Australian Government
Australian Institute of Health and Welfare

Better information and statistics for better health and wellbeing

Asthma among older people in Australia

May 2010

Australian Institute of Health and Welfare
Canberra
Cat. no. ACM 19

The Australian Institute of Health and Welfare is Australia's national health and welfare statistics and information agency. The Institute's mission is *better information and statistics for better health and wellbeing*.

A complete list of the Institute's publications is available from the Institute's website <www.aihw.gov.au>.

ISBN 978-1-74249-027-4

Suggested citation

Australian Institute of Health and Welfare 2010. Asthma among older people in Australia. Cat. no. ACM 19. Canberra: AIHW.

Any enquiries about or comments on this publication should be directed to:

Adrian Webster

Australian System for Monitoring Asthma

GPO Box 570

Canberra ACT 2601

Phone: (02) 6244 1144

Email: adrian.webster@aihw.gov.au

Published by the Australian Institute of Health and Welfare

Printed by Union Offset Printers

Please note that there is the potential for minor revisions of data in this report. Please check the online version at <www.aihw.gov.au> for any amendments.

Contents

Acknowledgments

The authors of this report are Adrian Webster, Malcolm Gall, Katarzyna Krysiak and Linda Kemp. They would like to acknowledge the significant contribution and guidance of Kuldeep Bhatia.

The authors appreciate the valuable input of the members of the Steering Committee of the Australian System for Monitoring Asthma (ASMA) and would like to make particular mention of Guy Marks and Christine Jenkins.

The Australian Government Department of Health and Ageing funded this publication.

Abbreviations

ABS	Australian Bureau of Statistics
ACAM	Australian Centre for Asthma Monitoring
AIHW	Australian Institute of Health and Welfare
BEACH	Bettering the Evaluation and Care of Health
CI	confidence interval
COPD	Chronic Obstructive Pulmonary Disease
CURF	Confidentialised Unit Record File
DALY	disability adjusted life year
GP	general practice
ICD	International Classification of Diseases
MPHS	Multi-Purpose Household Survey
NATSIHS	National Aboriginal and Torres Strait Islander Health Survey
NHMD	National Hospital Morbidity Database
NHS	National Health Survey
NMD	National Mortality Database
SEIFA	Socio-Economic Index for Area
SES	socioeconomic status
YLD	years of life lost due to disability
YLL	years of life lost due to premature mortality

Summary

Asthma in older Australians is distinct in many ways. The presence of comorbid conditions makes the management of asthma in older people more complex. The disease itself is also more persistent and severe than in the younger ages. Over 92% of the 402 asthma deaths in 2006 were among people aged 45 years and over, with many being associated with chronic obstructive pulmonary disease or bronchiectasis and acute respiratory infections.

This report highlights key national data relating to asthma in older Australians:

- There are two broad patterns of asthma prevalence over the life course. The older pattern begins around 45 years of age.
- Among older Australians, asthma is more prevalent among females (10.8%) than males (7.4%) but the gender difference lessens with age.
- There was little change in asthma prevalence in older Australians between 2001 and 2004–05.
- Asthma is considerably more prevalent among older Indigenous (19.4%) than non-Indigenous (9.1%) Australians of the same age (45 years and above), particularly among females (25.4% compared to 10.7% for non-Indigenous females).
- In 2004–05, the prevalence of asthma in older Australians was significantly higher for those living in the most disadvantaged localities, compared with the least disadvantaged localities.
- The number of asthma deaths was unexpectedly high in 2006 and 2007, considering the declining trend of the previous years. These relatively high death rates particularly affected the 70+ years age group. No single cause for this increase can be identified and data for further years are required before it can be ascertained if the increase in deaths has been sustained.
- The rate at which asthma is managed in primary care declined between 1998–99 and 2007–08.
- The asthma hospital separation rate in older Australians declined between 1999–00 and 2006–07 by around 40% and the average length of stay also fell.
- Acute respiratory infection in asthma sufferers appeared to increase between 1998 and 2006. This occurred despite relatively stable infection rates in the general population.

1. Introduction

As people with asthma age, the debilitating effects of asthma worsen (Tinkelman et al. 2006). Most deaths from asthma occur among older people. Of deaths due to asthma in 2006, 92% occurred among those aged 45 years and over and the average age at death was 79 years.

Managing asthma in older people is broadly similar to managing the condition in younger people. However, the existence of comorbid conditions and biological changes associated with the normal ageing process often make diagnosis and management more complex (Barua & O'Mahony 2005). Asthma is also more long term in adults, with few older people experiencing remission or disappearance of symptoms (Ronmark et al. 1999).

This report examines asthma in older Australians (those aged 45 years and over). It attempts to answer questions such as:

- How prevalent is asthma among older Australians and what effect does sex, ethnicity or location have on its distribution (Chapter 2)?
- What is the impact of asthma on older persons and how does its impact change over the life course (Chapter 3)?
- What is the impact of asthma in older age groups on the health system (Chapter 4)?
- What other comorbid conditions are common among older people with asthma (Chapter 5)?

1.1 Background issues

Diagnosis

The diagnosis of asthma in older people is often problematic (Bellia et al. 2003, Wilson et al. 2005). There are many clinical features and diagnostic investigations that, when collectively reviewed, help diagnose asthma in older people (Levy et al. 2009). The diagnostic difficulties are:

- Changes to the lung structure associated with the normal ageing process can alter the expression of asthma symptoms (Braman & Hanania 2007).
- Under-reporting of symptoms or attributing symptoms, such as breathlessness or coughing, to normal ageing may delay or prevent the diagnosis of asthma (Barua & O'Mahony 2005).
- Some symptoms of asthma, such as breathlessness, chest tightness and cough, can be similar to those characteristic of several other conditions, including chronic obstructive pulmonary disease (COPD), heart failure and obesity (Barua & O'Mahony 2005).
- There can be difficulties in performing diagnostic procedures due to disability or cognitive impairment in older people (Braman & Hanania 2007).
- The possibility of occupational asthma is often overlooked (Levy et al. 2009).

Management

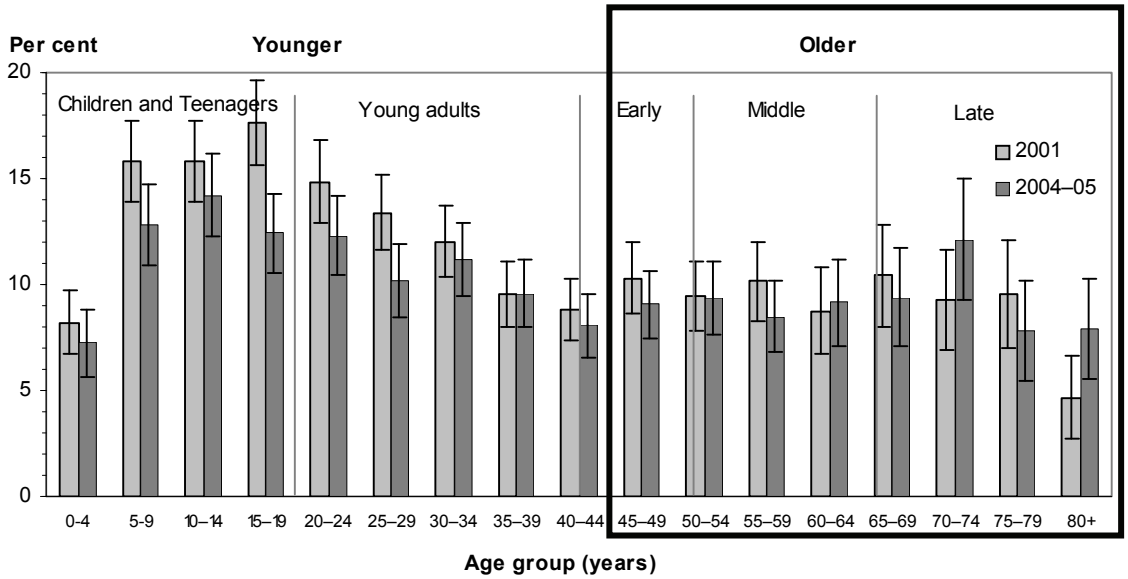
There are several issues specific to managing asthma in older people. These relate mainly to two aspects of ageing. The first is increased comorbidity and the second relates to the physical and psychosocial implications of the ageing process. Each of the following issues may have elements of both:

- Older people are more likely to suffer from multiple health conditions requiring multidisciplinary treatment and rehabilitation services.
- COPD often coexists in older patients with asthma. The two have many similarities, especially in clinical symptoms, although they have marked differences at the pathological level (Welte & Groneberg 2006). The misclassification of asthma as COPD and vice versa can lead to inappropriate management strategies.
- Medications used to manage and treat other comorbid conditions may either trigger asthma symptoms or interact with asthma drugs. Examples are beta blockers to treat heart disease and anti-inflammatory drugs to treat arthritis (Braman & Hanania 2007).
- Asthma medications themselves may have increased side effects in older people (Quadrelli & Roncoroni 2001).
- Older people may not respond as well to drug treatment as young people. This may require more frequent adjustments to their treatment (National Heart Lung and Blood Institute 2007).
- Correct use of asthma inhalers, in particular metered dose inhalers, requires good coordination. Proper technique may be difficult for older people to adopt, due to arthritis or reduced cognitive ability (deShazo & Stupka 2009).
- Older people may have difficulties in accessing health care because of mobility limitations and other activity restrictions.
- Medicine affordability is an issue in some cases (AIHW: Australian Centre for Asthma Monitoring 2008).
- Older people with asthma may need to take preventative actions, such as influenza vaccination, to minimise the exacerbation of their symptoms due to infections.

1.2 Asthma over the life course

The National Health Survey (NHS) includes self-report estimates of asthma prevalence. While the NHS is the best source of national prevalence data, it must be noted that the NHS sampling does not cover some of the institutions for the elderly, such as nursing homes, and other non-private dwellings.

Despite this limitation, it is clear that the distribution of asthma over the life course shows significant variation between children and adults. In the 2001 and 2004–05 NHS, age-specific prevalence of asthma was higher in children and peaked during the teenage years. In 2004–05, more young people aged 10–14 years had asthma than any other age group. The prevalence steadily declined in young adults to a low point around 40–44 years and then there was a levelling off in the older ages (Figure 1.1).



Notes

1. Current asthma defined as either those who reported asthma as a long-term condition or reported ever being told they have asthma by a doctor or nurse and also answered 'yes' to 'do you still get asthma?'

2. Does not include residents of hospitals, nursing and convalescent homes, prisons, reformatories and single quarters of military establishments.

3. The age-specific estimates represent point prevalences of the disease. While this illustration refers to the life course of asthma, the pattern should not necessarily be generalised to being representative of any individual or population group.

4. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

Sources: AIHW analysis of ABS 2001 and 2004–05 NHS.

Figure 1.1: Prevalence of current asthma across various life stages

Older Australians were divided into three age groups for the purpose of this report. The NHS data was not used in isolation for this categorisation. Other factors taken into consideration included typical health status levels and retirement status (as an indicator of changes in daily activities), as well as consultation with the recognised experts of the Australian System for Monitoring Asthma Steering Committee. The three age groups are described below:

- *The 45–54 years age group* represents the turning point in asthma prevalence and, for the purpose of this report, the beginning of the older ages. From the age of 45 onwards, asthma begins to occur concurrently with a range of other conditions more frequently.
- At this stage in life people are typically beginning to think about retirement but the majority are still working. According to the 2004–05 ABS Multi-Purpose Household Survey (MPHS), 24% of all retired people retired during this period. Of those 45 years and over and still working, only 2% intended to retire during this period (Table 1.1).
- *The 55–69 years age group* typically represents the years in which daily routine changes but a person's health has not yet started to deteriorate dramatically.
- This is the life stage during which most people retire. According to the 2004–05 MPHS, 51.2% of all retirees left work during this period and 89.2% of people aged 45 years and over indicated their intention to retire in this age range.
- *The 70+ years age group* is a period in which health levels worsen and physical activity begins to decline. This is the period when few Australians are still working. The 2004–05 MPHS estimates that 97.3% of Australians were no longer working in this age range.

Table 1.1: Retirement status and intention to retire (per cent), persons aged 45 and above, 2004–05

	Age group			
Retirement status	**0–44**	**45–54**	**55–69**	**70+**
Retired—age retired	22	24	51	3
Not retired—intended age of retirement[(a)]		2	89	8

(a) Excludes persons who did not know what age they intend to retire.

Source: AIHW 2007

1.3 Monitoring asthma in older Australians

This report draws together data from various health sources, both survey-based and administrative. These include:

National Health Survey (NHS)

The NHS has been conducted periodically by the ABS since 1977. The series records the prevalence and management of health conditions and also examines quality of life. This report uses data from the 2001 and 2004–05 NHS.

The information about asthma status and actions is as reported by the respondent. Prevalent cases of asthma were defined as either those who reported asthma as a current long-term condition or those who reported ever being told they have asthma by a doctor or nurse and who also answered 'yes' to 'do you still get asthma?' This definition includes all people with current asthma as a long-term condition but not necessarily diagnosed by a doctor or nurse.

National Aboriginal and Torres Strait Islander Health Survey (NATSIHS)

The NATSIHS collects information on personal and household characteristics of Aboriginal and Torres Strait Islander people resident in private dwellings across all states and territories, including people living in remote areas. The NATSIHS is conducted every six years in conjunction with every second NHS. The NATSIHS sample consists of those identified as Indigenous in the NHS plus a much larger targeted Indigenous sample.

Prevalent cases of asthma were defined as those who reported having current asthma as a long-term condition, regardless of whether it had been diagnosed by a doctor or nurse.

The Burden of Disease and Injury in Australia 2003

The Burden of Disease and Injury study was the second national assessment of the burden of health conditions on the Australian population. It covered 176 diseases, injuries and risk factors. Burden in this context was measured by the years of healthy life lost due to premature mortality and prolonged illness or disability. Australian and international epidemiological studies were used to estimate asthma prevalence and years lived with disability. The International Classification of Diseases (ICD)–10 codes J45–46 were used to estimate asthma deaths.

Bettering the Evaluation and Care of Health (BEACH)

BEACH is a survey of general practice activity in Australia. BEACH data are collected every year from a random sample of about 1,000 general practitioners using a structured paper survey form. GPs are only included if they have claimed at least 375 general practice items from the Medicare benefits scheme in the previous 3 months. Each participating GP is required to provide details for 100 consecutive GP–patient encounters.

Information on the diagnosis and problem managed was classified according to the International Classification of Primary Care, 2nd edition (ICPC-2 PLUS). The code used to identify asthma-related GP encounters was R96.

National Hospital Morbidity Database (NHMD)

The NHMD is compiled from data supplied by the state and territory health authorities. It is a collection of electronic, confidentialised summary records for separations (episodes of care) in hospitals in Australia. At the time of writing, data was held for the years 1993–94 to 2007–08. Almost all hospitals in Australia are included in the database: public acute and public psychiatric hospitals, private acute and private psychiatric hospitals, and private free-standing day hospital facilities. Diagnoses, procedures and external causes of injury are recorded using the ICD10-AM.

Hospital separations for asthma were identified as those where the principal diagnosis was asthma (ICD-10 codes J45 and J46).

National Mortality Database (NMD)

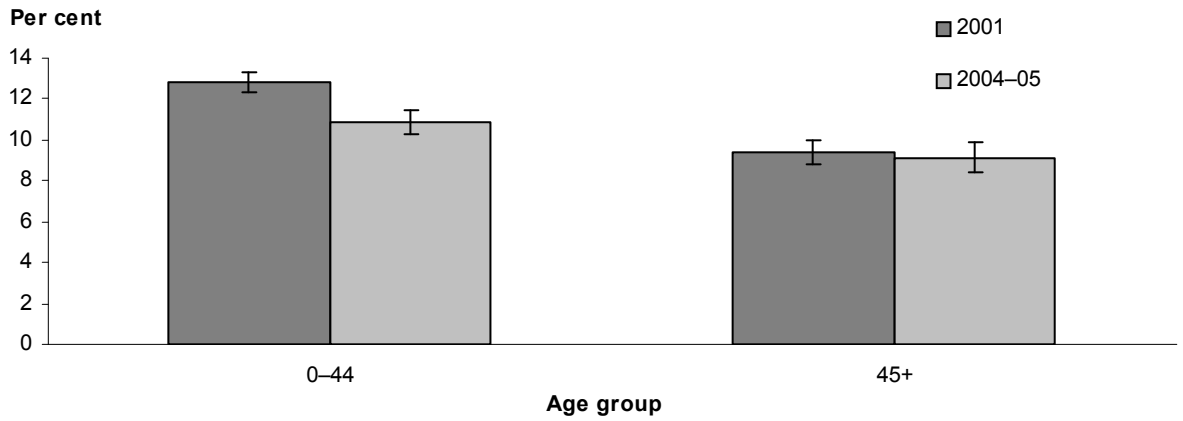
The NMD contains cause-based information for all deaths registered in Australia since 1964. Information is provided to the Australian Institute of Health and Welfare (AIHW) by the Registrars of Births, Deaths and Marriages, collated and coded nationally by the Australian Bureau of Statistics (ABS). Additional causes of death are available since 1997.

The classification of asthma as the underlying cause of death was based on ICD-10AM codes, J45 and J46.

2. Population statistics

2.1 Age distribution

Results from the NHS suggest that the overall prevalence of asthma in older Australians (those aged 45 years and over) did not change significantly between 2001 and 2004–2005 (9.1% versus 9.4% respectively). The prevalence of asthma in younger Australians (those aged under 45 years) varied more, but for both years the prevalence in older Australians was lower than in younger Australians (Figure 2.1).



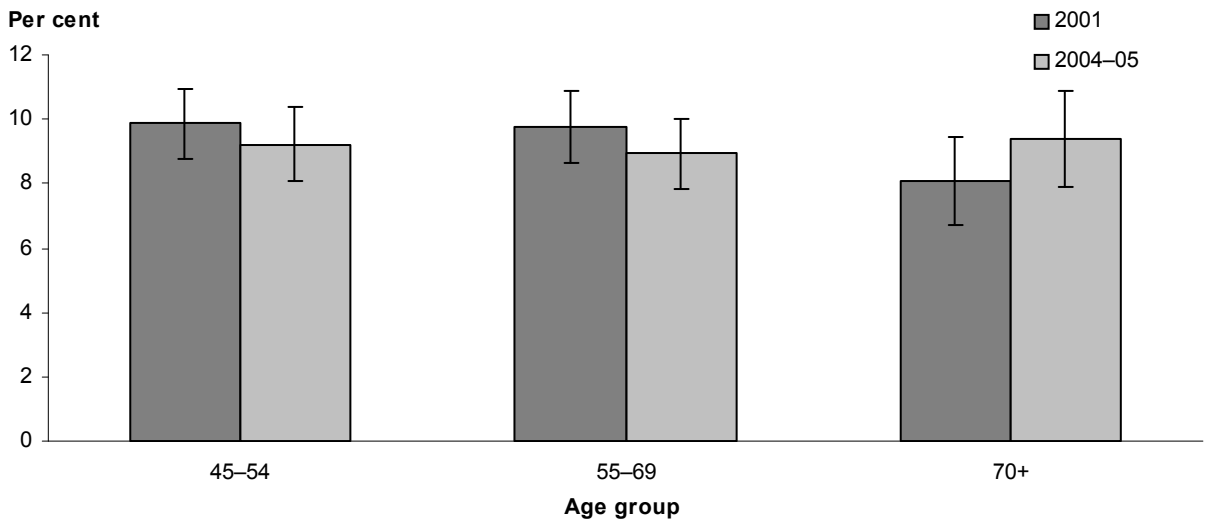
Notes

1. Current asthma defined as either those who reported asthma as a long-term condition or reported ever being told they have asthma by a doctor or nurse and also answered 'yes' to 'do you still get asthma?'
2. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

Sources: AIHW analysis of ABS 2001 and 2004–05 NHS CURFs.

Figure 2.1: Age-specific prevalence of current asthma, 2001 and 2004–05

The prevalence of asthma in older Australians in 2004–05 was 9.2% in the 45–54 years age group, 8.9% in the 55–69 years age group and 9.4% in the 70+ years age group. In 2001 the prevalence by age group was 9.9%, 9.8% and 8.1% respectively. This was not significantly different from the 2004–05 estimates (Figure 2.2). No significant variation in prevalence was found between the three age categories in either year.



Notes

1. Current asthma defined as either those who reported asthma as a long-term condition or reported ever being told they have asthma by a doctor or nurse and also answered 'yes' to 'do you still get asthma?'

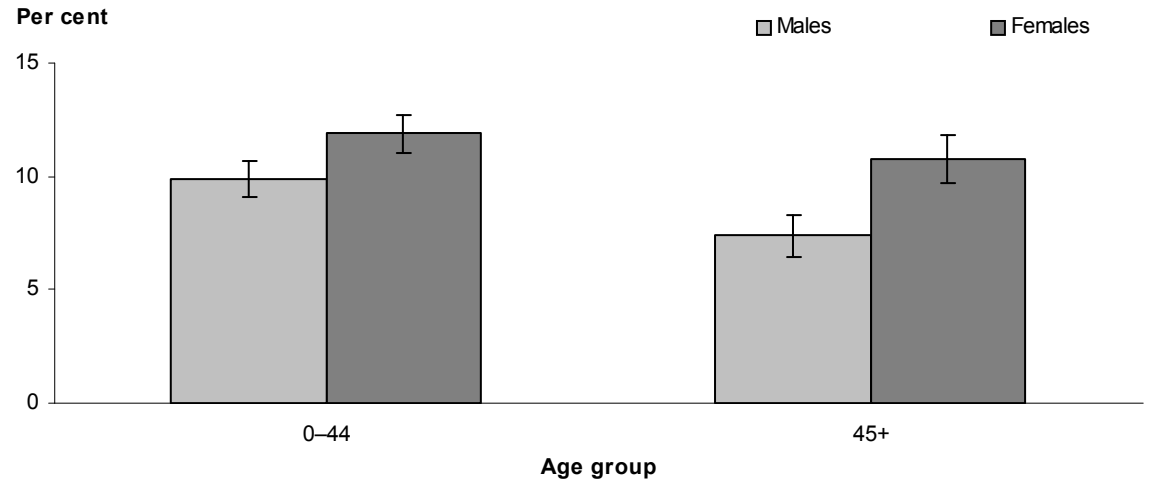
2. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

Sources: AIHW analysis of ABS 2001 and 2004–05 NHS CURFs.

Figure 2.2: Prevalence of current asthma in older Australians, 2001 and 2004–05

2.2 Gender

Among older Australians (those aged 45 years and over) asthma was more prevalent in females compared to males in 2004–05. This difference in prevalence between males and females was less evident in younger Australians (Figure 2.3).



Notes

1. Current asthma defined as either those who reported asthma as a long-term condition or reported ever being told they have asthma by a doctor or nurse and also answered 'yes' to 'do you still get asthma?'

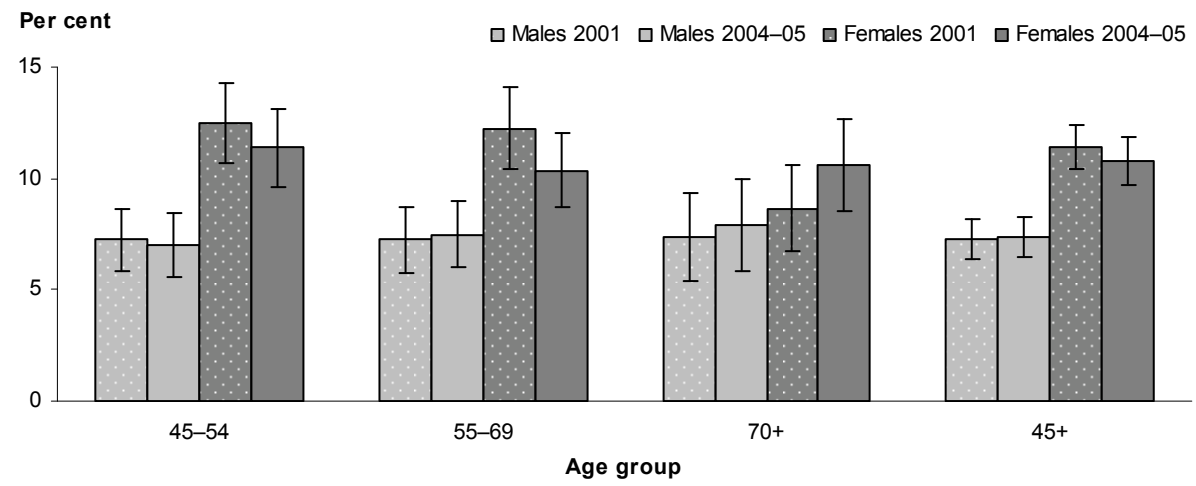
2. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

Source: AIHW analysis of ABS 2004–05 NHS CURFs.

Figure 2.3: Age-specific prevalence of current asthma, by sex, 2004–05

In 2004–05, the prevalence of asthma in older Australians was 10.8% for females and 7.4% for males. This was similar to 2001, where 11.4% of females and 7.3% of males reported asthma (Figure 2.4).

The higher prevalence of asthma among females compared to males was found across all three age groups in both the 2001 and 2004–05 surveys. The difference was greatest among the 45 to 54 years age group and least among the 70+ years age group. Of note is the relatively low prevalence of asthma among females aged 70+years in the 2001 survey. There was greater variability between the two surveys in female prevalence than in male prevalence.



Notes

1. Current asthma defined as either those who reported asthma as a long-term condition or reported ever being told they have asthma by a doctor or nurse and also answered 'yes' to 'do you still get asthma?'

2. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

Sources: AIHW analysis of ABS 2001 and 2004–05 NHS CURFs.

Figure 2.4: Prevalence of current asthma in older Australians, by age and sex, 2001 and 2004–05

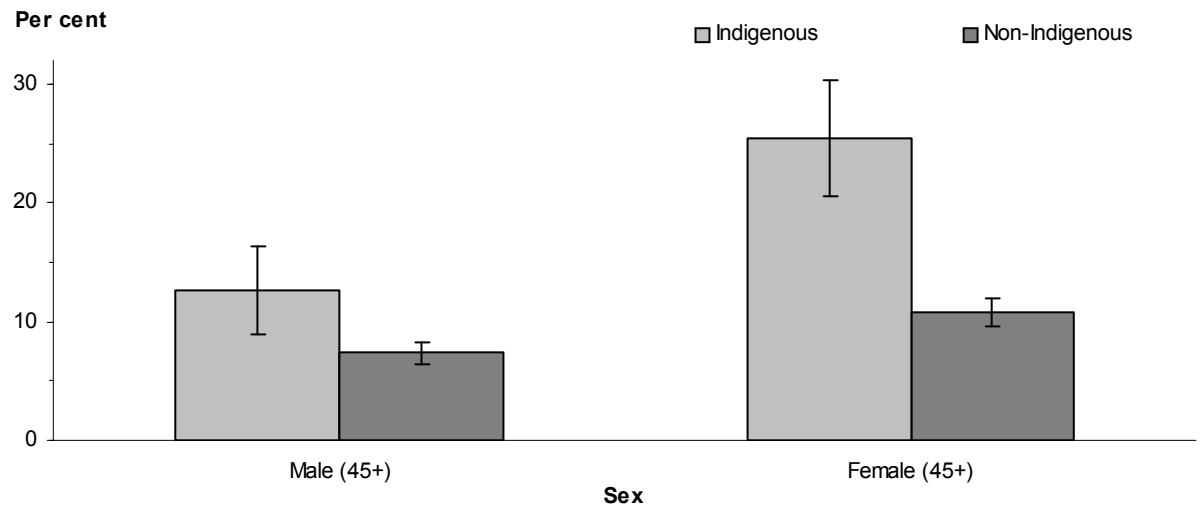
2.3 Aboriginal and Torres Strait Islander people

Among people aged 45 years and over, asthma is considerably more prevalent in Indigenous (19.4%) than non-Indigenous (9.1%) Australians. These findings are consistent with previous observations that the overall prevalence of asthma is higher among the Indigenous population (AIHW: ACAM 2008).

The higher prevalence among Indigenous people was seen in both males and females, despite there being relatively large confidence intervals around the Indigenous estimates. Of particular note is the difference in prevalence between the Indigenous (25.4%) and non-Indigenous (10.7%) females (Figure 2.5).

After adjusting for differences in their age structure, Indigenous males aged 45 and above were 1.9 times as likely to report having asthma as older non-Indigenous males. Indigenous females aged 45 and above were 2.2 times more likely to report having asthma compared to non-Indigenous females in the same age group.

Fewer Indigenous Australians reach the age ranges that are the focus of this report than non-Indigenous Australians, though. This causes difficulties in comparison and suggests that giving appropriate treatment to the issue of asthma among Indigenous Australians aged 45 years and over requires an independent study using alternative data sources to the NHS or NATSIHS.



Notes

1. Current asthma defined as either those who reported asthma as a long-term condition or reported ever being told they have asthma by a doctor or nurse and also answered 'yes' to 'do you still get asthma?'
2. Directly standardised to the Australian population as at 30 June 2001.
3. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

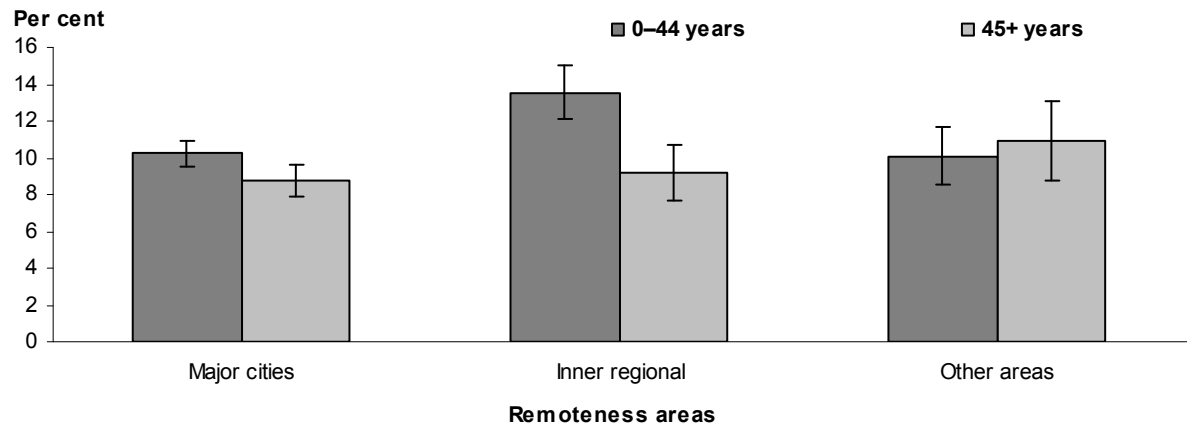
Source: AIHW analysis of ABS 2004–05 NATSIHS CURFs.

Figure 2.5: Prevalence of current asthma in older Australians, by indigenous status and sex, 2004–05

2.4 Remoteness

The prevalence of asthma in younger people (those aged less than 45 years) was highest in people living in *Inner regional* areas of Australia. The prevalence in older Australians was highest in people living in other, more remote, areas (*Outer regional, Remote and Very remote*).

In *Major cities* and in the *Inner regional* areas in 2004–05, asthma was less prevalent among older people than younger people (those aged less than 45 years). In *Major cities* the prevalence among older people was 8.8% compared with a significantly higher prevalence in the younger ages of 10.3%. In *Inner regional* areas, prevalence was 9.2% and 13.5% respectively (Figure 2.6).



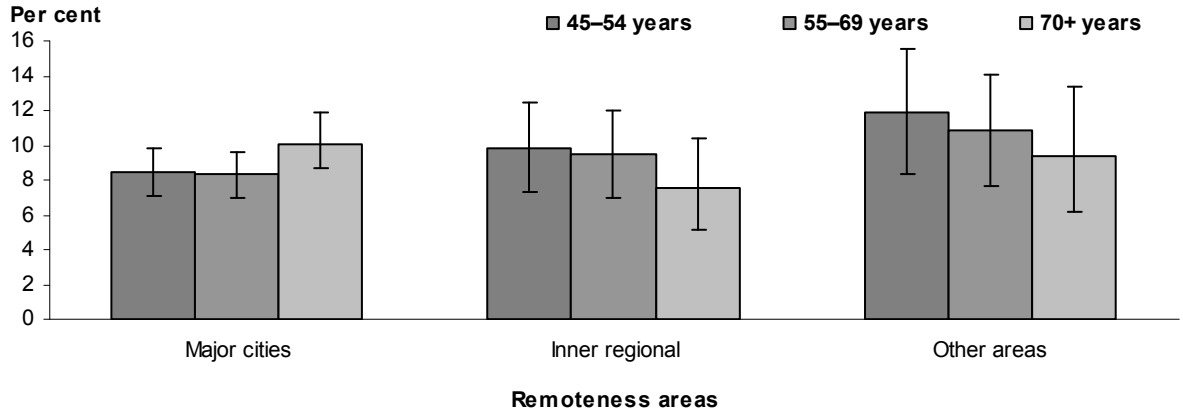
Notes

1. Other areas includes Outer regional, Remote and Very remote categories of remoteness.
2. Current asthma defined as either those who reported asthma as a long-term condition or reported ever being told they have asthma by a doctor or nurse and also answered 'yes' to 'do you still get asthma?'
3. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

Source: AIHW analysis of ABS 2004–05 NHS.

Figure 2.6: Prevalence of current asthma by age and remoteness area, 2004–05

For older Australians, the 70+ years age group in the *Inner regional* areas had the lowest estimated asthma prevalence (7.6%) (Figure 2.7); contrasting strongly with the young (those aged 0–44) in the same area where the prevalence was much higher at 13.5% (Figure 2.6). In *Asthma in Australia 2008* (AIHW: ACAM 2008) it was reported that among people in *Inner regional* areas, the prevalence of asthma was particularly high (15.1%) in people aged 5–34 years.



Notes

1. Other areas include Outer Regional, Remote and Very Remote categories of remoteness.
2. Current asthma defined as either those who reported asthma as a long-term condition or reported ever being told they have asthma by a doctor or nurse and also answered 'yes' to 'do you still get asthma?'
3. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

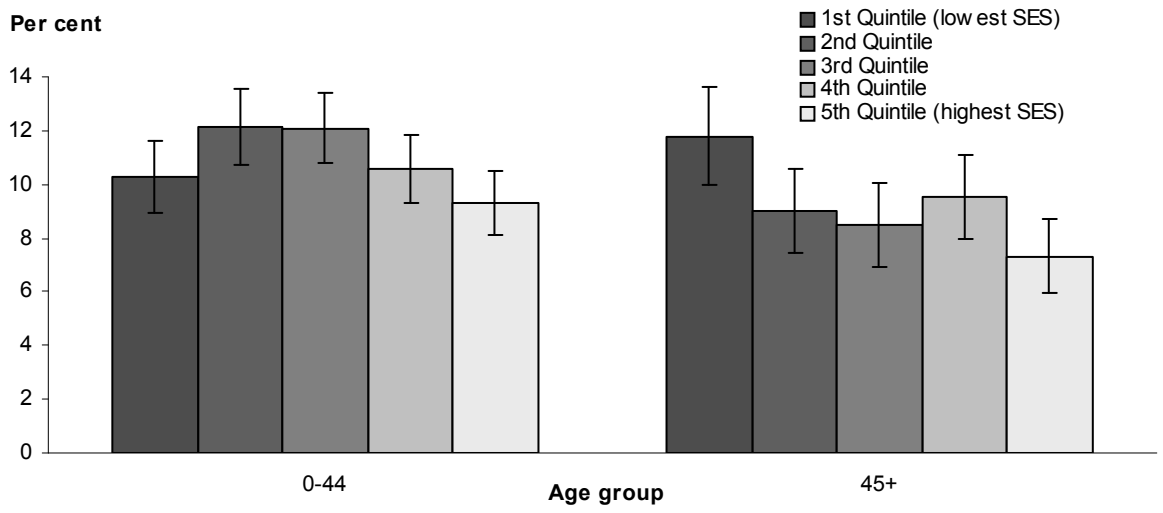
Source: AIHW analysis of ABS 2004–05 NHS CURFs.

Figure 2.7: Prevalence of current asthma in older Australians by age and remoteness area, 2004-05

2.5 Socioeconomic status

The Index of Relative Socioeconomic Disadvantage is one of four Socio-Economic Indexes for Areas (SEIFAs) developed by the Australian Bureau of Statistics. It was used to investigate the relationship between the prevalence of asthma and socioeconomic status.

In 2004–05, the prevalence of asthma showed greater variability by socioeconomic status in older Australians (those aged 45 years and over) than in younger Australians (those aged under 45 years) (Figure 2.8).



Notes

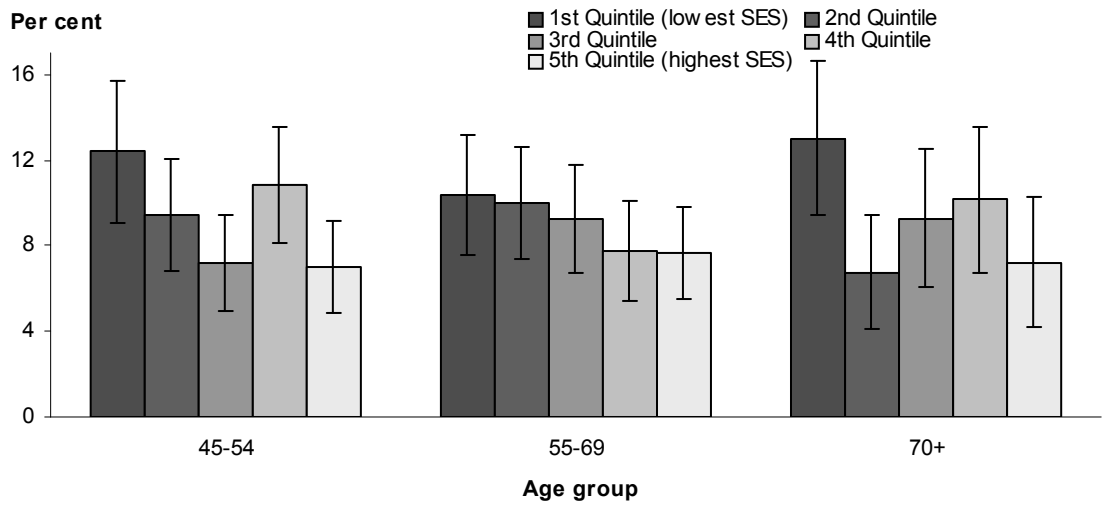
1. Current asthma defined as either those who reported asthma as a long-term condition or reported ever being told they have asthma by a doctor or nurse and also answered 'yes' to 'do you still get asthma?'

2. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

Source: AIHW analysis of ABS 2004–05 NHS CURFs.

Figure 2.8: Prevalence of current asthma by socioeconomic status (quintiles), 2004–05

In older people, prevalence was significantly higher in the lowest socioeconomic status (SES) localities compared with those in the highest SES localities. This difference was most pronounced in the 45–54 years and the 70+ years age groups (Figure 2.9).



Notes

1. Current asthma defined as either those who reported asthma as a long-term condition or reported ever being told they have asthma by a doctor or nurse and also answered 'yes' to 'do you still get asthma?'

2. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

Source: AIHW analysis of ABS 2004–05 NHS CURFs.

Figure 2.9: Prevalence of current asthma in older Australians by socioeconomic status (quintiles), 2004–05

3. Asthma and the older person

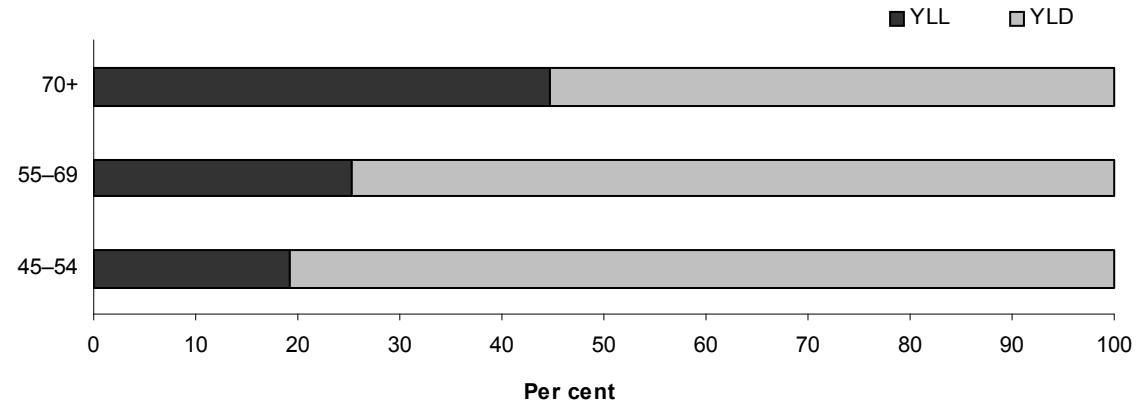
Asthma impacts older Australians adversely in two key ways—through affecting their ability to function at their full capacity and by contributing to premature death. The following section describes these impacts using the most recent data on the impact of asthma in terms of the burden of the disease, as measured by disability adjusted life years (DALYs) (Box 3.1).

Box 3.1: Disability adjusted life years

The statistic, disability adjusted life year (DALY) was developed in 1990 for the Global Burden of Disease study. It is used to measure 'burden of disease' caused by an illness or injury. The measure includes both a fatal and non-fatal component. The fatal component is the number of years lost due to premature death and the non-fatal component is the amount of time spent living with poor health or disability. One DALY is equal to one year of healthy life lost. The more DALYs, the greater the health burden. For each health condition the DALY is calculated as the sum of the years of life lost due to premature mortality (YLL) and the years of life lost due to disability (YLD). This measure can be calculated for any disease or injury that results in poor health, disability or death.

3.1 Disability and burden of disease

The majority (71%) of the asthma burden in older people (those aged 45 years and over) is due to years lost on account of disability (YLD) with years of life lost due to mortality (YLL) responsible for only 29% of DALYs. The contribution of mortality to the overall asthma burden increases with age, from 19% in those aged 45–54 years to 45% in those aged 70 years and over (Figure 3.1).



Source: AIHW: Begg et al. 2007

Figure 3.1: Burden of asthma in older Australians, by age

The 55–69 years age group accounted for just under half of the asthma DALYs for older Australians. Almost two-thirds of the overall asthma burden in older Australians was experienced by females (Table 3.1).

Table 3.1: Burden of asthma in older Australians, 2003

	Males				Females				Persons			
DALYs	**45–54**	**55–69**	**70+**	***Total***	**45–54**	**55–69**	**70+**	***Total***	**45–54**	**55–69**	**70+**	***Total***
Number	803	1,600	796	*3,199*	1,562	2,625	1,839	*6,027*	2,365	4,225	2,636	*9,226*
Per cent	25	50	25	*100*	26	44	31	*100*	26	46	29	*100*

3.2 Mortality

Another key indicator of the effect of asthma on a population is mortality. Deaths due to asthma represent a relatively rare outcome but may be an important indication of the overall impact of asthma exacerbations and are a particular issue for the older age groups.

In 2006, asthma was identified as the underlying cause of 402 deaths (139 males and 263 females) (Table 3.2). This accounted for 0.3% of all deaths in Australia that year with a rate of 9.2 deaths per 100,000 population. Over 90% of these deaths were among those aged 45 years and over. The 70+ age group accounted for more than two-thirds of all deaths. The average age at death was 79 years.

Information about deaths due to a specific condition may be listed as either the underlying cause of death (the condition that initiated the train of morbid events leading directly to death) or as an associated cause of death (a condition that gave rise to the underlying cause, or that, in some other way, contributed to death). Asthma was recorded as an associated cause in 853 deaths in 2006. Of these, almost 97% were among people aged 45 years and over.

Table 3.2: Deaths with asthma as the underlying cause, 1998 to 2006

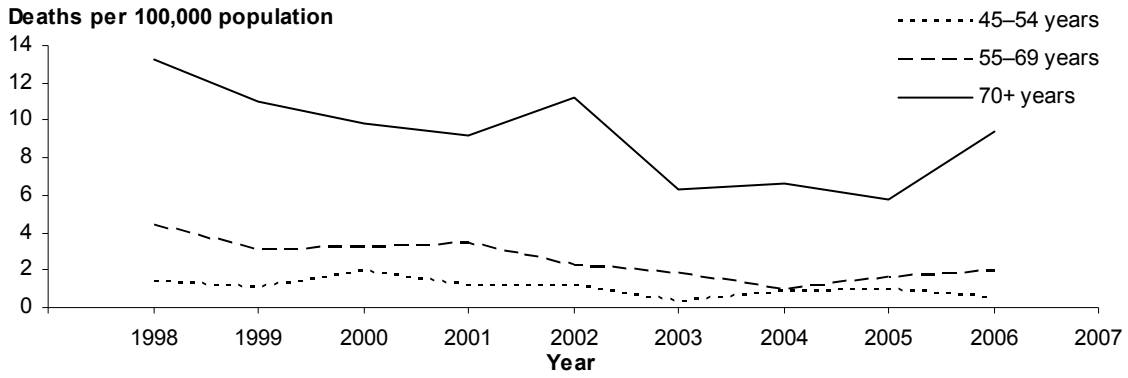
	Year								
Age group	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**
	Males								
0–44	31	36	35	48	27	28	28	24	19
45–54	17	13	25	16	16	5	12	13	8
55–69	52	37	39	43	29	25	14	23	28
70+	87	74	70	68	86	50	54	48	84
Total	*187*	*160*	*169*	*175*	*158*	*108*	*108*	*108*	*139*
	Females								
0–44	46	36	42	31	30	19	21	25	14
45–54	28	27	29	15	28	16	14	16	16
55–69	52	57	55	53	44	41	30	26	44
70+	168	144	159	148	137	130	140	143	189
Total	*294*	*264*	*285*	*247*	*239*	*206*	*205*	*210*	*263*
	Persons								
0–44	77	72	77	79	57	47	49	49	33
45–54	45	40	54	31	44	21	26	29	24
55–69	104	94	94	96	73	66	44	49	72
70+	255	218	229	216	223	180	194	191	273
Total	*481*	*424*	*454*	*422*	*397*	*314*	*313*	*318*	*402*

Note: Deaths for which the underlying cause of death was coded to ICD-10 J45–J46.
Source: AIHW National Mortality Database.

Mortality from asthma in Australia (all ages) has been declining since the late 1980s for both males and females, although there was an increase in the numbers in 2006. Most of the overall decline has occurred among the 70+ years age group.

Asthma mortality rates for males in the 55–69 years age group decreased steadily until 2004, then increased in 2005 and 2006 (Figure 3.2).

In the male 70+ years age group the rate of mortality attributed to asthma decreased from 13.3 per 100,000 in 1998 to 5.7 per 100,000 in 2005. There were two spikes in the asthma mortality rate in 2002 and 2006 for this age group.



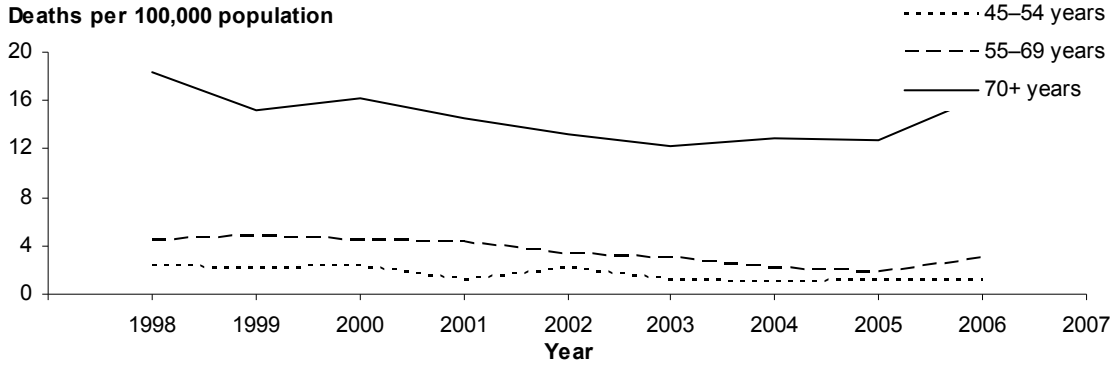
Note: Age-standardised to the Australian population as at June 2001. Asthma classified according to International Classification of Diseases, 10th revision (ICD-10) codes J45 and J46.

Source: AIHW National Mortality Database.

Figure 3.2: Trends in asthma deaths; older males, 1998 to 2006

Asthma mortality rates for females in the 55–69 age group showed a similar decreasing trend to males but rates were consistently higher in females compared with males (figures 3.3 and 3.4).

In the female 70+ years age group, the rate of mortality attributed to asthma decreased from 18.4 per 100,000 in 1998 to 12.7 per 100,000 in 2005. Though the overall asthma mortality rate decreased in this age group, there were increases in 2000, 2004 and in 2006.



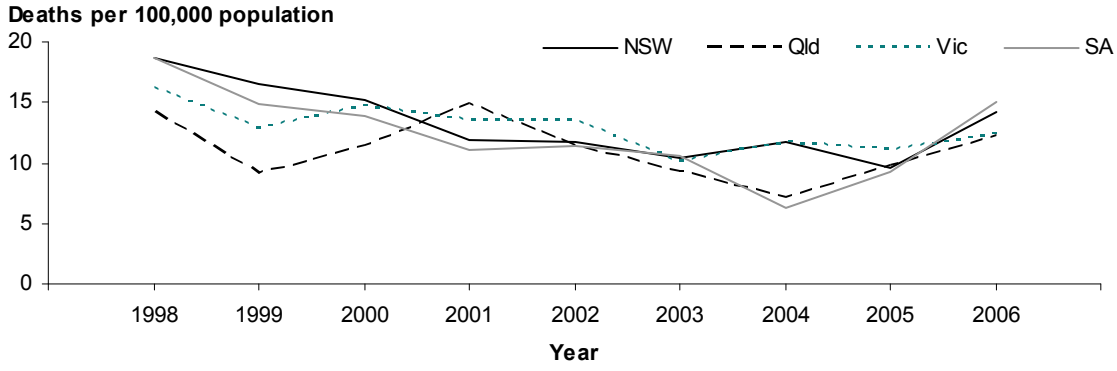
Note: Age-standardised to the Australian population as at June 2001. Asthma classified according to International Classification of Diseases, 10th revision (ICD- 10) codes J45 and J46.

Source: AIHW National Mortality Database.

Figure 3.3: Trends in asthma deaths; older females, 1998 to 2006

Preliminary data for 2007 suggests that the relatively high numbers of deaths in the 70+ age group in 2006 have continued. In 2007 there were 241 deaths (11.4 per 100,000 population) attributed to asthma in the 70+ years age group, 25% higher than the 191 deaths (9.7 per 100,000) in 2005 but down from 273 (13.3 per 100,000) in 2006.

Of the four states with the highest number of deaths in the 70+ years age group, New South Wales (NSW) and South Australia (SA) had the largest increase between 2005 and 2006 (Figure 3.4). The rise was concentrated in the months of February to May.



Note: Age-standardised to the Australian population as at June 2001. Asthma classified according to International Classification of Diseases, 10th revision (ICD–10) codes J45 and J46.

Source: AIHW National Mortality Database.

Figure 3.4: Trends in asthma deaths among in people aged 70+, NSW, Qld, Vic and SA

4. Asthma and health service use

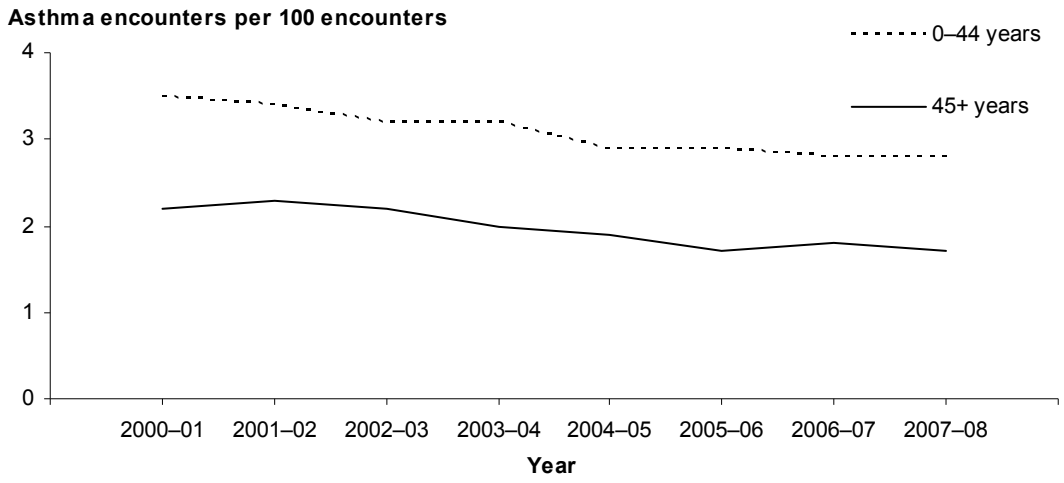
Beyond the impact on the individual, asthma in older Australians has a significant impact on the health sector. The management of asthma occurs mainly in the primary care setting. Because of added complications, hospitalisation is also often required in older age groups. The BEACH data collection is an important source of information on GP service utilisation for asthma, as is the National Hospital Morbidity Database (NHMD).

4.1 General practice encounters

Two main measures of GP service use are:

- The proportion of GP encounters for which asthma is a reason for the visit. This measure captures those cases where the patient specifically went to the GP to address issues with asthma.
- The proportion of encounters at which asthma was managed by the GP. This measure captures those visits in which the patient may not have gone to the GP specifically for asthma but where the GP addressed the patient's asthma.

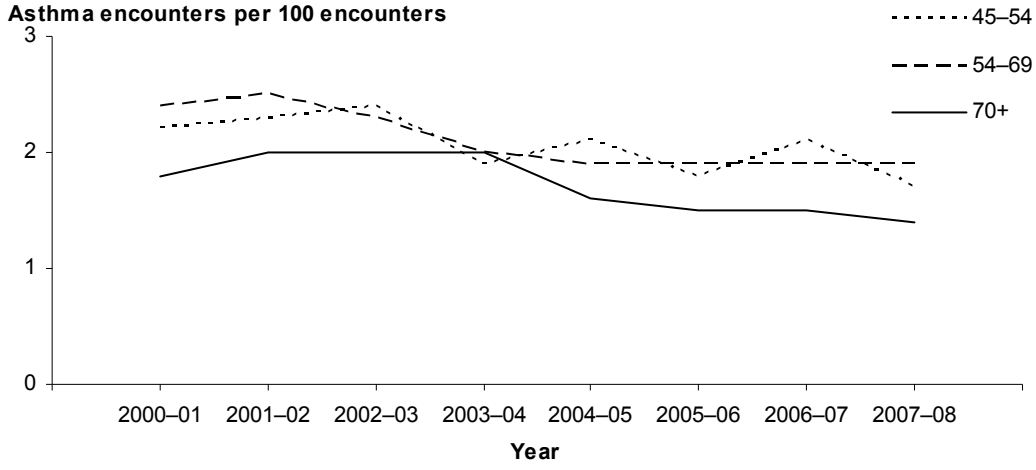
The proportion of GP encounters at which asthma was managed has declined from 2000–01 to 2007–08 for all age groups (Figure 4.1). The drop over this period has been similar both in younger Australians (20% decline) and older Australians (22.7% decline).



Source: Unpublished BEACH data

Figure 4.1: Trends in GP management of asthma, by age, 2001–01 to 2007–08

This trend has been somewhat consistent across all age groups of older Australians (Figure 4.2). All have shown a decline over the past eight years in the proportion of GP encounters in which asthma was managed. There was no meaningful difference among the age groups in the proportion of GP encounters at which asthma was managed or in the rate of decline over time.



Source: Unpublished BEACH data.

Figure 4.2: Asthma problems managed in older Australians per 100 GP encounters, 2001–01 to 2007–08

The rate that asthma was managed in GP encounters was higher in younger Australians compared to older Australians. Among those aged 45 years and above, the rate was lowest in the 70+ years age group, for all years except 2003–04.

4.2 Hospitalisations

People with severe exacerbations of asthma sometimes require in-patient hospital care, usually for a relatively short period.

The number of hospital separations with a principal diagnosis of asthma (ICD-10 codes J45 and J46) does not include events where asthma was treated in emergency departments only. When a person attends an emergency department only, there is no formal admission to hospital, no episode and no separation recorded in the NHMD.

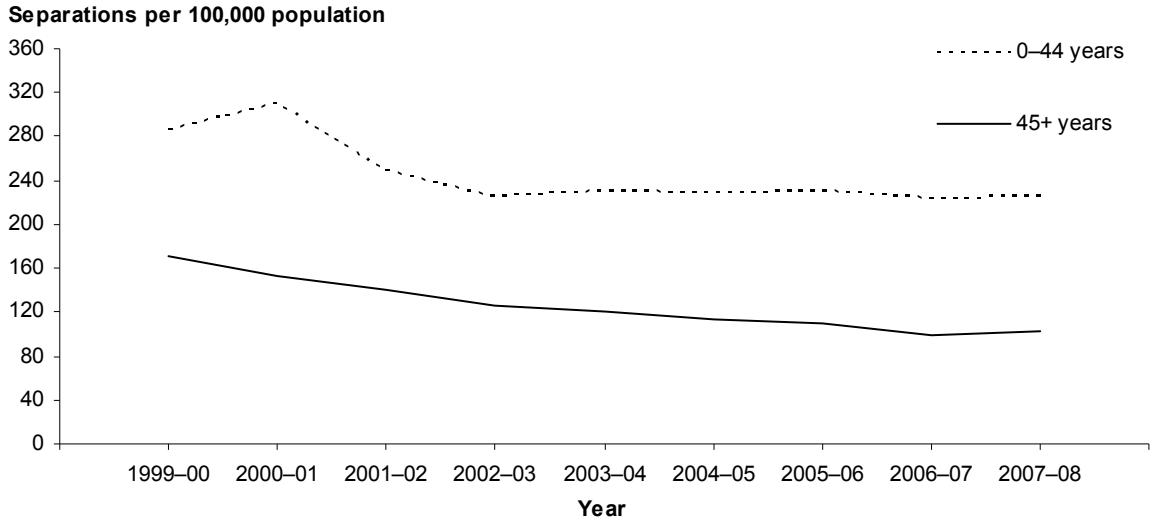
In 2007–08, there were 37,641 hospital separations with the principal diagnosis of asthma (0.5% of all hospital separations) for all ages. The majority of the hospital stays were for people aged less than 45 years (78%). For older Australians (those aged 45 years and over), hospital separation rates gradually increased with age, with the highest rates observed in the 70+ years age group.

The average length of stay in 2007–08 for all people admitted to hospital with a principal diagnosis of asthma was 2.2 days. In people aged 45 years and over, average length of stay was 4.3 days. The average length of hospital stay increases with age due to a combination of various factors, such as increased comorbidities and the slower pace of recovery with age (AIHW: Karmel et al. 2007).

4.2.1 Trends in hospital separations for asthma

Hospital separations for asthma are declining in both younger and older Australians. Between 1999–00 and 2007–08, the separation rate for asthma in people aged 45 years and over decreased by 40%. The corresponding rate decrease for people aged 0–44 years was 27% (Figure 4.3).

The rate of decrease of hospital separations for asthma in older Australians has remained relatively constant over the period examined. This decline runs contrary to the trend in total hospital separations in Australia (AIHW 2009). The total hospital separation rate (including asthma) in older Australians increased by 22% between 1999–00 and 2007–08.



Notes

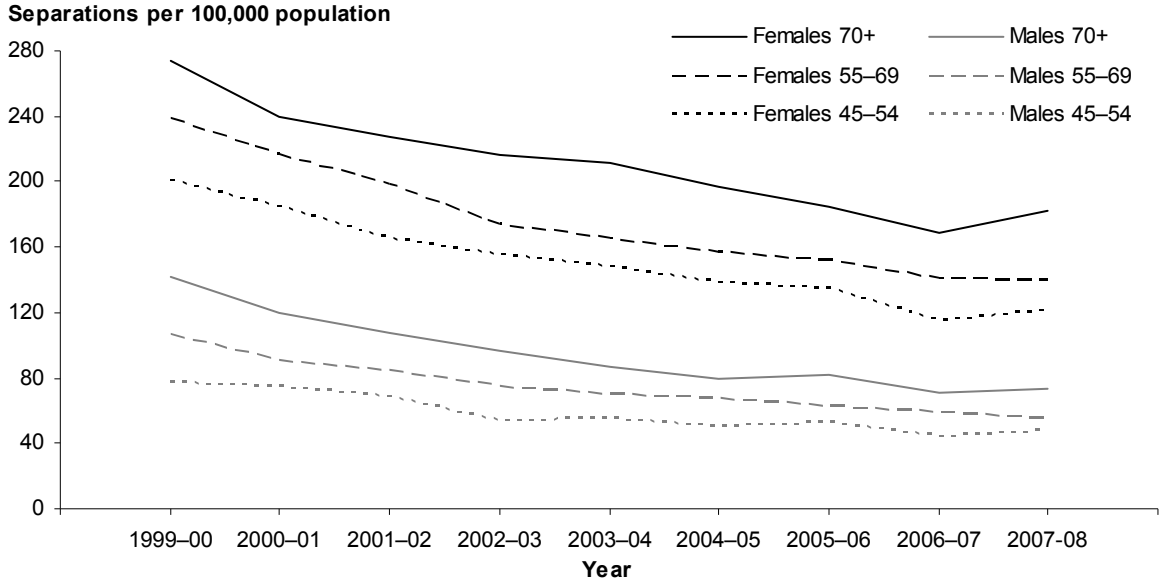
1. Age-standardised to the Australian population as at June 2001.

2. Asthma classified according to International Classification of Diseases, 10th revision (ICD-10) codes J45 and J46.

Source: AIHW National Hospital Morbidity Database.

Figure 4.3: Trends in asthma hospitalisations, by age, 1999-00 to 2007-08

The largest decrease in older Australians was seen in the males 55–69 and 70+ years age groups (a decrease in both of 48%), whereas the smallest change was observed in the females 70+ years age group (a 34% drop) (Figure 4.4). This differs from the overall upward trend in the hospital separation rate for people aged 70 years and over which increased by 36% between 1999–00 and 2007–08.



Notes

1. Age-standardised to the Australian population as at June 2001.

2. Asthma classified according to International Classification of Diseases, 10th revision (ICD-10) codes J45 and J46.

Source: AIHW National Hospital Morbidity Database.

Figure 4.4: Trends in asthma hospitalisations for older Australians, 1999–00 to 2006–07

Many factors may have influenced the decline in hospital separations for asthma in the older age groups. For instance, improvements in management or environmental changes may have contributed to declines in the severity of asthma (AIHW: Australian Centre for Asthma Monitoring 2008). This decline in hospital admissions is not reflected in a reduction in the prevalence of asthma for these age groups.

By way of comparison, COPD hospitalisations have shown relatively little change across the three age groups during this period. The drop in asthma hospitalisations, therefore, cannot be attributed to a transfer in classification as there was no corresponding rise in COPD separations.

4.2.2 Indigenous status

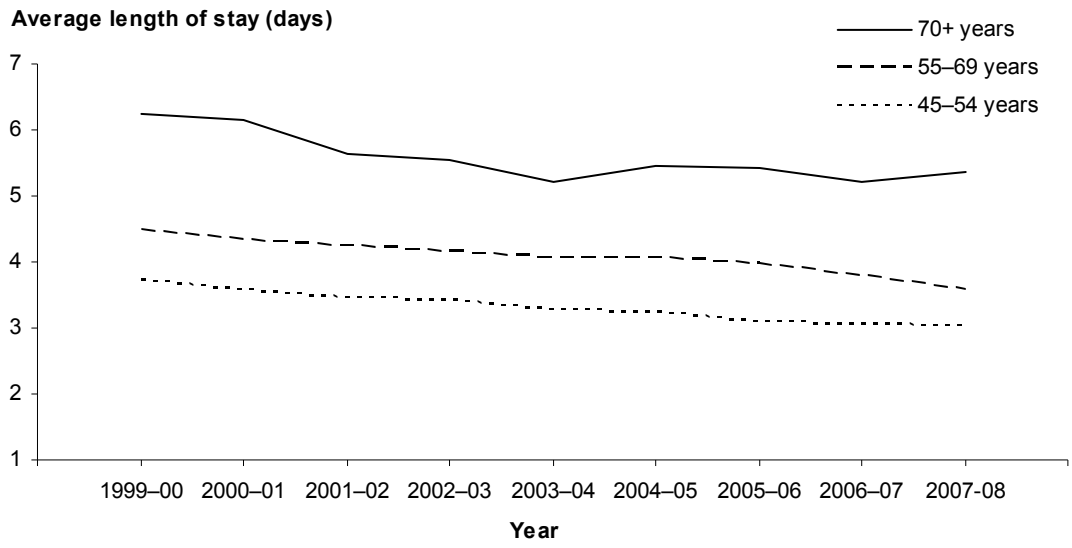
In 2007–08, Indigenous Australians aged 45 years and over were over four times as likely to be hospitalised for asthma compared to all Australians. Indigenous hospital separation rates were investigated for six states, NSW, Vic, Qld, WA, SA and NT (NT public hospitals only), for which the quality of Indigenous identification is considered acceptable for the purpose of analysis. These six jurisdictions represent 96% of the Indigenous population. In these six

states, the rate of separations for Indigenous Australians was 422.9 separations per 100,000 population. In comparison, the rate of hospital separations for all Australians in the six states was 96.0 separations per 100,000 population.

4.2.3 Trends in the length of hospital stays

The average length of hospital stay for asthma in older Australians has gradually declined since 1999–00 (Figure 4.5). This trend is consistent with an overall decline in the length of hospital stays in Australia. This partly reflects a steady upward trend in the proportion of separations that are day-only (AIHW 2009).

Among those aged 45 years and over, the length of stay for asthma decreased by 17% between 1999–00 and 2007–08. The decrease was similar across all age groups. For each year the length of stay among those aged 70+ years was almost double that for people aged 45–54 years.



Notes:

1. Asthma classified according to International Classification of Diseases, 10th revision (ICD-10) codes J45 and J46.

2. Separations for which the care type was reported as Newborn with no qualified days and records for Hospital boarders and Posthumous organ procurement have been excluded.

Source: AIHW National Hospital Morbidity Database.

Figure 4.5: Trends in average length of stay for asthma for older Australians, 1999–00 to 2006–07

5. Comorbidities at death in older people with asthma

One factor that differentiates asthma in older Australians from their younger counterparts is the greater presence of other comorbid conditions. These comorbidities contribute to asthma exacerbations and complicate the management and treatment of asthma.

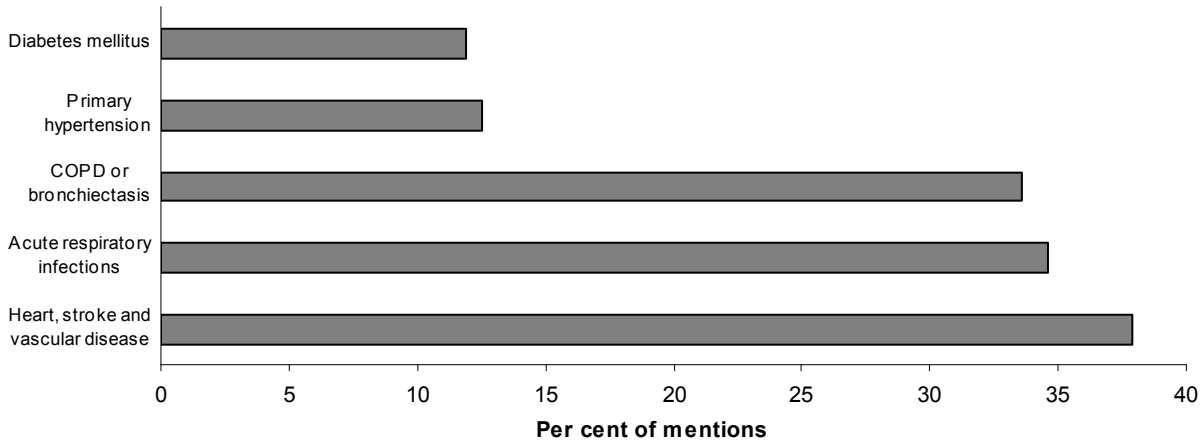
Analyses of comorbid conditions associated with asthma are based here on underlying and associated causes of death. Here we define a condition as comorbid where both asthma and the conditions are mentioned on the death certificate (either as underlying or associated causes of death).

This section examines the common comorbidities in older people with asthma and identifies those conditions that are more prevalent in those whose deaths were attributed to asthma compared with those who died due to other causes. For these conditions, overall trends are then outlined.

5.1 Comorbidities

Figure 5.1 presents conditions commonly listed as associated causes of death among people aged 45 years and over whose underlying cause of death in 2006 was asthma. A comparison with deaths below 45 years could not be made as the numbers were too small to generate reliable estimates.

Among asthma deaths at ages 45 years and over, the most common associated causes of death were heart, stroke and vascular disease (38%). This was closely followed by acute respiratory infections (35%) and chronic respiratory conditions, COPD or bronchiectasis (34%). Other comorbidities that were often listed as associated causes of death were primary hypertension and diabetes mellitus.



Note: Asthma classified according to International Statistical Classification of Diseases, 10th Revision (ICD-10) codes J45 and J46. Comorbidities were classified as follows: heart, stroke and vascular disease (I20–I25, I60–I69, I50,I70–I79); acute respiratory infections (J0–J22); chronic obstructive pulmonary disease (COPD) and bronchiectasis (J40–J44, J47); diabetes mellitus (E10–E14); primary hypertension (I10).

Source: AIHW National Mortality Database.

Figure 5.1: Associated causes of death where asthma was the underlying cause, 2006

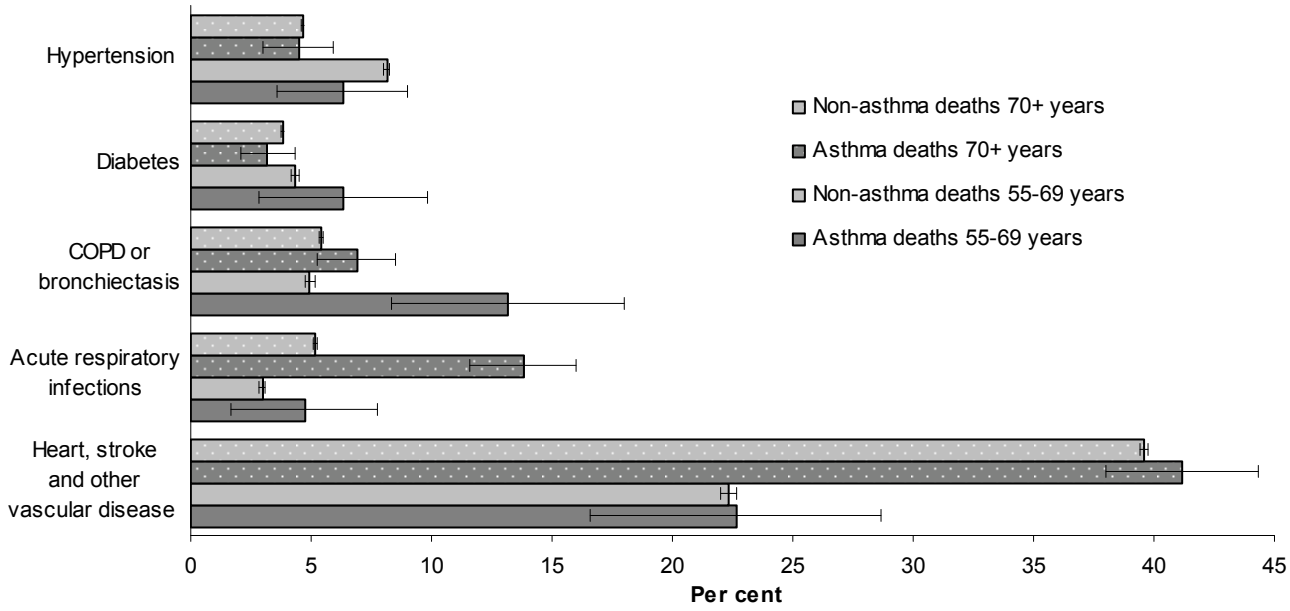
To determine whether these comorbidities were more prevalent in asthma deaths (where asthma was listed as either the principal cause of death or the associated cause of death) compared with non-asthma deaths (where asthma was not listed anywhere on the death certificate), the prevalence of each condition was examined.

Deaths in the 45–54 years age group were not analysed because there were too few to provide meaningful results.

The presence of COPD, bronchiectasis or acute respiratory infections were more commonly associated with asthma deaths than with non-asthma deaths in people aged 55 years and over (Figure 5.2).

The increased presence of COPD or bronchiectasis in people whose death was attributed to asthma was particularly marked among people aged 55–69 years. When asthma was either the principal or an associated cause of death in this age group, COPD or bronchiectasis were noted in 13.2% (95% confidence interval (CI) 8.3–18.0) of all deaths. This is more than twice the proportion that the two conditions were listed as a cause where asthma was not listed as a cause (4.9%; 95% CI 4.8–5.1). A smaller difference was seen in the 70+ years age group, 6.9% (95% CI 5.3–8.3) for asthma deaths compared with 5.4% (95% CI 5.3–5.5) in non-asthma deaths. These findings confirm other research suggesting that asthma deaths are more often

associated with COPD or bronchiectasis than non-asthma deaths (AIHW: ACAM 2008; Welte & Groneberg 2006).



Notes:

1. Asthma classified according to International Statistical Classification of Diseases, 10th revision (ICD-10) codes J45 and J46. Comorbidities were classified as follows: heart, stroke and vascular disease (I20–I25, I60–I69, I50, 70–I79); acute respiratory infections (J0–J22); chronic obstructive pulmonary disease (COPD) or bronchiectasis (J40–J44, J47); diabetes mellitus (E10–E14); primary hypertension (I10).

2. Error bars represent 95% confidence intervals; that is, a range (interval) of values within which we can be '95% confident' that the true value lies.

Source: AIHW National Mortality Database.

Figure 5.2: Associated causes of death in asthma and non-asthma deaths, 2006

The other commonly associated cause in asthma deaths was the group of acute respiratory infections, including influenza, pneumonia and other acute respiratory infections. In 2006, in people aged 55 years and over, acute respiratory infections were mentioned more commonly on the death certificates where asthma was mentioned than where asthma was not. In the 55–69 years age group the proportion of deaths where asthma was mentioned and an acute respiratory infection was also mentioned was 4.7% (95% CI 1.7–7.8) compared with 3.0% (95% CI 2.8–3.1) where an acute respiratory infection was mentioned but asthma was not. The difference was more significant among those aged 70 years and over where the prevalence of acute respiratory infections as an associated cause of death among people who died from asthma was almost three times higher than in those who died from other causes (13.8% (95% CI 11.6–16.0) compared with 5.2% (95% CI 5.1–5.2)).

The higher percentage of acute respiratory infections noted in asthma deaths compared with non-asthma deaths is likely to be due to the fact that some respiratory infections may act as a trigger for exacerbations of asthma and increase the risk of death in older age groups (Singh & Busse 2006).

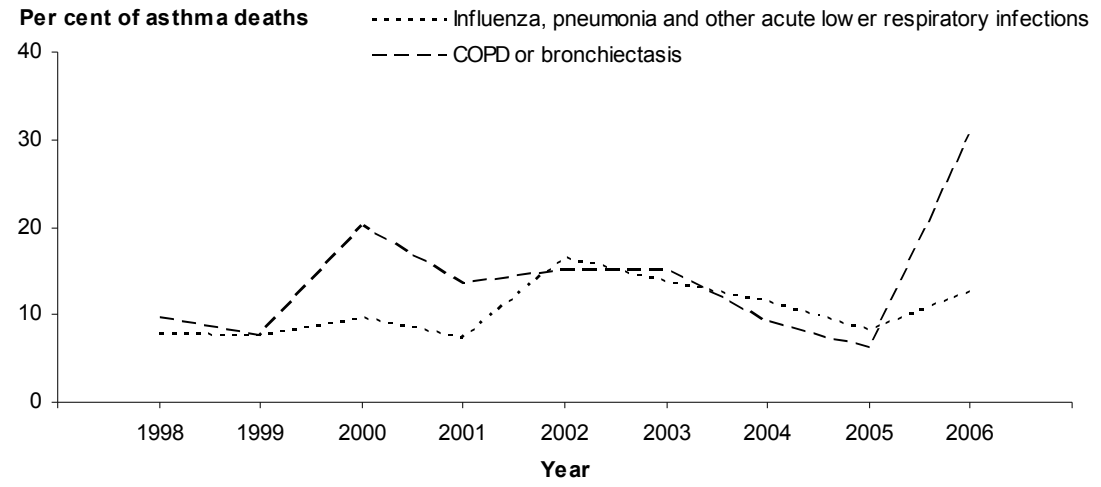
5.2 Trends in mortality and comorbidities

This section outlines the trends in the conditions identified above as being particularly associated with asthma, including influenza, pneumonia and other acute respiratory infections and COPD or bronchiectasis. The analysis was limited to the two age groups for which adequate numbers were available, the 55–69 years and 70+ years age groups. The trends are shown in Figures 5.3 and 5.4.

The proportion of people who died from asthma who had comorbid COPD or bronchiectasis remained relatively steady in both the 55–69 years age group and the 70+ years age group from 1998 to 2005. In 2006 there was a fourfold increase in COPD or bronchiectasis as a comorbid condition among asthma deaths in the 55–69 years age group and a twofold increase in the 70+ years age group. This contrasts with COPD death rates in general, which have been declining steadily for several decades.

Acute respiratory infection comorbidity increased from 1998 to 2006 in both age groups. The rise was consistent in the 70+ years age group, whereas there was greater variation in the 55–69 years age group. Acute respiratory infection comorbidity peaked in 2002 at 16.4% then decreased until 2005, after which it rose again.

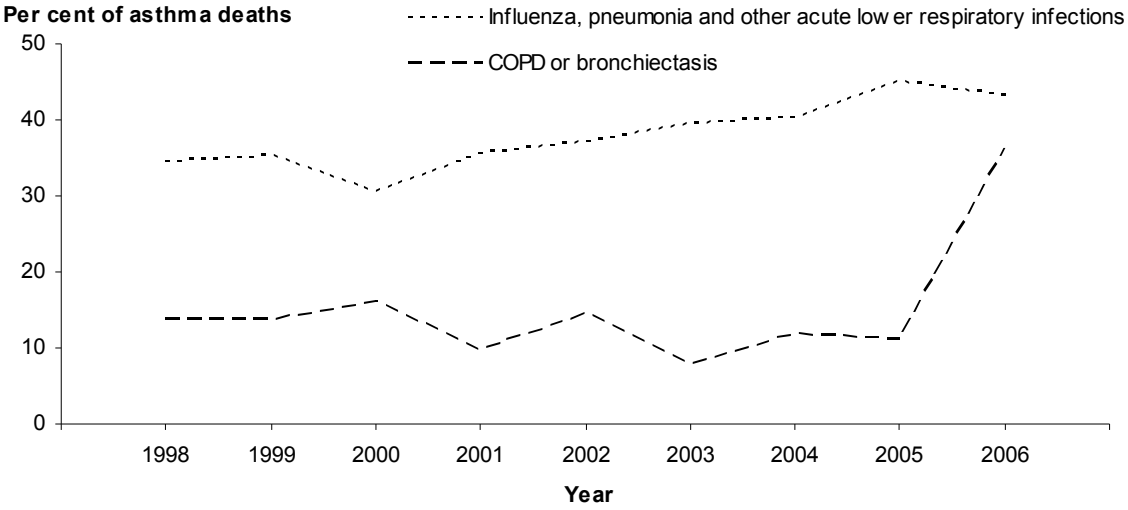
Rises in infection incidence rates do not seem to explain the general rise in acute respiratory infection comorbidity. Influenza notifications from the National Notifiable Diseases Surveillance System did not show an increase in the number of notifications for the years 2002 to 2006 and the rate of hospitalisation for acute respiratory diseases has remained relatively steady from 1999 to 2006 for both the 55–69 years and 70+ years age groups. These findings suggest acute respiratory infections are having increasingly more serious effects on asthma patients compared with the general population.



Note: Asthma classified according to International Statistical Classification of Diseases, 10th revision (ICD-10) codes J45 and J46. Comorbidities were classified as follows: acute respiratory infections (J0–J22); chronic obstructive pulmonary disease (COPD) or bronchiectasis (J40–J44, J47).

Source: AIHW National Mortality Database.

Figure 5.3: Trends in asthma comorbidities at death, 55–69 years age group, 1998–2006



Note: Asthma classified according to International Statistical Classification of Diseases, 10th revision (ICD-10) codes J45 and J46. Comorbidities were classified as follows: acute respiratory infections (J0–J22); chronic obstructive pulmonary disease (COPD) or bronchiectasis (J40–J44, J47).

Source: AIHW National Mortality Database.

Figure 5.4: Trends in asthma comorbidities at death, 70+ years age group, 1998–2006

6. Discussion

This report provides an overview of the impact of asthma on older people in Australia. It brings together data on asthma prevalence, health service utilisation, mortality, disability and comorbidities for Australians aged 45 years and over.

The age of 45 years was selected as the point at which asthma in older Australians can be distinguished from asthma in younger Australians because it represents a point of noticeable change in the age distribution of asthma prevalence. The prevalence of asthma rises sharply in young children and teenagers then gradually drops to a low point around 40–45 years of age. According to both the 2001 and 2004–05 NHS, fewer 40–50 year olds have asthma than in any other age group, except the extremely old or the extremely young. These data suggest that either a large proportion of those who had asthma in their younger years no longer have it by the time they reach their 40s or there are now more cases of asthma being diagnosed in younger ages. Older Australians in general also report poorer health and suffer from more comorbidities and have increased risk from asthma.

Some of the key findings of this report are:

- The number of deaths due to asthma in 2006 was unusually high. The 70+ years age group suffered in particular and it appears this trend continued into 2007. It has been nearly a decade since there were as many female asthma deaths aged 70+ years as there were in 2006 and 2007.
- People aged 55–69 years dying of asthma are more than twice as likely to have COPD or bronchiectasis compared with non-asthma deaths. These are serious comorbidities and often fatal conditions and they make the diagnosis and management of asthma much more difficult.
- Despite the recent rise in death rates, all age groups have shown a decline over the past decade in hospital separations and the proportion of GP encounters in which asthma was managed.

The recent rise in deaths due to asthma after a sustained drop from 1995–2005 needs further study, particularly among the 70+ years age group. Preliminary data for 2007 suggest that the death rates in this age group have not returned to their pre-2006 levels and that there may be a sustained factor contributing to an increase in asthma deaths in older Australians. No single cause for the recent increase in asthma deaths can be identified (a discussion of possible causes is provided in Appendix A). Data from further years are required before it can be ascertained if the increase in deaths was not just due to random variation.

If further increases do occur, a focused audit (case-note review) may be required of asthma deaths in older people, similar to the ones conducted in the 1980s and 1990s (Campbell et al. 1992 ; Sutherland et al. 1984).

For the time being, it is particularly important that older Australians with asthma and their carers are vigilant for signs of exacerbation and have in place appropriate asthma management plans.

Appendix A. Further discussion of recent increases in deaths due to asthma

The increased mortality in both sexes suggests that a single or a group of factors are affecting fatal outcomes, rather than a factor specific to either sex.

State by state examination suggests that NSW and SA had higher death rates per 100,000 population in 2006 compared to other states and that there was a particular influence on deaths in the months of February, March, April and May.

Some possible explanations for the recent increases in asthma deaths rates are:

Changes to coding practices for death certificates

The presence of comorbidities, such as COPD, often complicates deaths from asthma among older people. Studies of death certificates in Australia in the late 1980s concluded that the accuracy of the attribution of asthma on death certificates was very low in the older ages (Campbell et al. 1992; Jenkins et al. 1992).

The similarity in symptoms can make attributing the actual cause of death problematic. Changes in the attribution of death in difficult-to-diagnose cases may explain some of the recent rise in asthma death rates.

The recent increase in asthma deaths cannot solely be a result of attributing more deaths away from COPD to asthma. There have been no relevant changes to the rules for completing and coding death certificates during this period. There is also no reason why clinical practice would have changed. Furthermore, there has been no corresponding drop in COPD deaths to suggest that this shifting has occurred. For example, the death rates due to COPD for females aged 55–69 years and for both males and females aged 70+ years have shown smaller decreases between 2005 and 2006 than between 2004 and 2005.

Increases in conditions that exacerbate asthma

Respiratory infections, such as influenza and pneumonia, have also been noted to act as triggers for asthma exacerbations (Braman & Hanania 2007). However, the influenza notifications, death rates, hospitalisations and pneumonia death rates show a drop in infection rates from 2005 to 2006, suggesting that increased infections were not responsible for the rise in asthma mortality. The months identified as being of particular concern are also not known as high risk months for influenza or other respiratory infections.

Adverse reactions to medications

Historical data shows a link between $beta_2$-agonists used to treat asthma and increases in asthma mortality rates. The safety of long-acting $beta_2$-agonist inhalers in asthma in particular, without concurrent treatment with inhaled corticosteroids, has been an area of great interest and debate. Four recent reviews of the literature have found some evidence to suggest increased asthma-related deaths in people not using inhaled corticosteroids but the number of deaths was too small to draw a definite conclusion (Cates et al. 2008; Cates & Cates 2008; Cates et al. 2009).

Environmental factors

Air pollution is a known risk factor for asthma exacerbations (Denison et al. 2001). The air pollution data for NSW do not, however, suggest that there were particularly high levels of air pollution during the months of increased mortality of 2006, although the data do not cover all of NSW.

One environmental factor that does appear to match the overall timing and location of the asthma deaths is low rainfall. The months of February, March, April and May of 2006 appear to have had very low rainfall in 2006 for most of NSW[1].

A relationship between low rainfall and asthma mortality, however, has not been noted before. A literature search identified no studies addressing the potential link between prolonged periods without rain and asthma mortality.

Importantly, none of the above can account for the fact that neither the rate of GP visits nor hospitalisations increased between 2005 and 2006.

[1] The Bureau of Meteorology rainfall reference site at Richmond NSW recorded rainfall for February 2006 at 50% of the average for the period 1995–2005. March, April and May were even lower at 30%, 11% and 9% of the 1995–2005 average. The Sydney Observatory Hill rainfall collection site recorded similar results, with April recording only 8% of the average rainfall for that month over the 151-year period starting in 1858. The reference site at Cobar recorded no rainfall for February and only 7mm and 1mm in April and May respectively.

References

AIHW (Australian Institute of Health and Welfare) 2007. Older Australia at a glance (4th edition). Canberra: AIHW.

AIHW 2009. Australian hospital statistics 2007–08. Canberra: AIHW.

AIHW: ACAM (Australian Centre for Asthma Monitoring 2008). Asthma in Australia 2008. Canberra: AIHW.

AIHW: Begg S, Vos T, Barker B, Stevenson C, Stanley L & Lopez A 2007. The burden of disease and injury in Australia 2003. Canberra: AIHW.

AIHW: Karmel R, Hales C & Lloyd J 2007. Older Australians in hospital. Canberra: AIHW.

Barua O & O'Mahony M 2005. Overcoming gaps in the management of asthma in older patients - New insights. Drugs & Aging 22:1029–59.

Bellia V, Battaglia S & Catalano F 2003. Aging and disability affect misdiagnosis of COPD in elderly asthmatics - The SARA study. Chest 123:1066–72.

Braman SS & Hanania NA 2007. Asthma in the elderly. Clinical Chest Medicine 28:685–702.

Campbell DA, McLennan G, Coates JR, Frith PA, Gluyas PA, Latimer KM et al. 1992. Accuracy of asthma statistics from death certificates in South Australia. Medical Journal of Australia 156:860–3.

Cates C, Jefferson T & Rowe B 2008. Vaccines for preventing influenza in people with asthma (Cochrane Review). Cochrane Database of Systematic Reviews 2.

Cates CJ & Cates MJ 2008. Regular treatment with salmeterol for chronic asthma: serious adverse events. Cochrane Database of Systematic Reviews:CD006363.

Cates CJ, Lasserson TJ & Jaeschke R 2009. Regular treatment with salmeterol and inhaled steroids for chronic asthma: serious adverse events. Cochrane Database of Systematic Reviews:CD006922.

Denison L, Simpson R, Petroeschevsky A, Thalib L & Williams G 2001. Ambient air pollution and daily hospital admissions in Melbourne, 1994–1997. Melbourne: Environmental Protection Agency Victoria.

deShazo RD & Stupka JE 2009. Asthma in US seniors: part 2. Treatment. Seeing through the glass darkly. American Journal of Medicine 122:109–13.

Jenkins MA, Rubinfeld AR, Robertson CF & Bowes G 1992. Accuracy of asthma death statistics in Australia. Australian Journal of Public Health 16:427–9.

Levy ML, Thomas M, Small I, Pearce L, Pinnock H & Stephenson P 2009. Summary of the 2008 BTS/SIGN British Guideline on the management of asthma. Primary Care Respiratory Journal 18 Supplement 1:S1–16.

National Heart Lung and Blood Institute 2007. Expert Panel Report 3: Guidelines for the Diagnosis and Management of Asthma. Bethesda, MD: U.S. Department of Health and Human Services.

Quadrelli SA & Roncoroni A 2001. Features of asthma in the elderly. Journal of Asthma 38:377–89.

Ronmark E, Jonsson E & Lundback B 1999. Remission of asthma in the middle aged and elderly: report from the Obstructive Lung Disease in Northern Sweden study. Thorax 54:611–3.

Singh A & Busse W 2006. Asthma exacerbations ·2: Aetiology. Thorax 61:809–16.

Sutherland DC, Beaglehole R, Fenwick J, Jackson RT, Mullins P & Rea HH 1984. Death from asthma in Auckland: circumstances and validation of causes. New Zealand Medical Journal 97:845–8.

Tinkelman D, Price D, Nordyke R & Halbert R 2006. Misdiagnosis of COPD and Asthma in Primary care Patients 40 Years of Age and Over. Journal of Asthma 43:75–80.

Welte T & Groneberg DA 2006. Asthma and COPD. Experimental and Toxicologic Pathology 57:35–40.

Wilson D, Appleton S, Adams R & Ruffin R 2005. Undiagnosed asthma in older people: an underestimated problem. The Medical Journal of Australia 183:20-2.

List of figures