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Burden of lower limb amputations due to diabetes in Australia

Australian Burden of Disease Study 2011

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Contents

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Abbreviations

ABDS	Australian Burden of Disease Study
ABS	Australian Bureau of Statistics
ACHI	Australian Classification of Health Interventions
AHS	Australian Health Survey
AIHW	Australian Institute of Health and Welfare
ASGS	Australian Statistical Geography Standard
DALY	disability-adjusted life years
ICD-10-AM	International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification
NHMD	National Hospital Morbidity Database
OECD	Organisation for Economic Co-operation and Development
YLD	years lived with disability
YLL	years of life lost

Symbols

≥	greater than or equal to
+	over
%	per cent

Summary

Diabetes is associated with a range of potential complications, including foot ulcers and lower limb amputations. Nearly half of lower limb amputations involve above or below knee amputation; the remainder, which are classified as minor, involve toes or feet (ADS 2008). Diabetic foot ulcers and amputations severely reduce one's quality of life and have major impacts on related health problems, disability and premature death.

This report analyses data from the Australian Burden of Disease Study 2011 to provide information on the amount of non-fatal burden (as measured by years lived in less than full health) due to diabetes-related lower limb amputations in Australia.

In 2012–13, there were 3,570 lower limb amputations provided in hospital to admitted patients with a diagnosis of diabetes.

In 2011, after adjusting for differences in population age structures, the rate of non-fatal burden due to lower limb amputations as a result of diabetes complications was:

- 3 times as high for males as for females
- 4 times as high in the Northern Territory as the national rate
- highest among people living in *Very remote* areas, who experienced rates over 4 times as high as for people living in *Major cities* and *Inner regional* areas
- highest in the lowest socioeconomic group, who experienced a rate 1.8 times as high as that for the highest socioeconomic group
- higher among Indigenous Australians, who experienced a rate 3.8 times as high as that for non-Indigenous Australians.

While there was a marked increase (40%) in diagnosed diabetes prevalence between 2003 and 2011, the proportion of people with diagnosed diabetes who experienced lower limb amputation declined over this period (from 2.4% to 1.7%). This may reflect improved management of diabetes during this period and that people are being diagnosed earlier in their disease progression.

1 Introduction

Diabetes is a major public health challenge in Australia. It is associated with a range of complications and comorbidities requiring hospitalisation and treatment, including heart disease, stroke, kidney disease, peripheral vascular disease, retinopathy (loss of vision), neuropathy and lower limb amputation. Individuals with diabetes have an increased risk of lower limb amputation compared with people who do not have diabetes (Kvitkina et al. 2015).

This report presents key findings from the Australian Burden of Disease Study (ABDS) 2011 on the burden due to lower limb amputation as a result of diabetes in Australia. Lower limb amputation is often referred to in this report as 'amputation' for brevity.

These findings will help to inform policy, service planning and service delivery to promote earlier detection of diabetes-related complications, in line with a number of goals of the Australian Government—in particular, the *Australian National Diabetes Strategy 2016–2020* (Department of Health 2015) Goal 5: 'Reduce the impact of diabetes among Aboriginal and Torres Strait Islander peoples' and Goal 6: 'Reduce the impact of diabetes among other priority groups', for example, Australians living in rural and remote areas.

Assessing rates of lower limb amputation in people with diabetes is complex as there are confounding factors that may influence amputation rates, such as access to health services, disease severity, the level and type of amputation performed and the presence of other comorbidities. Amputations are generally classified as a major amputation (above the ankle) and a minor amputation (limited to the foot) (Font-Jiménez et al. 2016). Nearly half of lower limb amputations involve above or below knee amputation; the remainder are minor, involving toes or feet (ADS 2008).

1.1 How common are amputations?

In 2012–13, there were 4,190 lower limb amputations provided in hospital to admitted patients with a diagnosis of either diabetes or peripheral vascular disease. The majority of these amputations (3,570, or 85%) were provided for patients with diabetes and, of these, 12% also had peripheral vascular disease. These procedures were more common in males (72%; females 28%) and for those aged 65 and over (61%) (AIHW 2014b).

Hospitalisation rates for lower limb amputations remained relatively stable between 2000–01 and 2014–15, fluctuating between 3 and 5 per 1,000 people with diabetes (in 2014–15, the rate was 3 per 1,000 people) (AIHW 2016d).

The Organisation for Economic Co-operation and Development (OECD) reports on the hospitalisation rate for diabetes major lower limb amputation as a health-care quality indicator. In 2012–13, Australia's rate for diabetes major lower limb amputation was 4.5 per 100,000 people, which was lower than the OECD average of 6.4 per 100,000 people (AIHW 2016c; OECD 2015). The indicator measured only the rate of major lower limb amputation in adults with diabetes; the rate for minor amputation was not reported and so full comparisons cannot be made.

Rates of major and minor lower limb amputation were reported in a study undertaken in Western Australia, which examined trends in initial and recurrent lower limb amputations in people with diabetes (Kurowski et al. 2015). Between 2000 and 2010, rates of lower limb amputation in Western Australia declined by around 3% each year in both type 1 and type 2 diabetes groups. This was driven by a reduction in initial major amputations in people with type 2 diabetes. However, the rate of recurrent minor amputations increased considerably in this group, suggesting that timely management of diabetes and other risk factors may help to reduce or prevent major amputations. It should be noted that data from one state may not reflect the national picture.

In light of the rising prevalence of diabetes in Australia (AIHW 2016e), minor and major amputation rates might suggest different views of the same problem. For example, minor amputation rates might reflect rising prevalence of diabetes and the effects of primary prevention of foot ulcers (Kröger 2015). It is understood that minor amputation has an important role in preventing progression of foot disease into major amputation (Kurowski et al. 2015). The number of minor amputations may be reduced by improving primary prevention, such as adequate footwear and foot care, regular foot inspection to identify early ulcers, and adequate control of blood glucose. Major amputation rates might provide insight into the effectiveness of treatment strategies to prevent the deterioration of foot disease. Decreasing rates of major amputation may imply that more people at risk of lower limb amputation are receiving optimal treatment to prevent deterioration (Kröger 2015). Increasing prevalence of diabetes in Australia may lead to higher rates of minor amputations related to diabetes being performed, most of which are preventable (Kurowski et al. 2015) with better disease management.

The *Australian Atlas of Healthcare Variation* (ACSQHC 2015) looked at regional variations in health-care provision across Australia. The average number of hospital admissions for diabetes-related lower limb amputation in 2012–13 varied across states and territories, from 19 per 100,000 people aged 18 and over in Tasmania, to 65 per 100,000 in the Northern Territory (ACSQHC 2015). This may be associated with regional differences in the prevalence rate of diabetes; for instance, a higher prevalence rate of diabetes has been reported in the Northern Territory (Baker IDI Heart & Diabetes Institute 2012). Note that these findings are not comparable with Australian Institute of Health and Welfare (AIHW) data due to a difference in reporting methodology.

In 2000–2008, Norman et al. (2010) reported that nearly all (98%) of the amputations for Indigenous people in Western Australia were associated with diabetes. Among those aged 25–49 with diabetes in Western Australia, the rate of minor amputations for Indigenous people was 27 times as high, and the rate of major amputations for Indigenous people was 38 times as high, as that for the non-Indigenous population of the same age.

1.2 What causes lower limb amputations as a result of diabetes?

Diabetes (see Box 1.1) is associated with a range of complications, including foot disease and lower limb amputations. For people with diabetes, high blood glucose levels can damage the nerves (peripheral neuropathy) and narrow the blood vessels, resulting in poor circulation (peripheral vascular disease) in the lower limbs—causing ischemia, gangrene and impaired wound healing. These complications may lead to foot ulcers and infections and, in the most severe cases, to amputations. Diabetes is the leading cause of non-injury related lower limb amputation (Siitonen et al. 1993; The Global Lower Extremity Amputation Study Group 2000).

Box 1.1 What is diabetes?

Diabetes is a chronic condition marked by high levels of glucose in the blood. It is caused either by the inability to produce insulin (a hormone made in the pancreas to control blood glucose levels) or by the body not being able to use insulin effectively, or both. The main types of diabetes are:

- type 1 diabetes—an autoimmune condition that usually has its onset in childhood or early adulthood but can be diagnosed at any age
- type 2 diabetes—largely preventable, usually associated with lifestyle factors and with later onset
- gestational diabetes—when higher than normal blood glucose is diagnosed during pregnancy (AIHW 2014a).

Gestational diabetes is not considered to lead to amputation as it occurs during pregnancy. While gestational diabetes usually disappears after the baby is born, it can recur in later pregnancies and increases the risk that both the mother and the baby may develop type 2 diabetes later in life.

Risk factors for these forms of nerve damage and poor circulation include duration of diabetes, age, high blood pressure, high blood glucose levels and smoking (Tapp et al. 2003a).

Many people with diabetes who undergo amputation will have a subsequent amputation on the other side within a few years (Schaper et al. 2012), due to underlying vascular disease or neuropathy. Patients may undergo repeat amputation of the same side if the disease progresses along the limb or if the first amputation fails to heal.

Foot ulcers

Peripheral neuropathy and peripheral vascular disease cause the feet to be susceptible to skin damage and are the main predisposing risk factors for foot ulceration (Gale et al. 2008). Further, tissue repair for damaged skin may be impeded in people with peripheral vascular disease, causing infections (Gale et al. 2008). A combination of these risk factors (for example, poor sensation due to peripheral neuropathy, or dry, fragile skin due to peripheral vascular disease) and factors related to person's behaviour (for example, due to ill-fitting shoes, accidental injury to the foot) makes foot ulcers more likely to develop (NICE 2004). It has been reported the majority of lower limb amputations performed in people with diabetes are preceded by an infected, non-healing foot ulcer starting from a minor skin lesion (Moxey et al. 2011; Gale et al. 2008; NICE 2004).

Foot ulcers are common and costly complications of type 2 diabetes and their failure to heal can lead to amputation. Foot ulceration is a leading cause of hospitalisation for people with diabetes (NHMRC, and Baker IDI Heart & Diabetes Institute 2011). It is estimated that 15% of people with diabetes will develop a foot ulcer during their lifetime (NHMRC, and Baker IDI Heart & Diabetes Institute 2011). Timely and effective treatment and management of diabetes and foot care can prevent foot ulcers and, in turn, amputations. Australian and international guidelines on diabetic foot disease recommend that people with diabetes have their feet checked by a podiatrist at least every 12 months, and more frequently for those who also have peripheral neuropathy or peripheral vascular disease (NHMRC, and Baker IDI Heart & Diabetes Institute 2011).

Previous studies have shown that best practice for foot ulcer complications is using multidisciplinary teams, and well-structured and integrated health-care services (Krishnan et al. 2008; Santosa & Kröger 2013). Integrated teams assist people with chronic diseases with their nutrition, medication, self-monitoring and self-management. These strategies may lower the risk for chronic disease complications and reduce amputation rates, particularly for people with diabetes. The development of multidisciplinary foot clinics and streamlined care pathways in secondary and tertiary health-care settings has been associated with reductions in the rates of lower limb amputations (Alvarsson et al. 2012).

1.3 Previous methods used to report on diabetes-related lower limb amputations in Australia

Australian Atlas of Healthcare Variation

The Australian Commission on Safety and Quality in Health Care released the *Australian Atlas of Healthcare Variation* in 2015 (ACSQHC 2015), highlighting variation in health-care provision across Australia. This report included an indicator on hospital admission rates for diabetes-related lower limb amputations for people aged 18 and over across 80 local areas. This was calculated based on hospital episodes of care. In 2012–13, there were 4,402 diabetes-related lower limb amputation admissions to hospital, representing 23 admissions per 100,000 people aged 18 and over. Note that these results are slightly different from those reported by the AIHW in its annual Australian Hospital Statistics publications due to differences in reporting methodologies.

Western Australia

Kurowski et al. (2015) examined trends in initial and recurrent lower limb amputations in people with and without diabetes in Western Australia from 2000 to 2010. This project used linked hospital and mortality data from Western Australia over a 10-year period to identify major, minor, initial and recurrent amputations in people with and without diabetes. It used a look-back period of 15 years to examine prevalent cases of disease (see Section 1.1 for further information).

Australian Burden of Disease Study 2011

The ABDS 2011 included estimates of non-fatal burden (years lived with disability—YLD) for lower limb amputations due to diabetes; this was one of five sequelae (consequences) of diabetes included in the study (see Box 1.2 for more information about burden of disease). Equivalent estimates of fatal burden were not available from the study (these were calculated for total diabetes but not at the sequela level).

The ABDS 2011 captured four complications due to diabetes: diabetic neuropathy, diabetic foot ulcer, lower limb amputation, and vision impairment. The prevalence of these complications was estimated using a combination of data from published and unpublished results from the Fremantle Diabetes Study (Baba et al. 2015; Davis et al. 2012); the Australian Diabetes, Obesity and Lifestyle Study (Tapp et al. 2003a; Tapp et al. 2003b); and the National Hospital Morbidity Database (NHMD). It is acknowledged that there are other diabetes complications not captured in the ABDS 2011. The burden of diabetes-related cardiovascular disease and chronic kidney disease are included under cardiovascular diseases and kidney/urinary conditions, respectively.

In the absence of disease-registry data or national linked hospitalisation data that would allow accurate prevalence estimation of amputations in people with diabetes, the prevalence estimates in the ABDS 2011 used inputs from the NHMD and Western Australian linked hospitalisations and deaths data. The ABDS 2011 is the current preferable data source that measures the impact of amputations in the Australian population. The estimated burden due to lower limb amputation as a result of diabetes complications is presented.

Further information on the data sources used in this report can be found in Appendix A.

Box 1.2 What is burden of disease analysis?

Burden of disease analysis measures the combined impact of living with illness and injury (non-fatal burden) and dying prematurely (fatal burden). More than merely counting deaths and disease prevalence, it takes into account age at death and severity of disease. The summary measure 'disability-adjusted life years' (or DALYs) is used to count the years of healthy life lost from death and illness—1 DALY is equivalent to 1 year of healthy life lost. This measure quantifies the gap between a population's actual health and an ideal level of health in the given year—that is, every individual living in full health for his or her ideal life span—and includes both fatal and non-fatal components.

The non-fatal component is measured using YLD—1 YLD represents 1 year of life lost (due to ill health or disability). YLD measures the number of healthy years of life lost (YLL) due to disease in the reference year. This is calculated by estimating the amount of person-time spent with a condition, multiplied by a disability weight, which indicates the severity of the health loss associated with the condition. Total YLD are influenced by the number of people with each disease, the time spent in less than full health, and the disability weights defined for each disease. The disability weights used in this study were drawn from the Global Burden of Disease Study 2013 (GBD 2013 Collaborators 2015) and represented the health loss caused by the consequences of each disease.

Burden of disease analysis is a standard method for collating data of acceptable quality on causes of health loss to produce an internally consistent measure for all diseases. The health loss from lower limb amputation was measured as a consequence of diabetes. Its non-fatal burden may be small compared with other complications of diabetes (such as diabetic neuropathy). This is partly due to a lower prevalence of diabetes-related amputation and a smaller disability weight applied to this condition when compared with some of the other consequences of diabetes.

2 Findings

2.1 Overall diabetes prevalence

In 2011, it was estimated that about 930,000 Australians had diabetes, which corresponds to 4% of the Australian population (ABS 2013). Of these, 730,000 Australians had diagnosed diabetes and 200,000 had undiagnosed diabetes (see Box 2.1). This section focuses on prevalence results for diagnosed diabetes as there was no burden assigned to undiagnosed diabetes in the ABDS 2011 (see Box 2.1).

In both males and females, diagnosed diabetes prevalence varied by age (Figure 2.1). Diabetes was more prevalent in males than females in most age groups. In males, diabetes prevalence increased steadily to age 60–69, reaching a peak of about 120,000 males, and then decreased. Higher prevalence of diabetes was seen in females than males from age 80 onwards, probably influenced by the relative longevity in females. In females, diabetes prevalence increased with age—however, not as steeply as seen in males—and also peaked at age 60–69 (about 70,000 females).

Box 2.1 How was diabetes prevalence derived in the ABDS 2011?

Diabetes status in people aged 18 and over was derived using biomedical (measured) data from the Australian Health Survey (AHS) (ABS 2014a). This classification included:

- diagnosed diabetes (based on having a reported previous diagnosis of either diabetes and HbA1c ≥6.5%, or of diabetes and on diabetes medication)
- undiagnosed diabetes (based on having HbA1c ≥6.5% but reported no prior diagnosis of diabetes).

For those aged under 18, diabetes prevalence estimates were obtained from the National Diabetes Registry. It was assumed that there were no people with undiagnosed diabetes aged under 18. Undiagnosed diabetes was given an asymptomatic health state, which has a disability weight of 0, and therefore no burden was assigned.

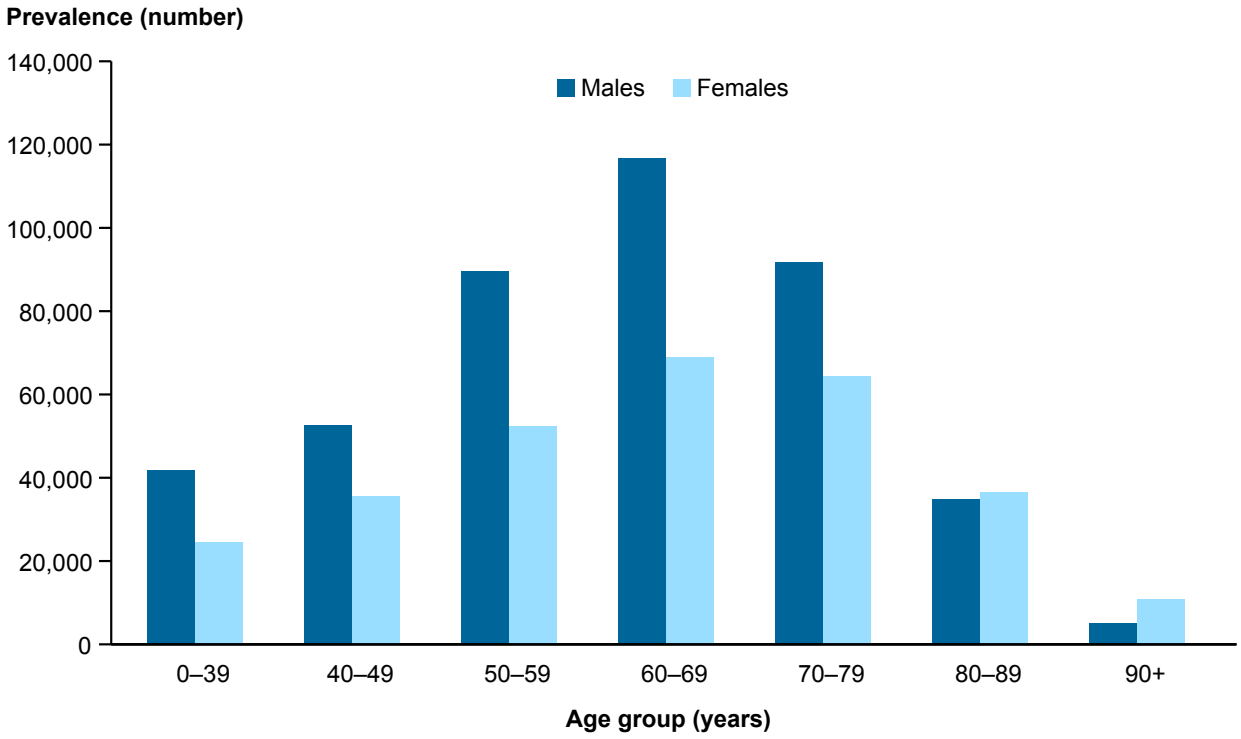
In the AHS, people with diabetes included those with type 1, type 2 and type unknown, and gestational diabetes was not included (ABS 2014a). Note that biomedical estimates in the AHS cannot detect diabetes type. As such, no national survey data are available on diabetes type based on measured data.

Data from the AHS are likely to underestimate the true prevalence of diabetes. This is because many cases remain unreported (due to survey participation) and people do not know or accurately report their diabetes status.

For diagnosed diabetes (since the health surveys before the AHS did not have biomedical components), the 2003 prevalence estimates were modelled using self-reported data from the 2001, 2004–05, 2007–08 National Health Survey and the AHS.

See *Australian Burden of Disease Study 2011: methods and supplementary material* (AIHW 2016b) and *Cardiovascular disease, diabetes and chronic kidney disease: Australian facts: prevalence and incidence* (AIHW 2014a) for detailed information.

Note: HbA1c = glycated haemoglobin.



Source: AIHW burden of disease database 2011.

Figure 2.1: Diagnosed diabetes prevalence, by age and sex, 2011

2.2 Prevalence of diabetes and related complications

There are many diseases and potential complications associated with diabetes. They include cardiovascular disease, cancer, chronic kidney disease, cognitive disorders, peripheral vascular disease and neuropathy (AIHW 2014a). Four complications of diabetes were captured in the ABDS 2011—diabetic neuropathy, diabetic foot ulcer, lower limb amputation and vision impairment—and their prevalence and burden were estimated.

In terms of the prevalence of diabetes, there has been a marked increase (40%) in the number of people diagnosed with diabetes since 2003, from 520,000 people in 2003 to 730,000 in 2011. Of those who had diabetes in 2011, 20% experienced diabetes-related complications. Of these complications, diabetic neuropathy was the most common (70%), followed by diabetic foot ulcer (15%), amputation due to diabetes (9%) and vision impairment due to diabetes (6%).

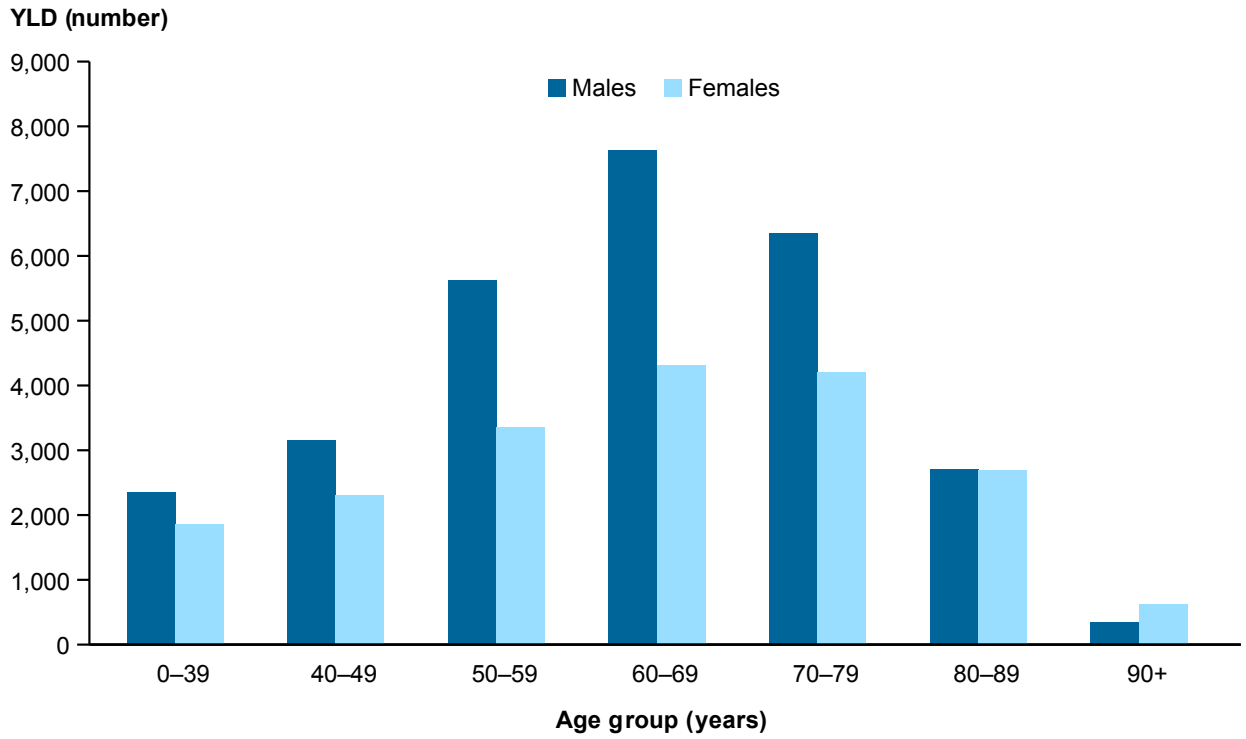
In terms of the prevalence of diabetes-related lower limb amputation, it was estimated that around 1.7% (12,300) of people with diabetes experienced lower limb amputation in 2011, which was a small decrease from the proportion estimated in 2003 (12,600, 2.4%). This may reflect improved management of diabetes during this period, or that people are being diagnosed earlier in their disease progression (those with diagnosed diabetes are less likely to have complications necessitating amputation (Kurowski et al. 2015). As well, reductions in smoking, and better blood pressure and lipids management, have helped to reduce the incidence of peripheral arterial disease and, therefore, consequent lower limb amputation. Future data linkage studies could provide further information on patterns and trends in diabetes-related lower limb amputation in Australia.

2.3 Overall diabetes burden

Diabetes burden refers to the burden from diagnosed diabetes and the four related complications captured in the ABDS 2011—diabetic neuropathy, diabetic foot ulcer, lower limb amputation and vision impairment.

In 2011, diabetes accounted for 2.3% of the total burden of disease and injuries in Australia (AIHW 2016a). Overall, diabetes was the twelfth leading cause of burden, equating to 101,653 DALYs. Around 47% of the diabetes burden was non-fatal, equating to 47,543 YLD.

Diabetes non-fatal burden showed a similar distribution in males and females (Figure 2.2). The burden increased steadily with age and peaked at age 60–69 (males 7,638 YLD; females 4,319 YLD); it was lower in older age groups.



Source: AIHW burden of disease database 2011.

Figure 2.2: Diabetes non-fatal burden (YLD), by age and sex, 2011

2.4 How much burden is caused by diabetes-related lower limb amputations in Australia?

Most of the non-fatal health loss due to diabetes reported in the ABDS 2011 was due to the general impact of diabetes; that is, living with diabetes, rather than from its complications (representing 71% of the total diabetes non-fatal burden in 2011, while its related complications contributed 29%). Health loss experienced as a direct result of diabetes-related lower limb amputation accounted for about 1% of total YLD estimated for diabetes in 2011, accounting for 456 years of healthy life lost due to living with disability (YLD) in Australia. This is equivalent to an age-standardised rate of 1.8 YLD per 100,000 people.

A relatively small proportion of people with diabetes experienced lower limb amputation, which is partly the reason that the YLD contribution is relatively small. It is acknowledged, however, that for these people the cost is huge, both at a personal and a societal level.

As well as lower limb amputation, people with diabetes may experience other complications captured in the ABDS 2011 as direct health consequences of diabetes—that is, diabetic foot ulcer, diabetic neuropathy, and vision impairment due to diabetes. The burden for these complications was also quantified. The estimated health loss from diabetes-related lower limb amputation (456 YLD) was higher than that estimated for foot ulcers (401 YLD) but lower than that for neuropathy (12,465 YLD) and vision impairment (545 YLD).

Rates of non-fatal burden 3 times as high in males

A higher proportion of burden due to diabetes-related lower limb amputation was evident in males (73%) compared with females (27%), with rates 3 times higher for males (Table 2.1).

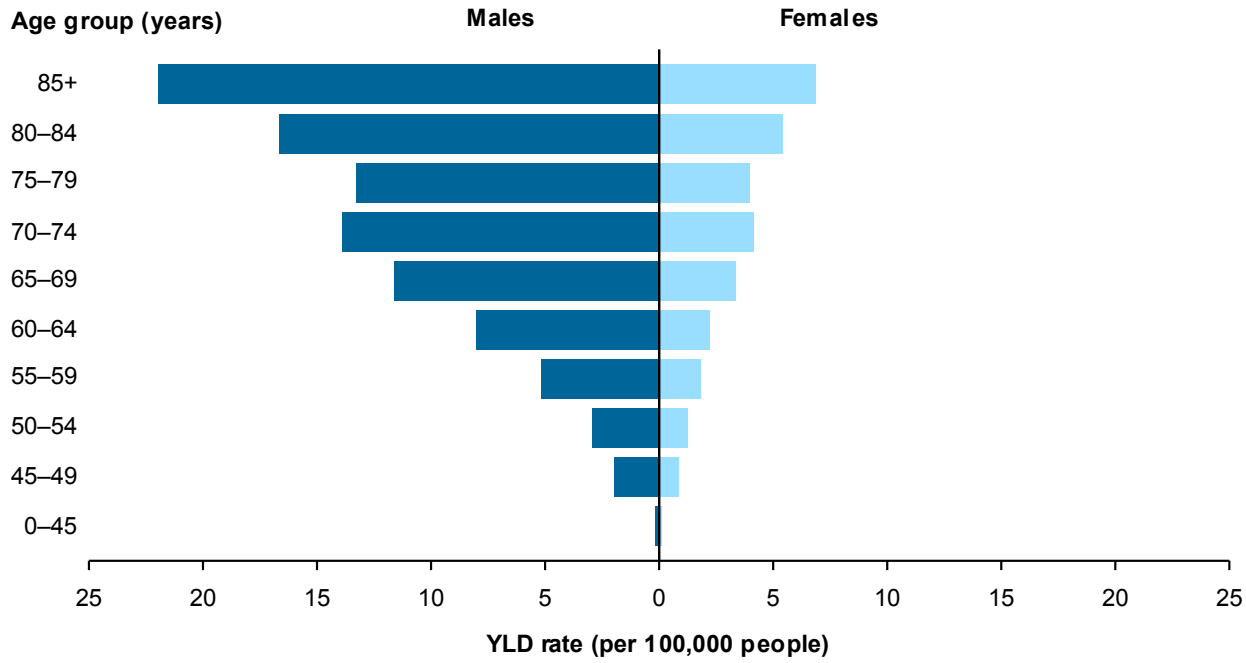
Table 2.1: Diabetes-related lower limb amputation burden by sex, 2011

	YLD			
Sex	**Number**	**%**	**Crude rate**	**Age-standardised rate[(a)]**
Males	332	72.8	3.0	2.9
Females	124	27.2	1.1	0.9
People	**456**	**100**	**2.0**	**1.8**

(a) Rates were age standardised to the 2001 Australian Standard Population and are expressed per 100,000 people.

Source: AIHW burden of disease database 2011.

In both males and females, rates of non-fatal burden due to diabetes-related lower limb amputations generally increased with age (Figure 2.3). Males experienced a higher rate of non-fatal burden than females in all age groups. In males, the rate increased steadily with age, reaching a peak of 22 YLD per 100,000 males in those aged 85 and over. Females experienced a much lower rate of non-fatal burden than males; the rate increased slightly with age—peaking at ages 85 and over (6.8 YLD per 100,000 females).



Source: AIHW burden of disease database 2011.

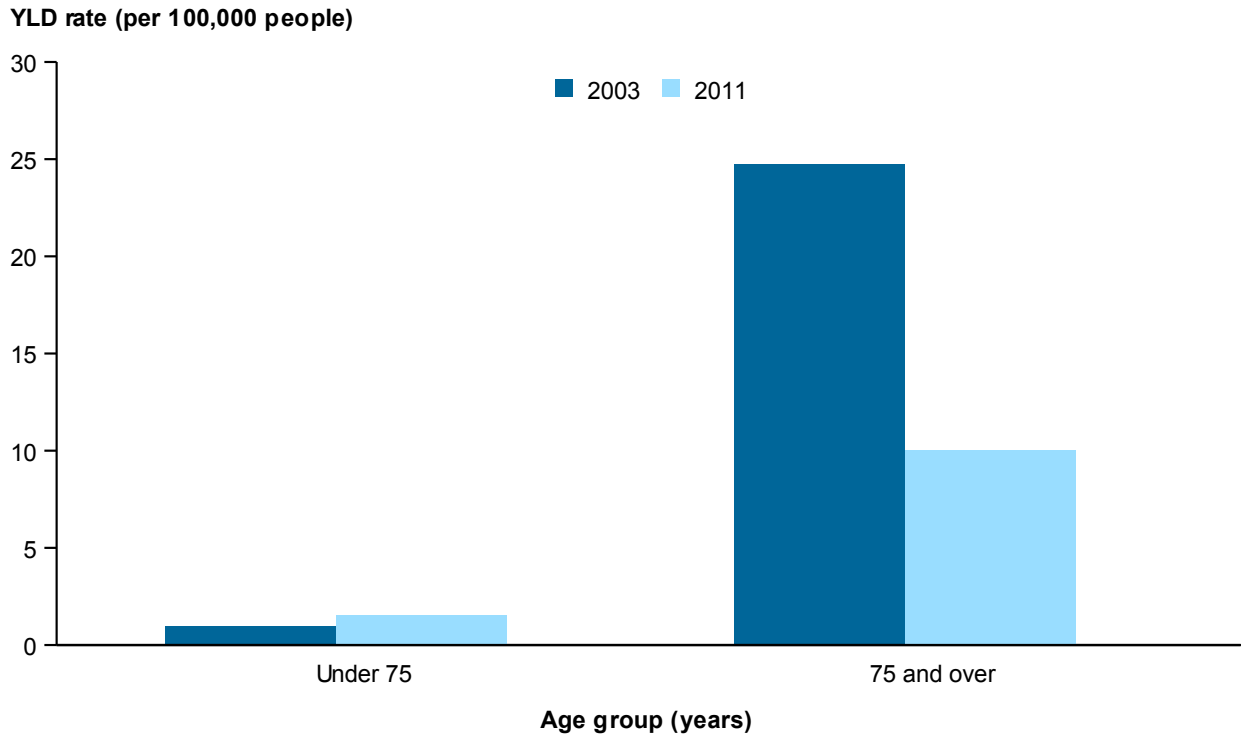
Figure 2.3: Diabetes-related lower limb amputation burden (YLD) rates, by age and sex, 2011

One-fifth decline in non-fatal burden between 2003 and 2011

Overall, the number of years lived in less than full health due to diabetes-related lower limb amputation was similar in 2003 and 2011 (464 YLD and 456 YLD, respectively). However, after taking account of the increasing size and age of the population, there was a small decrease in non-fatal burden between 2003 and 2011 (from 2.3 to 1.8 YLD per 100,000 people).

These estimates mask quite different patterns in the underlying age-specific rates of YLD (Figure 2.4). Rates of non-fatal burden for diabetes-related lower limb amputation were:

- 1.6 times as high in the under 75 age group in 2011 than in 2003 (1.5 and 0.9 YLD per 100,000 people, respectively)
- 60% lower in the 75 and over age group in 2011 than in 2003 (10 and 25 YLD per 100,000 people, respectively).



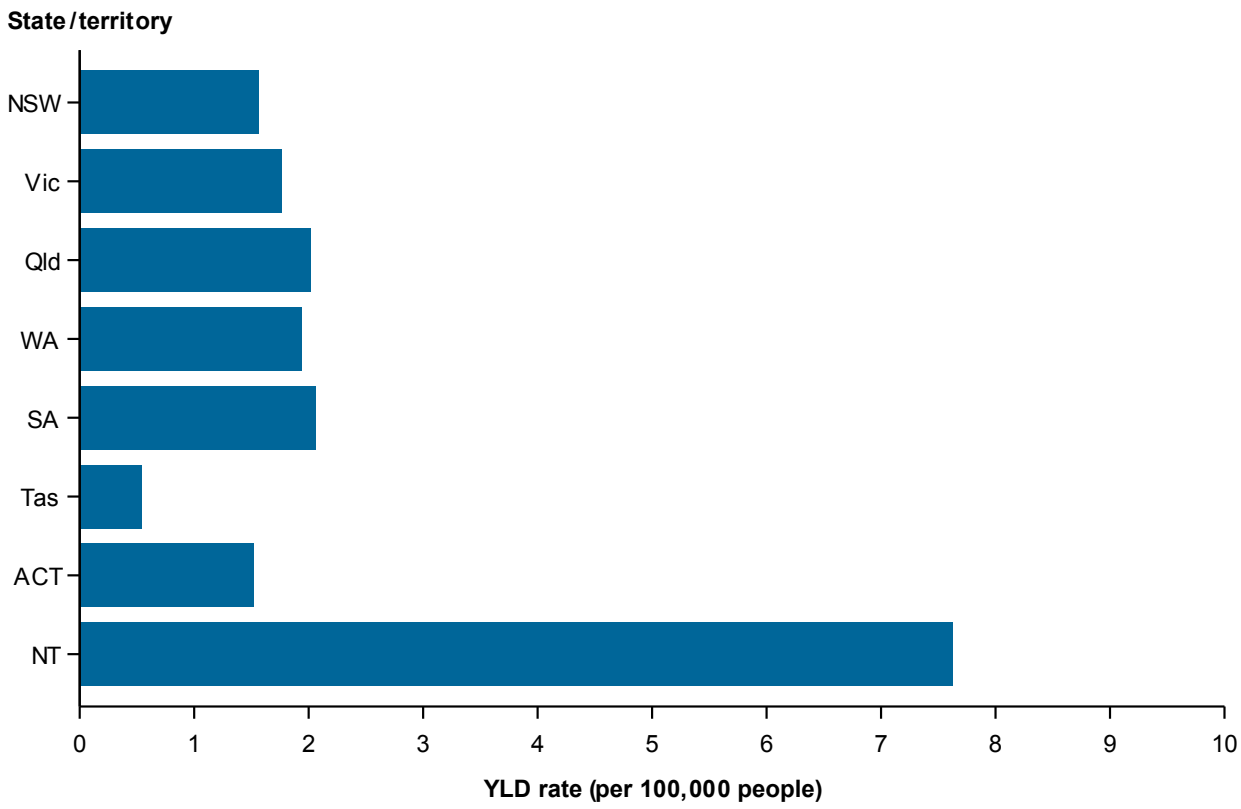
Source: AIHW burden of disease database 2011.

Figure 2.4: Diabetes-related lower limb amputation burden (YLD) rates, by age, 2003 and 2011

2.5 State and territory estimates

In 2011, the age-standardised rate of diabetes-related lower limb amputations ranged from 7.6 YLD per 100,000 people in the Northern Territory (which was about 4 times the national rate) to 0.5 YLD per 100,000 people in Tasmania (Figure 2.5).

State and territory differences largely reflect differences in hospitalisation rates of diabetes-related lower limb amputations. The higher rate for the Northern Territory is also likely to be related to the higher prevalence of diabetes in this region (Baker IDI Heart & Diabetes Institute 2012). This, in turn, reflects the higher proportion of Indigenous Australians living in the Northern Territory who have higher rates of type 2 diabetes than non-Indigenous Australians (AIHW 2014c).



Notes

1. Rates were age standardised to the 2001 Australian Standard Population and are expressed per 100,000 people.
2. NSW = New South Wales, Vic = Victoria, Qld = Queensland, WA = Western Australia, SA = South Australia, Tas = Tasmania, ACT = Australian Capital Territory, NT = Northern Territory.

Source: AIHW burden of disease database 2011.

Figure 2.5: Diabetes-related lower limb amputation burden (YLD) age-standardised rates (per 100,000 people), by state or territory, 2011

2.6 Health inequalities

Social, economic and environmental conditions can strongly influence health. Typically, health varies among different population groups depending on determinants such as geographical remoteness, socioeconomic position and Indigenous status. Some of these are interrelated.

Variations in burden of diabetes-related lower limb amputation between geographic and population groups are shown in Figure 2.6. These have been adjusted for the differing age structure of the population groups. Refer to Appendix B for information on the remoteness area and socioeconomic classifications used.

Indigenous Australians

In 2011, Indigenous Australians experienced much higher rates of burden due to diabetes-related lower limb amputations, at 3.8 times the rate of non-Indigenous Australians (10.8 and 2.8 YLD per 100,000 people respectively).

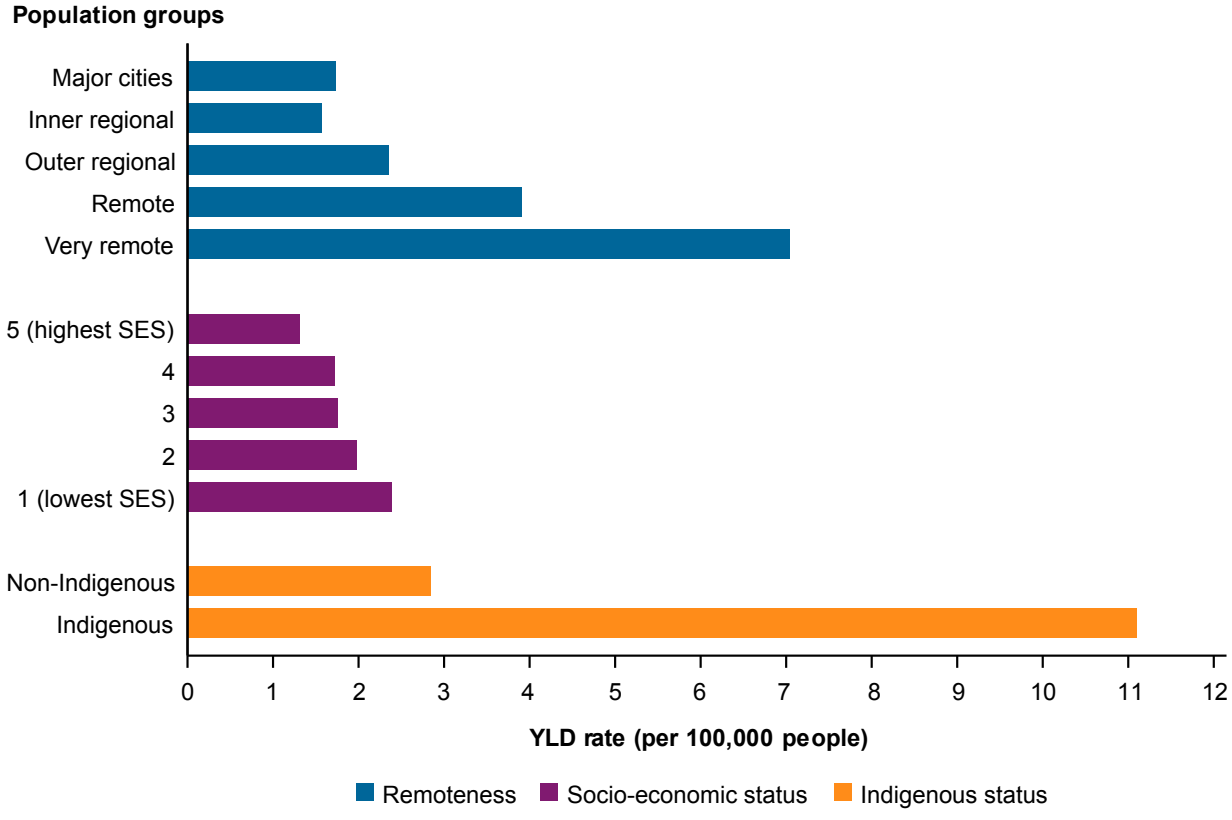
Remoteness

In 2011, the age-standardised rate of non-fatal burden due to diabetes-related lower limb amputations was highest among people living in *Remote* and *Very remote* areas (3.9 and 7.0 YLD per 100,000 people, respectively). It was lowest among people living in *Inner regional* areas and *Major cities* (1.6 and 1.7 YLD per 100,000 people, respectively).

The high burden rates in *Remote* and *Very remote* areas are likely to be influenced by the higher proportion of Indigenous Australians who live in these areas who have higher rates of diabetes and higher rates of burden due to diabetes-related amputations.

Socioeconomic disadvantage

There was a general pattern of increasing burden with lower socioeconomic disadvantage. For example, the highest socioeconomic group had the lowest rate of non-fatal burden due to diabetes-related lower limb amputations (1.3 YLD per 100,000 people), while the lowest socioeconomic group had the highest rate (2.4 YLD per 100,000 people).



Notes

1. Rates were age standardised to the 2001 Australian Standard Population and are expressed per 100,000 people.
2. SES = socioeconomic status group.

Source: AIHW burden of disease database 2011.

Figure 2.6: Diabetes-related lower limb amputation burden (YLD) age-standardised rates (per 100,000 people), by remoteness, socioeconomic status and Indigenous status, 2011

3 Future directions

3.1 What is missing from the picture?

Lower limb amputations are not coded as an underlying cause of death in the National Mortality Database as they relate to procedures. It is the disease or condition that initiated the sequence of events resulting in death that is captured in the data; hence deaths resulting from amputation cannot be identified. In the ABDS 2011, any such deaths were counted under diabetes at the disease level (that is, diabetes). Hence, there are no fatal (YLL) estimates available from the ABDS 2011 that are specific to amputations due to diabetes.

The burden estimates reported in this report for lower limb amputations cannot be disaggregated into type 1 or type 2 diabetes. This could potentially be done in future analysis, using linked hospitalisation data for each type of diabetes associated with lower limb amputation.

As part of the ABDS 2011, the AIHW has developed a system that will allow estimates of burden of disease in Australia to be updated and kept current with emerging information. This offers potential to monitor and update the estimates included in this report.

3.2 Future work planned

Currently, without data linkage, there are no national data sources that can be used to precisely measure the prevalence of diabetes-related lower limb amputations in Australia. AIHW publications and some studies have measured the incidence of amputation based on hospital admission data or observational studies (AIHW 2014b, 2016a; Davis et al. 2006), and a modelled estimate of prevalence was used as part of the ABDS 2011. Nationally linked hospitalisation data at the person level and its potential linkage to other disease registers would enable more accurate prevalence information to be reported in the future. Methods involving linked hospitalisation data and other potential data sources on lower limb amputation as a result of diabetes and cardiovascular diseases are currently being explored at the AIHW.

Appendix A: Data collection

How was the burden of disease estimates derived for diabetes-related lower limb amputations?

The ABDS 2011 included estimates of non-fatal burden (years lived with disability, or YLD) for lower limb amputations due to diabetes—one of five sequelae (consequences) of diabetes included in the study. Other sequelae included diagnosed diabetes, diabetic neuropathy, diabetic foot ulcer and vision impairment due to diabetes. Estimates by age group, sex, and population groups (Indigenous Australians, state/territory, remoteness, socioeconomic group) are available for analysis.

The prevalence of amputations due to diabetes was estimated using data from the NHMD and Western Australian linked hospitals and deaths data. The NHMD counts episodes of care and not individuals; as a result, multiple hospitalisations for the same event are counted more than once. Hence, Western Australian linked data were used to adjust the count of separations from the NHMD to better estimate prevalence for persons. This was done by applying separation: patient ratios by 5-year age group and sex derived from the Western Australian linked data to national hospital separations from the NHMD.

Indigenous estimates were calculated using the same methods, with hospital separations adjusted for Indigenous under-identification using standard adjustment factors from the AIHW 2010–12 Indigenous hospital separations data quality study (AIHW 2013).

From the NHMD, an amputation was determined to be related to diabetes if there was a principal or additional diagnosis of diabetes accompanying that amputation hospitalisation. The amputation had to be a lower limb amputation; that is, it had to have at least one of the following the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision, Australian Modification* (ICD-10-AM) procedure codes: 4436701, 4436702, 4433800, 4435800, 9055700, 4436100, 4436400, 4436401, 4436101, 4437000, 4437300 and 4436700.

Australian Burden of Disease Study 2011

The ABDS 2011 provides Australian-specific burden of disease estimates for the Australian population and the Aboriginal and Torres Strait Islander population for 2011 and 2003. The study uses and adapts the methods of global studies to produce estimates that are more relevant to the Australian health policy context.

The 2011 reference year was chosen as this was the latest year of data available for most of the key mortality and morbidity data sources used in the study at its start.

Results from the ABDS 2011 provide an important resource for health policy formulation, service planning and population health monitoring, including the gap between Indigenous and non-Indigenous health. The results provide a foundation for further assessments, such as in relation to health interventions that aim to prevent or treat diabetes and its complications, and disease expenditure.

Non-fatal burden (YLD) estimates in the ABDS 2011 are based on prevalent cases—that is, the number of people who have lower limb amputation at a given point in time. YLD are calculated from the *point prevalence* (the number of people experiencing health loss from the condition on a given day) multiplied by a *disability weight* (which reflects the severity of the disease). Hence, YLD should be interpreted as the total number of years spent in less than full health by the population in the reference year (2011), weighted according to the health loss associated with the disease.

The disability weights used in the ABDS 2011 were drawn from the Global Burden of Disease Study 2013 (GBD 2013 Collaborators 2015) and represented the health loss caused by the consequences of each disease.

Data quality

Burden estimates reported were extracted from the AIHW burden of disease database. Information on the quality of estimates included in this report can be obtained from *Australian Burden of Disease Study 2011: methods and supplementary material* (AIHW 2016b).

Australian Classification of Health Interventions

The Australian Classification of Health Interventions (ACHI) is Australia's intervention classification and is used in conjunction with ICD-10-AM to code interventions. Procedure codes used in this report are from the ACHI. The National Centre for Classification in Health issues new editions of ICD and ACHI codes every 2 years.

The data in this report were extracted from the procedures recorded using the 7th edition of the ACHI (NCCH 2010). The ACHI classification is divided into 20 chapters by anatomical site. These subchapters are further divided into more specific procedure blocks, ordered from the least invasive to the most invasive. The blocks, which are numbered sequentially, group the very specific procedure information. Procedures for diabetes related lower limb amputation are presented based on the ACHI procedure block: 1484, 1533 and part of 1505. See *Australian hospital statistics 2012–13* (AIHW 2014d) for more information.

Appendix B: Statistical notes and methods

Age-specific rates

Age-specific rates provide information on the incidence of a particular event in an age group relative to the total number of people at risk of that event in the same age group. It is calculated by dividing the number of events occurring in each specified age group by the corresponding 'at risk' population in the same age group, and then multiplying the result by a constant (for instance, 100,000) to derive the rate.

Age-standardised rates

Standardisation is a technique used to enhance the comparability of data from different populations or time periods by adjusting for the confounding effects of compositional differences in structure between the populations or subpopulations being compared (Earyes 2008). Age-standardised rates facilitate comparisons between population subgroups where the age distribution varies (for factors such as remoteness, socioeconomic status and Indigenous status), and for analysis over time). This standardisation process effectively removes the influence of age structure on the summary rate.

This report uses the direct method of standardisation, whereby standardised rates are derived by applying the specific rates observed in the study population to a single standard population. The Australian population at 30 June 2001 (ABS 2013) was used for all age-standardisation analyses in this report. Five-year age groups were used for all age-standardisation analyses, with an upper age group of 100 and over (except for analysis by remoteness area, socioeconomic status and Indigenous status, which used 85 and over).

The calculation of direct age-standardised rates consists of three steps:

1. calculate the age specific rate for each age group
2. calculate the expected number of cases in each age group by sex by multiplying the age specific rates by the corresponding standard population for each age group
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.

Estimated Resident Populations

Population data were used to derive rates of amputation burden. Population data held by the AIHW are sourced from the Australian Bureau of Statistics (ABS) and are updated as revised or new estimates become available. All population estimates currently produced by the ABS are based on usual residence; that is, where people usually reside. These Estimated Resident Populations are derived from the ABS Census of Population and Housing, and adjusted for deaths, births and net migration. The Estimated Resident Populations are based on the 2011-based population estimates for 2000–2011 (final and recast estimates).

Australia's Aboriginal and Torres Strait Islander population is calculated from the Census. However, because of the smaller Indigenous population, it is difficult to measure population changes accurately between Census years using the method described above. Therefore, the ABS developed experimental estimates and projections based on the 2011 Census. Calculations of rates for Aboriginal and Torres Strait Islander people used the ABS estimated resident Aboriginal and Torres Strait Islander population for 2011 (ABS 2014b).

Australian Statistical Geography Standard

Geographic location was classified according to the ABS's Australian Statistical Geography Standard (ASGS) 2011 Remoteness Areas; this standard groups geographic areas into categories, which are defined using the Accessibility/Remoteness Index for Australia. This index is a measure of the remoteness of a location from the services provided by large towns or cities. Accessibility is judged purely on distance to one of the metropolitan centres, so it provides a relative indication of how difficult it might be for residents to access certain services, such as health care and education. The categories used in this publication are:

- *Major cities*
- *Inner regional*
- *Outer regional*
- *Remote and Very remote*.

Estimates by remoteness were derived by applying 2011 ASGS remoteness areas to the Statistical Area Level 2 recorded in hospital separations data.

Index of Relative Socio-Economic Disadvantage

Socioeconomic classifications were based on the ABS Index of Relative Socio-Economic Disadvantage. Geographic areas are assigned a score based on attributes such as low income, low educational attainment, high unemployment, and jobs in relatively unskilled occupations. The index score does not refer to the socioeconomic situation of a particular individual; rather, it refers to the area in which a person lives. A low index score means an area has more low-income families, has people with little training and high unemployment, and may be considered disadvantaged relative to other areas with higher scores. Areas with high index scores may be considered less disadvantaged relative to other areas. It is important to note that high scores reflect a relative lack of disadvantage, rather than advantage, and that the Index of Relative Socio-Economic Disadvantage relates to the average disadvantage of all people living in a geographic area. It cannot be presumed to apply to all individuals living within the area.

Five population-based socioeconomic groups (fifths), based on the level of the index, were applied to the Statistical Area Level 2 recorded in hospital separations data. The first socioeconomic status group (quintile 1) corresponds to geographical areas that contain the 20% of the population living in the area with the most disadvantaged socioeconomic status; the fifth group (quintile 5) corresponds to the 20% of the population living in areas with the least disadvantaged socioeconomic status. This approach ensures that, regardless of the underlying geographical unit, approximately 20% of the population is allocated to each quintile.

Key terms

age-specific rates: Age-specific rates provide information on the incidence of a particular event in an age group relative to the total number of people at risk of that event in the same age group (see Appendix B for further information on age-specific rates).

age-standardised rate: A rate that removes the effect of differences in the age and size of a population when comparing population groups over time. It is usually expressed per 1,000 or per 100,000 people. Rates in this report have been standardised to the Australian population as at 30 June 2001 and are generally expressed per 100,000 people (see Appendix B for further information on age standardisation).

crude rate: A crude rate is the number of a particular event—in this report, healthy life lost due to living with disability (YLD)—relative to the total number of people in the population or subpopulation of interest, expressed per 100,000 people.

disability-adjusted life years (DALYs): A measure (in years) of healthy life lost, either through premature death—defined as dying before the expected life span (YLL)—or, equivalently, through living with ill health due to illness or injury (YLD).

disability weight: A factor that reflects the severity of health loss from a particular health state on a scale from 0 (perfect health) to 1 (equivalent to death).

incidence: The number of new cases (of an illness or event) occurring during a given period.

prevalence: The number of cases of a disease or injury in a population at a given time. The 'prevalence rate' is the number of cases existing at a point in time (point prevalence) or over a specified time period (period prevalence).

type 1 diabetes: An autoimmune condition that usually has its onset in childhood or early adulthood but can be diagnosed at any age.

type 2 diabetes: A chronic condition characterised by insulin resistance and/or insufficient production of insulin; it is the most common form of diabetes, usually occurring in older adults but can also occur in adolescents and children.

remoteness: A system that classifies geographical locations into groups (*Major cities*, *Inner regional*, *Outer regional*, *Remote*, *Very remote*) according to distance from major population centres and services. Remoteness is a geographical concept and does not take account of accessibility, which is influenced by factors such as the socioeconomic status or mobility of a population.

socioeconomic status: A status defined by the Australian Bureau of Statistics' Socio Economic Indexes for Areas (SEIFA), whereby areas are classified on the basis of social and economic information collected in the Census of Population and Housing. In this report, the SEIFA Index of Relative Socio-Economic Disadvantage was 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.

years lived with disability (YLD): A measure of the years of what could have been a healthy life but were instead spent in states of less than full health. YLD represent non fatal burden.

years of life lost (YLL): A measure of the years of life lost due to premature death, defined as dying before the ideal life span. YLL represents fatal burden.

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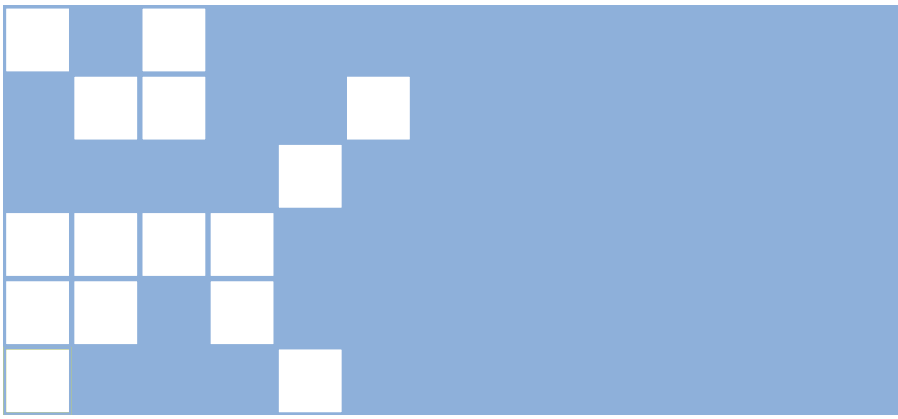
Where to find out more

This report, *Burden of lower limb amputations due to diabetes in Australia*, and other AIHW publications can be downloaded for free from the AIHW website <http://www.aihw.gov.au>.

The following related AIHW publications might also be of interest:

- *Australian Burden of Disease Study: impact and causes of illness and death in Australia 2011* (AIHW 2016a).
- *Australian Burden of Disease Study 2011: methods and supplementary material* (AIHW 2016b).
- *Cardiovascular disease, diabetes and chronic kidney disease: Australian facts: prevalence and incidence* (AIHW 2014a).
- *Cardiovascular disease, diabetes and chronic kidney disease: Australian facts: morbidity—hospital care* (AIHW 2014b).



The Australian Burden of Disease Study (ABDS) 2011 captured four complications of diabetes—diabetic neuropathy, diabetic foot ulcer, lower limb amputation, and vision impairment—and their prevalence and burden were estimated. This report presents findings from the ABDS on the burden of diabetes-related lower limb amputations in Australia.

In 2011, it was estimated that about 730,000 Australians had diagnosed diabetes, 1.7% (12,300) of whom experienced lower limb amputation. The health loss experienced as a direct result of diabetes-related lower limb amputation accounted for about 1% of total non fatal burden estimated for diabetes in 2011. This represented 456 years of healthy life lost due to living with disability in Australia.