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Acute kidney injury in Australia

A first national snapshot

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Authoritative information and statistics to promote better health and wellbeing

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Australian Institute of Health and Welfare
Canberra
Cat. no. PHE 190

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Contents

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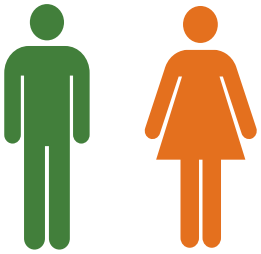
Abbreviations

AIHW	Australian Institute of Health and Welfare
AKI	acute kidney injury
CKD	chronic kidney disease
ESKD	end-stage kidney disease
ICD	International Statistical Classification of Diseases and Related Health Problems
ICU	intensive care unit
NHMD	National Hospital Morbidity Database
NMD	National Mortality Database
SES	socioeconomic status

Summary

Acute kidney injury (AKI) is increasing in incidence globally. This report presents the first national statistical snapshot on AKI and its impact in Australia.

Australian hospital and mortality data have been used to assess the burden of AKI. This report examines AKI as both the main and/or an associated cause of hospitalisations and deaths to present a more complete picture of the burden of AKI in Australia. The key findings highlight the substantial hospitalisations and deaths associated with AKI and the related inequalities that exist in the Australian population.

	In 2012–13, there were around 131,780 hospitalisations for AKI (as the principal and/or an additional diagnosis). The average length of stay for AKI hospitalisations was 11.4 days, which was twice as long as the average length of stay for hospitalisations overall (5.6 days). In 2012, there were around 5,160 deaths where AKI was recorded as the underlying or an associated cause of death.
	AKI hospitalisations (as a principal diagnosis) more than doubled between 2000–01 and 2012–13 (from 8,050 to 18,010), an average increase of 6% per year. Despite this large increase in AKI hospitalisations, deaths due to AKI have remained relatively similar over the last decade (an average of 4,670 deaths per year between 2000 and 2012).
	Hospitalisation and death rates for AKI increase rapidly with age, with the majority occurring in those aged 65 and over. For example, AKI hospitalisations for those aged 85 and over were at least 4 times those in the 65–74 age group. Males had higher rates of AKI hospitalisations (as an additional diagnosis) and deaths than females (at least 40% higher). For hospitalisations with a principal diagnosis of AKI, rates for males and females were similar.
	Those living in *Very remote* areas of Australia generally have a higher burden of AKI. For hospitalisations for AKI as a principal diagnosis and for AKI deaths, people living in *Very remote* areas had hospitalisation and death rates at least 1.5 times as high as those living in *Major cities*. This differed for AKI hospitalisations as an additional diagnosis, where people living in *Major cities* or *Very remote* areas were hospitalised at around 1.3 times the rate of those living in *Inner regional*, *Outer regional* and *Remote* areas.
	People living in socioeconomically disadvantaged areas had higher AKI hospitalisation and death rates. For hospitalisations for AKI as a principal diagnosis, rates in the lowest socioeconomic group were almost twice as high as in the highest group. For AKI hospitalisations as an additional diagnosis and for AKI deaths—rates were 1.3 times as high in the lowest socioeconomic group compared with the highest group.
	Aboriginal and Torres Strait Islander status was associated with higher hospitalisation and mortality rates. Hospitalisation and death rates for AKI were at least twice as high among Indigenous Australians compared to Other Australians/non-Indigenous Australians.

1 Introduction

About acute kidney injury

Acute kidney injury (AKI) is a common, often under-recognised disorder that is increasing in incidence globally, and is strongly associated with increased early and long-term morbidity and mortality (Lewington et al. 2013). It is a condition that occurs when there is an abrupt loss of kidney function to the point where the body accumulates waste products and becomes unable to maintain electrolyte, acid-base and water balance (Togel & Westenfelder 2014). Clinically, it is measured and diagnosed by an acute rise of serum creatinine and/or decline in urine output, caused by an acute fall in the glomerular filtration rate (Lewington et al. 2013).

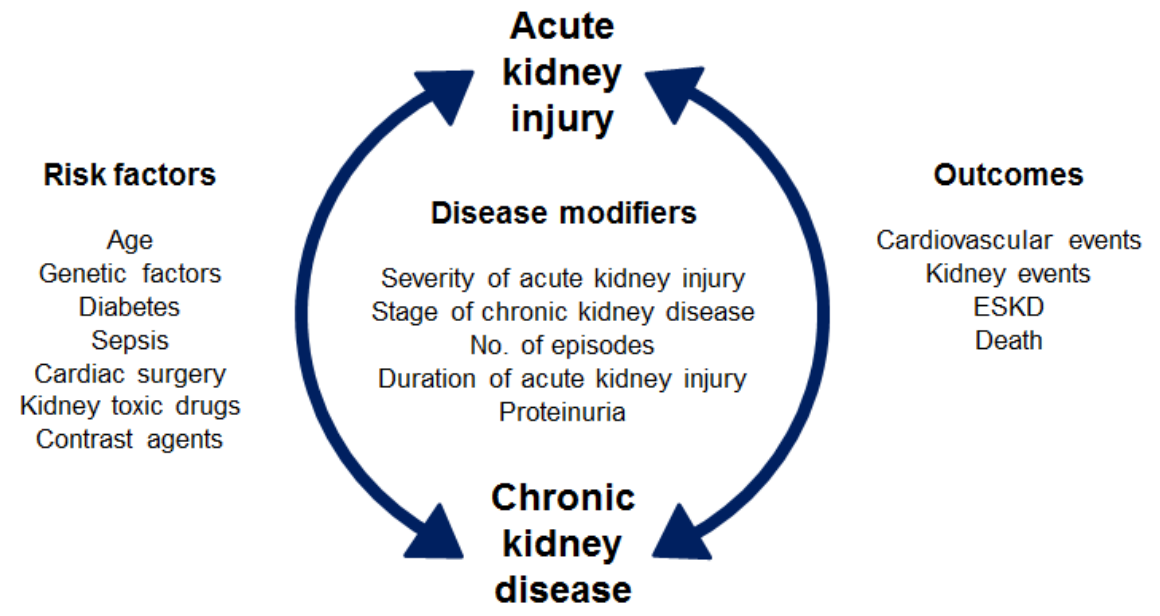
Causes and risk factors

AKI has a broad range of causes including various kidney diseases but is frequently the consequence of injury or trauma from restriction of blood supply to the tissues or as a result of extreme inflammation (for example with sepsis) (Togel & Westenfelder 2014). It can be acquired in the community (for example from specific infections or toxins) or in hospital. In developed countries such as Australia, AKI is predominantly diagnosed in the general hospitalised population, critically ill patients admitted to intensive care units (ICUs), and those receiving radiocontrast agents (substances commonly used to enhance the visibility of blood vessels) for cardiovascular-related surgery. As a result, AKI is mainly seen in the context of sepsis, multi-organ failure and post-cardiovascular procedures or as a complication of medications. While AKI occurs among all age groups, it is particularly prominent among older patients with substantial comorbidities (Lewington et al. 2013).

AKI risk factors include older age, diabetes, hypertension, obesity and cardiovascular disease. Further, pre-existing chronic kidney disease (CKD) has been found to be the most important risk factor for the development of AKI (Chawla et al. 2014).

The relationship between AKI and CKD

As noted above, CKD is a risk factor for AKI. However, several studies have also provided considerable evidence to suggest that AKI is an independent risk factor for CKD (Lewington et al. 2013) (Figure 1.1). Pre-existing CKD has been found to increase the risk of AKI by as much as 10 times (Chawla et al. 2014). Multiple studies have found evidence that AKI is not only directly linked to the progression of CKD but causes CKD as well. Further, both AKI and CKD are risk factors for cardiovascular disease (Chawla et al. 2014).



Note: Modified from Chawla et al. 2014.

Source: KDIGO 2012.

Figure 1.1: Acute kidney injury and chronic kidney disease as an interconnected syndrome

The impact of AKI

AKI has a variety of short- and long-term outcomes ranging from complete recovery of kidney function, through to mild degrees of chronic kidney disease, severe kidney damage leading to long-term dialysis dependency, and death (including increased short-term risk for in-hospital death). The severity and duration of the event heavily influence these outcomes (Lewington et al. 2013). Patients with severe forms of AKI requiring short-term dialysis are particularly at increased risk for the long-term development or acceleration of pre-existing CKD, resulting in end-stage kidney disease (ESKD) and long-term dialysis therapy (Koulouridis et al. 2014). Given that AKI often results in prolonged hospitalisation and a high need for post-acute care, this condition is associated with high resource consumption. There is increasing recognition of the impact that AKI has on the individual patient and the major economic burden its long-term effects have on society.

Defining AKI

AKI, previously known as acute kidney failure, has undergone significant re-examination in the last decade. Until recently, there were multiple definitions for the clinical definition/diagnostic criteria for AKI with no consensus (see Box 1.1). The shift in terminology from acute kidney failure to acute kidney injury occurred to encompass the entire spectrum of the syndrome, from minor changes in kidney function to kidney failure (KDIGO 2012). Although efforts to standardise the definition of AKI have come a long way, the concept of AKI is still evolving.

Box 1.1: History of acute kidney injury definitions

Until recently, there was no consensus on the clinical definition or diagnostic criteria of AKI (previously known as acute kidney failure). The lack of a standardised definition made it difficult to determine the epidemiology and outcomes of AKI, leading to wide variations in the reported incidence of AKI (Lewington & Kanagasundaram 2011).

In 2004, to address the lack of a universal definition for AKI, the Acute Dialysis Quality Initiative (ADQI)* produced the first consensus definition of AKI. They devised the Risk, Injury, Failure, Loss of kidney function and End-stage kidney disease (RIFLE) definition and staging system. RIFLE defined AKI as a rise in creatinine of ≥50% from its baseline value and/or a fall in the glomerular filtration rate (GFR) by ≥25%, and/or a decrease in urine output below 0.5 ml/kg/h for 6 hours or more (Thomas et al. 2014). This was an important step towards providing a standard by which comparative epidemiology and clinical outcomes could be judged (Pickering & Endre 2014).

In 2006, the Acute Kidney Injury Network (AKIN)* revised this definition. AKI replaced the term acute kidney failure to include the entire spectrum of kidney injury, from minor to more advanced forms when acute kidney failure may require renal replacement therapy (RRT) (Lewington & Kanagasundaram 2011). The AKIN definition introduced an absolute change in creatinine of ≥0.3 mg/dl (≥26.4 umol/l) within 48 hours, as well as an increase in creatinine of 50%, and the change in GFR was omitted entirely in the definition for AKI (Pickering & Endre 2014). This modification was included to reflect the increasing recognition of the clinical significance of relatively small rises in serum creatinine (Lewington & Kanagasundaram 2011).

In 2012, Kidney Disease: Improving Global Outcomes (KDIGO)* produced a definition and staging system that combined both previous definitions and staging systems that ADQI and AKIN proposed (Lewington & Kanagasundaram 2011). The KDIGO definition defines AKI by a ≥0.3 mg/dl increase in creatinine or a 50% increase above baseline within 48 hours, or a ≥50% increase in creatinine above baseline within 7 days (Pickering & Endre 2014).

Despite the significant contribution of these definitions towards the diagnosis and management of AKI, they have limitations. As a result, there are currently efforts to further refine the definition of AKI (Thomas et al. 2014).

*ADQI, AKIN, and KDIGO are international, interdisciplinary organisations.

National monitoring of AKI

Given the broad nature of this disorder, the incidence of AKI has been shown to vary widely across studies and is greatly dependent on the setting (hospital- vs. community-acquired) and the at-risk population investigated. Despite this, over the last decade, dramatic rises in the prevalence and incidence of AKI have been reported worldwide (Li et al. 2013; Siew & Davenport 2014).

Monitoring the direct or indirect impact of AKI is critical to better understand the syndrome and its burden on society. It is also needed to inform health-care policy and service planning, as well as evaluating progress in disease prevention and management. While individual cohort studies have been undertaken, there are currently no published national or jurisdictional reports on the burden and impact of AKI in Australia. Hence, it is intended that this report will contribute to filling this important information gap.

A diagnosis of AKI is captured in national hospital and mortality statistics, using defined codes based on the World Health Organization's International Statistical Classification of Diseases and Related Health Problems (ICD). Therefore, the AIHW National Morbidity Database and AIHW National Mortality Database can be used to assess the impact of AKI in Australia (see Appendix A for further details). A broad range of the ICD-10-AM/ICD-10 codes define AKI, including N17–Acute kidney failure; N00–Acute nephritic syndrome; N10–Acute tubulo-interstitial nephritis; and E10.29, E11.29, E13.29, E14.29–Diabetes with other specific kidney complication including acute kidney failure. Note that the majority of AKI cases are N17 (see Appendix A: tables A1 and A3). However, given that the clinical definition/diagnostic criteria for AKI is evolving, defining AKI by these codes may not capture all cases of AKI in hospital records and on death certificates.

Scope of this report

This is the first national report on hospitalisations and deaths related to AKI in Australia. It gives a statistical reference for policy makers, service providers, planners, clinicians and researchers.

This report examines AKI and its impact on hospitalisations and deaths in relation to: sex and age, remoteness of residence, socioeconomic disadvantage and Indigenous status. It also presents trends and describes the relationship between AKI and CKD. However, it was outside the scope of the report to explore the underlying factors that may contribute to higher rates of AKI among certain population groups.

2 Acute kidney injury hospitalisations

Acute kidney injury is linked with substantial ill health, in particular hospitalisations. In addition to causing hospitalisations, AKI is also a common hospital-acquired disorder, particularly among critically ill patients in ICUs (Lewington et al. 2013). Among the known causes of hospital-acquired AKI are hospital-acquired infections, sepsis, multi-organ failure and complex surgery (Li et al. 2013). Drug-induced kidney injury is also recognised as a major factor in hospital-acquired AKI. Further, several studies have highlighted a link between AKI events and hospital re-admissions, with one recent study finding that even mild episodes of AKI can result in hospital re-admissions (Koulouridis et al. 2014).

This section aims to describe the impact and assess the burden of all hospitalisations where AKI is recorded as a diagnosis (note that it does not look at hospital-acquired AKI specifically). The hospitalisation data in this report are sourced from the AIHW National Hospital Morbidity Database (NHMD), which records information on admitted patient care (separations or hospitalisations) in essentially all hospitals in Australia (see Box 2.1 and Appendix A). A range of ICD codes, as shown in Table A1, identify AKI in the NHMD.

Box 2.1: Defining hospitalisations in this report

Statistics on admitted patients are compiled when an admitted patient (a patient who undergoes a hospital's formal admission process) completes an episode of admitted patient care and 'separates' from the hospital. This is because most of the data on the use of hospitals by admitted patients are based on information provided at the end of the patient's episodes of care, rather than at the beginning. In this report, a 'hospitalisation' (or 'separation') refers to an episode of admitted care, which can be a total hospital stay (from admission to discharge, transfer or death) or a portion of a hospital stay beginning or ending in a change of type of care (for example, from acute care to rehabilitation).

Clinical information recorded in the NHMD includes information on principal and additional diagnoses:

- *The principal diagnosis* is the diagnosis established after study to be chiefly responsible for occasioning the patient's hospitalisation.
- *The additional diagnosis* is a condition or complaint that either coexists with the principal diagnosis or arises during the hospitalisation. An additional diagnosis is reported if the condition affects patient management.

Characteristics of the person (such as age and sex), length of stay in hospital and the outcome of the hospitalisation (discharge of home, transfer to another hospital, or death) are also recorded.

The same person can have multiple hospitalisations. This means that without linking records of multiple hospitalisations to individuals (not yet done at the national level), it is not possible to count the number of individuals being hospitalised nationally, and their patterns of hospitalisation. For this reason, the data presented in this report do not represent the number or proportion of people admitted to hospital in Australia with AKI.

For more information, see Appendix A.

Given that hospitalisation patterns differed for AKI as the principal diagnosis compared with an additional diagnosis, this section reports data for AKI as the principal and/or additional diagnosis combined and then separately.

Acute kidney injury as a principal and/or additional diagnosis

In 2012–13, there were around 131,780 hospitalisations for AKI recorded as the principal and/or an additional diagnosis (representing 1.6% of hospitalisations overall†). These hospitalisations accounted for around 1.5 million bed days (or 7% of all bed days). The average length of stay for AKI hospitalisations was 11.4 days, which was twice as long as the average length of stay for hospitalisations overall (5.6 days). Average length of stay refers to the average number of days a person spends in hospital; it excludes those who were admitted and discharged on the same date.

The majority (76%) of AKI hospitalisations were coded as 'Acute kidney failure' (ICD-10-AM code N17), followed by 'Diabetes with other specified kidney complication including acute kidney failure' (19%) and 'Acute tubulo-interstitial nephritis' (3.7%) (see Appendix A: Table A1).

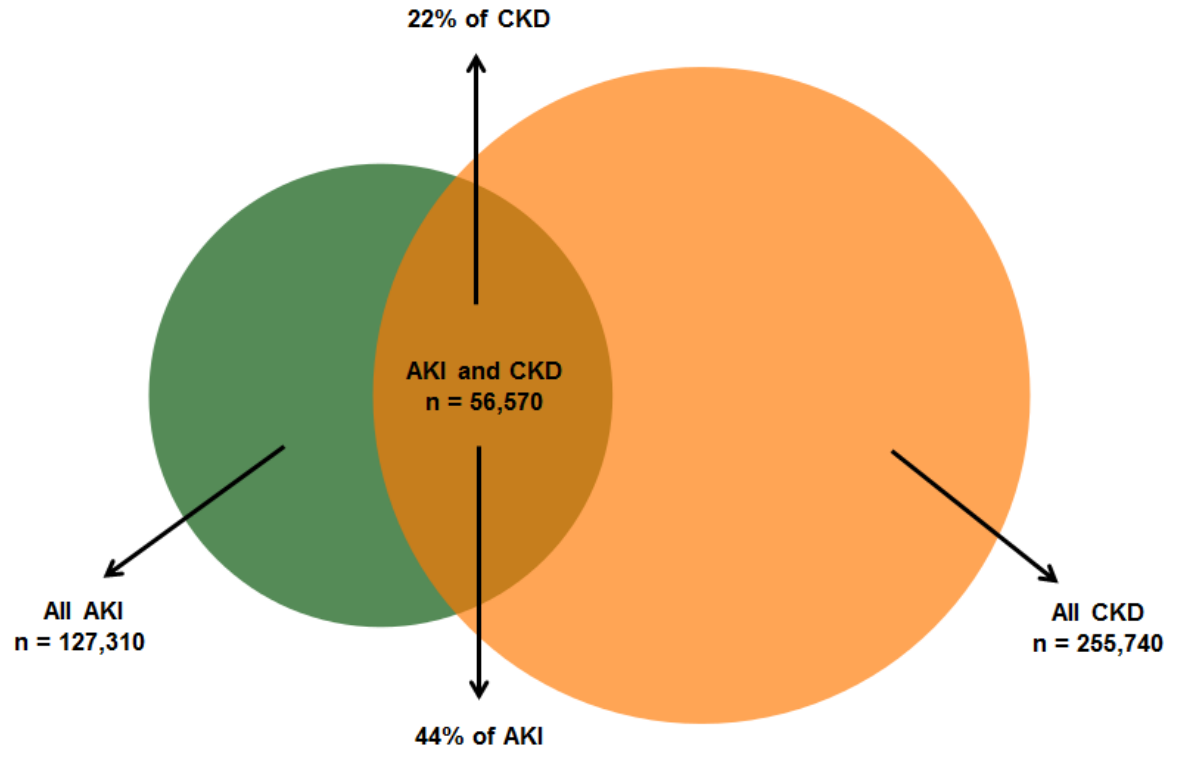
Of hospitalisations involving AKI, it was the principal diagnosis for around 18,010 hospitalisations (14%) and an additional diagnosis for a further 113,770 (86%). Hospitalisations with a principal diagnosis of AKI tended to have diabetes or other kidney diseases as an additional diagnosis. This differed for hospitalisations with AKI as an additional diagnosis, which tended to have a principal diagnosis of a cardiovascular- or respiratory system-related disease.

Relationship between AKI and CKD hospitalisations

As mentioned previously, AKI is strongly associated with the subsequent development of CKD and the most important risk factor for AKI is pre-existing CKD (Li et al. 2013; Ishani et al. 2009; Xue et al. 2006).

In 2012–13, there were around 56,570 hospitalisations in which AKI and CKD were both present as the principal and/or additional diagnosis. Of all AKI-related hospitalisations (as the principal and/or an additional diagnosis), 44% also had a diagnosis of CKD. For all CKD-related hospitalisations, 22% also had a diagnosis of AKI (Figure 2.1).

† Note that the hospitalisation analyses in this report exclude all hospitalisations with dialysis as a principal diagnosis (see Appendix A).



Note: The ICD-10-AM codes E10.29, E11.29, E13.29, E14.29 and N00 are overlapping codes for AKI and CKD and were excluded from this analysis. See Reporting AKI hospitalisations and deaths in Appendix A for further details.

Source: AIHW National Hospital Morbidity Database.

Figure 2.1: Hospitalisations for persons with acute kidney injury and/or chronic kidney disease, as the principal and/or additional diagnosis, 2012–13

Acute kidney injury as the principal diagnosis

In 2012–13, of the 18,010 hospitalisations where AKI was recorded as the principal diagnosis, the majority (74%) were coded as 'Acute kidney failure' followed by 'Acute tubulo-interstitial nephritis' (23%) (see Appendix A: Table A1).

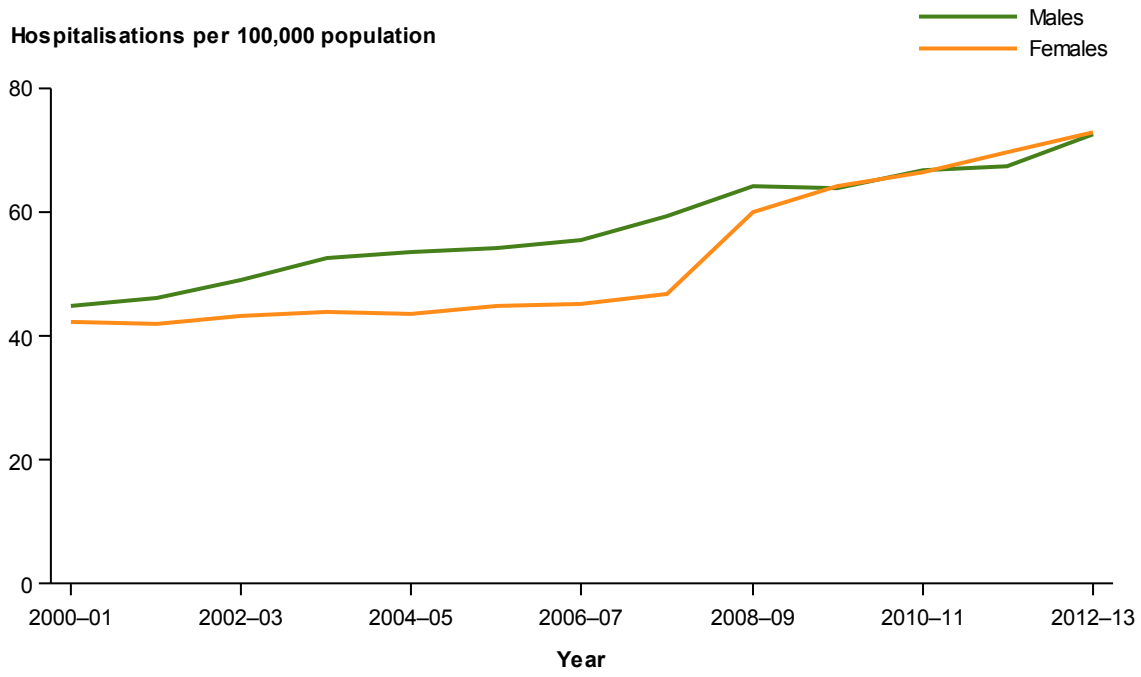
Trends

Between 2000–01 and 2012–13 there has been a considerable increase in the number and rate of hospitalisations where AKI was recorded as a principal diagnosis. The number of hospitalisations with AKI as a principal diagnosis more than doubled, from 8,050 to 18,010, an average increase of around 830 hospitalisations (or 6%) per year over this period.

Similarly, the age-standardised rate of hospitalisations for AKI increased over the same period—by 69% (from 42 to 71 hospitalisations per 100,000 population), an average annual increase of 4%.

The overall increase between 2000–01 and 2012–13 was less for males then females—62% and 72% respectively (Figure 2.2). The sharp increase in AKI hospitalisations among females from 2007–08 was due to high and increasing numbers and rates of ICD-10-AM code N10 'Acute tubulo-interstitial nephritis' (in 2012–13, N10 accounted for 36% of AKI hospitalisations in females compared with 8% for males). This increase in N10 among

females closed the gap in age-standardised AKI hospitalisations rates between males and females from 2007–08 (see Appendix B: Figure B1). The cause of this increase in N10 hospitalisations is unknown; however, no evidence was found of a change to ICD-10 coding rules for N10 during 2007–09.



Note: Age-standardised to the 2001 Australian population.

Source: AIHW National Hospital Morbidity Database.

Figure 2.2: Trends in acute kidney injury hospitalisation as the principal diagnosis, by sex, 2000–01 to 2012–13

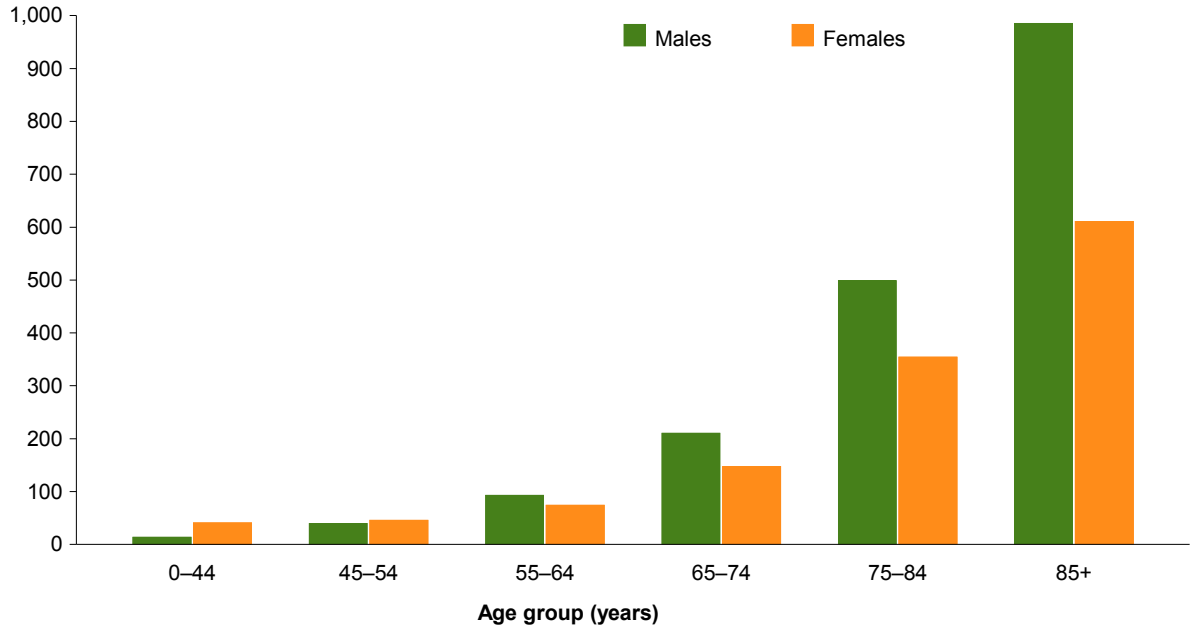
Sex and age

In 2012–13, males accounted for just under half of AKI hospitalisations (as a principal diagnosis) with 8,480 hospitalisations (47%) while females accounted for 53% (9,530 hospitalisations). However, after adjusting for age, AKI hospitalisation rates were similar for males and females (72 and 73 per 100,000 population, respectively).

Hospitalisation rates for AKI as the principal diagnosis increase rapidly with age, with 60% occurring in those aged 65 and over. Rates were highest among those aged 85 and over, and were 4 times the rate of those aged 65–74 (744 per 100,000 compared with 178, respectively) (Figure 2.3).

Males had substantially higher rates of hospitalisations for AKI than females among the older age groups, with the gap widening with age. For example, males aged 85 and over had AKI rates 1.6 times as high as for females (985 compared with 611 per 100,000 respectively), compared with 1.4 times as high for those aged 65–74 (210 and 147 per 100,000 respectively) (Figure 2.3). However, females had higher rates than males among those aged under 55.

Acute tubulo-interstitial nephritis (ICD-10-AM code N10) largely drives the higher rate of AKI hospitalisations among females compared with males aged under 55. It accounted for 76% of AKI hospitalisations in younger females compared with 19% for younger males (N10 is also higher among females than males in those aged 55 and over but the difference is not as large).



Note: See Appendix B: Table B2.

Source: AIHW National Hospital Morbidity Database.

Figure 2.3: Acute kidney injury hospitalisations as the principal diagnosis, by age and sex, 2012–13

Population groups

Remoteness

In 2012–13, the hospitalisation rate where AKI was recorded as a principal diagnosis was almost twice as high in *Very remote* areas compared with *Major cities*.

The gap in AKI hospitalisation rates between *Very remote* areas and *Major cities* was higher for females than males—2.3 times as high for females (157 and 68 per 100,000 population, respectively) compared with 1.3 times as high for males (90 and 71 per 100,000 population, respectively) (Figure 2.4).

Socioeconomic disadvantage

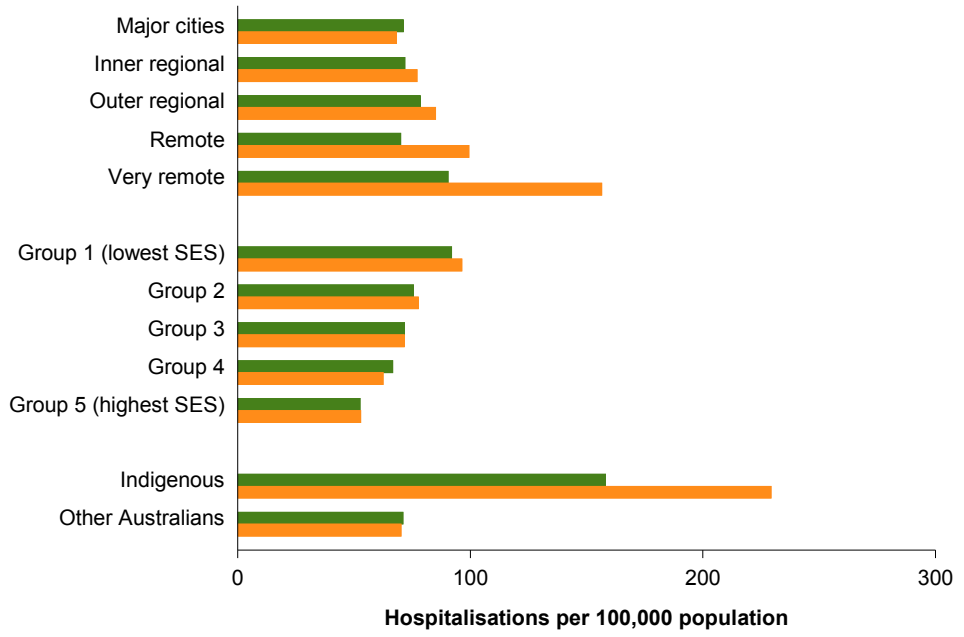
In 2012–13, living in an area with socioeconomic disadvantage was associated with higher hospitalisation rates where AKI was recorded as the principal diagnosis for both males and females (Figure 2.4). Rates in the lowest group were almost twice as high as rates in the highest group (92 compared with 53 per 100,000 for males, and 96 and 53 per 100,000 for females, respectively), based on area of usual residence.

Males and females had similar hospitalisation rates for AKI across all socioeconomic groups (Figure 2.4).

Aboriginal and Torres Strait Islander people

AKI is a significant contributor to hospitalisations and deaths among Aboriginal and Torres Strait Islander people. In 2012–13, the hospitalisation rate for AKI (as the principal diagnosis) was almost 3 times as high among Indigenous Australians than Other Australians (Figure 2.4).

Indigenous males were 2.2 times as likely as Other Australian males to be hospitalised for AKI as the principal diagnosis (158 and 71 per 1000,000 population, respectively). The disparity was even greater for females, with Indigenous females being 3.3 times as likely to be hospitalised for AKI as Other Australian females (229 and 70 per 100,000 population, respectively). The pattern of greater differences among females than males may in part be due to higher rates of CKD among Indigenous females (AIHW 2014c).



Notes

1. Age-standardised to the 2001 Australian population.
2. See Appendix B: Table B2.
3. Other Australians includes people who did not identify as being of Aboriginal and/or Torres Strait Islander origin, and people for whom information on their Indigenous status was not available (see Appendix A).
4. Refer to Appendix A for definitions of classifications for remoteness and socioeconomic groups.

Source: AIHW National Hospital Morbidity Database.

Figure 2.4: Acute kidney injury hospitalisations as the principal diagnosis, by sex and selected population characteristics, 2012–13

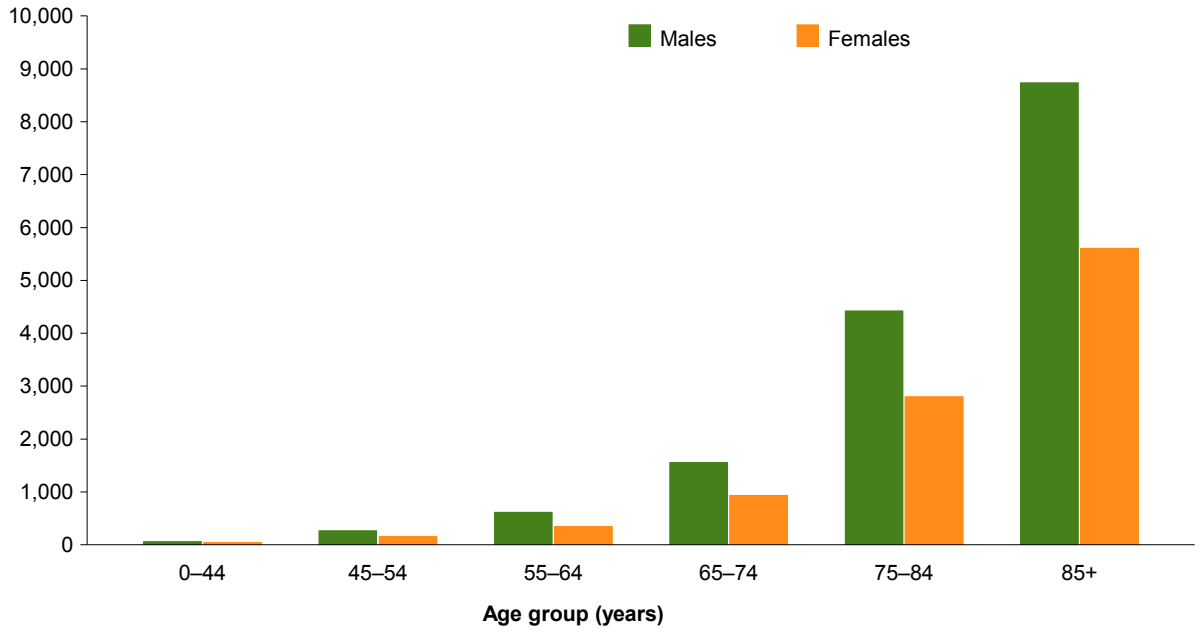
Acute kidney injury as an additional diagnosis

In 2012–13, there were around 113,770 hospitalisations for AKI recorded as an additional diagnosis. Of these hospitalisations, the majority (77%) were coded as 'Acute kidney failure' followed by 'Diabetes with other specified kidney complication including acute kidney failure' (22%) (see Appendix A: Table A1).

Sex and age

Males accounted for over half of all AKI hospitalisations (as an additional diagnosis), 56% compared with 44% for females (63,720 and 50,050, respectively). After adjusting for age, males had higher AKI hospitalisation rates than females (1.6 times as high; 547 and 346 per 100,000, respectively).

As with AKI as the principal diagnosis, hospitalisation rates for AKI as an additional diagnosis increase rapidly with age, with those aged 85 and over being hospitalised at 5 times the rate of those aged 65–74 (6,715 per 100,000 compared with 1,240, respectively). Males had higher rates than females across all age groups (Figure 2.5).



Note: See Appendix B: Table B2.

Source: AIHW National Hospital Morbidity Database.

Figure 2.5: Acute kidney injury hospitalisations as an additional diagnosis, by age and sex, 2012–2013

Population groups

Remoteness

In 2012–13, people living in *Major cities* or *Very remote* areas were hospitalised at around 1.3 times the rate for AKI (as the additional diagnosis) as those living in *Inner regional, Outer regional* and *Remote* areas. Males had higher AKI hospitalisation rates than females, with the gap being larger in *Major cities*, *Inner regional* and *Outer regional* areas (around 1.6–1.7 times as high). The gap between males and females was less in *Remote* areas (1.3); and in *Very remote* areas rates were similar for males and females (Figure 2.6).

Socioeconomic disadvantage

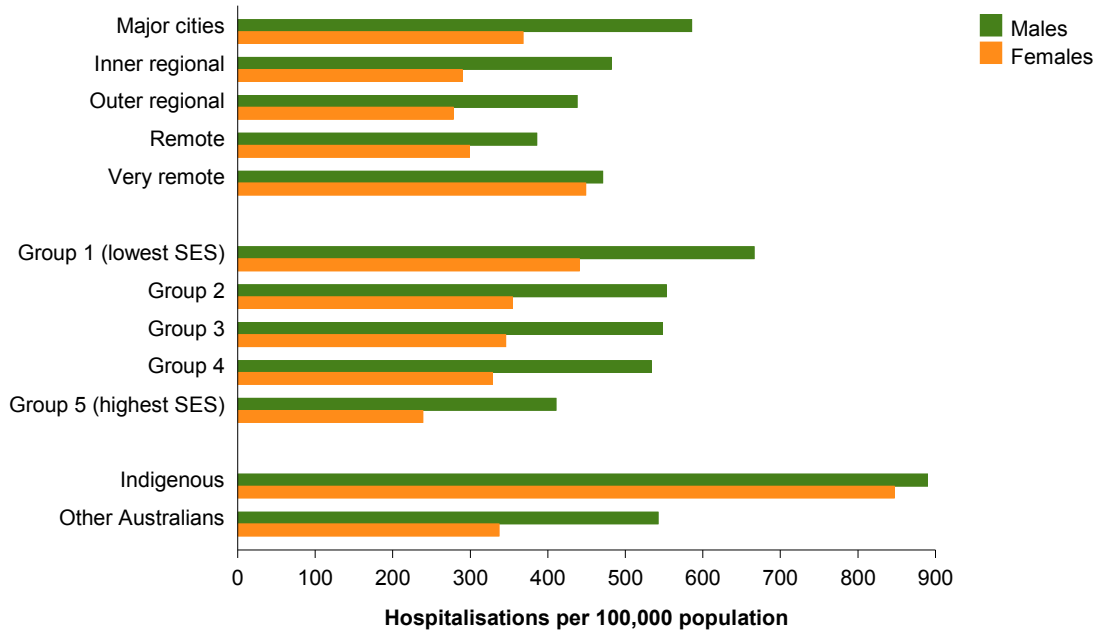
In 2012–13, living in an area with socioeconomic disadvantage was associated with higher hospitalisation rates, where AKI was recorded as the additional diagnosis, for both males and females (Figure 2.6). Rates of AKI hospitalisations based on area of usual residence were

1.3 times as high in the lowest socioeconomic group compared with the highest socioeconomic group. The gap in AKI hospitalisation rates between the lowest and highest socioeconomic group was greater for females than males—rates were 1.8 times as high for females (441 and 239 per 100,000, respectively) compared to almost 1.6 times for males (666 compared with 411 per 100,000, respectively) (Figure 2.6). Males had higher hospitalisation rates for AKI across all socioeconomic groups.

Aboriginal and Torres Strait Islander people

The rate of hospitalisations where AKI was an additional diagnosis was twice as high among Aboriginal and Torres Strait Islander people than Other Australians (866 compared with 429 per 100,000, respectively).

Among Indigenous people, AKI hospitalisation rates (as an additional diagnosis) were similar for males and females. However, for Other Australians the hospitalisation rates for AKI were 1.6 times as high for males as for females (542 compared to 337 per 100,000, respectively), reflecting the male and female pattern for AKI hospitalisations overall (Figure 2.6).



Notes

1. Age-standardised to the 2001 Australian population.
2. See Appendix B: Table B2.
3. Other Australians includes people who did not identify as being of Aboriginal and/or Torres Strait Islander origin, and people for whom information on their Indigenous status was not available (see Appendix A).
4. Refer to Appendix A for definitions of classifications for remoteness and socioeconomic groups.

Source: AIHW National Hospital Morbidity Database.

Figure 2.6: Acute kidney injury hospitalisations as an additional diagnosis, by sex and selected population characteristics, 2012–13

Principal diagnosis for hospitalisations where AKI is an additional diagnosis

Where AKI was recorded as an additional diagnosis, the most common principal diagnoses were diseases of the circulatory system (cardiovascular disease) (19%) and diseases of the respiratory system (12%) (Table 2.1).

Table 2.1: Hospitalisations with an additional diagnosis of AKI by their principal diagnosis, 2012–13

Principal diagnosis	Number of hospitalisations	Per cent
Diseases of the circulatory system	21,852	19.2
Diseases of the respiratory system	14,088	12.4
Certain infectious and parasitic diseases	10,474	9.2
Diseases of the digestive system	9,832	8.6
Injury and poisoning	9,126	8.0
Diseases of the genitourinary system	8,218	7.2
Neoplasms (mainly cancers)	7,402	6.5
Symptoms, signs and abnormal clinical and laboratory findings	6,428	5.7
Endocrine, nutritional and metabolic diseases	5,927	5.2
Rehabilitation	5,721	5.0
Other	14,700	12.9
Total	**113,768**	**100.0**

Source: AIHW National Hospital Morbidity Database.

AKI hospitalisations ending in death

As previously mentioned, AKI is associated with substantial mortality, including increased short-term risk for in-hospital death. There is growing evidence that mild degrees of kidney dysfunction, indicated by an increase in serum creatinine, are associated with increased inpatient deaths (Ricci et al. 2008). People with AKI who require dialysis are particularly at risk of death, and are the main contributors to high in-hospital AKI-related deaths (Bagshaw et al. 2008, Gallagher et al. 2014, Lewington et al. 2013, Ricci et al. 2008).

In 2012–13, more than 1 in 10 (11%; 14,590) hospitalisations with AKI as a principal or additional diagnosis ended in death during the episode of care. For hospitalisations with an additional diagnosis of AKI that resulted in death, the principal diagnoses were diseases of the circulatory system in almost 1 in 4 cases (23%), followed by diseases of the respiratory system (17% of cases), neoplasms (mainly cancer) (14%), certain infectious and parasitic diseases (13%) and diseases of the digestive system (12%).

3 Acute kidney injury mortality

AKI is independently associated with increased mortality (Thomas et al. 2014). As the severity of AKI increases, so does the rate of death. Further, even after recovery from an AKI episode, there is a link between AKI and long-term risk of death (KDIGO 2012).

The mortality data in this section have been sourced from the AIHW National Mortality Database (NMD), which records information on the causes of death in Australia from death certificates (see Box 3.1 and Appendix A). It includes deaths occurring both in and out of hospital but does not distinguish between these because the NMD does not contain information on place of death; the previous chapter supplied information on deaths in hospital.

This section focuses on deaths that can be attributed to AKI by examining deaths with AKI reported as the underlying or an associated cause (see Box 3.1). It is known that AKI is clinically under-recognised and as a result, may be under-recorded on death certificates (Selby et al. 2012). Hence, AKI deaths may be underestimated even when counting those with AKI as either the underlying or an associated cause of death.

Box 3.1: Describing causes of death

Death certificates document the diseases considered to be instrumental in causing a death. A medical practitioner or coroner usually completes these certificates.

The *underlying cause of death* is the condition, disease or injury that initiated the sequence of events leading directly to death; that is, the primary or main cause. For each death, only a single underlying cause is selected from all the conditions reported on a death certificate.

Associated causes of death are all causes listed on the death certificate, other than the underlying cause of death. They include the immediate cause, any intervening causes, and conditions that contributed to the death but were not related to the disease or condition causing the death.

Since deaths rarely have a single cause, analysis using multiple causes of death data (that is, the *underlying cause of death* and all *associated causes of death*) gives a more complete representation of all diseases and conditions that caused a death (AIHW 2012).

Acute kidney injury as the underlying or an associated cause of death

In 2012, there were around 5,160 deaths where AKI was recorded as the underlying or an associated cause of death (3.5% of all deaths in 2012). Nine in 10 (90%) were for AKI as an associated cause of death.

The majority (99%) of AKI deaths, as an underlying or associated cause, were coded as 'Acute kidney failure—unspecified' (ICD-10 code N17.9).

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

When AKI was listed as an associated cause of death, diseases of the circulatory system (cardiovascular disease) were the leading underlying cause of death—26% of deaths (around 1,210 deaths), followed by neoplasms (largely cancers; 18%; 850 deaths) and diseases of the genitourinary system (13%; almost 600 deaths) (Table 3.1).

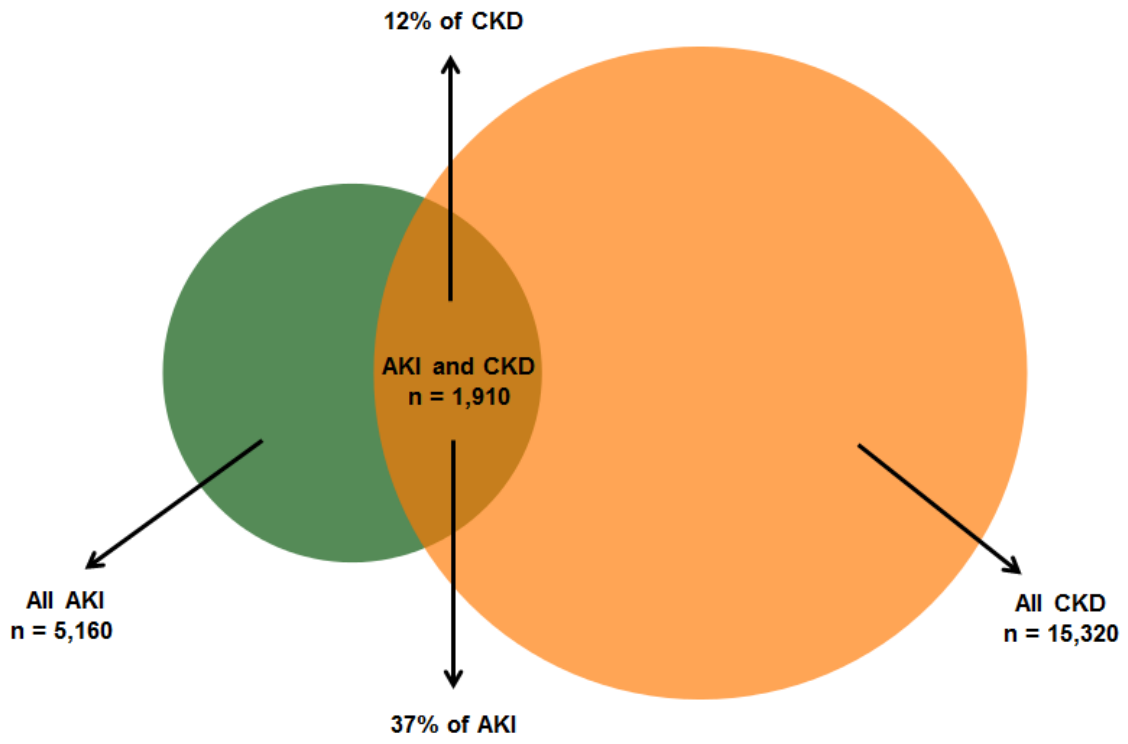
Table 3.1: Underlying causes of death where AKI is an associated cause of death, 2012

Underlying cause of death	Number of deaths	Per cent
Diseases of the circulatory system	1,209	26.0
Neoplasms (mainly cancer)	847	18.2
Diseases of the genitourinary system	596	12.8
Diseases of the digestive system	389	8.4
Diseases of the respiratory system	376	8.1
Endocrine, nutritional and metabolic diseases	374	8.1
Certain infectious and parasitic diseases	232	5.0
Other	622	13.4
Total	**4,645**	**100.0**

Source: AIHW National Mortality Database.

Relationship between AKI and CKD mortality

Several studies have suggested that AKI and CKD are not distinct entities but interconnected syndromes (Chawla et al. 2014; Ricci et al. 2008). In 2012, there were around 1,910 deaths recorded in which AKI and CKD were present as the underlying and/or an associated cause of death. Of all AKI-related deaths (underlying and/or an associated cause), 37% also had CKD listed as a cause of death. For all CKD-related deaths, 12% also had AKI listed as a cause of death (Figure 3.1).



Note: The ICD-10 code N00 is an overlapping code for AKI and CKD, that is, it can be used to define AKI or CKD. As a result, this code was excluded from this analysis to avoid overestimating the number of deaths with AKI, CKD, and AKI and CKD together.

Source: AIHW National Mortality Database.

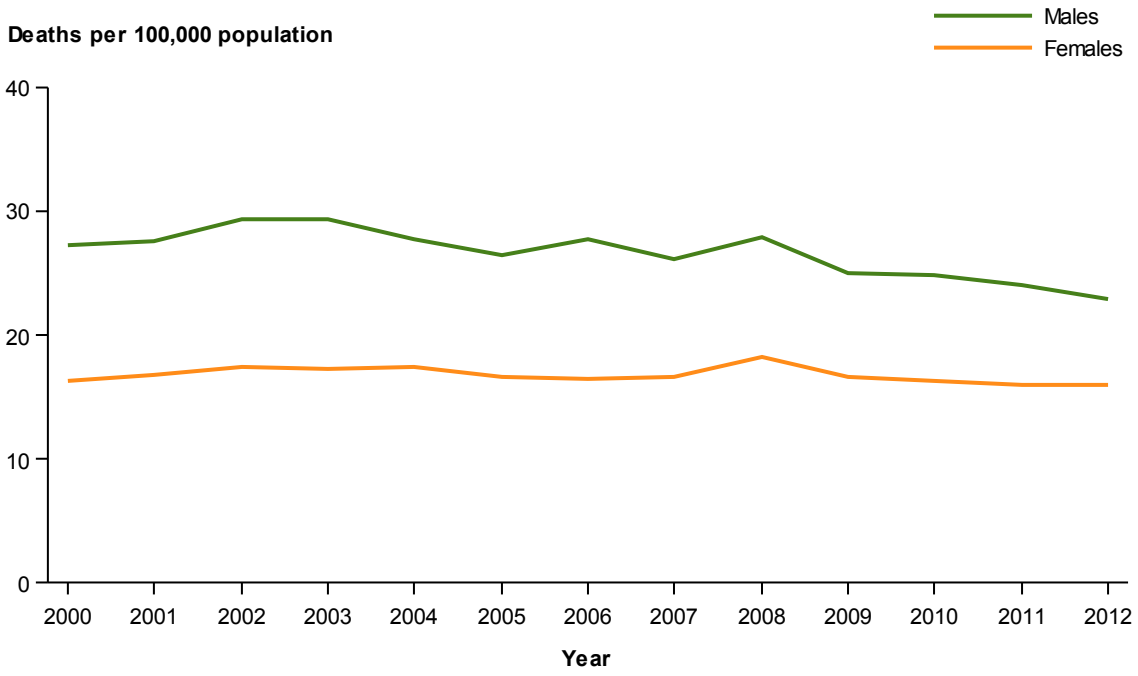
Figure 3.1: Deaths for persons with acute kidney injury and/or chronic kidney disease as the underlying and/or an associated cause of death, 2012

Trends

Between 2000 and 2012, there were around 60,770 deaths where AKI was listed as an underlying or associated cause of death. The number of deaths each year has remained similar over this period, an average of 4,670 deaths per year.

Despite large increases in AKI hospitalisation rates (from 42 to 71 hospitalisations per 100,000 between 2000–01 and 2012–13), age-adjusted AKI death rates have remained similar over this period (around 19–21 deaths per 100,000 population per year) (Figure 3.2).

Over this period, the male AKI death rate consistently remained 1.6 times as high as that of females (27 compared with 17 per 100,000 per year, respectively).



Note: Age-standardised to the 2001 Australian population.

Source: AIHW National Mortality Database.

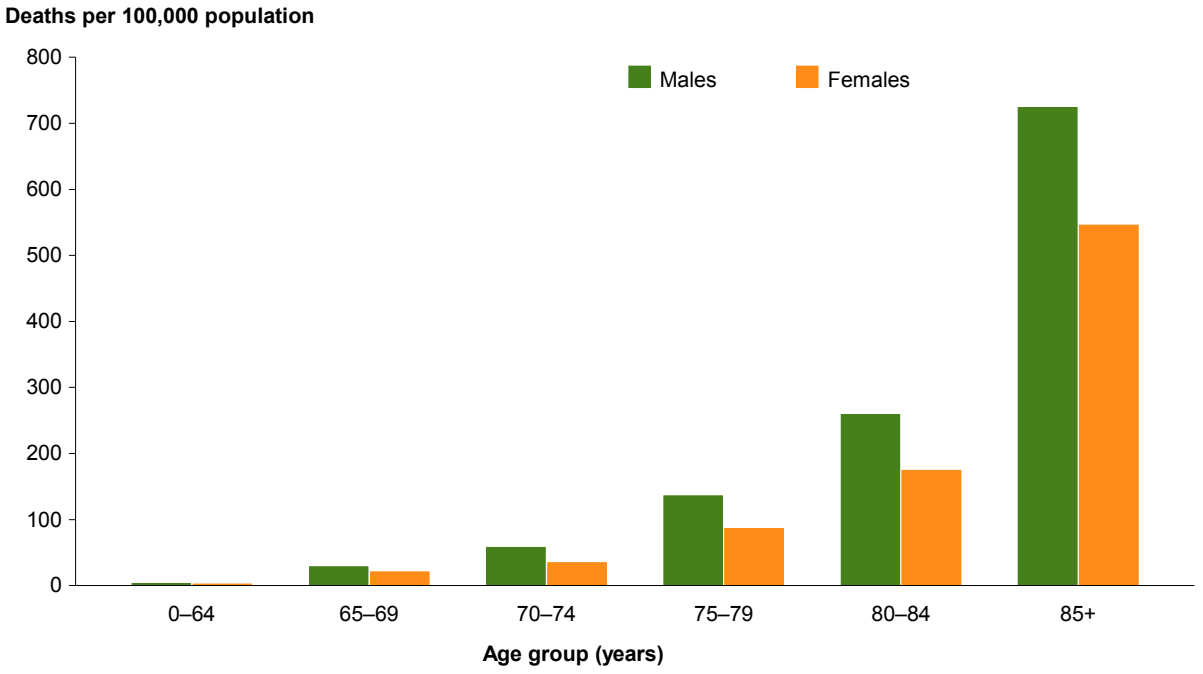
Figure 3.2: Trends in acute kidney injury deaths as the underlying or an associated cause, by sex, 2000–2012

Sex and age

AKI deaths (as the underlying or an associated cause of death) increase sharply with age for both males and females. In 2012, the rate of AKI deaths doubled for each age group from 65–69 to 80–84, and tripled between those aged 80–84 and 85 and over (see Appendix B: Table B4).

Across all age groups, AKI death rates were higher among males than females. Overall, death rates were 1.4 times as high among males compared with females (23 and 16 per 100,000 respectively; Figure 3.3).

While AKI death rates were higher in males than females, a similar number of males and females died from AKI in 2012 (2,555 compared with 2,609, respectively). This is due to the fact that a higher proportion of the female population lives to older ages with most deaths occurring in these age groups. The majority of AKI deaths among females (around 1,490, or 57%) occurred at age 85 and over compared with 42% (just over 1,060) of male deaths (see Table B3).



Note: See Appendix B: Table B4.

Source: AIHW National Mortality Database.

Figure 3.3: Acute kidney injury death as the underlying or an associated cause, by age and sex, 2012

When AKI was examined separately as either an underlying or associated cause of death, a similar pattern was seen with higher rates among males and increasing with age. The exception was for females aged 85 and over, who had higher death rates than males for AKI as the underlying cause of death (73 compared with 65 per 100,000 population, respectively).

Population groups

Remoteness

In 2008–2012, the rate of AKI deaths (as the underlying or an associated cause of death) was around 1.5 times as high in *Very remote* areas (28 per 100,000 population) when compared with all other areas: *Major cities* (21), *Inner regional* (19), *Outer Regional* (18) and *Remote* areas (19).

AKI death rates among males were similar across all remoteness areas. However, for females, the rate of AKI deaths was much higher in *Very remote* areas when compared with all other areas; around 1.9 times as high (Figure 3.4). This suggests that the pattern for females was the driver for the overall higher rate in *Very remote* areas.

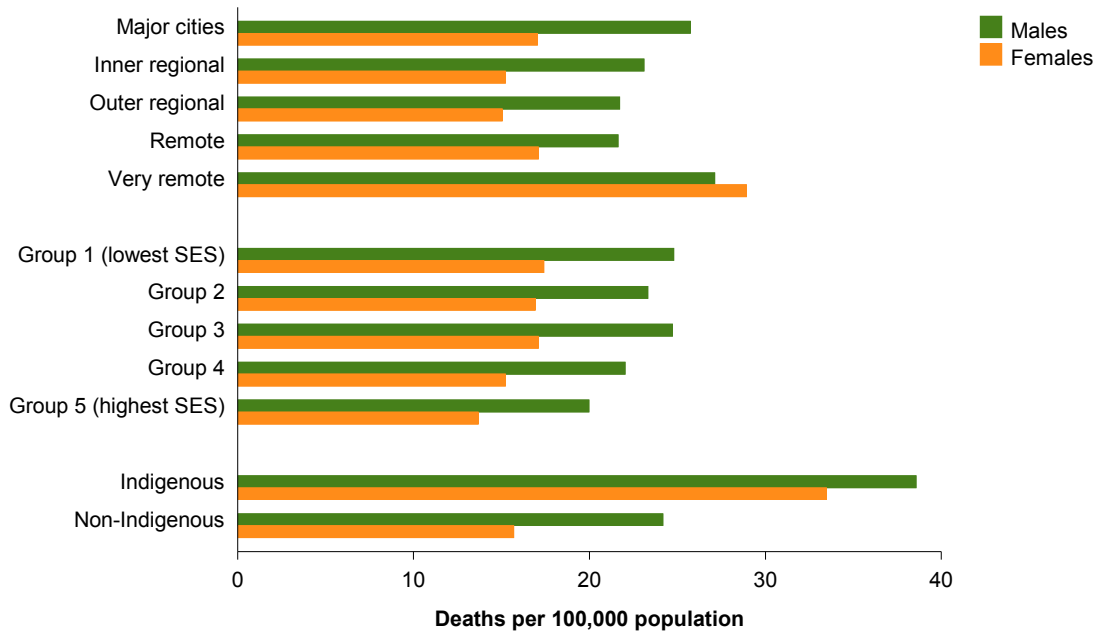
Socioeconomic disadvantage

In 2012, living in an area with socioeconomic disadvantage was associated with higher AKI death rates for both males and females—death rates were 1.3 times as high in the lowest socioeconomic group compared with the highest socioeconomic group (21 and 16 deaths per 100,000, respectively) (Figure 3.4). Overall, males had higher death rates than females in all socioeconomic groups for AKI as the underlying or an associated cause of death.

Aboriginal and Torres Strait Islander people

In 2008–2012, AKI was the underlying or associated cause of death for around 330 Aboriginal and Torres Strait Islander people in the 5 jurisdictions with adequate identification of Indigenous status. The AKI death rate for Indigenous Australians was 1.8 times as high as that for non-Indigenous Australians (35 compared with 19 per 100,000 population, respectively).

The gap in AKI death rates between Indigenous and non-Indigenous Australians was considerably higher for females than males—AKI death rates for Indigenous females and males were 2.1 and 1.6 times as high, respectively, as their non-Indigenous counterparts (Figure 3.4).



Notes

1. Age-standardised to the 2001 Australian population.
2. See Appendix B: Table B4.
3. Refer to Appendix A for definitions of classifications for remoteness and socioeconomic groups.
4. Data for Indigenous status is for NSW, QLD, WA, SA and NT (see Appendix A).
5. Excludes deaths with no stated information on Aboriginal and Torres Strait Islander status.
6. Data for socioeconomic status is for 2012 only.

Source: AIHW National Mortality Database.

Figure 3.4: Acute kidney injury deaths as the underlying or associated cause of death, by sex and selected population characteristics, 2008–2012

4 Discussion

The primary aim of this report is to provide an overview of AKI and its impact in Australia by describing the contribution of AKI towards hospitalisations and deaths. The findings are based on information recorded in hospital records and on death certificates, using a defined set of ICD-10 codes. However, this may not fully capture all cases of AKI in Australia, as it is an under-recognised condition for which the clinical definition/diagnostic criteria are still evolving.

This report has shown that AKI accounts for many hospitalisations and deaths and that the burden of this condition is not equally distributed across the Australian population. These inequalities were seen in relation to all population characteristics examined, namely sex, age, remoteness of residence, socioeconomic disadvantage and Indigenous status.

The burden of AKI

Between 2000–01 and 2012–13, age-standardised hospitalisations rates for AKI as a principal diagnosis have increased by 69%—an average annual increase of 4%. Despite this large increase, AKI death rates have remained similar over this period. A potential contributor to the growth in AKI hospitalisations is an increase in the number of patients hospitalised who are susceptible to the disease due to surgery, sepsis, infections and greater use of kidney-toxic medications (Siew & Davenport 2014).

Hospitalisations

In 2012–13, the average length of stay for AKI hospitalisations was twice as long as the average length of stay for hospitalisations overall (11.4 compared with 5.6 days, respectively).

Hospitalisation rates for AKI as a principal diagnosis rise rapidly with age, with the majority occurring in those aged 65 and over. Males had substantially higher rates of AKI hospitalisations than females among the older age groups, while females had higher rates among those aged less than 55. The latter was due to high rates of 'acute tubulo-interstitial nephritis' (ICD-10-AM code N10) among younger women. This code includes pyelonephritis, the most common cause being urinary tract infections for which adult women are at 50 times higher risk than men (Masson et al. 2009). Other factors which may warrant further investigation to better understand the higher rates in young women include the presence of other conditions (for example a diagnosis of lupus), and use of particular medications damaging to the kidneys.

AKI hospitalisation rates (as a principal diagnosis) were twice as high in *Very remote* areas than in *Major cities*. This may in part be due to the high rates of AKI hospitalisations for Indigenous Australians, where rates were 3 times as high as among Other Australians. AKI hospitalisation rates were also twice as high for those living in the lowest socioeconomic areas compared with the highest socioeconomic areas.

Similar patterns were seen in hospitalisations with an additional diagnosis of AKI. Overall, AKI hospitalisations increase rapidly with age. AKI hospitalisation rates for people living in the lowest socioeconomic areas were 1.3 times as high as in the highest socioeconomic areas and they were twice as high among Indigenous Australians as for Other Australians. The

only difference between hospitalisations for AKI as the principal diagnosis compared with an additional diagnosis was that people living in *Very remote* areas or *Major cities* were hospitalised at similar rates, around 1.3 times, as those living in *Inner regional*, *Outer regional* and *Remote* areas.

Deaths

Similar to the pattern for hospitalisations, AKI death rates also rise rapidly with age, with the majority occurring in those aged 65 and over. Overall, AKI death rates for males were 1.4 times as high as for females. People in *Very remote* areas had rates that were 1.5 times as high as people in *Major cities,* and rates among Indigenous Australians were nearly twice those of non-Indigenous Australians. People living in the lowest socioeconomic areas also had AKI death rates that were 1.3 times as high as people in the highest socioeconomic area.

Interpretation of findings on health inequalities

Each of the inequalities described above highlights areas where actions could be targeted to reduce AKI hospitalisations and deaths, bearing in mind overlaps among the population groups analysed here. For example, *Very remote* areas tend to have higher levels of socioeconomic disadvantage, and a higher proportion of the population that is Indigenous (AIHW 2014a).

The disparity in AKI hospitalisation (as a principal diagnosis) and death rates by remoteness categories may reflect the higher proportion of Aboriginal and Torres Strait Islander people living in *Remote* and *Very remote* areas of Australia and their higher rates of CKD (AIHW 2014a). In a previous AIHW report, it was found that Indigenous Australians accounted for 54% of CKD hospitalisations as the principal diagnosis in *Remote areas* despite only making up 15% of the population (AIHW 2011). Recent studies have highlighted the interconnectedness between AKI and CKD; CKD is a predominant risk factor for AKI and AKI is a risk factor for the development of CKD (Chawla et al. 2014; Siew & Davenport 2014). However, the higher proportion of Indigenous Australians in remote areas is only one potential explanation for the higher AKI hospitalisation and death rates in *Remote* and *Very remote* areas, since other geographical, environmental and social factors can often contribute to the poorer health of people living in remote areas of Australia (AIHW 2014a).

This report highlighted that AKI hospitalisation and death rates were considerably higher among Aboriginal and Torres Strait Islander people than other Australians, in particular Indigenous females. Previous studies have shown that there are higher rates of CKD and/or higher treated ESKD among Indigenous females compared with their male counterparts (AIHW 2011; Hoy et al. 2012). The reasons for this are complex and are likely to be influenced by several factors, including higher rates of diabetes and obesity in Indigenous females—both are key risk factors for CKD (Hoy et al. 2010; Hoy et al. 2012). This pattern of higher rates of CKD among Indigenous females may also contribute to the higher rates of AKI deaths and hospitalisations among females in *Very remote* areas.

There is a complex interaction between the 3 health determinants described here: Indigenous status, remoteness and socioeconomic status, together with a myriad of other determinants covering aspects such as nutrition, tobacco use, alcohol consumption, a safe environment, education, employment, social support and housing. Access to and use of health services such as primary care, hospital emergency department and outpatient services, specialist care and community services, vary substantially across the 3 population groups described in this

report. All these factors can influence people's health, increasing the risk of developing chronic conditions and associated complications, and consequently the risk of dying early. However, examining the effects of each factor independently was outside the scope of this report.

What's missing?

Elements that were not examined in this report but may be worth pursuing if data were available are:

- Prevalence and incidence of AKI—while individual studies examining the impact of AKI have been undertaken, there is a lack of reliable national data on the prevalence and incidence of AKI in Australia.
- An assessment of the potential underestimation of AKI in hospital and deaths data, given that standardised definitions of AKI have only appeared in the last decade and AKI is clinically under-recognised (Lewington et al. 2013).
- Patterns of hospitalisations for individuals with AKI using linked data. As previously noted, the hospital data in this report are based on episodes of admitted care which do not represent individuals.
- Detailed hospitalisation analyses such as hospital-acquired AKI in the general hospitalised population and ICU.
- The cause of gender differences in AKI hospitalisation rates (principal diagnosis) (as discussed above).
- The financial cost and burden of AKI on individuals, the community and the health system.

In addition, this report does not explain why inequalities exist, nor how socioeconomic, environmental and demographic factors interact to influence inequality. Further exploration and analysis of the social determinants of health could help to explain these relationships.

Conclusion

In conclusion, this first national report on AKI in Australia has shown that AKI is a growing problem that affects some groups in the population more than others. The impact of AKI on short- and long-term patient outcomes, and the escalating health-care costs and burden associated with the disease, highlight important and emerging challenges.

AKI is a complex multifactorial syndrome, the clinical definition for which is still evolving. As the understanding and evidence base for AKI increases, it will then be possible to better capture the impact of AKI in Australia. Further research into the areas described above may assist with policy development, health-care planning and service provision and to improve the outcomes for people with AKI.

Appendix A: Data sources and methods

Data sources

National Hospital Morbidity Database

The hospitalisation data in this report are sourced from the AIHW National Hospital Morbidity Database (NHMD), which is a compilation of episode-level records from admitted patient morbidity data collection systems in Australian hospitals. The NHMD is based on the Admitted Patient Care National Minimum Data Set (APC NMDS). It records information on admitted patient care (hospitalisations) in essentially all hospitals in Australia: all public and private acute and psychiatric hospitals, freestanding day hospital facilities and alcohol and drug treatment centres in Australia. Hospitals operated by the Australian Defence Force, corrections authorities and in Australia's offshore territories are not in scope but some are included. It includes information on demographic characteristics, administrative and length-of-stay data, as well as data on the diagnoses of the patients, the procedures they underwent in hospital and external causes of injury and poisoning.

Reporting to the NHMD occurs at the end of a person's admitted episode of care (separation or hospitalisation) and is based on the clinical documentation for that hospitalisation. Hospitalisations (separations) are reported to the NHMD in accordance with the requirements of the APC NMDS. The APC NMDS requires the principal diagnosis and any additional diagnoses to be reported according to the most recent edition of the International Statistical Classification of Diseases and Health Related Problems, 10th Revision, Australian Modification (ICD-10-AM) and associated Australian Coding Standards.

The Indigenous status data in the NHMD for all states and territories were considered of sufficient quality for statistical reporting for 2012–13. The AIHW found that, for 2011–12, an estimated 88% of Indigenous patients were correctly identified in public hospitals. The overall quality of the data supplied for Indigenous status is considered to be in need of some improvement and this varied between states and territories.

The hospital separations data do not include episodes of non-admitted patient care given in outpatient clinics or emergency departments. Patients in these settings may be admitted subsequently, with the care provided to them as admitted patients being included in the NHMD. The following care types were excluded when undertaking the analysis: 7.3 (newborn—unqualified days only), 9 (organ procurement—posthumous) and 10 (hospital boarder).

Most of the data used in this report were for the financial year 2012–13. Some trend information was also included from 2000–2001 to 2012–13.

The data in this report were extracted from the AIHW NHMD in November 2014.

Also see this link to National Hospital Morbidity Database Data Quality Statement: <http://meteor.aihw.gov.au/content/index.phtml/itemId/568730>.

National Mortality Database

The Registries of Births, Deaths and Marriages, the Coroners and the National Coroners Information System provided the mortality data used in this report and the Australian Bureau of Statistics (ABS) carried out the coding. These data are maintained at the AIHW in the National Mortality Database.

Indigenous analyses for 2010 have been adjusted for the additional deaths arising from outstanding registrations of deaths in Queensland in 2010. For more detail about the issue and the adjustments, please refer to the ABS Technical Note 3 in *Causes of death, Australia, 2010* (ABS cat. no. 3303.0).

Deaths registered in 2010 and earlier are based on the final version of cause of death data; deaths registered in 2011 and 2012 are based on revised and preliminary versions, respectively and are subject to further revision by the ABS.

The data quality statements underpinning the AIHW National Mortality Database can be found in the following ABS publications: ABS quality declaration summary for *Causes of death, Australia* (ABS cat. no. 3303.0) and the quality declaration summary for *Deaths, Australia* (ABS cat. no. 3302.0).

Reporting AKI hospitalisations and deaths

National Hospital Morbidity Database

Australia uses the International Statistical Classification of Diseases and Related Health Conditions. For hospital diagnoses and procedures, a slightly different classification, modified for morbidity coding in Australia, is used—the International Statistical Classification of Diseases and Related Health Conditions, 10th Revision, Australian Modification (ICD-10-AM).

The National Centre for Classification in Health (NCCH) developed the ICD-AM and it has been in use since 1998. It was developed with assistance from clinicians and clinical coders to ensure that the classification is current and appropriate for Australian clinical practice. ICD-10-AM is a derived version of the World Health Organization ICD-10. It uses an alphanumeric coding scheme for diseases and external causes of injury. It is structured by body system and aetiology, and comprises 3-, 4- and 5-character categories. ICD-10-AM is updated on a regular basis, with the regular updates of ICD-10 being included as part of the updating process (see AIHW 2014b and NCCH 2010 for more information).

Details of the codes used for diagnosis for AKI and CKD in this report are listed in tables A1–2. Further, this report excludes AKI hospitalisations with a principal diagnosis of dialysis (109 hospitalisations). Dialysis patients require frequent treatment—normally 3 times per week for in-centre dialysis, mostly provided in hospitals. Given that the NHMD records episodes of admitted care and not individuals, a patient receiving dialysis would be counted as a separate hospitalisation each time they received treatment, potentially inflating the number of hospitalisations for AKI. Therefore, dialysis as a principal diagnosis for people admitted to hospital with AKI as an additional diagnosis has been excluded from the analysis in this report.

Table A1: ICD-10-AM codes used to define diagnosis groups for acute kidney injury, 2012–13

Condition	ICD-10-AM codes	Number (%)		
		Principal diagnosis	Additional diagnosis	Principal and additional
Acute nephritic syndrome	N00	189 (1.1)	117 (0.1)	306 (0.2)
Acute tubulo-interstitial nephritis	N10	4,082 (22.7)	827 (0.7)	4,909 (3.7)
Acute kidney failure[(a)]	N17	13,353 (74.2)	87,144 (76.6)	100,497 (76.3)
Diabetes with other specified kidney complication including acute kidney failure/impairment and medullary (papillary) necrosis	E10.29 E11.29 E13.29 E14.29	331 (1.8)	24,689 (21.7)	25,020 (19.0)
Postpartum acute kidney failure/ Kidney failure follow abortion and ectopic or molar pregnancy	O90.4 O08.4	10 (0.1)	89 (0.1)	99 (0.1)
Post procedural kidney failure	N99.0	43 (0.2)	902 (0.8)	945 (0.7)
Total	**. .**	**18,008 (100.0)**	**113,768 (100.0)**	**131,776 (100.0)**

(a) 97% (97,291 cases) of N17 is N17.9 'Acute kidney failure, unspecified'; accounting for 74% of all AKI hospitalisations.

Source: AIHW National Hospital Morbidity Database.

Table A2: ICD-10-AM codes used to define diagnosis groups for chronic kidney disease

Condition	ICD-10-AM codes
Diabetic nephropathy	E10.2, E11.2, E13.2, E14.2
Hypertensive kidney disease	I12, I13, I15.0, I15.1
Glomerular diseases	N00–N08
Kidney tubulo-interstitial diseases	N11, N12, N14, N15, N16
Chronic kidney disease	N18
Unspecified kidney failure	N19
Other disorders of kidney and ureter	N25–N28, N39.1, N39.2
Congenital malformations	Q60–Q63
Complications related to dialysis and kidney transplant	T82.4, T86.1
Preparatory care for dialysis	Z49.0
Kidney transplant and dialysis status	Z94.0, Z99.2

National Mortality Database

Cause of death is coded according to rules set forward in various versions of the International Classification of Diseases (ICD) that the World Health Organization publishes. The relevant codes for deaths during the period covered by this report are provided in tables A3–4.

Table A3: ICD-10 codes used to define diagnosis groups for acute kidney injury, 2012

		Number (%)		
Condition	**ICD-10 codes**	**Underlying**	**Associated**	**Underlying and associated**
Acute nephritic syndrome	N00	2 (0.4)	7 (0.2)	9 (0.2)
Acute tubulo-interstitial nephritis	N10	4 (0.8)	14 (0.3)	18 (0.3)
Acute kidney failure[(a)]	N17	513 (98.8)	4,591 (98.8)	5,104 (98.8)
Postpartum acute kidney failure/ Kidney failure follow abortion and ectopic or molar pregnancy	O90.4 O08.4	0 (0.0)	0 (0.0)	0 (0.0)
Post procedural kidney failure	N99.0	0 (0.0)	33 (0.7)	33 (0.6)
Total	**. .**	**519 (100.0)**	**4,645 (100.0)**	**5,164 (100.0)**

(a) 99% (5,054 cases) of N17 is N17.9 'Acute kidney failure, unspecified'; accounting for 98% of all AKI deaths.

Source: AIHW National Mortality Database.

Table A4: ICD-10 codes used to define diagnosis groups for chronic kidney disease

Condition	**ICD-10-AM codes**
Diabetic nephropathy	E10.2, E11.2, E12.2, E13.2, E14.2
Hypertensive kidney disease	I12, I13, I15.0, I15.1
Glomerular diseases	N00–N07
Kidney tubulo-interstitial diseases	N11, N12, N14, N15
Chronic kidney disease	N18
Unspecified kidney failure	N19
Other disorders of kidney and ureter	N25–N28, N39.1, N39.2, E85.1, D59.3, B52.0
Congenital malformations	Q60–Q63
Complications related to dialysis and kidney transplant	T82.4, T86.1

The relationship between AKI and CKD

When examining the relationship between AKI and CKD in the NHMD (see Figure 2.1), the ICD-10-AM codes E10.29, E11.29, E13.29, E14.29 and N00 are overlapping codes for AKI and CKD; that is, they can be used to define AKI or CKD. As a result, these codes were excluded from this analysis to avoid overestimating the number of hospitalisations involving AKI, CKD, or AKI and CKD together. This resulted in 20,574 hospitalisations (27% of all hospitalisations with AKI or CKD as the principal or an additional diagnosis) being excluded from the analysis.

The excluded hospitalisations display similar sex, age, remoteness, socioeconomic and Indigenous distributions (data not shown) to the hospitalisations included in this analysis. Due to this, it is believed that the exclusion of these hospitalisations does not substantially impact on the results of this analysis.

When examining the relationship between AKI and CKD in the NMD (see Figure 3.1), the ICD-10 code N00 is an overlapping code for AKI and CKD. Nine deaths coded to N00 were excluded which accounted for less than 1% of all deaths with AKI or CKD as an underlying or an associated cause of death.

Remoteness

Comparisons of regions in this report use the Australian Statistical Geography Standard (ASGS) 2011 Remoteness Structure, developed by the ABS, which groups Australian regions into 6 remoteness areas. The 6 remoteness areas are *Major cities*, *Inner regional*, *Outer regional*, *Remote*, *Very remote* and *Migratory*. These areas are defined using the Accessibility/Remoteness Index for Australia (ARIA). ARIA is a measure of the remoteness of a location from the services that large towns or cities provide. Accessibility is based on distance to a metropolitan centre. A higher ARIA score denotes a more remote location. The category *Major cities* includes Australia's capital cities, with the exceptions of Hobart and Darwin, which are classified as *Inner regional*. The sixth Remoteness Area, *Migratory*, is not used in this publication.

Further information on the ASGS is available on the ABS website at: <http://www.abs.gov.au/websitedbs/d3310114.nsf/home/australian+statistical+geography+standard+(asgs)>.

Socioeconomic disadvantage

The ABS has constructed a number of socioeconomic indexes to classify areas on the basis of social and economic information collected in the Census of Population and Housing. In this report, the Socio-economic Indexes for Areas (SEIFA) Index of Relative Socio-economic Disadvantage (IRSD) is used. This is derived from social and economic characteristics of the local area such as low income, low educational attainment, high levels of public-sector housing, high unemployment and jobs in relatively unskilled occupations.

Since the IRSD summarises variables that indicate disadvantage, a low score indicates that an area has many low-income families, many people with little training and many people working in unskilled occupations; and this area may be considered as disadvantaged relative to other areas. It is important to understand that a high score reflects a relative lack of disadvantage rather than advantage, and that the IRSD relates to the average disadvantage of all people living in a geographical area. Thus it cannot be presumed to apply to all individuals living within the area. As the population of many areas covers a broad range of socioeconomic disadvantage, these measures will generally underestimate the true effect of disadvantage on health.

For analysis, the population was divided into 5 socioeconomic status (SES) groups with roughly equal populations (each around 20% of the total) based on the level of disadvantage of the statistical local area of their usual residence. The first group includes the 20% of the population living in areas with the highest levels of relative disadvantage (lowest SES), while the last group includes the 20% of the population living in areas with the lowest levels of relative disadvantage (highest SES).

The SEIFA IRSD values used in this report are based on the 2011 Census. Further information is available on the ABS website at: <http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/2033.0.55.0012011?OpenDocument>.

Aboriginal and Torres Strait Islander status

When reporting data by Aboriginal and Torres Strait Islander status the terminology differs between the NHMD and the NMD due to the way the data are collected in the 2 data sources:

- The NHMD—Indigenous Australians are compared with 'Other Australians' which includes people who did not identify as being of Aboriginal and/or Torres Strait Islander origin, and people for whom information on their Indigenous status was not available.
- The NMD—Indigenous Australians are compared with 'non-Indigenous' Australians for the 5 jurisdictions (NSW, QLD, WA, SA and NT) with adequate identification of Indigenous status.

Appendix B: Detailed statistical tables/figure

Table B1: Acute kidney injury hospitalisations, by principal and additional diagnosis, sex and selected population characteristics, 2012–13

	Number					
	Principal diagnosis			Additional diagnosis		
Population characteristics	Males	Females	Persons[(a)]	Males	Females	Persons[(a)]
Age group (years)						
0–44	956	2,808	3,764	3,866	3,163	7,029
45–54	596	701	1,297	3,975	2,404	6,379
55–64	1,200	976	2,176	7,895	4,565	12,460
65–74	1,891	1,358	3,249	14,011	8,589	22,600
75–84	2,313	1,981	4,294	20,504	15,642	36,146
85+	1,519	1,709	3,228	13,464	15,690	29,154
Total	**8,475**	**9,533**	**18,008**	**63,715**	**50,053**	**113,768**
Socioeconomic group						
Group 1 (lowest SES)	2,181	2,442	4,623	15,962	12,740	28,702
Group 2	1,875	2,069	3,944	13,698	10,665	24,363
Group 3	1,714	1,895	3,609	13,076	10,211	23,287
Group 4	1,443	1,604	3,047	11,365	9,008	20,373
Group 5 (highest SES)	1,155	1,373	2,528	8,854	6,864	15,718
Remoteness						
Major cities	5,534	6,286	11,820	45,134	37,072	82,206
Inner regional	1,780	1,921	3,701	12,075	8,502	20,577
Outer regional	914	956	1,870	5,156	3,502	8,658
Remote	114	143	257	600	426	1,026
Very remote	86	126	212	409	333	742
Aboriginal and Torres Strait Islander status						
Indigenous	284	519	803	1,391	1,493	2,884
Other Australians	8,191	9,014	17,205	62,324	48,560	110,884

(a) Males and females may not add up to persons due to missing sex data.

Source: AIHW National Hospital Morbidity Database.

Table B2: Acute kidney injury hospitalisation rates, by principal and additional diagnosis, sex and selected population characteristics, 2012–13

	Hospitalisations per 100,000 population					
	Principal diagnosis			Additional diagnosis		
Population characteristics	**Males**	**Females**	**Persons**	**Males**	**Females**	**Persons**
Age group (years)						
0–44	13.5	40.8	27.0	54.7	46.0	50.4
45–54	39.2	45.3	42.3	261.7	155.4	208.0
55–64	92.8	74.0	83.3	610.3	346.2	477.0
65–74	209.8	147.3	178.2	1,554.8	931.5	1,239.6
75–84	498.4	353.8	419.3	4,418.1	2,793.7	3,529.9
85+	985.0	610.5	743.6	8,731.1	5,605.1	6,715.5
Total age-standardised rate[(a)]	*72.4*	*73.3*	*71.6*	*547.0*	*345.7*	*436.4*
Socioeconomic group[(a)]						
Group 1 (lowest SES)	91.9	96.3	92.9	666.0	440.8	543.3
Group 2	75.6	77.7	75.5	552.8	354.2	444.4
Group 3	71.8	71.6	70.4	548.0	345.8	437.4
Group 4	66.6	62.5	63.3	533.4	328.9	420.0
Group 5 (highest SES)	52.6	52.8	51.4	410.5	238.7	313.5
Rate ratio (lowest/highest)	*1.7*	*1.8*	*1.8*	*1.6*	*1.8*	*1.7*
Remoteness[(a)]						
Major cities	71.2	68.3	68.3	585.5	367.9	463.9
Inner regional	71.9	77.0	73.5	482.0	289.4	377.6
Outer regional	78.5	85.1	81.0	437.6	278.0	354.0
Remote	70.0	99.4	83.1	385.8	298.8	342.7
Very remote	90.4	156.5	119.4	470.5	448.8	454.6
Rate ratio (Very remote/Major cities)	*1.3*	*2.3*	*1.7*	*0.8*	*1.2*	*1.0*
Aboriginal and Torres Strait Islander status[(a)]						
Indigenous	158.1	229.3	195.6	889.8	846.9	865.7
Other Australians	71.0	70.2	69.4	542.2	337.1	429.4
Rate ratio (Indigenous/Other Australians)	*2.2*	*3.3*	*2.8*	*1.6*	*2.5*	*2.0*

(a) Age-standardised to the 2001 Australian Standard Population.

Source: AIHW National Hospital Morbidity Database.

Table B3: Acute kidney injury deaths (as the underlying or an associated cause), by sex and selected population characteristics

		Number		
Year(s)	**Population characteristics**	**Males**	**Females**	**Persons**
2012	**Age group (years)**			
	0–64	272	175	447
	65–69	144	106	250
	70–74	214	133	347
	75–79	363	263	626
	80–84	499	441	940
	85 and over	1,063	1,491	2,554
	Total	**2,555**	**2,609**	**5,164**
2012	**Socioeconomic group**			
	Group 1 (lowest SES)	606	587	1,193
	Group 2	564	576	1,140
	Group 3	546	548	1,094
	Group 4	435	451	886
	Group 5 (highest SES)	394	443	837
2008–2012	**Remoteness**			
	Major cities	8,949	9,176	18,125
	Inner regional	2,567	2,390	4,957
	Outer regional	1,098	966	2,064
	Remote	128	108	236
	Very remote	79	77	156
2008–2012	**Aboriginal and Torres Straits Islander status**[(a)(b)(c)]			
	Indigenous	154	180	334
	Non-Indigenous	8,772	8,428	17,200

(a) These data have been adjusted for the additional deaths arising from outstanding registrations of deaths in Queensland in 2010. For more detail, please refer to Technical note 3 in *Causes of death, Australia, 2010* (ABS Cat. no. 3303.0).

(b) The analysis by Indigenous status includes data from NSW, QLD, WA, SA and NT only.

(c) Excludes deaths with no stated information on Aboriginal and Torres Strait Islander status.

Source: AIHW National Mortality Database.

Table B4: Acute kidney injury death rates (as the underlying or an associated cause), by sex and selected population characteristics

		Deaths per 100,000 population		
Year(s)	**Population characteristics**	**Males**	**Females**	**Persons**
2012	**Age group (years)**			
	0–64	2.8	1.8	2.3
	65–69	28.3	20.6	24.4
	70–74	57.7	34.6	45.9
	75–79	135.9	86.1	109.3
	80–84	259.0	174.3	210.9
	85 and over	723.7	545.4	607.7
	Total age-standardised rate[(a)]	*23.2*	*16.2*	*19.2*
2012	**Socioeconomic group**[(a)]			
	Group 1 (lowest SES)	24.8	17.4	20.6
	Group 2	23.3	16.9	19.7
	Group 3	24.7	17.1	20.3
	Group 4	22.0	15.2	18.0
	Group 5 (highest SES)	20.0	13.7	16.4
	Rate ratio (lowest/highest)	*1.2*	*1.3*	*1.3*
2008–2012	**Remoteness**[(a)]			
	Major cities	25.7	17.0	20.6
	Inner regional	23.1	15.2	18.5
	Outer regional	21.7	15.0	17.9
	Remote	21.6	17.1	19.2
	Very remote	27.1	28.9	28.1
	Rate ratio (Very remote/Major cities)	*1.1*	*1.7*	*1.4*
2008–2012	**Aboriginal and Torres Straits Islander status**[(a)(b)(c)(d)]			
	Indigenous	38.6	33.5	35.4
	Non-Indigenous	24.2	15.7	19.2
	Rate ratio (Indigenous/non-Indigenous)	*1.6*	*2.1*	*1.8*

(a) Age-standardised to the 2001 Australian population.

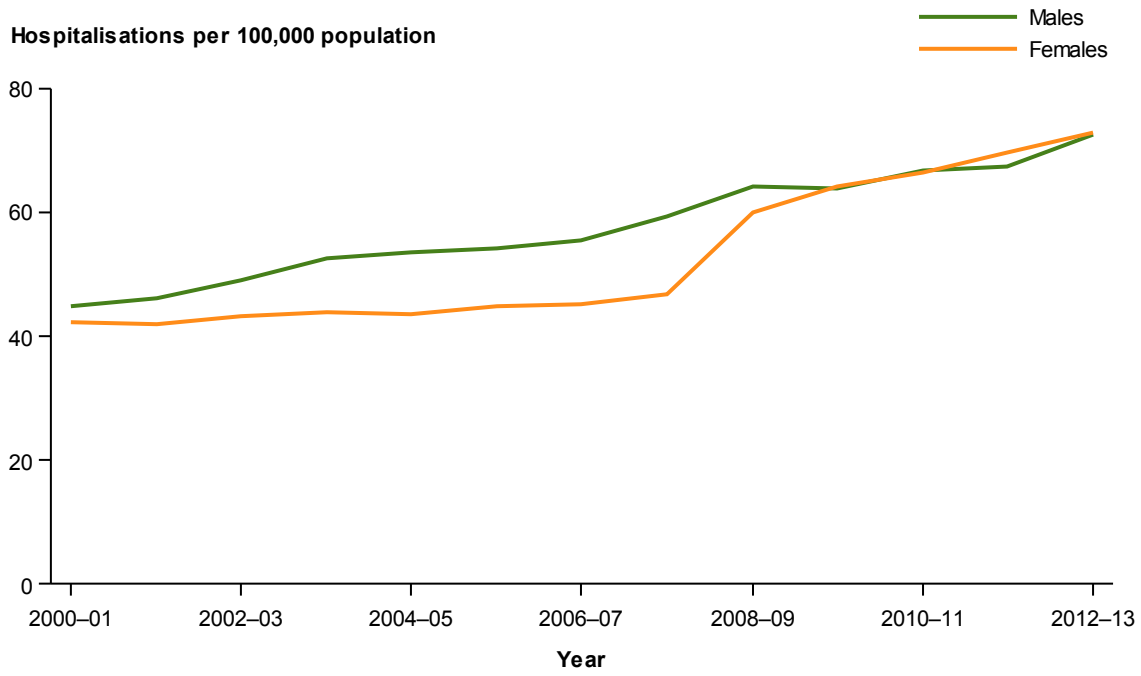
(b) These data have been adjusted for the additional deaths arising from outstanding registrations of deaths in Queensland in 2010. For more detail, please refer to Technical note 3 in *Causes of death, Australia, 2010* (ABS Cat. no. 3303.0).

(c) The analysis by Indigenous status includes data from NSW, QLD, WA, SA and NT only.

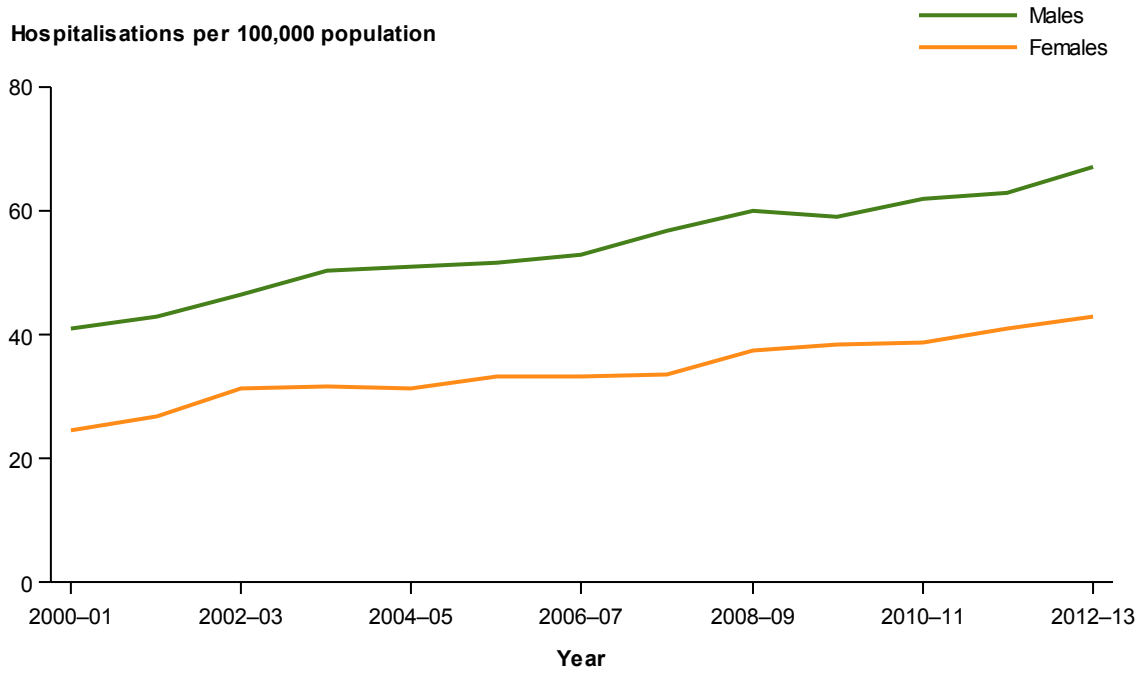
(d) Excludes deaths with no stated information on Aboriginal and Torres Strait Islander status.

Source: AIHW National Mortality Database.

Including acute interstitial nephritis (ICD-10-AM code N10)



Excluding acute interstitial nephritis (ICD-10-AM code N10)



Note: Age-standardised to the 2001 Australian population.

Source: AIHW National Hospital Morbidity Database.

Figure B1: Trends in AKI hospitalisations as the principal diagnosis, including and excluding acute interstitial nephritis (ICD-10-AM code N10), by sex, 2000–01 to 2012–13

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