditions	—	22.1	86.3	78.7	—
Total deaths with comorbidity of index conditions	**17,239**	**—**	**—**	**—**	**13.2**

Notes

1. Deaths for people aged 18 years and over only are included.
2. Per cent in the table is the proportion of index condition deaths with each comorbidity. Example: 67.1% of diabetes deaths had comorbidity of CVD without CKD recorded.

Source: AIHW National Mortality Database.

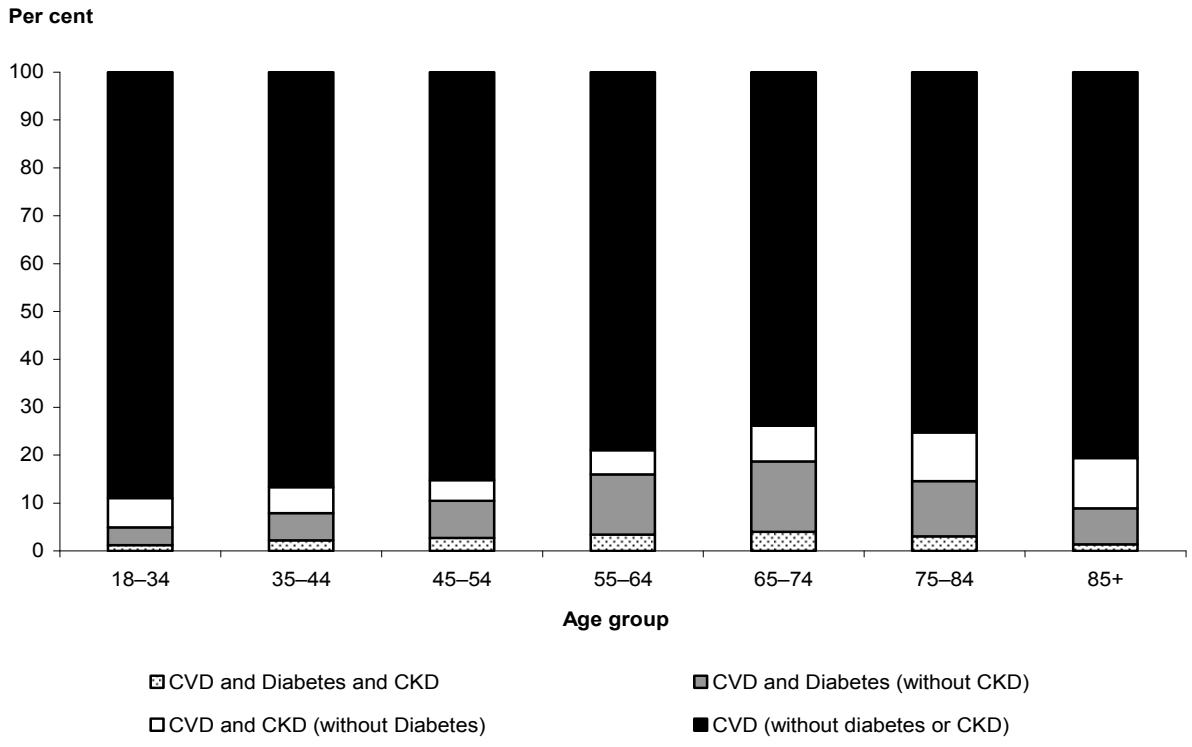
Comorbidity in deaths with CVD

In 2004, 76,443 people had at least one form of CVD recorded on their death certificates, which represents 58.6% of all adult deaths in that year. About 22.1% of deaths with CVD also had at least one other index condition recorded. However, this proportion varied by age group, increasing from around 11.1% of adults aged 18–34 years to 26.1% for deaths at age 65–74 years and then falling to 19.4% at age 85 years and over (Figure 4.3).

Overall, of the deaths with CVD, about 12.8% also recorded diabetes. This proportion differed in different forms of CVD—hypertension (22.3%), CHD (15.0%), heart failure (13.4%), cerebrovascular disease (11.5%) and TIA (9.9%). About 12.9% of deaths with other forms of CVD also recorded diabetes (Table 4.4).

About 11.9% of CVD deaths also recorded CKD. As with hospital separations, there was a strong association between heart failure and CKD in death records, where CKD contributed to more than 1 in 5 (21.3%) deaths with heart failure. In addition, 13.8% of hypertension deaths and 11.8% of CHD deaths also recorded CKD as a cause of death. CKD deaths were also associated with TIA (10.2%) and cerebrovascular disease (6.7%). About 13.0% of deaths with other forms of CVD also recorded CKD (Table 4.4).

Around 2.5% of people who died with CVD had both diabetes and CKD recorded (Table 4.3).



Note: Deaths for people aged 18 years and over only are included.
Source: AIHW National Mortality Database.

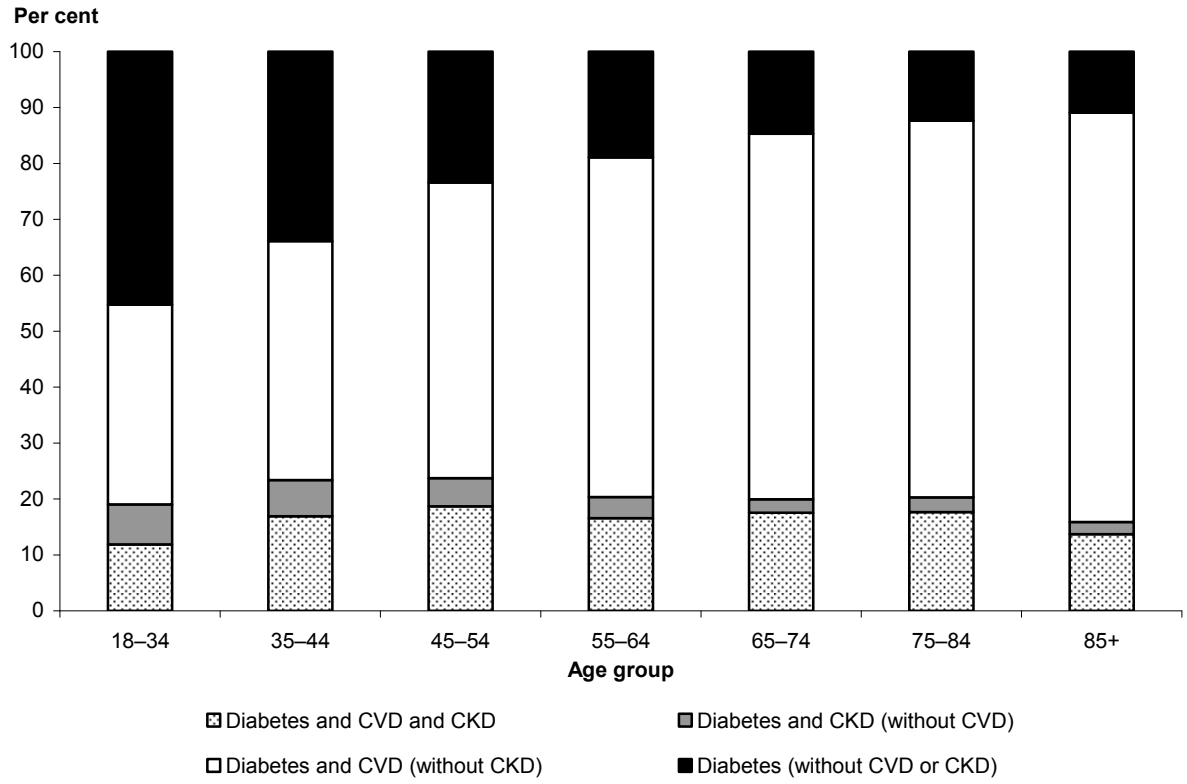
Figure 4.3: Comorbidity among Australian adults with CVD as a cause of death, by age group, 2004

Comorbidity in deaths with diabetes

There were 11,732 deaths with diabetes in 2004, which represents 9.0% of all adult deaths.

CVD contributed significantly to deaths with diabetes. About 83.6% of diabetes deaths had at least one form of CVD recorded. CHD was the most common (47.9%), followed by hypertension (28.6%) and heart failure (20.9%). In addition, more than 1 in 5 of them had cerebrovascular disease or TIA recorded (Table 4.4). About 36.4% of deaths with diabetes also recorded other forms of CVD. The strong association between CVD and deaths with diabetes appeared in all age groups. Around 47.6% of people aged 18–34 years had at least one form of CVD recorded if they died with diabetes. This proportion increased progressively with age to 86.9% at age 85 years and over (Figure 4.4).

CKD was associated with 19.2% of deaths with diabetes (Table 4.4), and most of them also had CVD recorded (Table 4.3).



Note: Deaths for people aged 18 years and over only are included.

Source: AIHW National Mortality Database.

Figure 4.4: Comorbidity among Australian adults with diabetes as a cause of death, by age group, 2004

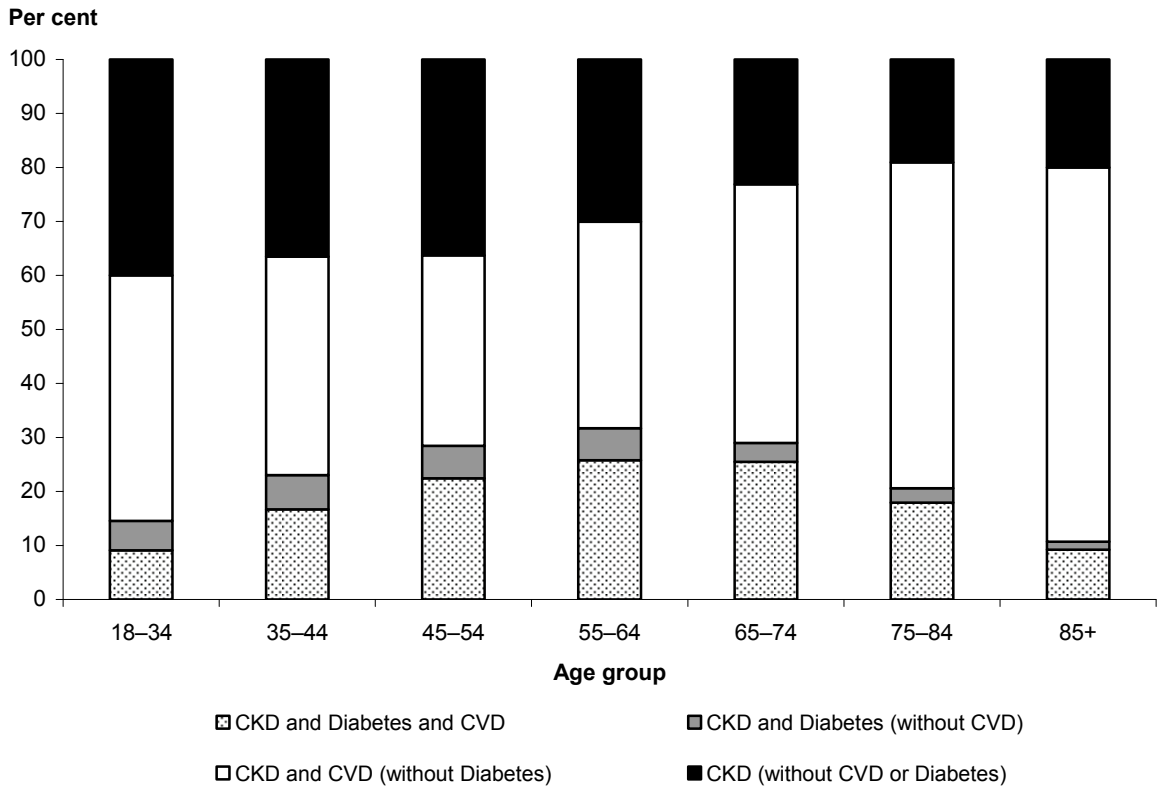
Comorbidity in deaths with CKD

There were 11,910 deaths where CKD was recorded as a cause of death, which represents 9.1% of all adult deaths.

About 76% of people who died with CKD also had at least one type of CVD recorded. CHD and heart failure were the most common forms of CVD—each of them contributed to more than a third of these deaths (36.9% and 32.6% respectively). In addition, 17.4% of these deaths were associated with hypertension and more than 12.4% of them were associated with cerebrovascular disease or TIA. About 36.3% of deaths with CKD also recorded other forms of CVD (Table 4.4).

Diabetes was recorded as a cause of death in 18.9% of deaths with CKD, and most of them also had comorbidity of CVD (Tables 4.3 and 4.4).

Among people who died with CKD recorded, the age-specific rate of comorbidity with the other two index conditions rose with age from 60.0% at age 18–34 years to 80.0% for deaths at age 85 years and over. The majority of these were deaths with both CKD and CVD (Figure 4.5).



Note: Deaths for people aged 18 years and over only are included.
Source: AIHW National Mortality Database.

Figure 4.5: Comorbidity among Australian adults with CKD as a cause of death, by age group, 2004

Table 4.4: Adult deaths with comorbidity of CVD, diabetes and CKD by disease category, 2004

Disease	Number (% of total deaths)	Comorbidity								
		All CVD	CHD	Heart failure	Cerebrovascular disease	TIA	Hypertension	Other CVD	Diabetes	CKD
						Per cent				
All CVD	76,443 (58.6)	—	—	—	—	—	—	—	12.8	11.9
CHD	37,347 (28.6)	—	—	21.6	13.1	0.5	18.6	36.5	15.0	11.8
Heart failure	18,247 (14.0)	—	44.2	—	11.4	0.6	12.8	40.6	13.4	21.3
Cerebrovascular disease	21,044 (16.1)	—	23.2	9.9	—	1.5	23.3	31.6	11.5	6.7
TIA	598 (0.5)	—	31.6	17.7	51.5	—	33.3	41.6	9.9	10.2
Hypertension	15,021 (11.5)	—	46.2	15.6	32.6	1.3	—	37.7	22.3	13.8
Other CVD	33,268 (25.5)	—	40.9	22.3	20.0	0.8	17.0	—	12.9	13.0
Diabetes	11,732 (9.0)	83.6	47.9	20.9	20.6	0.6	28.6	36.4	—	19.2
CKD	11,910 (9.1)	76.0	36.9	32.6	11.9	0.5	17.4	36.3	18.9	—
Total deaths with CVD, diabetes and CKD	*80,907 (62.0)*	—	—	—	—	—	—	—	—	—
Total adult deaths	**130,521**	—	—	—	—	—	—	—	—	—

Notes

1. The number and percentage of deaths with individual forms of CVD do not add up to the total deaths of all CVD because more than one of form of CVD can be recorded. Similarly, the number and percentage of deaths with individual index conditions also do not add up to the total deaths with index conditions for the same reason.
2. Deaths for people aged 18 years and over only are included.

Source: AIHW National Mortality Database.

5 Discussion

The purpose of this report is to assess the extent of comorbidity of CVD, diabetes and CKD in Australia, and to provide background information for further investigations. We have investigated the extent of these comorbidities in the general population, in hospital separations and in death records. We have also examined differences in the distribution of these comorbidities among age groups, sexes and in the context of each individual disease.

Extent of comorbidity

- Overall, 417,563 (2.9%) Australian adults not living in institutions had both CVD and diabetes in 2004–05.
- In 2003, 14,722 (8.1%) adults in institutions, such as nursing homes and aged care hostels, had both CVD and diabetes.
- Comorbidities of two or more index conditions (CVD, diabetes and CKD) were found in 365,245 (6.6%) non-dialysis hospital separations for adults in 2004–05.
- Comorbidity of two or more index conditions (CVD, diabetes and CKD) were recorded as causes of death for 17,239 (13.2%) people who died in 2004.

As discussed in the introduction to this report, there are a number of causes that can lead to this association. One of the major causes is shared common risk factors, such as poor nutrition, overweight and obesity, physical inactivity, smoking and high blood cholesterol. These risk factors do not just affect the onset of CVD, diabetes and CKD, but also accelerate their progression and increase the risk of complications. All these risk factors are common in the Australian population. Based on self-reported data, nearly 97% of adults had at least one of these risk factors in 2004–05: 54% were overweight or obese, 46% did not eat enough fruit, 34% had very low levels of physical activity, 21% were daily smokers, and 9% had high blood cholesterol (AIHW 2006b). About 44% of Australian adults had multiple risk factors (AIHW 2006b). Moreover, it has been estimated that 19% of Australians aged 25 years and over have metabolic syndrome, and are at high risk of developing CVD, diabetes, CKD and their complications (Zimmet et al. 2005).

For people with a single disease, adequate treatment and disease management are essential to prevent or delay the onset of its complications. This is especially important for preventing comorbidity of CVD, diabetes and CKD. However, there is substantial evidence that many people with these conditions do not achieve recommended treatment targets. Results from the 1999–2000 Australian Diabetes, Obesity and Lifestyle (AusDiab) study suggested that only half the participants met the individual blood sugar, lipid and blood pressure targets recommended at the time of the survey, and only about 1 in 7 met all three targets (Kemp et al. 2005). This survey also showed that over 53% of people with hypertension were untreated and only 19% had their blood pressure controlled (Briganti et al. 2003). The National Evaluation of the Frequency of Renal Impairment Co-existing with Non-insulin dependent diabetes mellitus (NEFRON) study showed that for more than 75% of patients with Type 2 diabetes, their GP did not routinely monitor their kidney function (Thomas et al. 2006).

In this report, we also found that the observed rate of these comorbidities greatly exceeded the expected rates if they happened by chance alone. The excess observed rate of

comorbidity occurred in the general population, as well as in hospitalisations and deaths. These results suggest that the coexistence of these diseases did not occur by chance and is mainly attributed to a strong association between the individual diseases. The causes of this association could be prevented by controlling common risk factors and by improving disease treatment and management. This could potentially reduce a great proportion of these comorbidities in the Australian population and a large number of hospitalisations and deaths associated with these comorbidities.

In 2006, Australian governments agreed on the first National Chronic Disease Strategy (NCDS) to provide national policy directions for improving chronic disease prevention and care across Australia for the next 5 to 10 years. The NCDS indicates that health promotion and risk reduction interventions are not just for healthy people, but are also relevant across the disease continuum and benefit people who are at risk of chronic disease, or living with these diseases. The NCDS also emphasises that it is essential to provide integration and continuity of prevention and care to ensure that people receive all the services they need in a timely manner, thus maximising their health outcomes (NHPAC 2006). The findings in this report again highlight the importance of disease prevention and management that are identified by the NCDS.

It is important to note that the extent of these comorbidities may vary between different population groups, such as those with disabilities, Indigenous people and people in different socio-economic groups. Examining these differences is very important to identify high-risk groups and to formulate effective and targeted health policies to reduce the disease burden. This is an area for future work.

Comorbidity in different age groups, and its impact on health services and health policy

The prevalence rate of comorbidity increased progressively with age before age 65 years, and then rose sharply in the 65 to 74 years age group. This rate remained high after age 75 years, although there was a slight decline. The decrease in prevalence rates in this age group is possibly due to the effect of 'better survival'—most people with severe diseases are likely to die earlier, and therefore, people who survive to over 75 years (especially over 85 years) tend to be healthier.

The overall pattern of distribution of comorbidity by age was consistent in the non-institutionalised population, the institutionalised population, hospitalisations and deaths.

A continuing high prevalence rate of comorbidity among people aged 65 years and over would have a substantial impact on the Australian health system. The Australian population is ageing rapidly. According to the ABS, there were an estimated 2.4 million Australians aged 65 years and over at 30 June 2001 (ABS 2002). The ABS projected that the size of this group will increase to more than 4.2 million people by 2021 (ABS 2000). As the prevalence of CVD, diabetes and CKD, as well as many other chronic conditions, increases with age, this demographic trend leads to an increase in the size of the population with these diseases and at risk of comorbidity. Therefore, the number of people with comorbidity in the Australian population, as well as among those seeking health services, would increase quickly even if the prevalence rate of comorbidity does not rise above the current level in the future.

This increase will become a challenge to health services, health expenditure and policies. Studies have found that comorbidity is associated with greater use of health services, including more visits to GPs and specialists, longer consultation times, more hospital admissions and longer stay in hospital. In addition, people with comorbidities also have special health care needs. Unlike people with a single disease, disease management for people with multiple conditions needs to focus on several conditions at the same time. The interactions between multiple medications and therapies required for different diseases complicate treatment and may increase the risk of side effects. To meet such complex health care needs, health services not only need to increase in number, but require better coordination between health care professionals.

Although the age-specific rates of comorbidity were much lower among younger people, the young made a big contribution to the burden of these comorbidities in terms of the absolute number of cases because people in younger groups comprise a large proportion of the population. About 43% of people with comorbidities in the non-institutionalised population, and 30–40% of those hospitalised, were aged less than 65 years. To reduce the burden of comorbidity effectively, disease prevention and detection interventions and policies need to start from a young age and take a whole-of-life approach.

Differences between sexes

Overall, the proportion of people with these comorbidities was greater among men than among women. In the younger age group, the prevalence of comorbidity was similar for both sexes, or only slightly higher for men. In the older age groups, prevalence rates among men were higher for all combinations of comorbidity studied. The higher proportion of comorbidity among men is in line with the greater prevalence of each individual disease in men. However, it is not clear if this is the full explanation.

Comorbidity in the context of each individual disease

Studies have demonstrated that CVD is a major cause of morbidity and mortality for people with diabetes and CKD (Garcia et al. 1974, AIHW 2005). The results in this report are consistent with this finding. We found that the prevalence of CVD among people with diabetes was 2.5 times as high as in the general population (60.6% versus 23.9%). The risk of having comorbidity with some forms of CVD was even greater—people with diabetes were 3 to 5 times as likely to have hypertension, CHD, heart failure and cerebrovascular disease as the general population. We also found that over 65% of hospital separations with diabetes or CKD also involved CVD. CVD was recorded as a cause of death for over 75% of people who died with diabetes or CKD.

These results suggest that CVD was very common among people with diabetes, and contributed largely to morbidity and mortality among people with diabetes and CKD. Diabetes and CKD lack specific symptoms in their early stages. For example, people with CKD may lose up to 85% of kidney function without manifestation. For this reason, the diagnosis of these diseases is often missed or delayed. In practice, some people with diabetes or CKD develop complications soon after these diseases are diagnosed. In some cases, they

already have complications when the diagnosis is made. Early detection is the key to preventing or delaying the development of CVD and other complications for these diseases.

In addition, besides helping patients to achieve their recommended targets for individual diseases, health professionals should be vigilant for comorbidities from the early stage of these diseases, particularly in older patients. There is strong evidence that the risk of CVD can be reduced by appropriate management. For example, a large international study showed a 51% reduction in major cardiovascular events among people with diabetes when their blood pressure was controlled under 80 mmHg (Hansson et al. 1998).

Compared with people with diabetes or CKD, the rate of comorbidities is relatively small among people with CVD. However, because a large number of people have CVD, comorbidity with diabetes and/or CKD account for many CVD cases. As both diabetes and CKD are major risk factors for CVD, there is the potential to prevent the occurrence of a number of CVD cases by reducing the number of cases of diabetes and CKD and their complications.

Comparison of comorbidity estimates from various data sources

The presence of comorbidity generally indicates more advanced disease and worse health. Thus, we would expect more people with these comorbidities among those in institutions such as hospitals and nursing homes, and among those who died, compared with the general community.

This hypothesis is supported by comparisons of the crude rates of comorbidity between the data sources used in this report (Table 5.1). These showed that comorbidity was more common in the institutionalised population compared with the non-institutionalised population. Similarly, comorbidity was greater in the hospital data compared with the non-institutionalised population and greater again in the mortality data. However, these differences were greatly reduced after the effect of differences in age structure was removed by age-standardising. The age-standardised rates indicate that the differences arising from the various data sources are related to differences in the age structure of the population represented in each data source. However, even with age-standardisation, there remains a pattern of greater comorbidity rates in hospitalisations compared with the non-institutionalised population and greater comorbidity rates in the deaths data compared with hospitalisations.

Although such comparisons provide some indication of comorbidity in the various settings, with implications for our understanding of these diseases, the comparisons should be treated with caution for several reasons. Firstly, the data in these sources were collected in different ways—the prevalence of comorbidity in the non-institutionalised and institutionalised populations was drawn from self-reported survey data, while hospital and mortality data were drawn from administrative data. Secondly, there is a slight difference in time frame of the data sources: SDAC—2003, NHS—2004–05, AIHW National Hospital Morbidity Database—2004–05 and AIHW National Mortality Database—2004. In addition, there are overlaps between the populations that were recorded in these data sources, especially between the hospitalised population and both the institutionalised and non-institutionalised populations.

Table 5.1: Comparison of comorbidity rates from various data sources

Comorbidity	Sex	Prevalence[a]		Hospitalisations[b]	Deaths[c]
		Non-institutionalised	Institutionalised		
			Crude rate (per cent)		
CVD and diabetes	Men	1.50	8.60	6.60	7.80
	Women	1.40	7.50	4.40	7.30
CVD and CKD	Men	n.a.	n.a.	2.60	8.30
	Women	n.a.	n.a.	1.60	6.60
Diabetes and CKD	Men	n.a.	n.a.	1.60	1.80
	Women	n.a.	n.a.	0.90	1.60
CVD and diabetes and CKD	Men	n.a.	n.a.	1.40	1.60
	Women	n.a.	n.a.	0.80	1.40
			Age-standardised rate (per cent)		
CVD and diabetes	Men	3.07	n.a[d]	4.00	3.77
	Women	2.69	n.a[d]	3.04	3.84
CVD and CKD	Men	n.a.	n.a.	1.58	2.82
	Women	n.a.	n.a.	0.99	1.54
Diabetes and CKD	Men	n.a.	n.a.	1.01	1.02
	Women	n.a.	n.a.	0.68	1.24
CVD and diabetes and CKD	Men	n.a.	n.a.	0.85	0.82
	Women	n.a.	n.a.	0.56	0.98

(a) Percentage of Australian population.

(b) Percentage of total hospitalisations.

(c) Percentage of total deaths.

(d) Due to small sample size, the age-standardised rate in the institutionalised population can not be calculated by sex separately.

n.a. not applicable

Note: Rates were age-standardised to the Australian population as at 30 June 2001.

Source: AIHW analysis of 2004–05 ABS National Health Survey Confidentialised Unit Record File and 2003 ABS Survey of Disability, Ageing and Carers Confidentialised Unit Record File, AIHW National Hospital Morbidity Database and AIHW National Mortality Database.

Data issues

At present, there are no data explicitly collected routinely to monitor these comorbidities at the population level. The data presented in this report were drawn from the best national data sources available. However, because of some limitations of these sources, none of them can provide a complete picture for these comorbidities, and may lead to some underestimation of the true burden of these comorbidities.

Both the NHS and the SDAC are very important information sources for chronic conditions. However, because both are self-reported surveys, the results are influenced by the

questionnaires used, and the knowledge and the awareness of specific conditions in the population. Self-reported data may underestimate the prevalence of diabetes especially, as some people with diabetes do not know they have the condition and therefore would not report it. Moreover, the prevalence of CKD is not available from either survey.

The AIHW National Hospital Morbidity Database provides essential information regarding morbidity and hospital services in Australia. However, because records are based on hospitalisations (episodes of care) rather than individual patients, the database cannot identify whether records relate to different patients or to a single patient with more than one episode of care. In addition, CVD and CKD may not be recorded in hospital records if they are not thought to affect that episode of hospital care. As a consequence, the results of the analysis may underestimate hospitalisations with comorbidity involving these two diseases. There may also be a lack of consistency in coding practices between jurisdictions and over time, making the monitoring of these comorbidities more difficult.

The AIHW National Mortality Database includes information on virtually all deaths. However, the data only represents the proportion of comorbidity as a cause of death, rather than the magnitude of comorbidity among people who have died. In addition, studies have shown that some diseases, such as CKD, were under-recorded in death certificates (Li et al. 2003).

There is no integrated health database that can track patients across different health services and over time. It is impossible to know for how long the comorbidity has developed from the onset of a single disease, how patients with comorbidity are managed, and what are the outcomes of disease management. All these questions are critical to the monitoring and surveillance of comorbidity.

As the burden of these comorbidities is expected to rise, the monitoring of these comorbidities is very important in terms of providing evidence for health policies and the appropriate level and combination of services to meet population needs. The gaps and limitations of the existing data sources suggest a need to improve information systems.

Conclusion

We found that CVD, diabetes and CKD coexisted in a considerable proportion of the Australian population. Comorbidity of these conditions especially affected older people, and men were at higher risk of these comorbidities than women. CVD was very common among people with diabetes, and contributed greatly to morbidity and mortality among people with diabetes and CKD.

These comorbidities are largely attributed to shared risk factors and complex causal relationships between these diseases. There is a large potential to reduce the burden of these comorbidities by improving disease prevention and management. With our rapidly ageing population, Australian health systems need to be prepared to meet an increasing demand on health services from people with comorbidities, and to promote high quality and coordinated health care for these people.

Appendix 1: Statistical methods

Age standardisation

This is a method for removing the influence of age when comparing populations with different age structures. Age-standardised rates in this report were calculated using direct age-standardisation. The directly age-standardised rate is the weighted sum of age-specific (5-year age groups) rates, where the weighting factor is the corresponding age-specific standard population. For this report, the Australian estimated residential population as at 30 June 2004 was used as the standard population. The same population was used for men and women to allow valid comparison of age-standardised rates between the sexes.

Direct age standardisation

Direct age standardisation is the most common method of age standardisation, and is used in this report for prevalence, hospitalisations and deaths data. This method of age-standardisation is generally used when the population under study is large and the age-specific rates can be reliably estimated. The calculation of direct age-standardised rates comprises three steps:

Step 1: Calculate the age-specific rate for each age group.

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

Step 3: Sum the expected number of cases in each age group and divide this sum by the total of the standard population to give the age-standardised rate.

Prevalence

Prevalence refers to the number (of cases, instances, and so on) present in a population at a given time.

Odds ratio and logistic regression

Odds ratios in this report are calculated using logistic regression models. They are used in this report to estimate the difference in the distribution of comorbidities between age groups and between sexes after adjusting for interactions between sex and age. For example: the odds ratio of comorbidity of CVD and diabetes from men to women was 1.32, meaning that men were 1.32 times as likely as women to have comorbidity of CVD and diabetes if the male and female populations had the same age structure.

Expected rate, observed rate and ratio

Any two diseases may occur in the same person by chance. The expected comorbidity rate is the rate that we would expect to see if the two diseases occurred together purely by chance. The observed comorbidity rate is the actual rate calculated from the number of cases of comorbidity that occurred in the population. The ratio of observed rate to expected rate is a measure of how much the observed rate differs from the expected rate. If the ratio is greater than one, then there are more cases of comorbidity than would be expected by chance (van den Akker M et al. 2001). In this report, the ratio of observed rate to expected rate is assessed using a 95% confidence interval. If the lower limit of the 95% confidence interval is greater than one, then the ratio is statistically significantly greater than one and we can conclude that the number of cases of comorbidity is greater than could be explained purely by chance.

Expected rate: When two diseases occur together by chance, their expected comorbidity rate is the product of their individual rates.

For example:

Expected hospitalisation rate for comorbidity of CVD and diabetes (with and without CKD)

= hospitalisation rate of CVD (21.0%) × hospitalisation rate of diabetes (8.3%) × 100 = 1.74%

Observed rate: This rate is calculated based on the actual number of cases of comorbidity that occurred in the population.

For example:

Observed number of hospitalisations with comorbidity of CVD and diabetes (with CKD) = 60,415

Observed number of hospitalisations with comorbidity of CVD and diabetes (without CKD) = 241,187

Observed number of hospitalisations with comorbidity of CVD and diabetes

= 60,415 + 241,187 = 301,602

Total hospitalisations = 5,473,337

Observed hospitalisation rate with comorbidity of CVD and diabetes

= 301,602/5,573,337 = 5.41%

Ratio of observed rate to expected rate

= observed rate (5.41%) / expected rate (1.74%) = 3.10

95% confidence interval of the ratio of observed rate to expected rate for hospitalisation and mortality:

If D is the observed number of events and E is the expected number of events, then

$$\mu_L = D\left(1-\frac{1}{9D}-\frac{1.96}{3D^{1/2}}\right)^3 \qquad \textit{and} \qquad \mu_U = (D+1)\left(1-\frac{1}{9(D+1)}+\frac{1.96}{3(D+1)^{1/2}}\right)^3$$

are the upper and lower limits of the 95% confidence interval around the observed number of events (Breslow & Day 1987).

If N is the total population, then the ratio of the observed to the expected rate is

$$\frac{D/N}{E/N}=\frac{D}{E}$$

The expected rate is assumed to be constant, so the 95% confidence interval of the ratio of observed rate to expected rate will be

$$\left[\frac{\mu_L}{E}, \frac{\mu_U}{E}\right]$$

95% confidence interval of the ratio of observed rate to expected rate for 2004–05 NHS and 2003 SDAC:

The above formula is not applicable to estimates arising from a sample survey because it does not take account of the variability arising from the sampling process and the survey design. Instead the confidence interval is based on the survey standard errors as published by ABS (ABS 2006c). The ABS publishes a table of standard errors for selected values of estimates from the survey. The standard error of the estimated observed number (SE(a)) in the formula below is calculated by interpolating between adjacent values in the published standard error table. If D is the estimated observed number of events, DL and DU are adjacent numbers in the ABS standard error table, and lower SE(b) and upper SE(b) are their associated published standard errors, then

$$\text{SE(a)} = \text{lower SE(b)} + \left(\left(\frac{D - DL}{DU - DL}\right) \text{ x (upper SE(b) – lower SE(b))}\right)$$

and

$$\mu_L = D - 1.96x\text{SE(a)} \qquad \textit{and} \qquad \mu_U = D + 1.96x\text{SE(a)}$$

are the upper and lower limits of the 95% confidence interval around the observed number of events. If N is the total population and E is the estimated expected number of events, then the ratio of the observed to the expected rate is

$$\frac{D/N}{E/N} = \frac{D}{E}$$

The expected rate is assumed to be constant, so the 95% confidence interval of the ratio of observed rate to expected rate will be

$$\left[\frac{\mu_L}{E}, \frac{\mu_U}{E}\right]$$

Appendix 2: Classification of CVD, diabetes and CKD

Cause of death and diagnosis of hospitalisation

Australia uses the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10) to code causes of death. The diagnoses associated with hospitalisations are coded according to the 10th revision of the International Classification of Diseases, Australian Modification (ICD-10-AM).

For this report we used extended ICD–10 and ICD–10 AM codes to identify people with CVD, diabetes and CKD. Although some of these codes are not currently classified as diseases of the circulatory system, diabetes or diseases of the urinary system in ICD–10 or ICD–10 AM, the codes are recommended as appropriate and helpful to improve accuracy of identification of people with comorbidity by experts in the field. These codes are listed in Table A1.

Comorbidity is identified if two or more index conditions were recorded as diagnoses in one hospital separation or as the cause of death in one death certificate. Conditions can be recorded as separate diagnoses or causes of death, or they can be recorded in one diagnosis or cause of death that contains two diseases, such as 'diabetic renal complications'.

Long-term conditions in the 2004–05 NHS and the 2003 SDAC

A long-term condition in the 2004-05 NHS is defined as 'one reported by respondents as being a condition which they currently had and which had lasted or they expected to last for six months or more'. Some reported conditions were assumed to be long-term, including diabetes, rheumatic heart disease, heart attack and stroke. Long-term conditions in the 2004–05 NHS were classified based on ICD-10 and were coded using the 2004–05 NHS confidentialised unit record file (CURF) codes (ABS 2006b). The CURF codes used to identify people with diabetes and CVD in the non-institutionalised population based on 2004–05 NHS are listed in the Table A2.

In the 2003 SDAC, a long-term condition is defined as 'a disease or disorder which has lasted or is likely to last for at least six months; or a disease, disorder or event (such as stroke, poisoning, accident, and so on), which produces an impairment or restriction which has lasted or is likely to last for at least six months'. The long-term conditions in the 2003 SDAC were classified based on ICD-10 and were coded using the 2003 SDAC CURF codes (ABS 2005). The CURF codes used to identify people with diabetes and CVD in the institutionalised population based on 2003 SDAC are listed in Table A3.

Comorbidity is identified if a respondent reported they had both CVD and diabetes as long-term conditions.

Appendix 3: Codes used in this report

Table A1: Codes for deaths and hospital separations used in this report

Disease	ICD–10/ ICD–10 AM code	Description
CVD		
CHD	I20–I25	Ischaemic heart disease
Heart failure	I50	Heart failure
	I110	Hypertensive heart disease with (congestive) heart failure
	I130	Hypertensive heart and renal disease with (congestive) heart
	I132	Hypertensive heart and renal disease with (congestive) heart
	I25.5	Ischaemic cardiomyopathy
	I42.0	Dilated cardiomyopathy
	I42.6	Alcoholic cardiomyopathy
Cerebrovascular disease	I60–I69	Cerebrovascular disease
TIA	G45	Transient cerebral ischaemic attacks and related syndromes
Hypertensive diseases	I10	Essential (primary) hypertension
	I119	Hypertensive heart disease without (congestive) heart failure
	I12	Hypertensive renal disease
	I131	Hypertensive heart and renal disease with renal failure
	I139	Hypertensive heart and renal disease, unspecified
Other CVD	I00–I02	Acute rheumatic fever
	I05–I09	Chronic rheumatic heart diseases
	I26 –I28	Pulmonary heart disease and diseases of pulmonary
	I30–I52	Other forms of heart disease
	I70– I79	Diseases of arteries, arterioles and capillaries
	I80–I89	Diseases of veins, lymphatic vessels and lymph nodes, not elsewhere classified
	I95–I99	Other and unspecified disorders of the circulatory system
	E10.5, E11.5, E13.5, E14.5	Diabetes with peripheral circulatory complications
	E10.71, E11.71, E13.71, E14.71	Diabetes with multiple microvascular complications

(continued)

Table A1 (continued): Codes for deaths and hospital separations used in this report

Disease	ICD-10/ICD-10 AM code	Description
Diabetes	E10–E14	Diabetes mellitus
CKD		
	B52.0[(a)]	Plasmodium malariae malaria with nephropathy
	D59.3[(a)]	Haemolytic-uraemic syndrome
	E10.2	Insulin-dependent diabetes mellitus with renal complication
	E11.2	Non-insulin-dependent diabetes mellitus with renal complication
	E12.2	Malnutrition-related diabetes mellitus with renal complication
	E13.2	Other specified diabetes mellitus with renal complication
	E14.2	Unspecified diabetes mellitus with renal complication
	E85.1[(a)]	Neuropathic heredofamilial amyloidosis
	I12	Hypertensive renal disease
	I13	Hypertensive heart and renal disease
	I15.0	Renovascular hypertension
	I15.1	Hypertension secondary to other renal disorders
	N00	Acute nephritic syndrome
	N01	Rapidly progressive nephritic syndrome
	N02	Recurrent and persistent haematuria
	N03	Chronic nephritic syndrome
	N04	Nephrotic syndrome
	N05	Unspecified nephritic syndrome
	N06	Isolated proteinuria with specified morphological lesion
	N07	Hereditary nephropathy, not elsewhere classified
	N08[(b)]	Glomerular disorders in diseases classified elsewhere
	N11	Chronic tubulo-interstitial nephritis
	N12	Tubulo-interstitial nephritis, not specified as acute or chronic
	N14	Drug- and heavy-metal-induced tubulo-interstitial and tubular
	N15	Other renal tubulo-interstitial diseases
	N16[(b)]	Renal tubulo-interstitial disorders in diseases classified
	N18	Chronic renal failure
	N19	Unspecified renal failure

(*continued*)

Table A1 (continued): Codes for deaths and hospital separations used in this report

Disease	ICD-10/ICD-10 AM code	Description
	N25	Disorders resulting from impaired renal tubular function
	N26	Unspecified contracted kidney
	N27	Small kidney of unknown cause
	N28	Other disorders of kidney and ureter, not elsewhere classified
	N39.1	Persistent proteinuria, unspecified
	N39.2	Orthostatic proteinuria, unspecified
	Q60	Renal agenesis and other reduction defects of kidney
	Q61	Cystic kidney disease
	Q62	Congenital obstructive defects of renal pelvis and congenital
	Q63	Other congenital malformations of kidney
	T82.4	Mechanical complication of vascular dialysis catheter
	T86.1	Kidney transplant failure and rejection.
	Z49[(b)]	Care involving dialysis
	Z94.0[(b)]	Kidney transplant status
	Z99.2[(b)]	Dialysis status

(a) These codes are to be used for identification in mortality data only.

(b) These codes are to be used for identification in hospital morbidity data only.

Table A2: Codes used to identify CVD and diabetes in the non-institutionalised population, based on the 2004–05 NHS confidentialised unit record file (CURF)

Disease	CURF codes
CVD	
CHD	19117, 19382
Heart failure	19135
Hypertensive diseases	19392
Cerebrovascular disease	19396
Other CVD	19114, 19403, 19402, 19067, 19116, 1937719389,19362
Diabetes	14688, 14689, 14690 [(a)]

(a) Gestational diabetes is not included.

Source: ABS 2006b.

Table A3: Codes used to identify CVD and diabetes in the institutionalised population, based on 2003 SDAC confidentialised unit record file (CURF)

Disease	CURF codes
CVD	
Heart disease	910, 913, 914, 919
Hypertension	922
Stroke	923
Other CVD	929
Diabetes	402

Source: ABS 2005.

Appendix 4: Detailed statistical tables

Table A4: People with comorbidity of CVD and diabetes in the non-institutionalised and institutionalised populations by age group and sex, aged 20 years and over, 2004–05

	Men		Women		Persons	
Age group	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
Non-institutionalised population						
20–44	*9,612	0.3	*9,264	0.3	18,876	0.3
45–54	29,940	2.2	24,057	1.7	53,997	2.0
55–64	49,424	4.6	56,394	5.3	105,819	5.0
65–74	75,319	11.4	62,702	9.0	138,021	10.2
75–84	42,380	11.2	41,115	8.0	83,495	9.4
85+	*6,474	7.8	*10,881	9.9	17,355	9.0
Total	**213,350**	**3.0**	**204,414**	**2.8**	**417,563**	**2.9**
Institutionalised population						
20–74	n.a.	n.a.	n.a.	n.a.	*2,719	7.6
75–84	n.a.	n.a.	n.a.	n.a.	*5,961	10.1
85+	n.a.	n.a.	n.a.	n.a.	*6,042	6.9
Total	***4,838**	**8.6**	***9,884**	**7.8**	**14,722**	**8.1**

n.a. not applicable

* Estimate has a relative standard error of 25% to 50% and should be used with caution.

Note: Due to small sample size, some age groups were merged for analysis.

Source: AIHW analysis of 2004–05 ABS National Health Survey Confidentialised Unit Record File., AIHW analysis of 2003 ABS Survey of Disability, Ageing and Carers Confidentialised Unit Record File.

Table A5: Hospitalisations with comorbidity of CVD, diabetes and CKD, by age group and sex, for people aged 18 years and over, 2004–05

	Men		Women		Persons	
Age group	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
Comorbidity of CVD and diabetes (without CKD)						
18–24	100	0.1	150	0.1	250	0.1
25–34	667	0.3	729	0.1	1,396	0.2
35–44	3,164	1.2	2,955	0.7	6,119	0.9
45–54	11,913	3.4	9,007	2.2	20,920	2.7
55–64	28,978	6.2	18,714	4.4	47,692	5.3
65–74	39,738	8.4	30,731	7.5	70,469	8.0
75–84	35,897	8.3	37,443	8.4	73,340	8.4
85+	7,858	6.6	13,143	6.9	21,001	6.8
Total	**128,315**	**5.2**	**112,872**	**3.6**	**241,187**	**4.3**
Comorbidity of CVD and CKD (without diabetes)						
18–24	150	0.1	183	0.1	333	0.1
25–34	538	0.3	466	0.1	1,004	0.1
35–44	1,034	0.4	737	0.2	1,771	0.3
45–54	1,701	0.5	1,148	0.3	2,849	0.4
55–64	2,858	0.6	1,945	0.5	4,803	0.5
65–74	5,989	1.3	3,867	0.9	9,856	1.1
75–84	11,780	2.7	7,958	1.8	19,738	2.3
85+	6,299	5.3	7,013	3.7	13,312	4.3
Total	**30,349**	**1.2**	**23,317**	**0.8**	**53,666**	**1.0**

(continued)

Table A5 (continued): Hospitalisations with comorbidity of CVD, diabetes and CKD, by age group and sex, for people aged 18 years and over, 2004–05

	Men		Women		Persons	
Age group	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
Comorbidity of diabetes and CKD (without CVD)						
18–24	59	0.0	70	0.0	129	0.0
25–34	117	0.1	302	0.1	419	0.1
35–44	323	0.1	415	0.1	738	0.1
45–54	655	0.2	580	0.1	1,235	0.2
55–64	953	0.2	744	0.2	1,697	0.2
65–74	1,378	0.3	934	0.2	2,312	0.3
75–84	1,557	0.4	993	0.2	2,550	0.3
85+	467	0.4	428	0.2	895	0.3
Total	**5,509**	**0.2**	**4,466**	**0.1**	**9,975**	**0.2**
Comorbidity of CVD and diabetes and CKD						
18–24	150	0.1	183	0.1	333	0.1
25–34	538	0.3	466	0.1	1,004	0.1
35–44	1,034	0.4	737	0.2	1,771	0.3
45–54	1,701	0.5	1,148	0.3	2,849	0.4
55–64	2,858	0.6	1,945	0.5	4,803	0.5
65–74	5,989	1.3	3,867	0.9	9,856	1.1
75–84	11,780	2.7	7,958	1.8	19,738	2.3
85+	6,299	5.3	7,013	3.7	13,312	4.3
Total	**30,349**	**1.2**	**23,317**	**0.8**	**53,666**	**1.0**

Note: Per cent in the table is the percentage of hospitalisations in corresponding age group.

Source: AIHW National Hospital Morbidity Database.

Table A6: Deaths with comorbidity of CVD, diabetes and CKD for ages 18 years and over, by age group and sex, 2004

	Men		Women		Persons	
Age group	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
Comorbidity of CVD and diabetes (without CKD)						
18–34	9	0.4	6	0.7	15	0.4
35–44	29	1.4	24	2.0	53	1.6
45–54	128	3.1	50	2.0	178	2.7
55–64	411	5.5	213	4.8	624	5.2
65–74	1,094	8.0	578	7.1	1,672	7.7
75–84	1,659	7.2	1,469	7.4	3,128	7.3
85+	833	5.7	1,365	5.2	2,198	5.4
Total	**4,163**	**6.2**	**3,705**	**5.9**	**7,868**	**6.0**
Comorbidity of CVD and CKD (without diabetes)						
18–34	14	0.6	11	1.2	25	0.8
35–44	34	1.6	17	1.4	51	1.5
45–54	54	1.3	45	1.8	99	1.5
55–64	167	2.2	85	1.9	252	2.1
65–74	527	3.9	316	3.9	843	3.9
75–84	1,636	7.1	1,122	5.6	2,758	6.4
85+	1,400	9.6	1,688	6.5	3,088	7.6
Total	**3,832**	**5.7**	**3,284**	**5.2**	**7,116**	**5.5**

(continued)

Table A6 (continued): Deaths with comorbidity of CVD, diabetes and CKD for ages 18 years and over, by age group and sex, 2004

	Men		Women		Persons	
Age group	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
Comorbidity of diabetes and CKD (without CVD)						
18–54	15	0.2	13	0.3	28	0.2
55–64	20	0.3	19	0.4	39	0.3
65–74	37	0.3	25	0.3	62	0.3
75–84	57	0.3	65	0.3	122	0.3
85+	32	0.2	33	0.1	65	0.2
Total	**161**	**0.2**	**155**	**0.2**	**316**	**0.2**
Comorbidity of CVD and diabetes and CKD						
18–44	13	0.3	13	0.6	26	0.4
45–54	44	1.1	19	0.8	63	1.0
55–64	92	1.2	78	1.8	170	1.4
65–74	289	2.1	160	2.0	449	2.1
75–84	456	2.0	363	1.8	819	1.9
85+	187	1.3	225	0.9	412	1.0
Total	**1,081**	**1.6**	**858**	**1.4**	**1,939**	**1.5**

Note: Per cent in the table is the percentage of deaths in corresponding age group.

Source: AIHW National Hospital Mortality Database.

Table A7: People in the non-institutionalised population aged 20 years and over, by age group and sex, 2004–05

	Men		Women		Persons	
Age group	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
20–24	698,723	9.8	666,134	9.1	1,364,857	9.5
25–29	663,713	9.4	663,774	9.1	1,327,487	9.2
30–34	732,752	10.3	753,407	10.3	1,486,159	10.3
35–39	714,889	10.1	726,790	9.9	1,441,680	10.0
40–44	753,376	10.6	764,177	10.4	1,517,553	10.5
45–49	706,859	10.0	719,148	9.8	1,426,006	9.9
50–54	644,431	9.1	664,388	9.1	1,308,819	9.1
55–59	604,375	8.5	602,258	8.2	1,206,633	8.4
60–64	460,043	6.5	453,548	6.2	913,592	6.3
65–69	368,234	5.2	376,762	5.1	744,996	5.2
70–74	291,162	4.1	317,511	4.3	608,673	4.2
75–79	238,778	3.4	295,730	4.0	534,509	3.7
80–84	139,377	2.0	219,449	3.0	358,826	2.5
85+	82,690	1.2	110,358	1.5	193,048	1.3
Total	**7,099,402**	**100.0**	**7,333,436**	**100.0**	**14,432,838**	**100.0**

Source: AIHW analysis of 2004–05 ABS National Health Survey Confidentialised Unit Record File.

Table A8: People in the institutionalised population aged 20 years and over, by age group and sex, 2003

	Men		Women		Persons	
Age group	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
20–24	424	0.8	231	0.18	655	0.4
25–29	699	1.3	514	0.41	1,213	0.7
30–34	994	1.8	693	0.55	1,686	0.9
35–39	1,107	2.0	642	0.51	1,749	1.0
40–44	1,193	2.1	770	0.61	1,963	1.1
45–49	1,612	2.9	990	0.79	2,602	1.4
50–54	1,239	2.2	921	0.73	2,160	1.2
55–59	1,433	2.6	1,235	0.98	2,668	1.5
60–64	1,993	3.6	1,838	1.46	3,831	2.1
65–69	3,093	5.5	3,329	2.64	6,423	3.5
70–74	5,224	9.3	5,738	4.55	10,963	6.0
75–79	7,949	14.2	14,013	11.12	21,963	12.1
80–84	9,672	17.3	27,337	21.69	37,009	20.3
85+	19,393	34.6	67,785	53.78	87,178	47.9
Total	**56,024**	**100.0**	**126,037**	**100.0**	**182,061**	**100.0**

Source: AIHW analysis of 2003 ABS Survey of Disability, Ageing and Carers Confidentialised Unit Record File.

Table A9: Hospital separations for people aged 18 years and over, by age group and sex, 2004–05

	Men		Women		Persons	
Age group	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
18–19	37,960	1.5	61,613	2.0	99,573	1.8
20–24	96,056	3.9	185,617	6.0	281,673	5.1
25–29	93,507	3.8	230,777	7.4	324,284	5.8
30–34	115,816	4.7	295,266	9.5	411,082	7.4
35–39	124,526	5.1	240,533	7.7	365,059	6.6
40–44	148,642	6.0	205,393	6.6	354,035	6.4
45–49	162,127	6.6	202,285	6.5	364,412	6.5
50–54	189,901	7.7	215,363	6.9	405,264	7.3
55–59	237,361	9.7	225,526	7.2	462,887	8.3
60–64	229,358	9.3	203,530	6.5	432,888	7.8
65–69	235,780	9.6	203,473	6.5	439,253	7.9
70–74	236,979	9.6	209,146	6.7	446,125	8.0
75–79	244,468	9.9	235,680	7.6	480,148	8.6
80–84	189,048	7.7	208,500	6.7	397,548	7.1
85+	118,713	4.8	190,383	6.1	309,096	5.5
Total	**2,460,242**	**100.0**	**3,113,085**	**100.0**	**5,573,327**	**100.0**

Source: AIHW National Hospital Morbidity Database.

Table A10: Deaths for ages 18 years and over, by age group and sex, 2004

	Men		Women		Persons	
Age group	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
18–19	215	0.3	93	0.2	308	0.2
20–24	592	0.9	223	0.4	815	0.6
25–29	644	1.0	244	0.4	888	0.7
30–34	876	1.3	322	0.5	1,198	0.9
35–39	849	1.3	468	0.7	1,317	1.0
40–44	1,287	1.9	725	1.2	2,012	1.5
45–49	1,711	2.5	1,119	1.8	2,830	2.2
50–54	2,376	3.5	1,413	2.2	3,789	2.9
55–59	3,290	4.9	2,011	3.2	5,301	4.1
60–64	4,235	6.3	2,428	3.8	6,663	5.1
65–69	5,585	8.3	3,402	5.4	8,987	6.9
70–74	8,036	12.0	4,799	7.6	12,835	9.8
75–79	11,102	16.5	8,226	13.0	19,328	14.8
80–84	11,809	17.6	11,763	18.6	23,572	18.1
85+	14,631	21.8	26,047	41.2	40,678	31.2
Total	**67,238**	**100.0**	**63,283**	**100.0**	**130,521**	**100.0**

Source: AIHW National Mortality Database.

Table A11: Australian population aged 20 years and over at 30 June 2001

	Men		Women		Persons	
Age group	**Number**	**Per cent**	**Number**	**Per cent**	**Number**	**Per cent**
20–24	660,776	9.6	641,636	8.9	1,302,412	9.3
25–29	700,910	10.2	706,171	9.8	1,407,081	10.0
30–34	726,919	10.5	739,696	10.3	1,466,615	10.4
35–39	741,434	10.8	750,770	10.5	1,492,204	10.6
40–44	734,436	10.7	744,821	10.4	1,479,257	10.5
45–49	675,055	9.8	683,539	9.5	1,358,594	9.7
50–54	652,540	9.5	648,237	9.0	1,300,777	9.2
55–59	512,888	7.4	495,911	6.9	1,008,799	7.2
60–64	413,982	6.0	408,042	5.7	822,024	5.8
65–69	335,590	4.9	346,923	4.8	682,513	4.8
70–74	303,554	4.4	334,826	4.7	638,380	4.5
75–79	227,356	3.3	292,000	4.1	519,356	3.7
80–84	128,250	1.9	201,800	2.8	330,050	2.3
85+	81,922	1.2	183,313	2.6	265,235	1.9
Total	6,895,612	100.0	7,177,685	100.0	14,073,297	100.0

Note: This is the population used as the standard population in all age-standardised rates reported in this report.

Source: ABS 2003; AIHW National Population Database.

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