1 Overview

This chapter addresses the broad range of issues related to diabetes[3] epidemiology, risk factors and complications. It provides a brief overview of the disease, including its possible causes, and its impact in terms of morbidity, mortality and health care costs. The chapter aims to provide background information critical to the development of strategies for diabetes prevention and management.

1.1 Background

Diabetes is a chronic disease, characterised by hyperglycaemia or high levels of glucose, which is caused by deficient insulin production and/or resistance to its action. It is the seventh leading cause of death in Australia, and contributes significantly to morbidity, disability, poor quality of life and loss of potential years of life. Over the course of the disease, diabetes can lead to a variety of complications including heart disease, stroke, blindness, kidney problems and lower limb amputations (AIHW & DHFS 1997). Diabetes can also lead to pregnancy-related complications, both for the mother and the foetus or newborn baby.

The incidence and prevalence of diabetes are rising worldwide. According to the WHO, there will be an estimated 300 million people with diabetes in the year 2025, a large proportion in countries with limited opportunity for its management and control (King et al 1998). The progressive ageing of the population means that a growing number of people are at increased risk of diabetes. Risk factors such as obesity, inappropriate nutrition and physical inactivity are also increasingly unmasking susceptibilities to the disease, even in non-industrialised communities (Bhatia et al 1984; King et al 1985).

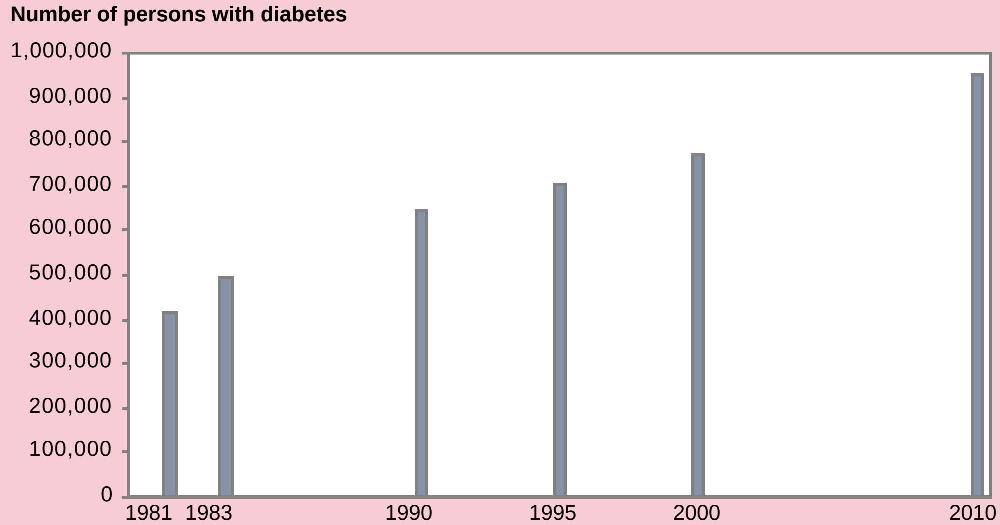
The rise and rise of diabetes has also been observed in Australia (McCarty et al 1996). According to a conservative estimate by the International Diabetes Institute, an estimated 700,000 Australians (about 4 per cent of the total population) had diagnosed or undiagnosed diabetes in 1995 (Amos et al 1997). The number has almost doubled since the early 1980s, and is projected to rise to 770,000 by the year 2000 and to 950,000 by 2010 (see Figure 1.1). Unless effective prevention strategies are put into place, the figure will pass one million over the next 15 to 20 years. The disease is much more prevalent among some Australian communities, in particular the Indigenous population and people of Asian/Pacific Islander descent (McGrath et al 1991; Strong et al 1998a).

Diabetes and its complications are a sharply increasing component of health care costs, and this is likely to continue to increase as the population ages further. For 1993–94 alone, the direct costs of diabetes and its complications are estimated to be $681 million (Mathers & Penm 1999). This figure does not include indirect costs, such as lost productivity and premature mortality.

Diabetes and its associated complications compromise the quality of life of many Australians. However, there is now evidence that tight control of glucose, lipids and blood pressure levels is effective in preventing diabetes-associated complications in both Type 1 (DCCT Research Group 1996a) and Type 2 diabetes (UKPDS Group 1998a; 1998b; 1998c). Early detection and effective management are therefore the keys to diabetes control. While improved detection of the disease may add to disease costs in the short term, the total costs are likely to stabilise or fall with earlier diagnosis and prevention of complications.

3 Unless otherwise noted, the term diabetes refers to diabetes under code 250 of the International Classification of Disease, 9th Revision (WHO 1977).

Figure 1.1: Estimates and projections of diabetes prevalence in Australia, 1981–2010



Note: Estimates and projections include both diagnosed and undiagnosed diabetes.

Sources: Based on data from Amos et al (1997); McCarty et al (1996).

1.2 Types of diabetes

Because the common feature of diabetes is elevated blood glucose concentration, in the past it was considered to be a single disease. However, it is now clear that diabetes is a heterogeneous metabolic abnormality caused by many different mechanisms. Four major types of diabetes are commonly recognised (Alberti & Zimmet 1998). In addition, impaired glucose tolerance defines a level of blood glucose catabolism that is intermediate between normal and diabetes.

Type 1 diabetes. One of the most common chronic conditions of childhood (although about half of all new cases are among adults), Type 1 diabetes is characterised by a complete deficiency of insulin, the hormone that metabolises glucose. The clinical onset of Type 1 diabetes is usually quite sudden, but may be gradual in adults and in some children. People with Type 1 diabetes require insulin therapy for glycaemic control to survive, the condition is therefore also termed *insulin-dependent diabetes mellitus or IDDM*. Usually an autoimmune disease — a condition in which the immune system attacks its own tissues — the development of Type 1 diabetes may also be idiopathic.

Type 2 diabetes. One of the common chronic diseases among people 40 years and over, Type 2 diabetes is characterised by relative insulin insufficiency or resistance to its action. People with this form of diabetes do not usually require insulin to survive, hence it is also known by the term *non-insulin-dependent diabetes mellitus or NIDDM*. The pathogenetic mechanisms of Type 2 diabetes are not fully understood. However, it appears to be a two-stage process; resistance to insulin action that often is exacerbated by obesity, followed by inability of the β cells in the pancreas to produce adequate amounts of insulin (Bishop et al 1993).

Some of the characteristics that distinguish Type 1 and Type 2 diabetes are described in Table 1.1.

Table 1.1: Characteristics of Type 1 and Type 2 diabetes

Type 1 diabetes

- Most commonly appears under age 40, but can appear at any age
- Results from the destruction of insulin-producing pancreatic β cells
- Absolute insulin deficiency — insulin required for survival
- Abrupt onset of severe symptoms, but the clinical picture may develop slowly in some cases
- Proneness to ketoacidosis
- Strong association with human leucocyte antigens

Type 2 diabetes

- Appears primarily in adults, but can present at any age
- Can be asymptomatic for many years
- Associated with obesity, but can also develop in non-obese people
- Many people with Type 2 diabetes exhibit insulin resistance, hyperinsulinaemia, hypertension or dyslipidaemia
- Limited dependence on exogenous insulin, and not ketoacidosis prone
- The need to follow a careful diet and exercise regimen
- Complex aetiology and pathophysiology
- High heritability, but no strong association with known genetic markers

Gestational diabetes. About 4–6 per cent of women not previously known to have diabetes develop hyperglycaemia during pregnancy. Women with known diabetes who become pregnant do not fall into this category. In most cases of gestational diabetes, the hyperglycaemia resolves soon after the delivery; however, in some cases, especially among those from high-risk population groups, it may continue, leading to a diagnosis of diabetes. Gestational diabetes carries health risks for the infant, and even when the mother's blood glucose levels return to normal after the pregnancy, the mother remains at high risk of developing diabetes later in life.

Other types of diabetes. This category is uncommon, and includes diabetes caused by a variety of distinct genetic and pathological mechanisms that are generally clearly defined.

1.3 Disease incidence and prevalence

There are no national estimates of the incidence or prevalence of diabetes in Australia that are based on blood glucose testing. However, the Australian Bureau of Statistics (ABS) has generated national information on self-reported prevalence of diabetes through its National Health Surveys (NHS).

Overview

According to the NHS conducted in 1995, nearly 430,700 persons (2.4 per cent of the total population) reported having had diabetes at some time during their lives. More than 80 per cent of this group of people reported current diabetes. A further 225,000 persons (1.2 per cent of the population) reported high blood glucose levels (ABS 1997a).

These figures are considered to be significant underestimates for two reasons:

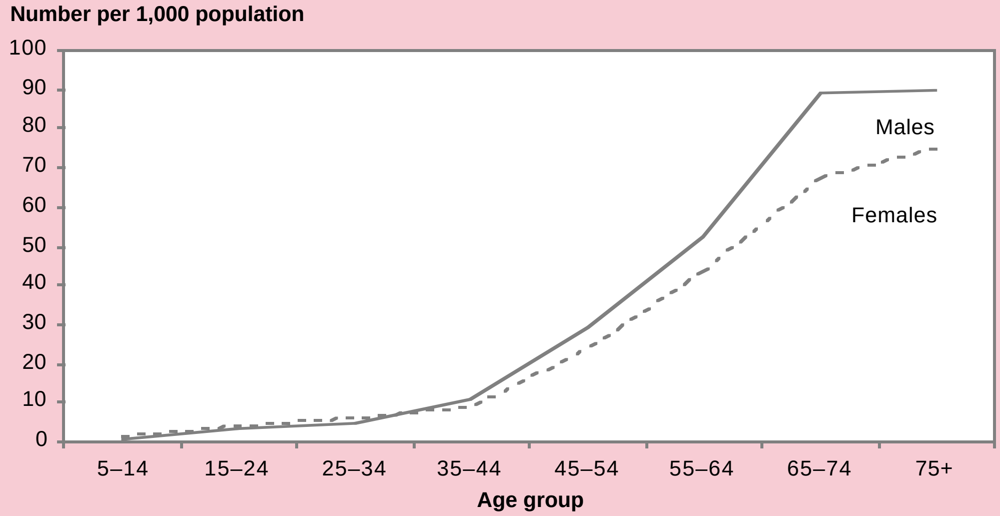
- since the estimate is based on self reporting, the true prevalence of diagnosed diabetes is more likely to be under-reported; and
- a large proportion of diabetes in the community remains undiagnosed.

It has been estimated that for each known case of Type 2 diabetes, there may be at least one person in the population whose diabetes has not been diagnosed. Using this ratio as the correction factor, a revised estimate is that around 4 per cent of the population (nearly 700,000 persons) had diabetes in 1995 (Amos et al 1997). This estimate is supported by several regional studies that also suggest a prevalence rate of between 3 and 5 per cent (McCarty et al 1996).

Age-specific prevalence

The prevalence of diabetes increases with age, from 1 per 1,000 persons among those aged less than 15 years to 89 per 1,000 persons among those aged 75 years and over. The prevalence increases in a similar fashion in both sexes up to the age of 40 years. From then on, the prevalence rate increase is faster in both sexes, but considerably more so among males, being almost one-third higher in the 65–74 year age group (Figure 1.2).

Figure 1.2: Age-specific prevalence of diabetes by sex, Australia, 1995



Note: Rates are based on self-reported diabetes.

Source: ABS (1997b).

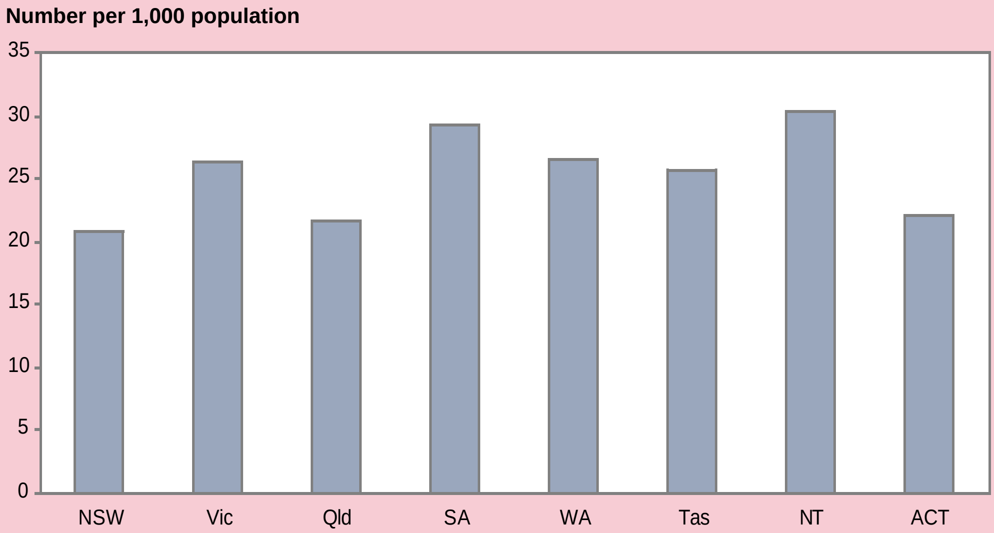
Type 1 diabetes is the dominant form of the disease in age groups to 34 years; in older age groups Type 2 becomes the major form.

Regional variation

There is significant regional variation in the prevalence of diabetes in Australia (Figure 1.3). The age-standardised prevalence for the Northern Territory is around 50 per cent higher than the rate for New South Wales. This probably reflects the Northern Territory's much larger proportion of Indigenous people, among whom Type 2 diabetes is highly prevalent.

Several community studies on diabetes in Australia have revealed regional variations in the prevalence of diabetes (McCarty et al 1996). Substantial variation has also been noted in associated complications and mortality.

Figure 1.3: Regional variation in the prevalence of diabetes, Australia, 1995



Note: Age-standardised rates based on self-reported diabetes.

Source: ABS (1997b).

Disease prevalence by type of diabetes

There are no national estimates of the relative distribution of the various forms of diabetes, but figures have been derived from self-reported information from the 1995 NHS (ABS 1997b). According to these derived estimates, 12 per cent of all those reporting current diabetes have Type 1 and 88 per cent have Type 2 diabetes (ABS 1997b).

Type 1 diabetes

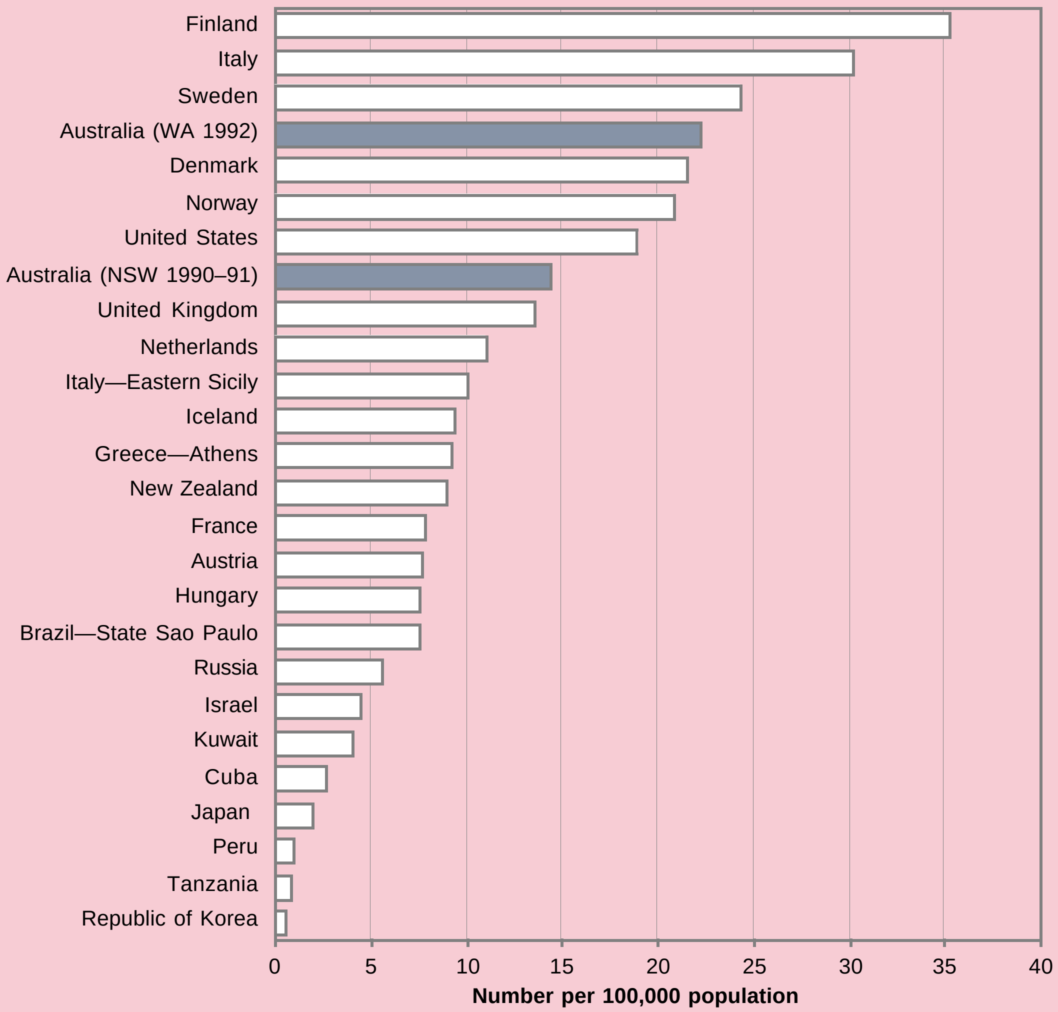
Although the incidence of Type 1 diabetes is significantly lower than that of Type 2 diabetes, the former accounts for a high proportion of existing cases because of its peak onset much earlier in life. Based on the 1995 NHS self-reported information (ABS 1997b), around 42,600 persons — with an estimated prevalence rate of around 218 per 100,000 persons — are estimated to have Type 1 diabetes.

Estimates from regional studies indicate that the incidence of Type 1 diabetes ranges from 12 to 15 per 100,000 persons among those younger than 15 years. The prevalence estimates vary from 59 to 74 per 100,000 among those in the age range 0 to 19 years (McCarty et al 1996).

Overview

Significant inter-population variation exists in the incidence of Type 1 diabetes (Karvonen et al 1993). No information is available on the disease incidence and prevalence among population groups currently resident in Australia. However, the disease is relatively uncommon in source countries of people of non-European descent (Figure 1.4). When present, it is more often of the idiopathic rather than the autoimmune type.

Figure 1.4: Incidence of Type 1 diabetes — international comparisons



Note: Ages 0–14 years.

Source: Based on data from Karvonen et al (1993).

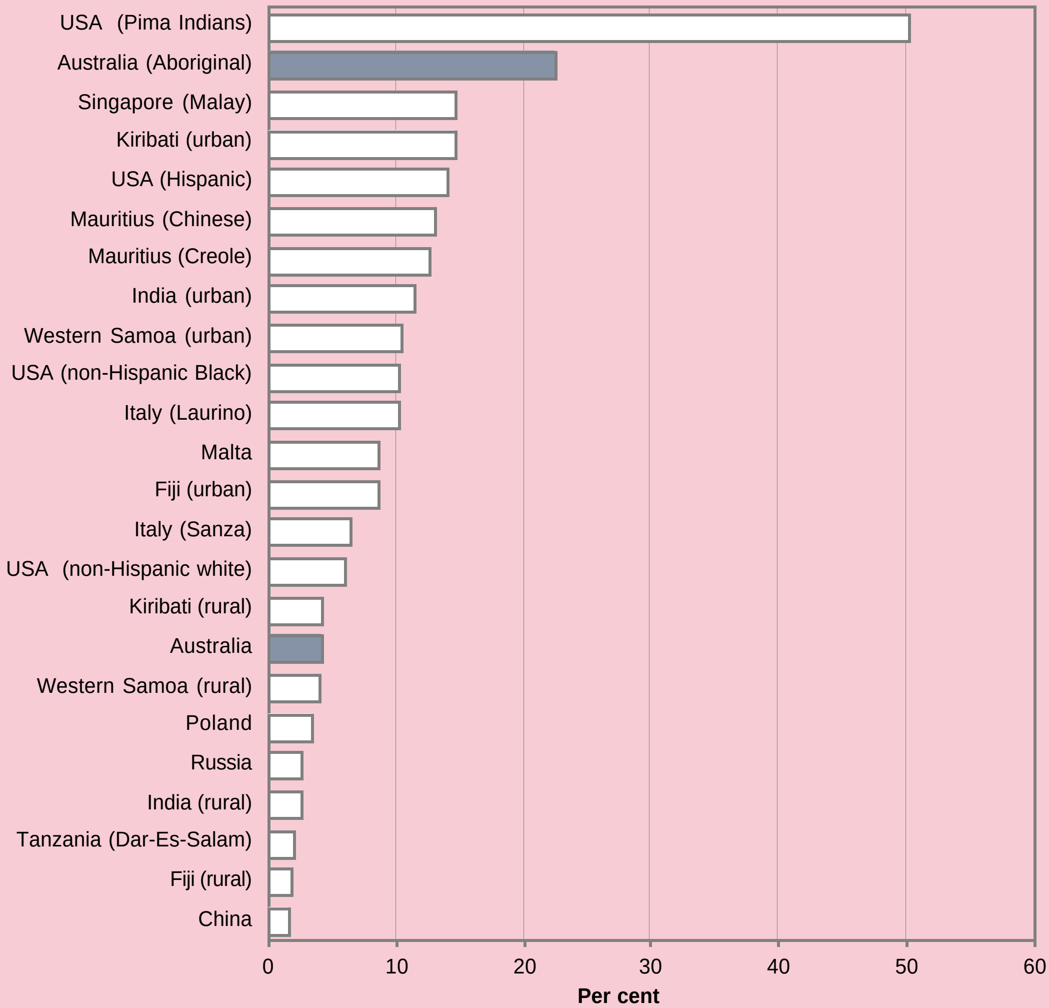
Type 2 diabetes

Type 2 is the predominant form of diabetes in Australia and worldwide. However, the disease may remain undetected for extended periods, leading to underestimation of its incidence and prevalence.

It is estimated from NHS data that around 312,400 persons had Type 2 diabetes in 1995. A large proportion of those who did not know their type of diabetes, as well those who were on insulin but not classifiable as Type 1, are also assigned to this category. The estimate needs further adjustment to allow for the proportion of undiagnosed cases (one to one) in the population. Accordingly, the prevalence of Type 2 diabetes in Australia is estimated to be around 3,320 per 100,000 persons.

The proportion of Type 2 diabetes is much higher among people from Asia and the Pacific Islands (Figure 1.5). In some population groups, eg the Wanigela people of Papua New Guinea, almost one in two persons in the age group 30 to 54 years is known to have this form of diabetes (Dowse et al 1994). More than 20 per cent of Indigenous Australians in this age group are estimated to have diabetes (McCarty et al 1996).

Figure 1.5: Prevalence of Type 2 diabetes — international comparisons



Source: Adapted from King & Rewers (1993).

Gestational diabetes

In Australia, rates of gestational diabetes range from 6 to 9 per cent among women from a European background. Almost one in five Indigenous women may experience gestational diabetes. The prevalence of gestational diabetes among certain ethnic populations (eg from India, Asia, Pacific Islands) is much higher (up to 20 per cent) than in Caucasian women (3–5 per cent) (Beischer et al 1991; Yue et al 1996).

According to the 1995 NHS, some 12 per cent of women (aged 20 years and above) who were told they had diabetes reported having had gestational diabetes. The proportion rose from less than 40 per cent among those aged 20–24 years to more than 50 per cent among those aged 30–39 years.

Overview

An analysis of 1996 New South Wales data on mothers and babies indicates that 3 per cent of mothers developed gestational diabetes during their pregnancy (NSW Health Department 1998). The proportion with gestational diabetes was much higher among mothers from north-east Asia (8 per cent), and south Asia and south-east Asia (both around 7 per cent).

Other types of diabetes

There is limited information available on the prevalence in Australia of various types of diabetes grouped under this category, which currently account for a very small proportion of cases. Most of the reports are based on specific family studies.

1.4 Risk factors

Type 1 diabetes

The condition usually results from an autoimmune process, where the body creates antibodies against components of the pancreatic β cells, which are then destroyed, leaving the individual virtually unable to produce insulin. The process is triggered by environmental factors in genetically predisposed individuals.

Although no modifiable risk factors have been clearly identified, variation in incidence over time, geographical distributions and twin studies all suggest the role of both genetic and environmental factors in the pathogenesis of Type 1 diabetes.

Genetic factors

In families who have a member with Type 1 diabetes, other family members have a higher risk of developing the disease than do people in the general population, suggesting the presence of a genetic component. However, more than 80 per cent of Type 1 diabetes occurs in people with no family history of the disease. Concordance for Type 1 diabetes among identical twins is only about 30–50 per cent (Dorman et al 1995). However, a strong association of this form of diabetes with various human leucocyte antigens has been demonstrated.

Environmental factors

A variety of environmental factors that trigger autoimmune destruction of β cells has been proposed. Children who are breastfed for a shorter time and/or are introduced to cow's milk early are at an increased risk of developing Type 1 diabetes, suggesting a response to cow's milk may lead to increased risk (Dahl-Jorgensen et al 1991; Gerstein 1994). Certain viruses have also been implicated as risk factors, but have not been substantiated in large-scale studies.

Type 2 diabetes

Type 2 diabetes results from a combination of abnormalities of insulin secretion and insulin action. The pancreatic β cells are unable to produce enough insulin to cope with the amount of circulating glucose, and the muscle, fat and liver (on which insulin mainly works) are relatively resistant to its action (insulin resistance).

Conditions associated with insulin resistance are therefore important risk factors for this type of diabetes. Several genetic and environmental factors also contribute to the precipitation of Type 2 diabetes.

Genetic factors

Type 2 diabetes is known to have a strong genetic component, with twin studies showing concordance rates of up to 80 per cent. Although the genes for certain rare forms of Type 2 diabetes have been identified, the genetic basis of the more common form remains unknown. It is likely that multiple genes in various combinations, acting on different metabolic functions, lead to Type 2 diabetes.

Other risk factors

Obesity: The risk of developing Type 2 diabetes rises continuously with increasing obesity, and is approximately five to ten times greater in those classified as obese (body mass index [BMI] 30 and over) than in those with an acceptable weight (BMI under 25) (Perry et al 1995; Shaten et al 1993).

The proportion of overweight adults in Australia is high, and continues to rise. The proportion of overweight or obese females (BMI over 25) increased from almost 27 per cent in 1980 to 46 per cent in 1995 (AIHW 1998a). The proportion of overweight or obese males also increased from almost 48 per cent to more than 68 per cent over the same period. The proportion of obese males (BMI 30 and over) increased dramatically, more than two times, from about 8 to 19 per cent, between 1980 and 1995. The proportion of obese females increased from around 7 to 16 per cent during this period.

Physical inactivity: Several studies indicate that physical activity plays a protective role against the development of diabetes (Helmrich et al 1991; Manson et al 1991, 1992; Perry et al 1995). After other risk factors have been accounted for, people who undertake regular exercise have a 30 to 60 per cent lower risk of developing diabetes than those who do not. The effect appears to be somewhat weaker in females, and in those who are not overweight.

In Australia, the proportion of adults who do not exercise regularly is high. Almost one-third of Australian adults do not participate in any physical activity (AIHW & DHFS 1997). Reported participation in exercise undertaken for sport, recreation or fitness increased slightly between 1989–90 and 1995, from 64 to 67 per cent in males and 64 to 66 per cent in females, but these increases are mainly due to increased participation in physical activity by people aged 35–54 years. The proportion of people undertaking physical activity at low, moderate and high levels remained fairly stable between 1989–90 and 1995 (Armstrong 1998).

Diet: Diet is an important determinant of obesity, and as such is thought to play a crucial role in the development of Type 2 diabetes. Research into the long-term effects of diet is hindered by difficulties in accurately measuring dietary intake. High saturated fat intake is considered to be an important dietary determinant of Type 2 diabetes (Marshall et al 1994), although this has not been confirmed by other studies (de Courten et al 1997).

Age: Increasing age is a major risk factor for Type 2 diabetes. As the population of Australia progressively ages, the burden of Type 2 diabetes is expected to rise.

Low birth weight: Studies linking low birth weight with disease later in life suggest an increased lifetime risk for Type 2 diabetes (Hales & Barker 1992). The association is independent of gestational age, gender, adult BMI, waist-to-hip ratio, and social class at birth and in adulthood (Rewers & Hamman 1995). The risk also extends to impaired glucose tolerance and insulin resistance (Phillips et al 1994).

Gestational diabetes

The aetiology and risk factors for gestational diabetes are generally similar to those of Type 2 diabetes. Population variation in the prevalence of gestational diabetes also suggests the presence of a genetic component in this condition. The genetic factors may be the same as those that bring about Type 2 diabetes in later years.

Other forms of diabetes

A variety of risk factors and genetic defects are known to contribute to these forms of diabetes. The environmental factors precipitating these forms are not always identifiable, but may include infections and drug or chemical induced factors.

1.5 Diabetes-related complications

Diabetes results in a variety of complications over the course of the disease, often resulting in limitation of activity and disability. Psychosocial effects of this life long problem have also been documented.

Complications of diabetes can be broadly classified as microvascular, macrovascular and those associated with pregnancy (see Table 1.2). The risk of microvascular complications is similar in Type 1 and Type 2 diabetes (after accounting for age and duration of diabetes), but macrovascular complications are more common with Type 2 diabetes. All types of diabetes in pregnancy are associated with obstetric and neonatal complications, although gestational diabetes is not known to be associated with foetal malformations.

Table 1.2: Major diabetes-related complications

Microvascular disease	**Intra-uterine problems**
• Nephropathy	• Foetal malformations
• Retinopathy*	• Spontaneous abortions
• Neuropathy	• Stillbirths
Macrovascular complications	• Macrosomia
• Coronary heart disease	• Neonatal hypoglycaemia and other metabolic abnormalities
• Stroke	• Increased obstetric interventions
• Peripheral vascular disease	

* Other visual disorders such as cataracts and glaucoma are also present more commonly among persons with diabetes.

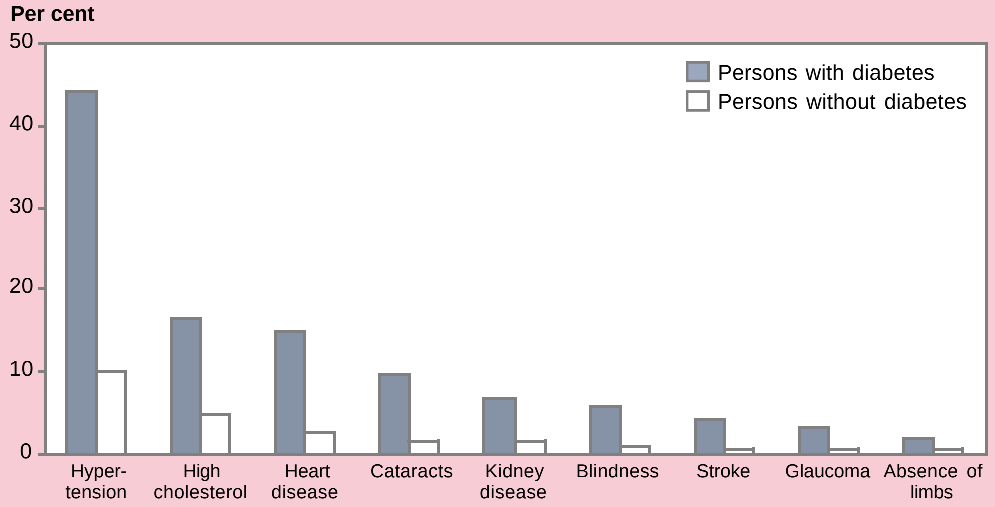
Note: Risk factors for some of the above listed complications, such as high blood pressure and elevated levels of cholesterol, are also present more commonly among persons with diabetes.

A range of risk factors is known to contribute or lead to the development of complications among people with diabetes. In addition to age, sex, duration of disease and genetic factors, these include hyperglycaemia, obesity, high blood pressure, high cholesterol, tobacco smoking, lack of self-management skills and poor access to appropriate care.

Tight glucose control can delay the onset and slows the progression of complications in both Type 1 (DCCT Research Group 1993) and Type 2 (UKPDS Group 1998a) diabetes. All of the complications can progress to an advanced stage before the person with diabetes becomes symptomatic, and only regular medical screening can detect the complications at the earlier treatable stages. Similarly, the prevention of foetal malformations requires excellent glucose control from before conception, while other pregnancy-related complications need regular obstetric monitoring and timely intervention.

Australian data on the complications of diabetes are limited. A study in South Australia has estimated that among people with Type 2 diabetes, more than 66 per cent had at least one microvascular complication and 53 per cent at least one macrovascular complication (Phillips et al 1998). The National Diabetes Clinical Data Collection Project, conducted by the National Association of Diabetes Centres (NADC 1998), collects information on some of the complications of diabetes among those attending specialist services. Self-reported information on the complications was also collected during the 1995 NHS (Figure 1.6).

Figure 1.6: Self-reported prevalence of associated conditions and complications of diabetes, Australia, 1995



Source: ABS (1997b).

Microvascular complications

Nephropathy

Kidney disease, or nephropathy, is a major complication of diabetes. It is first diagnosed by the detection of protein in the urine (albuminuria). On average, more than 40 per cent of people with diabetes have elevated levels of urinary albumin and the prevalence is higher in those with diabetes of longer duration (Nelson et al 1995).

Overview

The South Australian survey reveals the presence of albuminuria in more than 34 per cent of people with Type 2 diabetes (Phillips et al 1998). The survey also shows evidence of renal dysfunction among 23 per cent of males and 41 per cent of females with Type 2 diabetes.

During the 1995 NHS, around 7 per cent of people with diabetes reported some form of kidney disease (ABS 1997b). This proportion was more than four times that noted among those without diabetes.

Over time, diabetic nephropathy can progress to end-stage renal disease, requiring dialysis or transplantation for survival. Within 10 years of the development of nephropathy, progression to renal failure occurs in about 10 per cent of people with Type 2 diabetes, and in 50 per cent of those with Type 1 diabetes (Nelson et al 1995).

Diabetes is the second most common reason for entering end-stage renal disease programs, up from fourth over the past decade (Disney 1996). The proportion of people with diabetic nephropathy among Australian patients registered in the Australia and New Zealand Dialysis and Transplant Registry was about 14 per cent in 1992 and 18 per cent in 1996 (Disney et al 1997). Renal failure as a consequence of diabetes is common among Indigenous Australians. In Central Australia, it is estimated that renal disease is the direct cause of death in 22 per cent of Indigenous people with diabetes (Phillips et al 1995).

Retinopathy

Diabetic retinopathy is the most common cause of visual loss in adult Australians under the age of 60. Its prevalence in Australia is estimated to vary from 28 to 51 per cent, with about 12 per cent having vision-threatening retinopathy (Mitchell & Moffitt 1990; Constable et al 1983; Phillips et al 1998). The estimated annual incidence of new retinopathy in Australia is between 6 and 14 per cent. The problem is caused by damage to small blood vessels in the retina and is readily treatable by laser therapy if identified early. Two other eye complications that lead to loss of vision, glaucoma and cataracts, are also more common among those with diabetes.

The onset of retinopathy may be early among people with Type 1 diabetes. Overseas studies indicate that the prevalence of early retinopathy in young people varies from 18 to 64 per cent (Burger et al 1986; Frank et al 1982; Kingsley et al 1988; Klein et al 1984). In New South Wales, the prevalence of early retinopathy among adolescents with diabetes, aged 11 to 20 years, has been estimated at 42 per cent (Fairchild et al 1994).

According to the 1995 NHS, glaucoma and cataracts are respectively five and six times more prevalent among people with diabetes than among those without it (ABS 1997b). Similarly, the rate ratio for blindness is estimated to be around six times greater among those with diabetes. The annual incidence of blindness among people with diabetes attending specialist diabetes services is estimated to be less than 1 per cent (NADC 1998).

Neuropathy, infections and amputations

Neuropathy (damage to the nerves) is a common debilitating complication of diabetes, mainly affecting the feet and legs. Neuropathy can cause pain, but more importantly can lead to foot ulcers, foot infections and gangrene. The prevalence of neuropathy is similar in both Type 1 and Type 2 diabetes, and increases with age, duration of diabetes, and worsening of glucose control (Eastman 1995).

According to a study in Western Australia, 14 per cent of people with diabetes had neuropathy (Knuiman et al 1986). The South Australian study revealed neuropathy among 20 per cent of people with Type 2 diabetes (Phillips et al 1998). Large studies from Europe and the United States report the prevalence of neuropathy between 16 and 32 per cent (Tesfaye et al 1996; Fedele et al 1997; Franklin et al 1994; Walters et al 1992).

The prevalence of neuropathy and various foot problems among people with diabetes attending specialist diabetes services are estimated to be:

- peripheral neuropathy — 28 per cent;
- peripheral vascular disease — 13 per cent;
- current foot ulcers — 2 per cent;
- previous foot ulcers — 6 per cent; and
- amputations in the last 12 months — 1 per cent (NADC 1998).

According to the 1995 NHS, almost 2 per cent of people with diabetes had an amputation, at three times the rate for people without diabetes (ABS 1997b). Several overseas studies indicate that the amputation rate is about 10 times higher among diabetic than among non-diabetic people, and also that 50 per cent of all non-traumatic amputations are carried out in people with diabetes (Reiber 1996).

Macrovascular complications

Cardiovascular disease

The age-adjusted relative risk for cardiovascular disease is two to three times higher for those with diabetes than those without it, and is higher for females than males (in contrast to the general population). The 10-year risk for a cardiovascular event in a 51-year-old person with Type 2 diabetes has been calculated as 16 per cent for males and 15 per cent for females. These rates are more than doubled, to 38 and 36 per cent respectively, if the person smokes, has high cholesterol and high blood pressure (Eastman & Keen 1997).

Coronary heart disease. People with diabetes have higher rates of coronary heart disease than those without diabetes. This is partly because they have higher levels of risk factors such as obesity, high blood pressure and high cholesterol, although this does not fully explain the excess of coronary heart disease in people with diabetes (Tuomilehto et al 1997). Diabetes is considered to be an independent risk factor for coronary heart disease.

During the 1995 NHS, about 15 per cent of people with diabetes reported the presence of coronary heart disease, which is almost six times the rate reported by people without diabetes (ABS 1997b). The South Australian survey indicates the presence of coronary heart disease in more than 34 per cent of respondents (Phillips et al 1998). According to the NADC study, around 5 per cent of people with diabetes attending diabetes clinics experienced a heart attack in the 12 months prior to attendance (NADC 1998).

Stroke. Data from the United States show that strokes occur two to six times more frequently in people with diabetes than in the rest of the population. High blood pressure, which is common in people with Type 2 diabetes, seems to be a strong contributing factor. During the 1995 NHS, more than 4 per cent of people with diabetes reported having suffered a stroke, in comparison to less than 0.5 per cent among those without diabetes (ABS 1997b). The NADC study has estimated the incidence of stroke to be more than 2 per cent among people with diabetes (NADC 1998).

Peripheral vascular disease. This disease results in a reduced blood flow to legs and feet. Studies in Sweden and the United States indicate that peripheral vascular disease is about four times as common in people with diabetes as in those without diabetes (Palumbo & Melton 1995), and its prevalence rises with the duration of disease. The incidence of peripheral vascular disease among people with diabetes is estimated to be around 13 per cent (NADC 1998). The South Australian survey indicates the presence of peripheral vascular disease in about 32 per cent of participants (Phillips et al 1998).

Intra-uterine complications

Women with diabetes are at a higher risk of having a large for gestational age baby (Mello et al 1997; McMahon et al 1998), leading to an increased risk of difficult labour and delivery (Casey et al 1997).

It has been suggested that insulin therapy may reduce the incidence of large for gestational age babies born to women with diabetes (Simmons & Robertson 1997; Moses & Griffiths 1995). Compared to those without diabetes, mothers with diabetes experience a significantly higher incidence of pregnancy-induced hypertension and pre-term birth (Mello et al 1997), urinary tract infection, pre-eclampsia and uterine bleeding (McMahon et al 1998; Martinez-Frias et al 1998).

Children born to mothers with diabetes are at a high risk of developing foetal malformations, foetal distress, and neonatal complications including hypoglycaemia, respiratory distress and jaundice (Kamath et al 1998; Martinez-Frias et al 1998; ADA 1993). It has been suggested that Down’s syndrome may also occur more often in babies born to mothers with diabetes (Narchi & Kulaylat 1997). The infants of mothers with pre-gestational Type 1 diabetes or gestational diabetes may also develop insulin resistance and impaired glucose tolerance early in life (Plagemann et al 1997).

1.6 Health service use

People with diabetes are approximately twice as likely as those without it to consult health professionals or use hospital services (ABS 1997b). The higher rate of use is related to treatment and metabolic control, as well as to complications associated with the disease.

People with Type 1 diabetes seek medical help much more often than those with Type 2 diabetes. According to the 1995 NHS, the average annual number of medical services used by people with Type 1 diabetes is almost six times higher than for those with Type 2 diabetes, and the ratio for average number of hospital separations is more than eight times.

Visits to the doctor

According to the 1995 NHS, people with diabetes consult a doctor (general practitioner [GP] or any specialist) twice as often as those without diabetes (46 per cent compared with 23 per cent). Among those people with diabetes who visited the doctor in the two weeks before the survey, the proportion was 100 per cent among persons with Type 1 diabetes aged 0–24 years. The proportion decreased to 60 per cent for those aged 25–34 years, and between 30 and 50 per cent for ages above 35 years (Mathers & Penm 1999).

Consultations with other health professionals

People with diabetes consult other health professionals and facilities more often than those without the condition. According to the 1995 NHS, at least one out of fourteen people with diabetes had visited hospital casualty, emergency or outpatients in the last two weeks, almost three times the rate of people without diabetes. Almost 2 per cent of people with diabetes also reported a hospital inpatient episode during that period (ABS 1997b).

Hospital separations

In 1996–97, a total of 267,449 hospital separations listed diabetes as a diagnosis. Diabetes was the principal diagnosis for about 9 per cent of these separations.

Diabetes is not always reported as the principal diagnosis in hospital separations data because the condition considered responsible for the hospitalisation is recorded as the principal diagnosis. The more frequent primary diagnoses of interest, where diabetes was listed as an additional diagnosis, were:

- cardiovascular disease, ICD-9-CM:390–459 (23 per cent),
  - — coronary heart disease, ICD-9:410–414 (12 per cent),
  - — stroke, ICD-9:430–438 (4 per cent),
  - — peripheral vascular disease, ICD-9:441–444 (1 per cent),
  - — heart failure, ICD-9:428 (4 per cent);
- eye disease, ICD-9:360–379 (5 per cent),
  - — cataracts, excluding congenital forms (4 per cent); and
- kidney disease, ICD-9:580–589 (1 per cent).

Data on hospital separations provide an indication of the use of health care. However, because hospital separation collections in Australia do not have a unique patient identifier, there can be multiple counting of patients depending on the number of inpatient episodes. The above hospital separation figures are therefore only an estimate of the extent of morbidity associated with diabetes requiring hospitalisation, and cannot be used as population-based estimates of diabetes prevalence.

1.7 Mortality

In 1996, diabetes was cited as the underlying cause of 2,991 deaths in Australia, accounting for more than 2 per cent of deaths from all causes, with an age-standardised rate of 16 per 100,000 persons (ABS 1997c). It was the seventh leading cause of death that year.

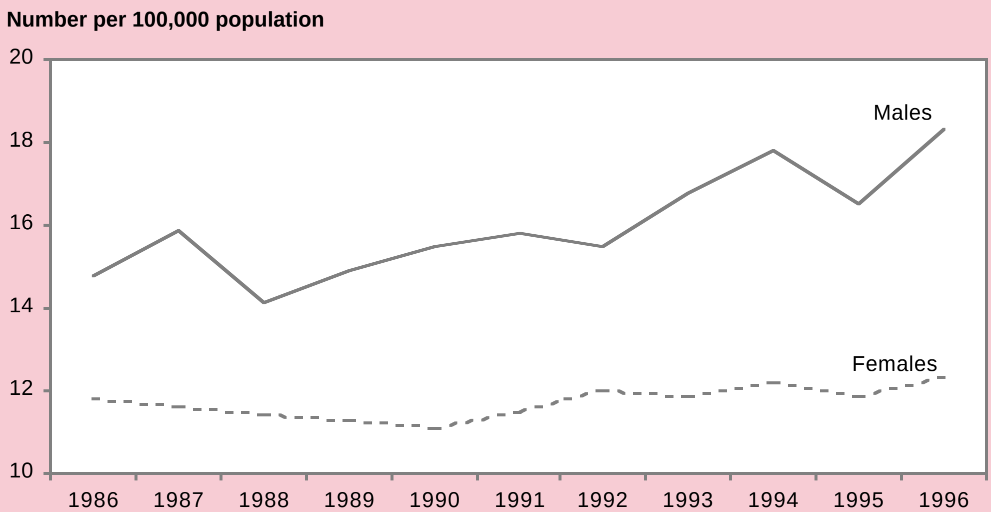
Diabetes contributes to a much larger proportion of deaths than the above figures would suggest. In 1995, diabetes was the underlying cause of death for 2,708 persons. However, there were an additional 8,839 deaths where diabetes was mentioned on the death certificate but was not reported as the underlying cause of death. Diabetes thus could have contributed to almost 7 per cent of total deaths, with an age-standardised rate of 49 per 100,000 population in 1995 (ABS 1997c).

The above statistics do not account for lack of recording of diabetes on death certificates. It is estimated that between 27 and 44 per cent of death certificates for people with diabetes do not even list diabetes as a cause of death (Whittall et al 1990; Riley et al 1995; Phillips et al 1995).

Trends in diabetes mortality

Between 1991 and 1996, death rates for diabetes increased annually by 1.5 per cent and 5.9 per cent among males and females respectively. While some of this change reflects the increasing prevalence of the disease, changing practices in determining the underlying cause of death may have also contributed to this trend. No data are available to separately determine trends in mortality associated with Type 1 and Type 2 diabetes. Age-standardised death rates for diabetes and trends over time since 1986 are plotted in Figure 1.7.

Figure 1.7: Trends in death rates for diabetes, by sex, Australia, 1986–1996



Note: Rates are age standardised to the total 1991 Australian population.

Source: AIHW National Mortality Database.

Premature mortality

Premature mortality is more common among people with diabetes than in the general population. Diabetes mortality increases sharply after age 50, and is higher among males than females in each age group in Australia.

In the United States, using data from the 1970s and early 1980s, the death rate ratio for people with Type 1 diabetes in comparison with those without diabetes is estimated to be between 5 and 12, with their life expectancy reduced by about 15 years (Harris 1995). More recent European studies indicate a ratio of between 2 and 4 (Nystrom et al 1992; Modan et al 1991). Similarly, for people with Type 2 diabetes in the United States, the death rate is estimated to be about twice that of the general population (Harris 1995).

People with childhood-onset Type 1 diabetes in Tasmania are reported to have more than four-fold excess mortality, and those with adult-onset Type 1 diabetes a 1.8-fold excess mortality, over the general population (Riley et al 1995). In Western Australia, the death rate for people with diabetes has been estimated to be between 20 to 80 per cent higher than that for the general population (Knuiman et al 1992; McCann et al 1994).

No national estimates of these ratios are currently possible due to the lack of multiple cause-of-death data. However, the ABS has recently introduced multiple coding for death data which should allow an assessment of this risk ratio in Australia.

Causes of death among people with diabetes

Cardiovascular disease is the leading cause of death among people with diabetes, followed by renal disease (Phillips et al 1990). Among Indigenous adults in Central Australia, renal disease and infections were the direct cause of death in around 22 per cent and 21 per cent of people with diabetes, respectively (Phillips et al 1995).

Due to the lack of multiple coding, it has not been possible to generate national cause of death statistics for people with diabetes until now. However, since 1997 ABS has initiated the coding of underlying as well as associated causes of death and this will allow better analysis in the future.

1.8 Special population groups

The *National Diabetes Strategy and Implementation Plan* report (Colagiuri et al 1998) has highlighted several population groups that require special consideration in diabetes prevention and care services. These population groups are:

- Indigenous Australians;
- people from culturally and linguistically diverse backgrounds;
- people living in rural and remote areas;
- children and adolescents; and
- older Australians.

Indigenous Australians

Diabetes, mostly Type 2, is a major cause of morbidity and mortality among Indigenous Australians. Epidemiological investigations suggest that the overall prevalence of diabetes among Indigenous adults is between 10 and 30 per cent, at least two to four times that of the non-Indigenous population (de Courten et al 1998). A recent study of Indigenous children and adolescents has documented a high prevalence of Type 2 diabetes (2.7 per cent), and of risk factors for Type 2 diabetes (Braun et al 1996). Pooled data from south-eastern and central Australian Indigenous people, aged 20–49 years, also show a 12 per cent prevalence of Type 2 diabetes, compared with 1 per cent in a Victorian country town sample of non-Indigenous people in the same age range (Guest & O'Dea 1992).

In the 1994 National Aboriginal and Torres Strait Islander Survey (NATSIS), more than 4 per cent of Indigenous persons reported diabetes as a long-term illness (ABS 1996a). The rate is one-third higher among Indigenous females than males. The survey also indicated that diabetes is more prevalent among Indigenous people living in rural areas. An oversample of Indigenous individuals during the 1995 NHS has also provided similar estimates (ABS 1999).

The high prevalence of diabetes among Indigenous populations is thought to relate to a rapid change from a traditional to a Westernised lifestyle. In addition, obesity is common — 25 per cent of males and 29 per cent of females have a BMI over 30 (ABS 1996a). Furthermore, Indigenous mothers are two to three times more likely to have babies of low birth weight (ABS & AIHW 1997), a risk factor for diabetes as described earlier.

The full impact of diabetes-related complications has not been studied in the Indigenous population. However, in a study from the Northern Territory, the incidence of end-stage renal disease associated with diabetes was found to be more than 26 times higher in the Indigenous population (Hoy et al 1997).

According to Phillips et al (1995), among Indigenous people diagnosed with Type 2 diabetes, the eight-year survival rate is less than 56 per cent in males and 80 per cent in females. The death rate ratios, when compared to non-diabetic Indigenous Australians, were 2.1 for males and 1.7 for females. Renal disease was the direct cause of death in more than 22 per cent of cases, infections accounted for almost 21 per cent of deaths and coronary heart disease for almost 14 per cent of deaths.

An increasing trend in diabetes mortality has been noted among Indigenous Australians. Between 1985 and 1994, diabetes mortality rose sharply, at an annual rate of 9.6 per cent among males and 5.4 per cent among females (Anderson et al 1996). In 1996, the death rates for diabetes among Indigenous males and females were 149 and 216 per 100,000 persons respectively.

People from culturally and linguistically diverse backgrounds

Australia's population now has about 23 per cent overseas-born people. On arrival, the migrants tend to have better health than people born in Australia, although rates of illness and disability increase with duration of residence (AIHW 1998a).

However, certain migrant groups have a high prevalence of and mortality from diabetes (Strong et al 1998a). The 1995 NHS data indicate a higher prevalence of diabetes among people born in southern Europe, other European countries, Asia, and other countries compared with those born in mainly English-speaking countries. In particular, diabetes is highly prevalent among Micronesian, Polynesian and certain Melanesian Pacific Islanders, migrant Asian Indians and Chinese (Dowse et al 1990; King & Rewers 1993). Some Arab populations and people from some European communities, especially those from southern Europe, also have a high prevalence of Type 2 diabetes (King & Rewers 1993).

There is also evidence of an increased incidence of gestational diabetes among women born on the Indian subcontinent, or in Africa, Vietnam, Mediterranean countries, Egypt and other Arab countries or other Asian nations, compared with women born in Australia and New Zealand (Beischer et al 1991; Moses et al 1994).

These patterns are in contrast to the overall health status of persons born overseas (Strong et al 1998a). Two major risk factors for diabetes, physical inactivity and obesity, are significantly higher among adults in some population groups (Welborn et al 1995). People of some population groups are also less likely to be screened for diabetes.

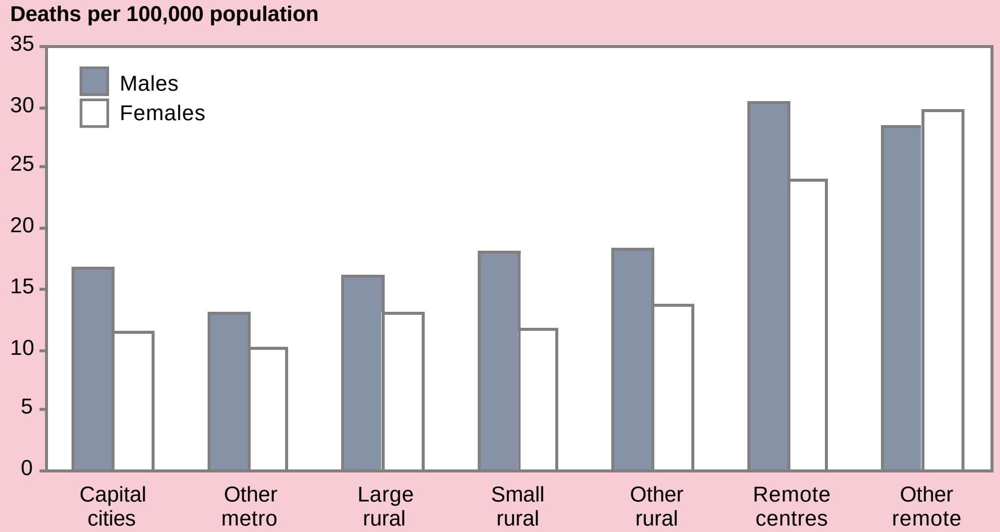
While overseas-born people represent a significant proportion of people with diabetes, language may be a barrier to accessing relevant services (Flack et al 1997). For example, it is known that many people from culturally and linguistically diverse backgrounds use ambulatory care services less often than English-speaking people, and practise less self care than recommended, but use inpatient services more often (de Blieck et al 1993). Poor glycaemic control is also common and more marked in some ethnic groups (Diabetes Australia & FECCA 1997).

People living in rural and remote areas

The health of populations living in rural and remote areas is worse than those living in urban areas (Trickett et al 1997; Strong et al 1998b). Death rates for all major causes, coronary heart disease, respiratory disease and injury are higher in rural and remote areas. These differences also apply to diabetes.

Mortality from diabetes is significantly higher in remote areas when compared to other areas (see Figure 1.8). During 1992–1996, for example, the death rates for diabetes in the remote areas of Australia were two to three times higher than in metropolitan areas. Slightly higher rates are observed for hospitalisation with diabetes as the principal diagnosis (Strong et al 1998b).

Figure 1.8: Rural and remote area variation in death rates for diabetes, Australia, 1992–1996



Note: Rates are age standardised to the total 1991 Australian population.

Source: Strong et al (1998b).

Rural and remote Australians have slightly different patterns of risk factors and health actions compared with their metropolitan counterparts (Trickett et al 1997). For example, more than 53 per cent of males and 43 per cent of females in 'other remote areas' are reported to be overweight compared with 49 per cent of males and 34 per cent of females living in 'metropolitan areas'. High alcohol consumption is also more common in rural and remote areas (Strong et al 1998b).

Hospital separation rates for endocrine, nutritional and metabolic diseases and for diseases and disorders of the kidney and urinary tract are substantially higher in remote areas. The higher rate of problems of the kidneys and urinary tract in remote areas is largely due to renal failure among Indigenous people in remote communities (Trickett et al 1997; Strong et al 1998b).

Children and adolescents

Almost all diabetes among children and adolescents is Type 1, although Type 2 diabetes may be present in a small number of cases.

It is believed that the incidence of diabetes in childhood has increased substantially in developed countries in the last 40 years (Waterson et al 1997). In Australia, the prevalence is estimated to be around 130 per 100,000 (Silink 1994). There are two peaks in the incidence of diabetes among children and adolescents, at 4–6 and 10–14 years.

The frequency of severe hypoglycaemia in children and adolescents is approximately twice that in adults (Colagiuri et al 1998). In particular, among those diagnosed with diabetes before the age of five years, ketoacidosis, severe hypoglycaemia, cognitive disabilities and electroencephalogram abnormalities are common. Virtually all children with diabetes will have evidence of diabetes-related complications in adulthood.

Morbidity among children with diabetes is high. The hospital separation rate for children with the principal diagnosis of diabetes was 44 per 100,000 in 1996–97 (Moon et al 1998). A study in Newcastle has found that among adolescents (aged 11–19 years) with Type 1 diabetes of a median duration of seven years, the prevalence of retinopathy was 42 per cent. Nearly all had mild background retinopathy, a rate comparable to recent reports from other centres (Fairchild et al 1994).

Mortality is also two to four times higher in diabetic children than in their non-diabetic counterparts. Over the period 1979–1996, there were 40 deaths in children under the age of 15 years from diabetes.

The social costs of childhood diabetes are substantial — 39 per cent of children with diabetes missed school in the two weeks prior to the 1995 NHS because of their condition, and 9 per cent of adolescents missed school for the same reason.

Optimising diabetes control among children and adolescents with diabetes may be more difficult than among adults, as children and adolescents have a number of additional challenges including erratic eating patterns, the tendency to get four to six viral illnesses each year and hormonal changes associated with growth spurts and pubertal development. The psychological effects of diabetes and the need for constant monitoring are also higher among children and adolescents.

Older Australians

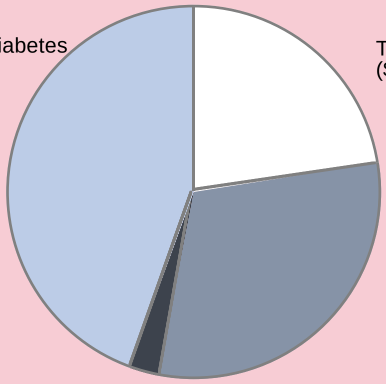
The prevalence of diabetes increases steadily with age. Increased longevity increases the likelihood of co-existence of multiple chronic conditions. Diabetes, together with ageing, makes older people more vulnerable to diseases such as cardiovascular disease (Colagiuri et al 1998). However, the presence of diabetes in older Australians may be sometimes overlooked, with many of the classic symptoms of diabetes dismissed as part of the ageing process which may lead to unwarranted diabetes-related complications.

The risk of developing diabetes-related complications such as macrovascular disease and renal failure also increases with age. More than 20 per cent of older people with diabetes have retinopathy and symptoms of macrovascular disease at the time of diagnosis (NHMRC 1997a; Colagiuri et al 1998).

1.9 Health system costs

The 1993–94 health system costs attributable directly to diabetes are estimated to be $387 million (Mathers & Penm 1999). These include costs incurred for hospitalisation, medical consultation and procedures, pharmaceuticals, allied health services, research and other support. Although only accounting for around 12 per cent of the total cases of diabetes, Type 1 accounts for more than 40 per cent of diabetes costs (Figure 1.9).

Figure 1.9: Diabetes costs in Australia, 1993–94



Source: Mathers & Penm (1999).

The above costs relate to health services for which diabetes is identified as the diagnosis or the underlying problem. However, as described earlier, diabetes also contributes substantially to morbidity and mortality resulting from a variety of conditions. Some of the health system costs for these conditions can be attributed to diabetes. Mathers and Penm (1999) estimate this amount to be around $294 million.

The total figure for health system costs attributable to diabetes thus amounts to $681 million. Estimated average annual health system costs attributable to each diagnosed case of diabetes are about $1,727 for males and $2,124 for females. Estimated lifetime attributable health system costs in Australia for each diagnosed case of diabetes are about $25,880 for males and $37,830 for females (Mathers & Penm 1999).

1.10 Diabetes and other national health priority areas

The burden of diabetes overlaps with and contributes to the burden of disease for other NHPA diseases and conditions. The most prominent connection is between diabetes and cardiovascular diseases, because of their shared risk factors. People with diabetes, in particular those on insulin therapy, are also prone to a variety of mental problems and conditions.

Cardiovascular health

Not only do diabetes and cardiovascular disease share common risk factors, but diabetes is an independent risk factor for cardiovascular disease as well. The presence of a common aetiological factor for risk factors for cardiovascular disease and diabetes has been proposed. However, limited information is available on whether the presence of cardiovascular disease promotes diabetes in some way.

As discussed earlier, diabetes is an important cause of coronary heart disease and stroke. In contrast to people without diabetes, coronary heart disease appears earlier in life and is more often fatal among those with diabetes. People with diabetes may have a worse prognosis after stroke, and the role of elevated blood pressure in stroke may be accentuated by the presence of diabetes. Mortality is also increased among people with diabetes and peripheral vascular disease, in particular if foot ulcerations, infection or gangrene occur.

High blood pressure, high cholesterol and obesity often present along with diabetes, as well as all being independent risk factors for cardiovascular disease. In combination with glucose intolerance and other risk factors such as physical inactivity and smoking, each one of these factors presents a greater cardiovascular risk. In particular, high blood pressure and diabetes often occur together. Evidence is also accumulating that high cholesterol and glucose intolerance may have a common aetiological factor.

Despite these similarities, mortality from cardiovascular disease and diabetes are moving in opposite directions. While the ageing of the population following reductions in mortality from cardiovascular disease may have contributed to these opposite trends, the role of other factors also needs to be understood if common risk factor prevention strategies are to be considered.

Cancer control

Several studies have shown that diabetes is associated with some forms of cancer. It has been identified as a risk factor for pancreatic cancer (Fisher et al 1996; Lee et al 1996) and as a possible risk factor for prostate cancer (Ilic et al 1996). People with diabetes have also been shown to be at a higher risk of developing primary liver cancer and perhaps cancer of the biliary tract (Adami et al 1996). In a 15-year follow-up study of people with Type 2 diabetes in Japan, death rates for cancers of the liver and the pancreas have been shown to be respectively three times and twice the expected rates (Sasaki et al 1996). However, a significant association between pancreatic cancer and diabetes has been discounted in other studies (Gullo et al 1996).

Mental health

There have been several studies of depression and anxiety in individuals with diabetes, including assessment of quality of life and symptom reporting. Some have concluded that depression is related to diabetes itself, others to associated psychosocial factors. Kohen et al (1998) report that the effect of diabetes, especially the depressive effect, is an important factor in determining quality of life independent of the level of physical illness. Depression may affect individuals at different stages of the illness.

A study conducted in south-west Sydney (Flack et al 1995) has found mild to moderate levels of depression and significant anxiety, irrespective of diabetes type or duration of disease among individuals commencing insulin therapy. Amato et al (1996) have found depression in association with diabetes among a group of older patients.

Peyrot and Rubin (1997) also report higher levels of depression and anxiety among individuals with diabetes than in the general population, especially for those with more diabetes-related complications. This finding is supported by the United Kingdom Prospective Diabetes Study (UKPDS), which concludes that the prevention of complications could prevent deterioration in quality of life for people with diabetes.

Rajala et al (1997), on the other hand, have found that the impact of diabetes on depression is not strong. Depression is present as a comorbidity with several chronic diseases and unfavourable social factors, such as sick leave and retirement, suggesting a psychosocial origin of depression in persons with Type 2 diabetes.

Suicide is not generally one of the adverse outcomes among people with diabetes, but may be under-reported or represented as deaths from hypoglycaemia resulting from intentional insulin overdose (Robinson & Rabins 1989). Depression among people with chronic renal failure, a serious complication of diabetes, has been shown to result in outright termination of treatment, and covert or overt suicide. Data from Europe and the United States suggest that the suicide rate among those on dialysis is 10 to 15 times that in the general population (Haenel et al 1980; Neu & Kjellstrand 1986).

Injury prevention and control

There is some evidence of an increased association between diabetes and injury. Data from Finland indicate a high rate of accidents among people with Type 1 diabetes (DERI Mortality Study Group 1991).

Hypoglycaemia when driving is known to cause accidents as it affects the person's level of consciousness. Visual impairment due to diabetic retinopathy and cataracts can also interfere with driving ability. Diabetic retinopathy affects night vision and cataracts are associated with excessive headlight glare (Frier 1992).

However, the evidence to indicate that drivers with diabetes have a higher rate of road accidents than their non-diabetic counterparts is limited. Recent studies have shown only a minor or no increase in accident rates among drivers with diabetes (Stevens et al 1989; Songer et al 1988). A study in Western Australia has also shown that there is no overall difference in the hospital admission rates from accidents between those with diabetes and the general population (de Klerk & Armstrong 1983).