ASTHMA CONTROL IN AUSTRALIA 1990-2011

21 YEARS SINCE THE INTRODUCTION OF ASTHMA MANAGEMENT GUIDELINES – WHERE ARE WE NOW?

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EXECUTIVE SUMMARY

Asthma affects people of all ages and is associated with a substantial impact on the community, affecting 10% of the Australian population. While there is currently no cure for asthma, effective management strategies are available to control the disease and its symptoms, and to prevent flare-ups (exacerbations). Asthma is no longer considered to be a single disease, and the manifestations of asthma may represent the outcome of a range of disease processes.

"Control" of asthma is now accepted as comprising two domains, namely the person's level of *current asthma control* which is assessed from features such as symptoms, ability to carry out daily activities, and quality of life, and their *risk factors* for future adverse events including exacerbations (flare-ups), greater loss of lung function, and side effects of treatment.

This report aimed to examine trends in indicators of asthma control in Australia over the past 21 years since introduction of asthma management guidelines. We examined all available population-based studies that could potentially provide data about standardised indicators; in addition, we examined results of three large surveys in selected populations.

While there have been numerous Australian surveys about the prevalence of asthma, we found that few studies have provided detailed longitudinal information about the impact of asthma on individuals or on the community.

Over the first half of the period studied, there were very substantial improvements in mortality and morbidity attributed to asthma, with a levelling off in the past 7-10 years. However, rates of Emergency Department presentations by children, particularly in February each year, have not decreased, indicating that asthma remains a substantial burden on children, families, the health system and the community.

For adults, assessment by general practitioners of their patients' symptom frequency suggests that between 1998-2008, a decreasing proportion of adults presented with symptom frequency consistent with poorly-controlled asthma. Data for children suggest that wheeze frequency, activity limitation and reliever use may have improved, but few studies have been performed in recent years.

Currently, around 15-25% of people with asthma have features of poorly-controlled asthma, depending on which measure is considered. The burden of poorly controlled asthma is likely to be found in three diverse groups – firstly, patients not taking (or not taking enough) regular preventer medication, who essentially have untreated asthma; secondly, patients taking preventer medications who have residual symptoms due to co-morbidities or missed diagnoses that are being mistakenly attributed to asthma; and thirdly, the small proportion of patients who despite taking regular preventer medication have residual symptoms due to severe refractory asthma. These groups of patients have very different needs, but without objective measures, they are difficult to distinguish.

Overall, the most striking finding of this study was the paucity of data for most of the conventional measures of asthma control, making it difficult to assess trends in Australia. This indicates a need for additional population-level monitoring of asthma, to help to improve our understanding of the

nature and impact of this common chronic disease, and to inform policy asthma services, including appropriate resource allocation within the health sector.

For future monitoring, new strategies may need to be developed in order to allow representative samples to be obtained. Obtaining agreement on a standardised minimal set of questions and responses would allow more efficient use of scarce research resources and participant time. However, self-reported asthma control is not a useful tool for asthma monitoring, as people with asthma interpret the term differently from the medical meaning.

Incorporation of objective testing would remove many of the uncertainties that apply to present indicators, especially those based on self-report. Greater use can also be made of data collected in past population-based surveys, using online repositories.

One of the challenges for Australia is to acknowledge the substantial improvements that have been made in asthma management in the past 21 years, without ignoring the fact that asthma prevalence and deaths due to asthma are still amongst the highest in the world, and that there is still a considerable burden from asthma in the community.

Knowledge of the overall level of asthma control in Australia provides insight into the burden of disease and the effectiveness of asthma management; and hence, the need for further efforts aimed at improving asthma management.

INTRODUCTION

Asthma affects people of all ages and is associated with a substantial impact on the community. The 2007–08 National Health Survey estimated that 2,049,086 Australians had current asthma, representing nearly 10% of the Australian population.[1]

Asthma has long been recognised as a major problem in Australia. During the 1980s and early 1990s there was a substantial worldwide increase in the prevalence of asthma, including in Australia.[2] In 1964, 19% of Australian children were reported to have had asthma or wheezing at some time during their first 7 years of life.[3] By 1990, this proportion had increased to 46%.[4] In addition, a steadily rising trend in mortality due to asthma during the 1980s, particularly in New Zealand and Australia, led to widespread concern and was the subject of extensive investigations.[5-7]

By the late 1980s, health professionals, consumers and governments shared a common concern about rising morbidity and mortality attributable to asthma.[8 9] Although inhaled corticosteroids had been available for the treatment of asthma since the early 1970s,[10] it was not until the late 1980s that compelling evidence of their effectiveness in the long-term treatment of asthma became available.[11] Also at this time, consensus developed around the value of a systematic approach to asthma management. In Australia, the national Asthma Management Plan was published in 1989;[12] the National Asthma Campaign (later renamed the National Asthma Council), a coalition of major stakeholders, was launched in 1990 to improve awareness and management of asthma through public health campaigns and educational strategies.[13 14]

In the 1990s, recognition of the impact of asthma in Australia, in terms of prevalence, mortality and burden of disease, together with evidence about the availability of effective therapies and strategies to control the disease, led to the declaration of asthma in 1999 as a National Health Priority Area. Systematic review by GPs of people with asthma was encouraged by the launch in 2001 of a Practice Incentive Payment for GPs completing the Asthma 3+ Plan, which was replaced 2006 by the Asthma Cycle of Care programme.[15] Updates of Australian asthma guidelines were released by the National Asthma Council in 1993, 1996, 2002 and 2006. A systematic approach to monitoring of asthma in Australia was also adopted, with the establishment in 2002 of the Australian Centre for Asthma Monitoring (ACAM). Over the past 10 years, ACAM has developed and refined indicators for population-level monitoring of asthma management in Australia (www.asthmamonitoring.org).

While there is currently no cure for asthma, effective management strategies are available to control the disease and its symptoms, and to prevent flare-ups (exacerbations), thus reducing the impact of asthma on the individual and on the community. These management strategies focus on guiding treatment by assessment of asthma control. Although mortality due to asthma has decreased substantially since the peak of the mid-1980s,[16] there still appears to be a substantial burden of asthma on individuals, family and the community in Australia.[17] In light of the focus of clinical practice guidelines on the assessment of asthma control, this report aims to document trends in indicators of asthma control in Australia over the past 21 years.

OBJECTIVES

In the 21 years since the publication of the Australian asthma management plan, led by the late Professor Ann Woolcock,[12] there have been substantial changes in the medications and management strategies available to clinicians for treatment of asthma. A thorough review of the current state of asthma control and management in Australia is a necessary and worthwhile exercise at this point in time. This will help to describe the changes in asthma outcomes that have occurred in Australia over the past 21 years, how asthma management compares with indicators of quality of care, and if any areas for improvement can be identified.

The objectives of this review are to:

- identify and review Australian data on trends in indicators of asthma control and asthma management in adults and children since 1990;
- comment on what Australia has achieved in terms of better asthma management in the last 21 years;
- identify any remaining gaps in knowledge or areas for improvement in asthma management.

WHAT IS ASTHMA CONTROL?

From the time of publication of the first clinical practice guidelines for asthma in 1989 [12] to the present time, the goals of asthma management have focussed on minimisation of asthma symptoms and prevention of exacerbations and death due to asthma. In addition, over this time, the concept of adjusting the patient's treatment upwards or downwards according to simple measures of symptoms and (in some cases) lung function has been a core component of guidelines, with this approach being formally described as 'control-based management' in 2006.[18]

Clinicians monitor markers of asthma control to guide patient management and changes in medication, and to evaluate the effectiveness of treatment.[19] A Task Force established by the American Thoracic Society and European Respiratory Society to provide standardised measures of asthma control, asthma severity and asthma exacerbations defined asthma control as follows:

> *'Asthma control is the extent to which the various manifestations of asthma have been reduced or removed by treatment. This includes two components:*
>
> 1. *the level of clinical asthma control, which is gauged from features such as symptoms and the extent to which the patient can carry out activities of daily living and achieve optimum quality of life, and*
> 2. *the risk of future adverse events including loss of control, exacerbations, accelerated decline in lung function, and side effects of treatment.'* .[19]

These two domains of asthma control are commonly referred to as 'current control' and 'future risk'.[20] Poor current control itself strongly increases the risk of asthma exacerbations, but the concept of 'future risk' was introduced by the Task Force in recognition of other factors that increase

the probability of adverse asthma outcomes, *independent* of the patient's current level of clinical control. In addition, it was recognised that patients with mild[21] or well-controlled[22] asthma may still experience severe asthma exacerbations, for example following viral respiratory infections.

The term 'well-controlled asthma' is used by clinicians when symptoms are infrequent, sleep is not disturbed by asthma, asthma does not interfere with the patient's usual activities, lung function is normal or near normal, and there are few, if any, exacerbations[23] Well-controlled asthma indicates that a patient's disease is mild (able to be well-controlled with minimal or no maintenance therapy) or that their current level of treatment is appropriate, whereas poor asthma control may indicate severe disease and/or poor management.

ASSESSMENT OF ASTHMA CONTROL IN POPULATIONS

Knowledge of the overall level of asthma control in a community provides some insight into the effectiveness of the management of asthma in that community and, by implication, the need for further efforts aimed at improving asthma management.

In clinical practice or clinical trials, current asthma control can be assessed in individual patients using standard clinical indicators including symptom frequency, sleep disturbance, frequency of reliever use, limitation of activity, and lung function.[19] Several standardised composite asthma control tools such as Asthma Control Questionnaire[24] and Asthma Control Test [25] are also available for use in clinical trials and clinical practice. Patients' future risk of adverse outcomes such as exacerbations, accelerated decline in lung function, and side-effects of treatment, can be estimated from an evaluation of risk factors such as a history of exacerbations in the previous 12 months, smoking, lung function, sputum inflammatory cells (if available), and medication step.[23]

However, information on these clinical attributes may not necessarily be available at a population level. Surveys usually do not include all of the relevant questions, and they rarely include objective measures of lung function or sputum inflammatory cells. Even in the clinical setting, systematic evaluation of the attributes of asthma control is rarely performed. Hence, data collection by mining electronic medical records is of limited value.

In the absence of direct measures of asthma control, indirect measures such as days lost from work or school and health-related quality of life can also be used to provide evidence about the impact of asthma on the individual and on the community. The frequency of exacerbations and short-term episodes of loss of control are also key components of the assessment of asthma control, and have an important impact on health-related quality of life. Data about urgent health care utilisation, such as Emergency Department visits and hospital admission, can be used as surrogates for the frequency of more severe asthma exacerbations.[19]

METHODS

Australian data sources were identified for inclusion in this project, including publicly available data and data accessible by the funding body (see Acknowledgements). Table 1 lists the types of data sources that were found. Information from data sources was reviewed for its relevance to asthma control and asthma management over the last 21 years, and for the quality of data.

Data were obtained from data custodians as either aggregated data or de-identified individual patient records, depending on the agreement between The Woolcock Institute of Medical Research, the funding body and the data custodians. No identifiable data were obtained. Data from published material were collated and interpreted. In some instances, data custodians performed the analysis of their data and provided the results to The Woolcock Institute of Medical Research.

Table 1: List of data sources reviewed

Data sources
DATA FROM POPULATION-BASED SOURCES
General population surveys
- National Health Surveys
- State/Territory Computer Assisted Telephone Interviewing (CATI) surveys
- Published research studies of randomly selected populations
General practice surveys
- BEACH (Bettering the Evaluation and Care of Health) surveys
- SAND (Supplementary Analysis of Nominated Data) surveys
Health service data
- NSW Emergency Department Data Collection (EDDC)
- Australian Institute of Health and Welfare (AIHW) National Hospital Morbidity Database
- Medicare Benefits Scheme (MBS) online statistics
Mortality data
- AIHW National Mortality Database
Pharmaceutical data
- Pharmaceutical Benefits Scheme (PBS) data
- IMS Health data (wholesale supply of medications)
- Australian Statistics on Medicine (PBS/RPBS and Pharmacy Guild survey)
DATA FROM SELECTED POPULATIONS OR SOURCES
Surveys in large non-random populations
- Asthma Foundation NSW survey 2007
- Short on Air online survey 2010
- Asthma Foundation Queensland online survey 2011
Pharmaceutical data from selected pharmacies
- NostraData (pharmacy dispensing and sales data)
- Aztec data (pharmacy sales data)

This report summarises all available general population-based data on indicators of asthma control and asthma management in Australia since 1990 were summarised. These data were derived from both surveys and administrative databases listed in the top portion of Table 1. Data for adults and children are presented separately, where relevant. Medication data were obtained from a range of sources, described in Appendix 1.

In addition, some data from surveys conducted in selected populations (lower portion of Table 1) were reviewed and summarised in the text. Details of the three main surveys of selected populations are provided in Appendix 2.

Time-trend plots and analyses are presented where appropriate data are available. Details about the statistical methods are provided in Appendix 3.

Reporting of measures of asthma control follows, where possible, the recommendations of the ATS/ERS Task Force on asthma control and exacerbations.[19]

RESULTS

PREVALENCE OF ASTHMA

Estimating the number of people in the community who have asthma is fundamentally relevant to assessment of the impact of asthma at a population level. Examination of changes over time in the number of people who have asthma contributes to the evaluation of population-based efforts to prevent or control the disease.

In clinical practice, the diagnosis of asthma is primarily based on the presence of a typical time-variable pattern of symptoms together with evidence of variable airflow limitation.[23 26] Many surveys classify people as having asthma based on self-reported doctor diagnosis, i.e. whether the person has ever been told by a doctor (or sometimes by a nurse) that they have asthma. Changes in the prevalence of asthma over time may thus be affected by changes in diagnostic preference.

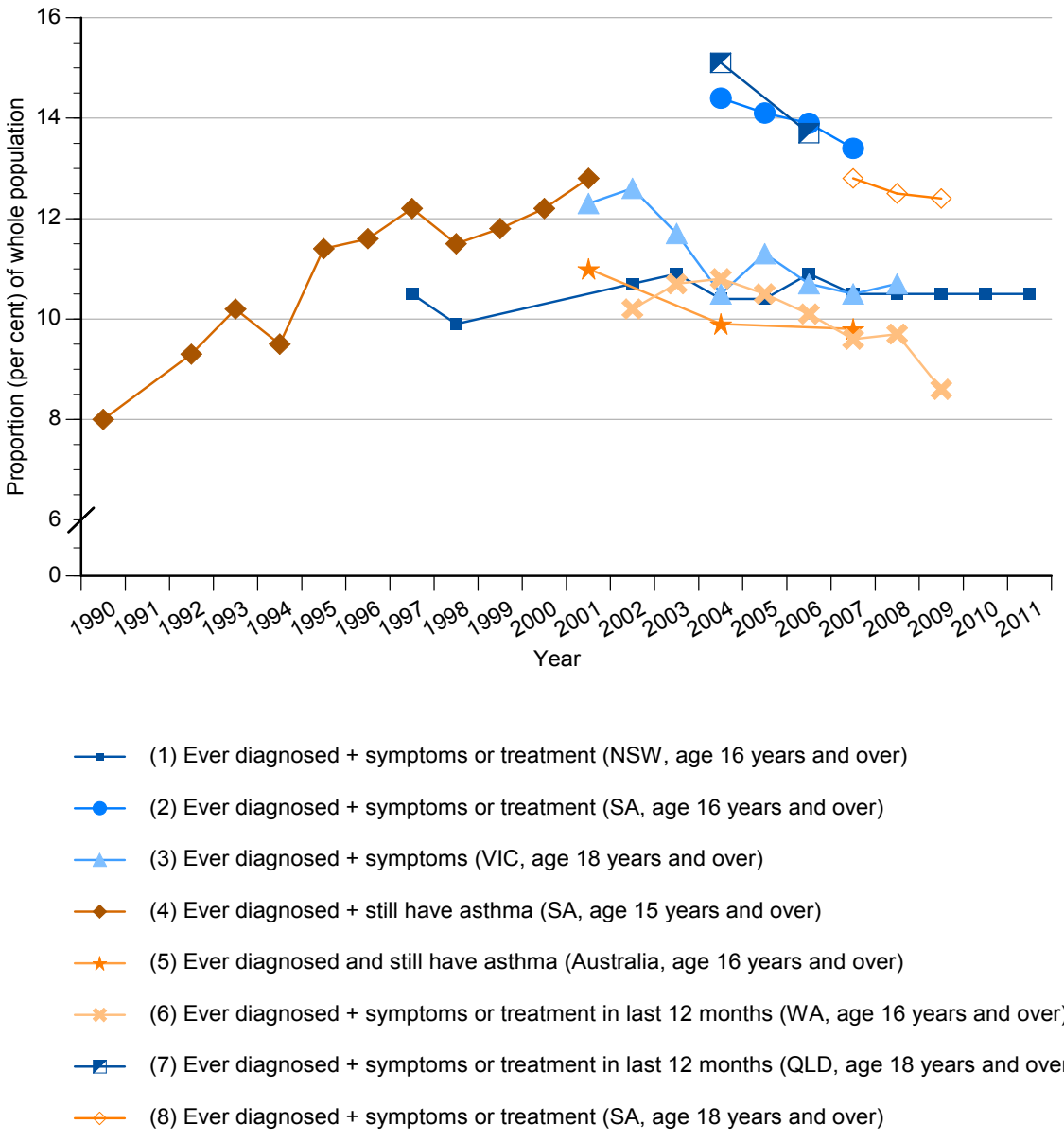
Many surveys also evaluate the prevalence of 'current asthma', usually requiring both a doctor diagnosis of asthma plus some evidence that the patient's asthma is still active. 'Current asthma' excludes people who have previously been diagnosed with asthma but are in remission. Different definitions for current asthma have been used in the various surveys. In particular, the definition of current asthma for National Health Surveys (NHS) has changed over time, with 'Do you still get asthma?' replaced in recent years by 'Have you had any symptoms of asthma or taken treatment for asthma in the last 12 months?'. Inclusion of both questions in the 2007-8 NHS survey allowed direct comparison, which demonstrated very good agreement between the two definitions. Since the definition of current asthma includes the requirement for a doctor diagnosis of asthma, changes in diagnostic preferences may also influence the prevalence of current asthma.

A full discussion of the various definitions of current asthma can be found in Asthma in Australia 2011, a report by the Australian Centre for Asthma Monitoring, published by the Australian Institute of Health and Welfare.[1]

ADULTS

Population-based studies

Figure 1 shows trends in the prevalence of asthma in Australian adults since 1990. Prior to 2000, few studies investigated the prevalence of asthma among adults, so the reliability of information for this period is limited. However, a number of studies have been conducted since 2000, providing more reliable estimates.



Note: NHS data are age-standardised to the Australian population as at June 2001.

Sources: (1) NSW Population Health Survey 2007–08, Health Outcomes and Information Statistical Toolkit (HOIST). (2) & (8) South Australian Monitoring and Surveillance System (SAMSS), Department of Health, Government of South Australia. (3) Victorian Child Health and Wellbeing Survey. (4) South Australian Omnibus Survey. (5) ABS National Health Surveys. (6) WA Health & Wellbeing Surveillance System, Epidemiology Branch, WA Health. (7) Queensland Omnibus Survey, Epidemiology Services Unit, Queensland Health.

Figure 1: Prevalence of current asthma amongst adults, 1990–2011

In the early 1990s, the South Australian Health Omnibus Study showed an increase in the prevalence of current asthma (diagnosed by a doctor and still present), especially among females and the elderly.[27] However, more recent studies have shown decreasing prevalence in adults. In 2007-08 the National Health Survey estimated that the prevalence of current asthma in adults (age 15 years and older) was 9.8%.[1]

The North West Adelaide Health Study, in which asthma was defined as either doctor diagnosed asthma or significant (>12%) bronchodilator responsiveness, found an increase in the prevalence of asthma from 12.5% of adults for 2000-03 to 16.2% for 2004-06.[28]

Data from the National Health Surveys in 2001, 2004-05 and 2007-08 show that the prevalence of current asthma declined over this period among young adults aged 15–34 years ($p<0.0001$), but has remained relatively stable among people aged 35 years and over (data not shown).[29 30]

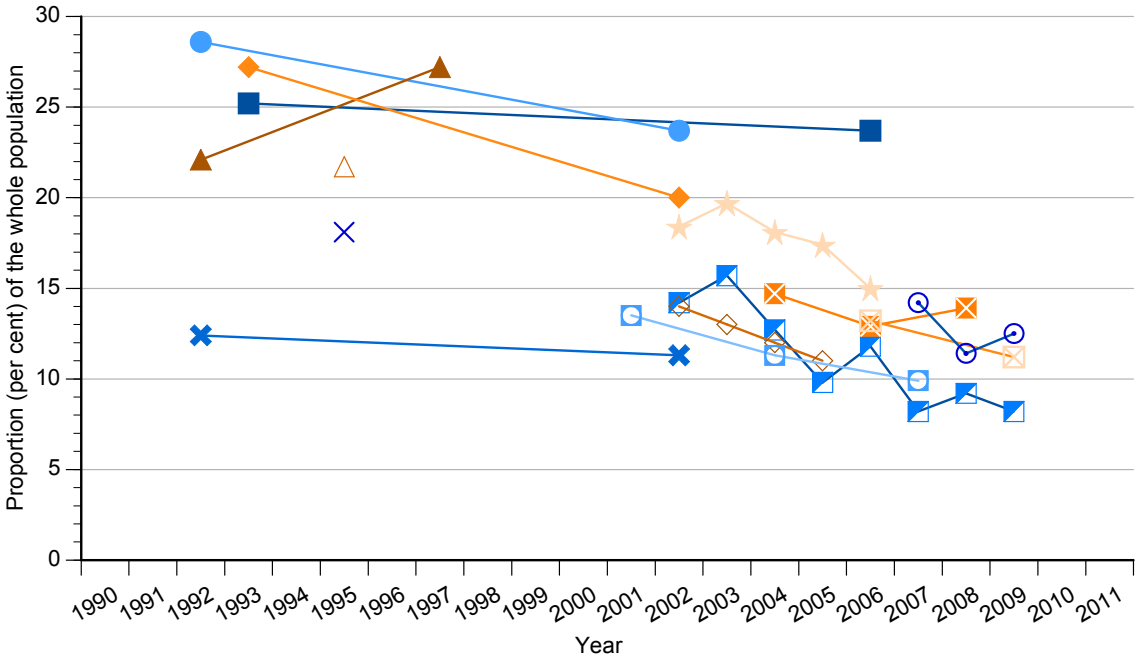
Combining data from all these studies for the period 2000 to 2009 reveals that there was small, but significant, decrease in the prevalence of asthma in adults of 0.18 percentage points per year (95% confidence interval 0.12–0.23; $p<0.0001$) over this period.

CHILDREN

Figure 2 shows data for the prevalence of current asthma among children between 1990 and 2011. During the 1980s, a consistent increase in the prevalence of current asthma in Australian children was observed.[1] However, since that time the trend has reversed.

Data from the National Health Surveys show that the nationwide prevalence of current asthma among children aged 0–15 years declined from 13.5% in 2001 to 11.3% in 2004–05 and 9.9% in 2007–08 ($p<0.0001$). This downward trend is confirmed in several series of surveys conducted on children since the mid-1990s.

Combining data from all the available studies for the period 2000 to 2009 reveals that the prevalence of asthma in children decreased by 0.63 percentage points per year (CI: 0.45–0.81; $p<0.0001$) during this period.



(1) Recent wheeze (SA, age 4-5 years)

(2) Recent wheeze (Belmont, NSW age 8-11 years)

(3) Recent wheeze (Wagga Wagga, NSW age 8-11 years)

(4) Current wheeze (Melbourne, VIC age 6-7 years)

(5) Ever diagnosed + symptoms or treatment (SA, SAMMS, age 2-15 years)

(6) Recent wheeze + AHR (Belmont, NSW age 8-11 years)

(7) Ever diagnosed + symptoms or treatment in the last 12 months (WA, CATI, age 0 -15 years)

(8) Ever diagnosed + symptoms or treatment in last 12 months (ACT, age 4-6 years)

(9) Ever diagnosed + symptoms or treatment in last 12 months (NSW, CATI, age 2 -15 years)

(10) Ever diagnosed + symptoms in last 12 months (VIC, CATI, age 1 -12 years)

(11) Ever diagnosed + symptoms or treatment in last 12 months (SA, CATI, age 2- 17 years)

(12) Ever diagnosed + symptoms or treatment in last 12 months (Australia, NHS, age 0 -15 years)

(13) Ever diagnosed asthma + symptoms + treatment (Lismore, NSW age 3-5 years)

(14) Ever diagnosed asthma + symptoms + treatment (Wagga Wagga, NSW, age 3-5 years)

Note: NHS data are age-standardised to the Australian population as at June 2001. AHR= Airway hyper responsiveness. CATI=Computer-assisted Telephone Interviewing.

Sources: (1) Population Research and Outcome Studies Unit, South Australian Department of Human Services. (2) & (6) Toelle et al. BMJ 2004; 328:386-7. (3) Downs et al. ADC 2001; 84:20-3. (4) Robertson et al. MJA 2004; 180:273-6. (5) Population Research and Outcome Studies Unit, South Australian Department of Human Services, Tai et al. J Asthma 2009; 46:343-6. (7) WA Health and Wellbeing Surveillance System, Epidemiology Branch, Department of Health, Government of Western Australia. (8) Phillips et al. MJA 2007; 187:10-3. (9) NSW Population Health Survey 2007–08, Health Outcomes and Information Statistical Toolkit (HOIST). (10) Victorian Child Health and Wellbeing Survey. (11) South Australian Monitoring and Surveillance System (SAMSS), Department of Health, Government of South Australia. (12) Asthma in Australia 2011. (13) Comino et al. MJA 1996; 164:403-6 (Probable asthma defined as 3 or more episodes of wheeze and or troublesome cough more than once a week over 12 months).

Figure 2 : Prevalence of current asthma amongst children aged 17 years and under, 1990–2011

DIRECT MEASURES OF ASTHMA CONTROL

The following sections report population-level data for clinical measures of current asthma control, namely symptom frequency, sleep disturbance due to asthma, frequency of reliever use, activity limitation due to asthma, and composite asthma control tools. Because these measures have only recently been standardised,[19] few data were found for some of these variables.

ASTHMA SYMPTOM FREQUENCY

The criteria for well-controlled asthma, as described in the Global Initiative for Asthma strategy report[23] , include daytime symptom frequency of two times a week or less, evaluated over the past month. Despite the importance of the assessment of asthma symptom frequency in clinical asthma management, this was one of the asthma control variables for which the least population-based data were available.

ADULTS

Population-level data

The Living with Asthma study by Sawyer and Fardy [31] was a telephone survey conducted in a randomly selected sample of the population during May 1999 in NSW, Victoria and Queensland. Of the 386 adults with asthma that were interviewed, 42% had asthma symptoms at least every 2-3 days, i.e. 42% had symptom frequency consistent with poorly controlled asthma. Twenty-five percent of adults with asthma reported having asthma symptoms every day.[31]

From a CATI survey of a stratified random sample of the Australian population conducted in summer 2003/4, Marks and colleagues[32] reported that 33% of the 1006 adult participants had no asthma symptoms in a typical week, 49% had symptoms occasionally, 11% had symptoms most days, and 7% had symptoms every day, i.e. at least 18% of adults had symptom frequency consistent with poorly-controlled asthma.

The paucity of data for symptom frequency makes interpretation of time trends difficult

Selected populations

The Short on Air survey (n=1000 adults) [33] was a national online survey of people with asthma described by the investigators as having moderate to severe asthma. This survey was conducted in 2010, amongst members of an online market research panel. Eligibility criteria included having asthma and taking both a preventer and a reliever medication, and participants were excluded if they experienced only exercise-induced symptoms. In this survey, the proportion of participants with symptom frequency consistent with poorly-controlled asthma cannot be assessed since no direct question was asked about symptom days per week. Two or more different *types* of daytime symptoms (e.g. wheeze plus cough) were reported by 62% of participants in the week prior to assessment, but the frequency of these symptoms were not reported.

In the same survey, 15% of participants reported experiencing 5 or more ‘asthma attacks’, defined as when asthma flared up or was out of control, in the previous 30 days. There is evidence from other

studies that there is substantial variability in patient usage of the term 'asthma attack', with some using the term for any asthma symptoms, however mild, and others reserving its use for life-threatening asthma requiring intensive care admission.[34] Hence, these data do not necessarily indicate poorly-controlled asthma.

Asthma symptom frequency was not reported in the 2007 Asthma Foundation NSW survey (n=608 adults) [35] or the 2011 Asthma Foundation Queensland survey (n=602) .[36]

CHILDREN

Population-level data

Frequency of asthma symptoms per week: In the 1990 study by Bauman and colleagues, 17% of children with 'probable' asthma were reported to wheeze more than twice a week.[37] The criteria for probable asthma (≥3 episodes of wheeze in previous year, cough more than once/week, or a current diagnosis of asthma) may have selected children with more frequent symptoms.

In the 1999 Living with Asthma study,[31] interviews with 313 carers of children with asthma revealed that 26% experienced symptoms at least every 2-3 days, i.e. 26% of children with asthma had symptom frequency consistent with poorly-controlled asthma. Nine per cent of children experienced asthma symptoms every day.

In the 2003 study by Marks and colleagues (n=199),[32] 1% of children were reported as having asthma symptoms every day, 8% had symptoms most days, 49% reported occasional symptoms, and 43% reported no asthma symptoms in a typical week, i.e. at least 9% of children with asthma had symptom frequency consistent with poorly-controlled asthma.

Frequency of wheezing 'episodes' or 'attacks' per year: Additional information about symptom frequency is available in some paediatric surveys which ask about 'episodes' or 'attacks' of wheezing. The term 'episode' is often used in paediatric asthma management to refer to asthma symptoms (or worse asthma symptoms) lasting for several days at a time. A question about the number of episodes or attacks experienced in the last 12 months has been asked in some population-based surveys, with the purpose at the time of identifying children who were more likely to have asthma. No information is available about whether these children had interval symptoms, so these episodes may have corresponded to viral-induced wheeze, or to flare-ups or exacerbations in children with persistent asthma. However, some studies have reported the frequency of these episodes in children considered likely to have asthma.

In population-based studies by Comino et al [38] of primary school children (mean age 9), 35% of those with probable asthma reported an episode of symptoms at least once a month in 1990, increasing to 45.8% in 1993. Again, the criteria for probable asthma (≥3 episodes of wheeze in previous year, troublesome cough especially at night more than once/week in the previous year, or a diagnosis of asthma) may have selected children with more frequent symptoms.

Several studies using the ISAAC questionnaire (International Study of Asthma and Allergies in Childhood) [39 40] reported the proportion of children with any wheezing in the previous 12 months who had experienced 12 or more 'wheezing attacks' in 12 months, i.e. in whom symptoms had

occurred on average at least every month. In 6-7 year olds, the proportions with ≥12 wheezing attacks in 12 months was reported as 9% in 1990,[4] 7.1% in 1993,[41] 7.4% in 2003,[40] and approximately 3% in 2005.[39] These data may underestimate the proportion of children with asthma who had symptoms at least monthly, since other children may have had milder asthma symptoms which their parents did not consider to be 'attacks'.

Symptoms severe enough to limit speech: Asthma symptoms that are severe enough to limit speech to one or two words at a time are usually indicative of a severe asthma exacerbation.[42] Some general population studies have included a question about the frequency of such episodes, again usually to identify children more likely to have asthma.

In the 1990 study by Robertson and colleagues, of 7 year old children who had wheezed within the last 12 months, 16% had experienced a wheezing attack in the last 12 months that was severe enough to limit speech to only one or two words at a time[4] In later studies of 7-year olds with recent wheeze, the prevalence of speech-limiting episodes was 14.9% in 1993 and 15.3% in 2002,[40] i.e. no change was observed between 1990 and 2002 in the proportion of wheezing 7-year olds who had experienced a severe asthma exacerbation within 12 months.

Selected populations

No measures of symptom frequency for children with asthma were found in the surveys of selected populations identified in this review.

SLEEP DISTURBANCE

One of the most distinctive features of asthma is the occurrence of symptoms that wake the person during the night or earlier than usual in the morning, although this is generally only seen in poorly controlled asthma. When asthma control is worsening, e.g. during the development of a flare-up or exacerbation, the onset of night waking due to asthma has been observed to develop later than the increase in daytime symptoms.[43] Sleep disturbance due to asthma is quick to resolve after initiation of inhaled corticosteroid treatment.[22 44]

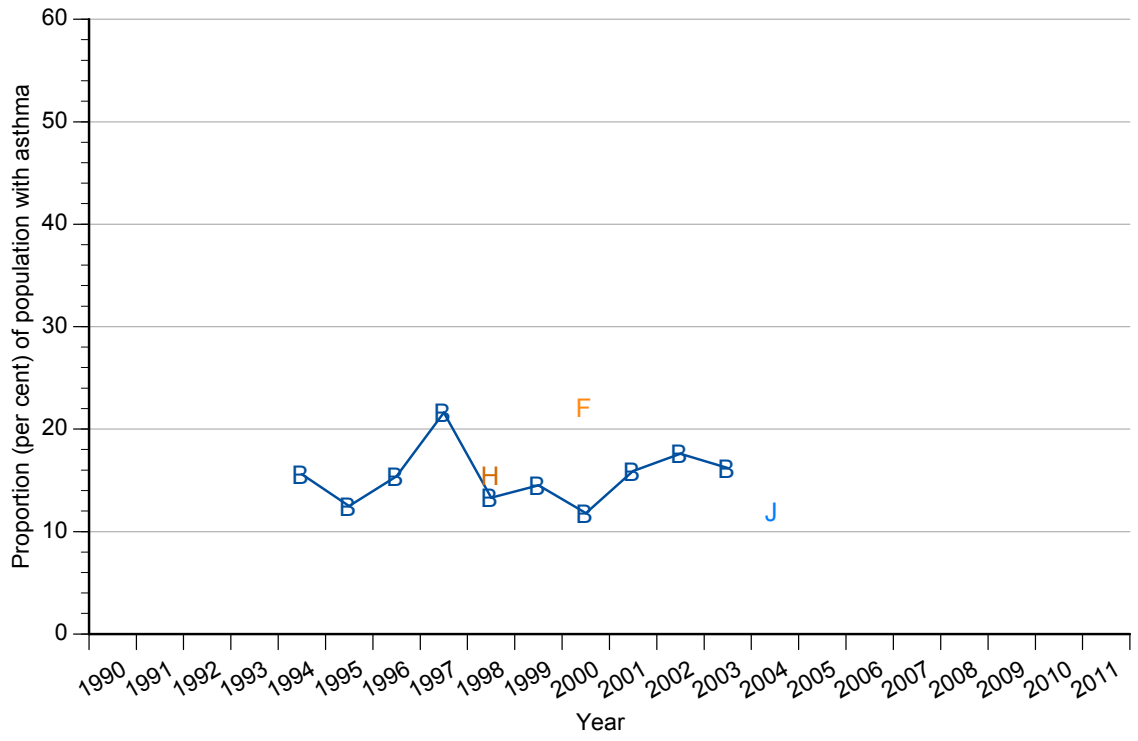
In population studies, night waking due to asthma is a significant predictor of the risk of future exacerbations [19]; because of this, and because of the substantial impact of disturbed sleep on overall functioning, sleep disturbance due to asthma has an important impact on the burden to the patient and the community.

In Australian [26] and GINA [23] guidelines, the occurrence of *any* night waking due to asthma in the previous 4 weeks is regarded as a marker of poor asthma control. By contrast, current American asthma guidelines permit asthma to be classified as well-controlled even if the patient wakes due to asthma twice in the previous month.[45]

ADULTS

Population-based data

Cross-sectional population surveys, using a range of different questions, confirm that sleep disturbance is a significant problem in people with asthma in Australia. However, consistent long-term trend data are limited.



Note: Questions asked; (1) Waking at night due to asthma (weekly or more often. (2) How many times have you woken up because of your asthma in the last 4 weeks? Every night, more than once per week, less than once per week or not at all. (3) & (4) Number of nights in the last month has your sleep been disturbed by your asthma? (graph shows 5 or more nights)

Sources: (1) Wilson et. al. In:Wilkinson D & Blue I (eds.). The new rural health. South Melbourne: Oxford University Press 2002; 149-70, MJA 2006; 184:226-9. (2) Marks et al. Respir 2007; 12:212-9. (3) NSW Population Health Survey Data. (4) QLD, Epidemiology and services unit, Asthma in Australia 2005.

Figure 3: Proportion of adults with asthma who were woken at night due to asthma weekly or more often, 1990-2011

In the NSW Health Survey of 1997-8, 38.3% of adults with asthma reported waking due to asthma one or more nights in the previous four weeks.[46] In the 2003 survey by Marks and colleagues,[32] 22.5% of adults reported waking because of asthma at least once in the previous four weeks. The lower proportion in the latter survey may be due to differences in asthma control, or may relate to the fact that participants in the NSW Health Survey were offered 6 response options for this question compared with 4 response options in the survey by Marks et al.[32]

Waking due to asthma once a week or more often (Figure 3) is consistent with very poorly controlled asthma. The proportion of adults waking ≥5 nights in the previous 4 weeks (i.e. averaging more than once a week) was 15.5% in the NSW Health Survey of 1997-8, and 22.1% in the Queensland Chronic Disease Survey of 2000.[46] In the South Australian Omnibus surveys,[47] waking during the night due to asthma remained relatively stable between 1994 and 2003, with around 10-20% of adults in each survey reporting that they woke once or more per week due to asthma. In the 2003 survey by Marks and colleagues,[32] 12% of adults reported waking more than once a week in the previous month.

Selected populations

In the Asthma Foundation NSW 2007 survey, data about night waking due to asthma were only available from one of the components of the Asthma Control Questionnaire, a question about the average frequency of waking per night in the previous week (not the average number of nights per week). From six responses (Not at all, Hardly ever, A few times, Several times, Many times, A great many times, and Unable to sleep because of asthma), only 54% of adults responded Not at all.

In the 2010 Short on Air survey of adults with moderate to severe asthma, 54% of participants reported waking because of their asthma at least once in the week prior to the survey.[33]

CHILDREN

Population-based data

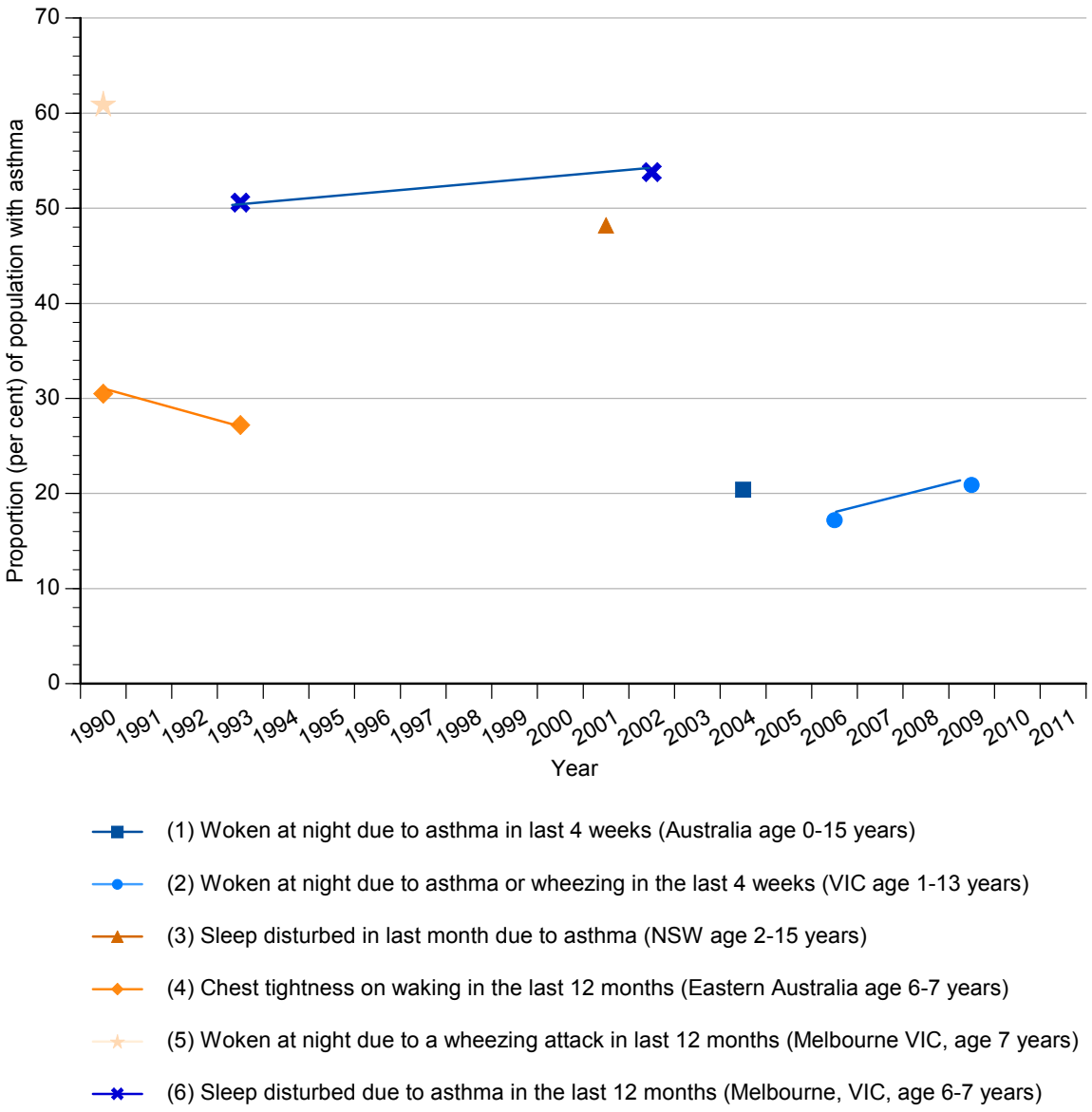
Figure 4 shows the proportion of children with asthma who had disturbed sleep due to asthma, with data from some studies relating to the previous 4 weeks, and from others, to the previous 12 months.

In the 1990 study of primary school aged children by Comino and colleagues,[38] 30.5% of children with probable asthma reported disturbance of sleep due to symptoms in the previous 12 months; there was no significant change to 1993 (27.2%).

In the 2003 survey by Marks and colleagues,[32] a total of 20% of children were reported to have woken because of asthma at least once in the previous month (12% waking because of asthma less than once a week, and a further 8.5% waking because of their asthma either every night or most nights). In the Victorian Child Health and Wellbeing Surveys (2006 and 2009) [48] , 15-20% of children were reported as being woken by asthma or wheezing in the previous 4 weeks.

In the 2001-2 survey by Kenny and colleagues,[49] 44% of participants reported that their sleep was disturbed by asthma within the previous 4 weeks. This survey included 208 people recruited from a random community sample, and 37 patients recruited from Emergency Departments, and data were reported for adults and children combined.

Among children and adults combined, between 1990 and 2009, the odds of reporting waking at night within the last 12 months decreased by 0.986 (95% CI 0.955 - 1.017) fold per year and the odds of waking at night within the last 4 weeks increased by 1.10 (95% CI 0.73 - 1.66) fold per year. There was substantial variation between different studies, and the trends over time were not statistically significant.



Note Question asked: (1) How many times have you woken up because of your asthma in the last 4 weeks? (graph shows combination of every night, more than once per week and less than once per week) (2) Been woken by asthma or wheezing in last 4 weeks? (3) Sleep disturbed in last month due to asthma? (4) Chest tightness on waking in the last 12 months? (5) In the past 12 months has any wheezing attack woken your child at night? (6) In the past 12 months has any wheezing attack woken your child at night?

Source: (1) Marks et al. Respir 2007; 12:212-9. (2) Victorian Child Health Survey (3) NSW Population Health Survey. (4) Comino et al. MJA 1996; 164:403-6 (5) Robertson et al. BMJ 1991; 302:1116-18. (6) Robertson et al. MJA 2004; 180:273-6.

Figure 4: Proportion of children with asthma who were woken at night due to asthma, in the last four weeks or last 12 months, 1990-2011

RELIEVER MEDICATION USE

Short-acting beta$_2$-agonists (SABA) are commonly used by patients with asthma or COPD for relief of symptoms. In people with asthma, frequent use of SABA is considered an indicator of poor asthma control and a prompt to review maintenance treatment. There is also some evidence that regular and/or excessive use of SABA may also contribute to poor asthma control.[50]

In clinical practice guidelines, use of SABA more than twice a week [23] (sometimes expressed as more than two days a week) is regarded as consistent with suboptimally-controlled asthma.

Data about the frequency of SABA use by individual persons are presented below. Additional population-level data about SABA supply and dispensing are presented later in this report.

SURVEY DATA - ADULTS

Population-based data

Metrics for reporting of reliever frequency vary between studies. In the 1995 South Australian Omnibus Survey, 33.6% of participants had required two or more reliever canisters in three months, corresponding to an average of 4.4 puffs/day, and 10.3% had needed over four canisters (8.9 puffs/day) .[51] In the NSW Health Survey of 1997-8, 38% of people aged 15-54 years with current asthma reported using their reliever medication on half or more days in the previous month.[52 53] In the 1999 Living with Asthma survey,[31] 37% of adults reported using a SABA more than four times in the previous week. In a 2001-2 NSW survey by Kenny et al (n=294),[49] 38% of people with asthma (ages 5-75 combined) reported using reliever medication on most or all days in the previous 4 weeks. In the 2002 South Australian Omnibus Survey,[54] 25% of people with asthma aged 15 or more reported using reliever daily and 12% reported using it at least twice weekly, i.e. 37% had reliever use consistent with poorly-controlled asthma.

In the 2003 Australian asthma survey,[32] the frequency of SABA use was not reported. However, 33.9% of adult participants reported using an inhaled drug for quick relief of symptoms but were not currently taking inhaled corticosteroids (ICS). This proportion was similar among those classified as having symptoms daily, on most days or occasionally. From these data, it appears that the proportion of adults using reliever medication at least daily decreased in the 10 years to 2002, but unfortunately, no more recent data are available.

Selected populations

In the 2007 Asthma Foundation NSW survey,[35] 80% of adults reported using a reliever inhaler in the previous 4 weeks, with 64% of participants reporting use of their reliever more than two days per week. Adults owned a median of 3 reliever inhalers (IQR 2-5, range 0-18) at the time of the survey, with the inhalers kept at various locations at home, work, gym etc, indicating that data about SABA purchases or supply in a specific period of time may not necessarily represent actual use.

In the 2010 Short on Air survey of people with moderate to severe asthma,[33] 63% of respondents reported using their reliever inhaler one puff a day or more (given that standard dosage is 2 puffs at a time, this corresponds to more than three times a week), and 39% used their reliever at least 3

puffs/day (i.e. 1.5 'times' a day). Of participants 55 years and older, 48% reported using their reliever three or more puffs a day. About half of participants reported having purchased a reliever medication over the counter in the previous month (28).

In the 2011 Asthma Foundation Queensland survey,[36] 66% of adults with asthma reported having a blue reliever inhaler (i.e. SABA) 'to use to manage asthma symptoms', although this proportion may be an underestimate due to the rather unusual wording of the question. Of these, 39% (26% of participants) reported using SABA more than three times a week.

SURVEY DATA - CHILDREN

Population-based surveys

Of primary school children considered to have 'probable asthma' in the 1990 study by Comino and colleagues,[38] 78% had used SABA regularly or during an 'attack'. Almost half (48.9%) reported using SABA daily. This had fallen to 30.2% by the 1993 study by the same authors ($p<0.001$).

In the 1999 Living with Asthma survey,[31] 26% of children were reported to have used their reliever inhaler more than four times in the previous week. A further 5% of carers did not know how many times their child had used a reliever in the past week.

Selected populations

In the 2007 Asthma Foundation NSW survey,[35] 89% of carers reported that the child had used reliever medication in the previous 4 weeks, with 17% reporting that reliever was used most days, 67% that it was used in response to symptoms, and 15% reporting both. The median frequency of reliever usage was 3 days/week (IQR 2-6.5).

In the 2010 Asthma Foundation Queensland survey,[36] 40% of carers of children or adults with asthma reported use of reliever inhalers three times or more per week.

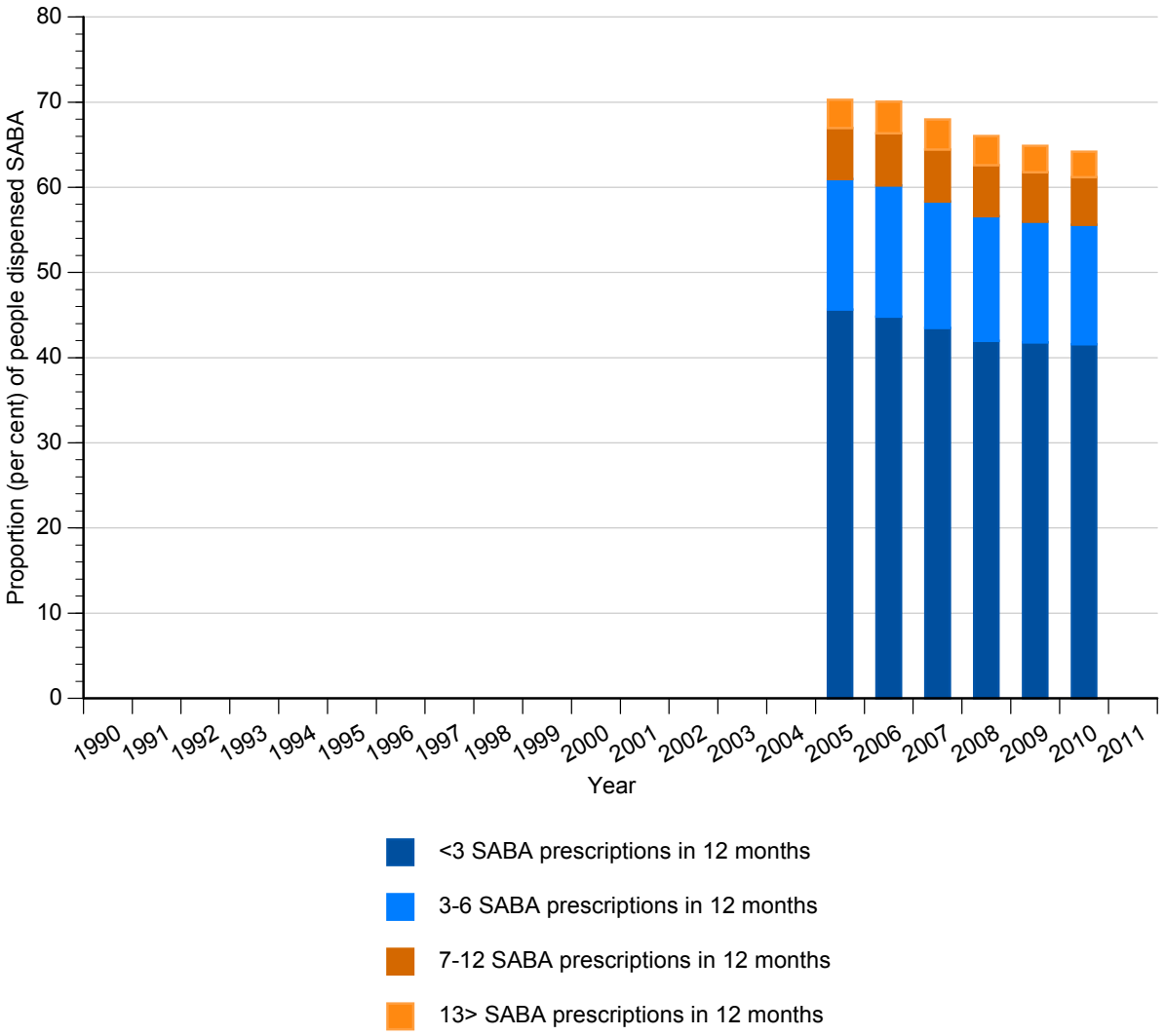
DISPENSING DATA - ALL AGES

Population-based data

Analysis of dispensing data from the Pharmaceutical Benefits Scheme (PBS) database can provide information about the number of prescribed SABA inhalers that were dispensed per individual in a 12 month period. The database does not include any information about diagnosis or the reason for prescription, so these data include SABA inhalers dispensed to patients with COPD as well as patients with asthma. Since the cost of SABA falls below the general (non-concessional) co-payment amount, the following analysis was based on data for concessional patients with an adjustment for general patients (see Appendix 2). The data in this section exclude all over-the-counter SABA purchases. From various pharmacy-based surveys, the proportion of SABA purchases by people with asthma that were over-the-counter rather than by prescription was 45% in 1989,[55] 60% in 1993,[56] and 40% in 2004/5.[57]

From PBS data for the period 2005 to 2010, dispensing of SABA prescriptions was examined for individuals who had been dispensed any inhaled or oral medications for asthma or COPD. Based on

the number of doses per canister for formulations available in Australia, and assumed equivalence of 2 puffs of salbutamol and 1 dose of terbutaline, dispensing of 1-2 SABA prescriptions per year is consistent with guidelines criteria for use of SABA twice a week or less.[1] In the analysis presented here, four arbitrary thresholds for SABA dispensing were used as indicators of good, poor, very poor and extremely poor asthma control: dispensing of 1-2, 3-6, 7–12 and 13 or more SABA prescriptions per year respectively.



Sources: Pharmaceutical Benefits Scheme

Figure 5: Proportion of people taking any inhaled or oral medications for asthma or COPD who were dispensed short-acting beta-agonist prescriptions, by number of prescriptions per year, all ages, 1990-2011

The proportion of people receiving any respiratory medications who had a SABA prescription dispensing record consistent with poor (or worse) asthma control, i.e. ≥3 SABA prescriptions per year, remained stable at around 20% during the period 2005 to 2010 (Figure 5). The proportion of people who were dispensed fewer than three SABA prescriptions per year decreased over this period, from 39.1% to 34.7%, and the proportion of people who received any respiratory

medications but were not dispensed any prescribed SABA medication increased. Potential reasons for this change include improved asthma control, an increase in use of budesonide/formoterol maintenance and reliever therapy (in which this medication is used as reliever medication in place of SABA), and/or more people with asthma purchasing SABA medication over-the-counter.

INTERFERENCE WITH DAILY ACTIVITY DUE TO ASTHMA

Limitation of daily activity is a useful measure for monitoring the impact of asthma at a population level.[58] However, in longitudinal population surveys, there are few Australian data about the extent to which asthma interferes with daily activity for adults or children.

Current guidelines regard any limitation of activity due to asthma as being inconsistent with well-controlled asthma.[23 26] However, in surveys and in clinical practice, it is difficult to identify the extent to which obesity and lack of fitness may contribute to activity limitation in a person with asthma.

Population-based data

In the 1999 Living with Asthma survey,[31] parents of children diagnosed with asthma were asked about the impact that asthma had on their children's daily life. The survey found that, due to their asthma, 18% of children with asthma did not play at school, 20% did not swim, 21% did not ride a bike and 19% avoided playing with animals. Approximately one in three children with asthma did not participate in organized sport (31%) or sleep over at a friend's house (35%) because of their asthma [31]

In the 2001-2 survey by Kenny et al,[49] 72% of adults and children (combined) reported asthma interfering with sporting or strenuous activities in the previous 6 months. In the NSW Population Health surveys, data for activity limitation are available for 2003-2007. Between 2003-2005, there was a decrease in the proportion of adults and children for whom asthma had interfered with ability to manage day-to-day activities to a moderate or extreme extent over the previous 4 weeks (Figure 6) .[59 60]

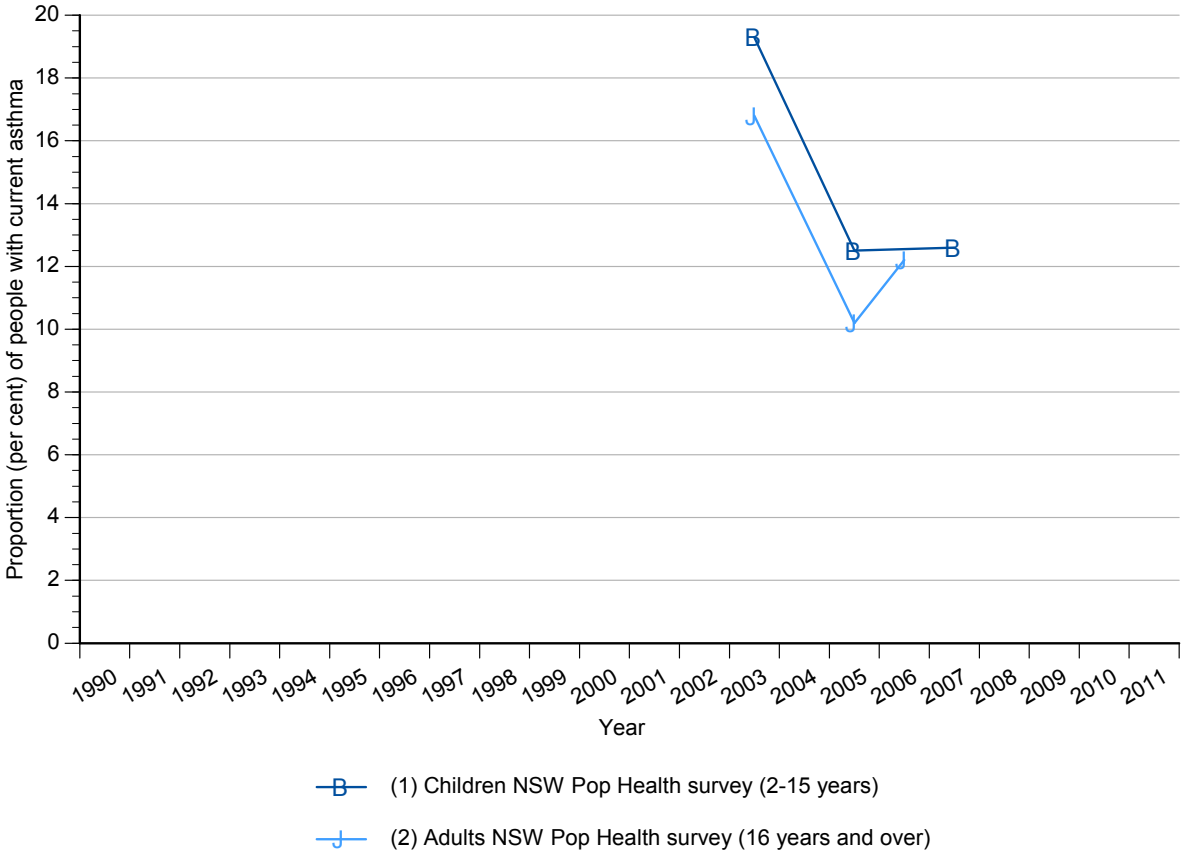
Over the period 1997 to 2007 (Figure 6) there was no significant change in the odds of reporting moderate to extreme interference with daily activities in adults and children with current asthma (0.937 (95% CI; 0.722 - 1.216) fold decrease per year).

Selected populations

In the Asthma Foundation NSW 2007 survey,[35] 13% of adults with asthma reported interference with activity most or all of the time, and 44% some of the time, in the previous 4 weeks.

In the Short on Air 2010 survey,[33] 25% of adults with moderate to severe asthma reported that asthma interfered with their daily activities and lifestyle at least once in the previous week. Among people with asthma 12% reported that the disease prevented them from doing everyday physical activities such as walking up stairs or walking at a fast pace to the bus, 11% reported being prevented from doing light exercise like going for long walks, 30% were prevented from doing moderate exercise like light swimming, running or jogging, 45% were prevented from doing intensive physical activity such as tennis or football, and 9% were prevented from undertaking sexual activity.

In the Asthma Foundation Queensland 2011 survey, 8% of participants reported that asthma interfered with their activity at least weekly.[36]



Note: Question asked; During the last 4 weeks, did your/child's asthma interfere with your/child's ability to manage your/child's day to day activities? and Did it interfere with these activities: A little bit, Moderately, Quite a lot or Extremely? Data presented for moderately to extremely.

Source: NSW Population Health Survey.

Figure 6: Moderate to extreme interference with daily activities in the last 4 weeks among children and adults with current asthma, 1990-2011

COMPOSITE ASTHMA CONTROL SCORES

Over the past 15 years, several composite scores have been developed and validated to assist in the assessment of asthma control. These tools usually assess the 'current control' component of asthma control.

The Asthma Control Questionnaire (ACQ)[24] is one such tool, which has been used extensively in clinical trials. The ACQ is a 7-item questionnaire with 5 items for symptoms, 1 item for reliever use, and 1 item for pre-bronchodilator forced expiratory volume in 1 second (FEV_1) expressed as % predicted. For each item, 7 responses are provided, with scores ranging from 0 to 6. The responses for reliever use range from (0=0 puffs/day, 1=1-2 puffs/day, up to 6=>16 puffs/day). The average of all scores gives the ACQ score, which ranges from 0 indicating no impact to 6 indicating life-

threatening asthma.[24] Based on physician assessment of asthma control, an ACQ score of ≥1.5 was found to be consistent with poorly-controlled asthma, and an ACQ score of ≤0.75 was consistent with well-controlled asthma.[24] Shorter versions of the ACQ have been developed for situations in which pre-bronchodilator lung function cannot be measured, or when agents other than SABA are used for relief of asthma symptoms.[61]

Another validated asthma control score is the Asthma Control Test[25] (in Australia also called the Asthma Score), a 5 item scale about activity limitation, symptoms, night waking due to asthma, reliever use, and self-assessed level of asthma control (see below), with the summed scores ranging from 5-25 (higher is better).

Population-based studies

No population-based Australian data for composite asthma control scores were found.

Selected populations

In the 2007 Asthma Foundation NSW survey, the median ACQ score for adult participants (n=646) was 1.17 (IQR 0.5, 2.0).[35] Forty per cent of participants had asthma that was not well-controlled as indicated by an ACQ score of ≥1.5. For those participants recruited through community pharmacies, asthma was less well-controlled, as indicated by median ACQ score of 1.7 (IQR 0.8-2.5) and a higher proportion with ACQ score ≥1.5 (56%), compared with those recruited from the Woolcock volunteer database (29% poorly-controlled) or Asthma Foundation NSW (37% poorly controlled).[35] This could represent selection bias, in that people whose asthma was currently not well-controlled may have been more likely to visit a pharmacy during survey recruitment. Of the 81 adult respondents who were not using an ICS-containing medication in the previous 4 weeks, 30 (37%) had poorly-controlled asthma (ACQ ≥1.5).

At the time the survey was conducted, validation of the child-completed ACQ [62] had not yet been published; parents were asked to complete the adult ACQ questions with regard to their child's asthma (n=82), and 38% of children had an ACQ score ≥1.5.

OTHER ASSESSMENTS OF ASTHMA CONTROL

SELF-ASSESSED ASTHMA CONTROL OR SEVERITY

In many studies about asthma control over the past 10-15 years, results have been reported for asthma control as self-assessed by patients. In these reports, comparisons have been made with an assessment of asthma control based on standard guidelines-based measures such as symptom frequency and night waking due to asthma, recorded by the physician or calculated from a daily diary. Commentary on such studies has often stated that differences between the self and physician assessment of asthma control indicate that patients 'over-estimate' their asthma control and 'under-estimate' their asthma severity, 'suggesting a willingness to accept symptoms and lifestyle limitations as unavoidable consequences of their disease'.[63]

However, differences in patient-assessed and physician-assessed asthma control are much more likely to be due to patients using the word 'control' differently from its medical usage. In guidelines and research literature, the term 'asthma control' is used with a specific technical meaning relating to the frequency of features such as asthma symptoms and reliever use, i.e. it is medical jargon. By contrast, patients may think of 'control' of their asthma in terms of self-control, the way they are managing their asthma, or the rapidity with which their symptoms are relieved when they take medication. A similar discrepancy between lay and medical meanings exists with the use of the term 'shock' in the context of trauma.[20]

A corollary important for longitudinal studies is that patient-assessed asthma control is directly modifiable by education, since if patients are taught the medical meaning of 'asthma control' they may adopt this interpretation in later responses. The potential impact of such educational input on longitudinal results for Asthma Control Test (in which self-assessed asthma control is one component) has not yet been investigated. Based on existing data, it seems unlikely that examination of patient-reported asthma control in future studies would add further to current knowledge.

Some studies have asked patients to self-assess their asthma severity, but the meaning patients attribute to this term is unknown.

Population-based studies

In the 2002 South Australian Omnibus survey, 5% of adults self-rated their asthma as severe, 15% as moderate, 44% as mild, and 36% as 'not a problem'.

In the 2003 survey by Marks and colleagues,[32] adult participants were asked how well their asthma had been controlled in the last 4 weeks. Overall, 78% of adult participants reported that their asthma was 'well-controlled', 18% 'somewhat controlled', and 4% 'poorly controlled'. Almost half of patients who experienced symptoms every day or most days described their asthma as well-controlled, indicating, not surprisingly, that patients were using the term differently from the way it is defined in asthma guidelines.

Selected populations

In the Short on Air 2010 study,[33] 31% of patients described by the investigators as having moderate to severe asthma reported that their asthma was very well controlled, 53% fairly well controlled, and 16% poorly controlled or not controlled. Those aged 55 years and older were more likely to consider that their asthma was well controlled.

In the Asthma Foundation Queensland 2011 survey (n=602), 27% of participants described their asthma as totally under control, 45% well under control, 22% somewhat under control, and 5% not very under control or not at all under control.[36]

GP-REPORTED ASTHMA 'SEVERITY'

Since 2009, when the recommendations of the ATS/ERS Task Force were published,[19] asthma severity has generally been classified according to the level of treatment required to achieve good asthma control. Prior to 2006, clinical practice guidelines recommended that asthma should be

classified according to its 'severity', defined according to frequency of symptoms and reliever use and level of lung function.[20] In some guidelines, severity was to be assessed before anti-inflammatory treatment was started, and in others, the timing was not specified; in many cases, the same assessment was used regardless of whether patients were on or off treatment. Since these classification factors were very similar to those now used to classify asthma control (see 'What is Asthma Control?'), older publications reporting GP-classified 'asthma severity' may often be used to provide an indication of the patients' level of asthma control by current criteria.

This section of the report presents GP-reported asthma severity from the Supplementary Analysis of Nominated Data (SAND). SAND data are collected as a supplementary dataset of the BEACH program.[64] Organisations sponsoring blocks of SAND data collection ask questions on topics of their choice. GPs participating in SAND ask and record responses to specific questions in consecutive members of targeted patient groups. SAND modules relevant to asthma severity and comparable with each other were conducted in 1999, 2000–01, 2002, 2003, 2004, 2006,[65] 2007,[66] and 2008.[67]

ADULTS

For SAND reports, GPs were asked to classify the severity of asthma in adults as very mild, mild, moderate and severe asthma, either by asking the patient or from their knowledge of the patient. They were provided with a reference card describing typical characteristics for each of the severity categories (Table 2), with these features based on Australian asthma guidelines of 1998 and 2002.

Using current GINA classification of asthma control,[23] patients with 'very mild' and 'mild' asthma would now be considered to have well-controlled or partly-controlled asthma, and patients with 'moderate' or 'severe' asthma would be considered to have poorly-controlled (uncontrolled) asthma.

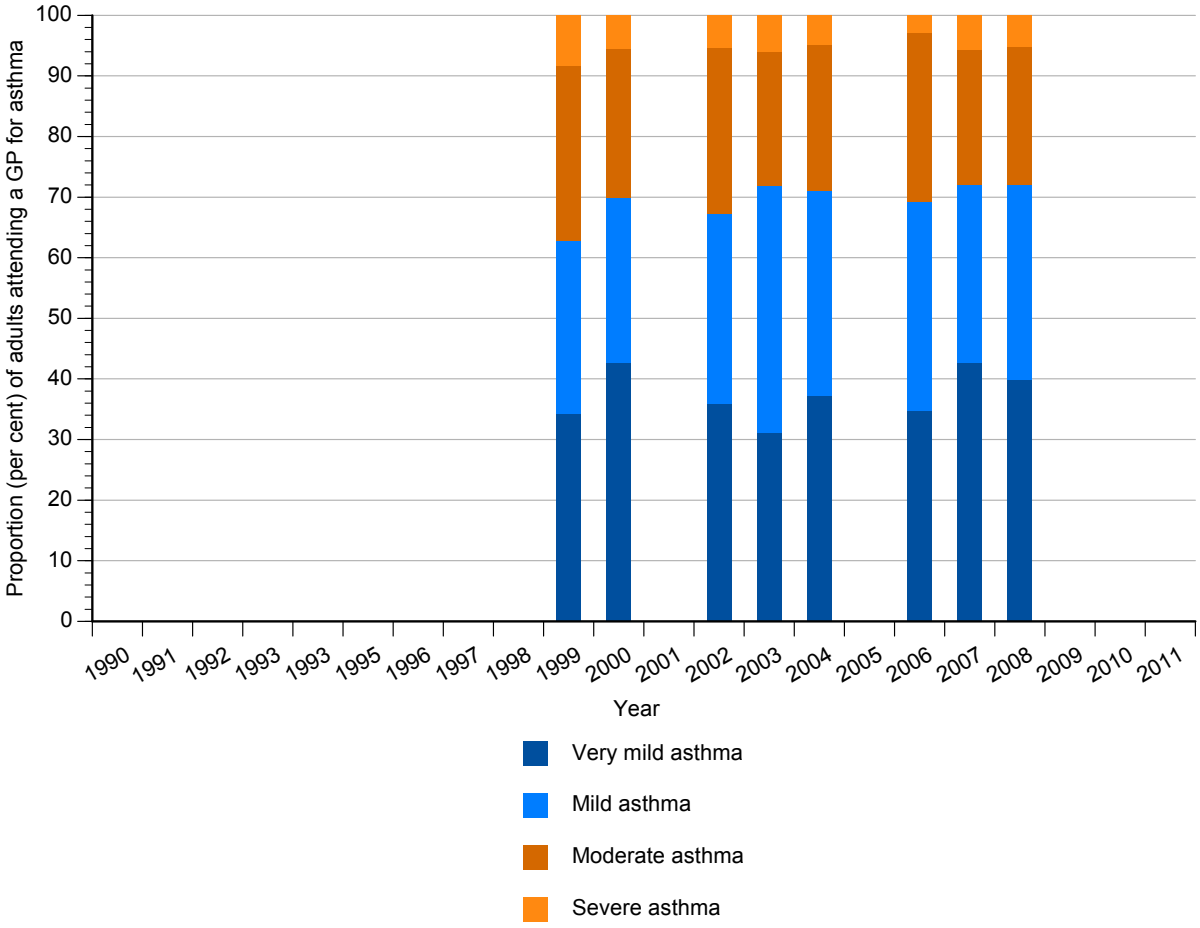
Table 2. SAND surveys: classification and characteristics for GP-reported asthma 'severity' in adults

Asthma severity*	**Common features**
Very mild	Episodic
Mild	Occasional symptoms (up to 2/wk); exacerbations >6-8 weeks apart; normal FEV_1 when asymptomatic
Moderate	Symptoms most days; exacerbations <6-8 weeks apart which affect day-time activity and sleep; exacerbations last several days; occasional emergency room visit.
Severe	Persistent; limited activity level; nocturnal symptoms > 1/wk; frequent emergency room visits and hospital admission in past year; FEV_1 may be significantly reduced between exacerbations

*Severity classes were adapted for the SAND reports from the NAC Asthma Management Handbooks of 1998 and 2002.

Figure 7 shows that, over the 10 years of these SAND surveys, a small decrease was observed in the proportion of patients classified by GPs as having 'moderate' or 'severe' asthma, from around 37% in

1999 to around 28% in 2008. This suggests a small decrease in the proportion of patients whose GPs considered they had symptoms consistent with poorly-controlled asthma.



Note: Asthma was defined as "Do you suffer from asthma?" If 'Yes', GP was asked "How severe is the asthma?" Based on the criteria provided to GP's in the SAND surveys, patients with 'moderate' or 'severe' asthma would be considered to have poorly controlled asthma.

Source: Supplementary Analysis of Nominated Data (SAND)

Figure 7: GP-reported asthma 'severity' amongst adults 1990-2011

CHILDREN

For SAND reports, GPs were asked to classify the severity of asthma in children aged 1-14 as 'infrequent', 'frequent' and 'persistent', again using criteria from the 1998 and 2002 Asthma Management Handbooks (Table 3).

Using the current GINA classification of asthma control,[23] children with 'infrequent' asthma would be considered to have well-controlled or partly-controlled asthma, those with 'frequent' asthma would be considered to have partly-controlled or poorly-controlled (uncontrolled) asthma, and those with 'persistent' asthma would be considered to have poorly-controlled asthma.

Over the period covered by the SAND surveys (1999-2008), the proportion of children with infrequent asthma ranged between 73-82%, and only a small proportion of children (0-8%) were classified as having 'persistent' asthma, with no apparent trend. However, numbers of children were small, ranging from 53 to 136.

Table 3. SAND surveys: classification and characteristics for GP-reported asthma 'severity' in children

Asthma severity*	**Common features**
Infrequent	Episodes 6-8 weeks or more apart and from 1 to 2 days up to 1-2 weeks duration; usually triggered by URTI or environmental allergen; attacks generally not severe; symptoms rare between attacks; normal examination and lung function except when symptomatic
Frequent	Attacks <6 weeks apart; attacks more troublesome; minimal symptoms such as exercise induces wheeze between attacks; normal examination and lung function except when symptomatic; commonly troubled through winter months only
Persistent	Symptoms most days; nocturnal asthma >1/wk with sleep disturbance; early morning chest tightness; exercise intolerance and spontaneous wheeze; daily use of beta2 antagonist; abnormal lung function; history of emergency room visits or hospital admissions

*Severity classes were adapted for the SAND reports from the NAC Asthma Management Handbook.

INDIRECT MEASURES OF ASTHMA CONTROL

Most markers of asthma control require clinical measures that are not readily available at a population level. However, additional indicators that have been recommended for population-level monitoring include health-related quality of life, days lost from work or school, and urgent health care utilization.[19]

Health-related quality of life measures provide information about the patient's perception of the impact that a disease has on their physical, psychological (emotional) and social wellbeing. Evidence indicates that people with asthma fare worse than those without asthma in all three domains.[1] These measures can be used to assess the impact of asthma on a person's health and everyday functioning.

Asthma exacerbations or flare-ups are an indicator of poor asthma control that can be examined from administrative data at a population level, using health-care utilisation data as a proxy for the occurrence of exacerbations. The nature and level of health service use gives a further indication of disease control by reflecting the severity of the exacerbations. People with asthma who experience worsening symptoms may self-manage the episode or seek urgent medical care from their general practitioner. In more severe cases, they may seek care from a hospital Emergency Department, and a small proportion of those attending the Emergency Department will require hospitalisation. Delay

in obtaining medical care during a severe exacerbation is a risk factor for death from asthma.[68] Patients may delay seeking care for many reasons, including fear of systemic corticosteroids.[69]

Some level of *health care utilisation* is desirable and appropriate for people with asthma. For example, patients may seek non-urgent health care from their general practitioner or a specialist for, scheduled review, which is recommended at least annually for all people with asthma, or for prescription of usual asthma therapy. Urgent health care utilisation may also be appropriate, to prevent a more serious exacerbation; for example a patient may be directed on their written asthma action plan to go to the Emergency Department if self-management strategies have not led to resolution of the exacerbation, or if the patient is continuing to deteriorate.

HEALTH-RELATED QUALITY OF LIFE

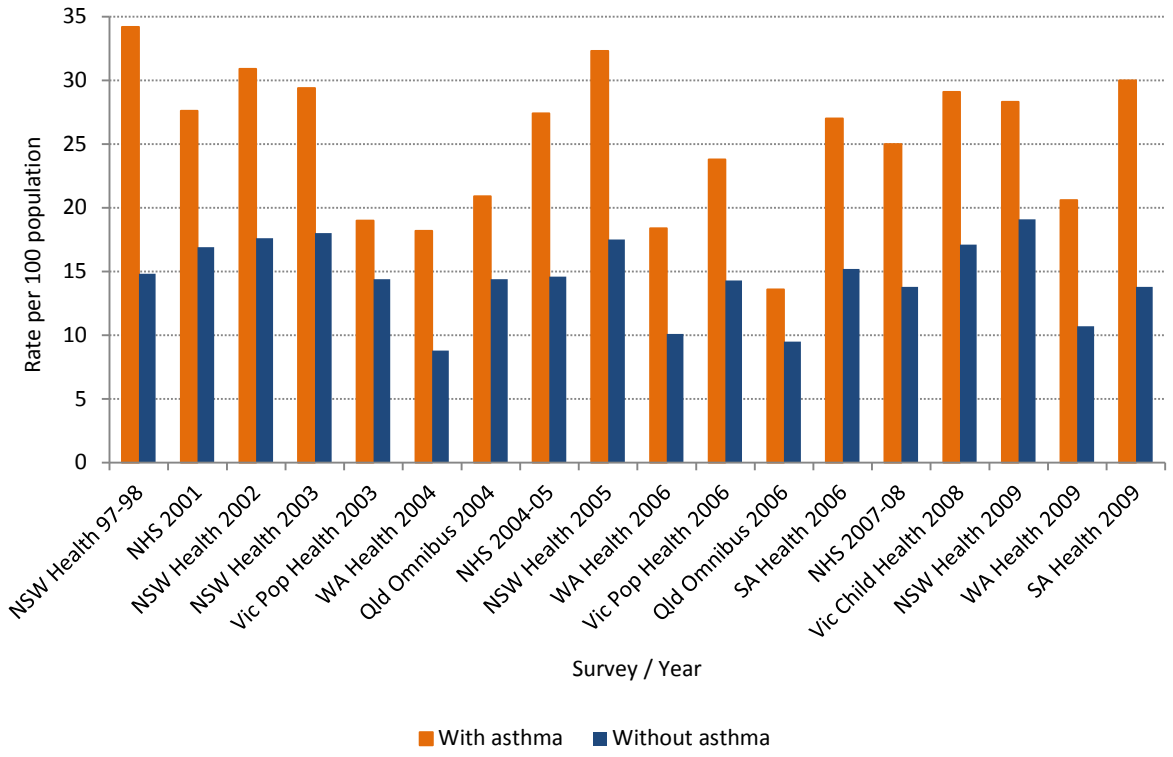
There is consistent evidence that having asthma is associated with worse self-assessed health status. The simplest measures of health-related quality of life ask only a single question, and thereby provide a global measure of quality of life. A widely used example is the question 'In general, would you say your health is excellent, very good, good, fair or poor?' This is sometimes referred to as the 'SF-1', since it appears as a preliminary global question at the commencement of the Short-Form 36 item questionnaire for assessing health-related quality of life. A similar question ('Please select one box to show how you describe your current health') appears at the start of the St George's Respiratory Questionnaire,[70] with responses ranging from very good to very poor.

More complex tools used to assess health-related quality of life in asthma include disease-specific questionnaires such as the Asthma Quality of Life Questionnaires.[71] Most of these instruments include several items for the patient's functional status (ability to perform certain activities) or health status (symptom frequency, reliever use, need for urgent care), with few items assessing the impact of the disease on the patient's quality of life or general well-being,[58 72] so the distinction between asthma control measures and disease-related quality of life measures has become less clear.

Population-based data

In the 2007–08 National Health Survey among adults aged 15 years and over, 25% of people with asthma rated their health as 'poor' or 'fair' compared with 14% of people without asthma. Of those with current asthma, 39% rated their health as 'excellent' or 'very good', compared with 58% of those without asthma.[30]

In an analysis by Ampon and colleagues, the proportions of people with poor quality of life, low health satisfaction and psychological distress attributable to asthma were higher than the proportions attributable to diabetes but lower than the proportions attributable to arthritis.[73]



*Sources: (*1) NSW Health Survey 1997–98 (2) NHS 2001 (3) New South Wales, 2002 (4) New South Wales, 2003 (5) Victorian Population Health Survey (6) WA Health and Wellbeing Surveillance System 2004 (7) Queensland Omnibus Survey 2004 (8) National Health Survey, 2004–05 (9) New South Wales, 2005 (10) Western Australia, 2006 (11) Victoria, 2006 (12) Queensland, 2006 (13) South Australia, 2006–07 (14) National Health Survey, 2007–08 (15) Victoria, 2008 (16) New South Wales, 2009 (17) Western Australia, 2009 (18) South Australia, 2009.

Figure 8: Fair/poor/very poor self-assessed health by asthma status, 15 years and over.

Figure 8 shows the proportion of adults, with and without asthma, who rated their overall health status as fair, poor or very poor, sorted by year of study. The majority of these surveys used the 5 response categories described above; however, the NSW Health Surveys for 2002 onwards included an additional response category of 'very poor'(42, 47, 48). The latter surveys were excluded for trend analysis. For people with asthma, there was a non-significant trend to decreased odds of reporting fair/poor health status by 0.98 fold (95% CI 0.872-1.103, p=0.70) per year over the period 1998 to 2009. By contrast, among people without asthma, the odds of reporting fair/poor self-assessed health status decreased (i.e. health status improved) by 0.848 fold (95%CI=0.806-0.893, p=0.0002) per year over the same period.

No separate health status data were found for children.

Selected populations

In the NSW Asthma Foundation survey of 2007, 36% of adults with asthma rated their health as 'excellent' or 'very good', and 24% rated their health as 'fair' or 'poor'. Parents of 67% children with asthma rated their health as 'excellent' or 'very good', and 9% rated their health as 'fair' or 'poor'.[35]

DAYS LOST FROM WORK/SCHOOL/STUDY DUE TO ASTHMA

The number of days lost from work, school or study is an indicator of the impact of asthma on daily activity. Asthma accounts for a large proportion of days lost from work, school or study.[1 71] People with severe asthma have greater levels of absenteeism due to their disease than people with mild-moderate asthma.[74]

Population-based data

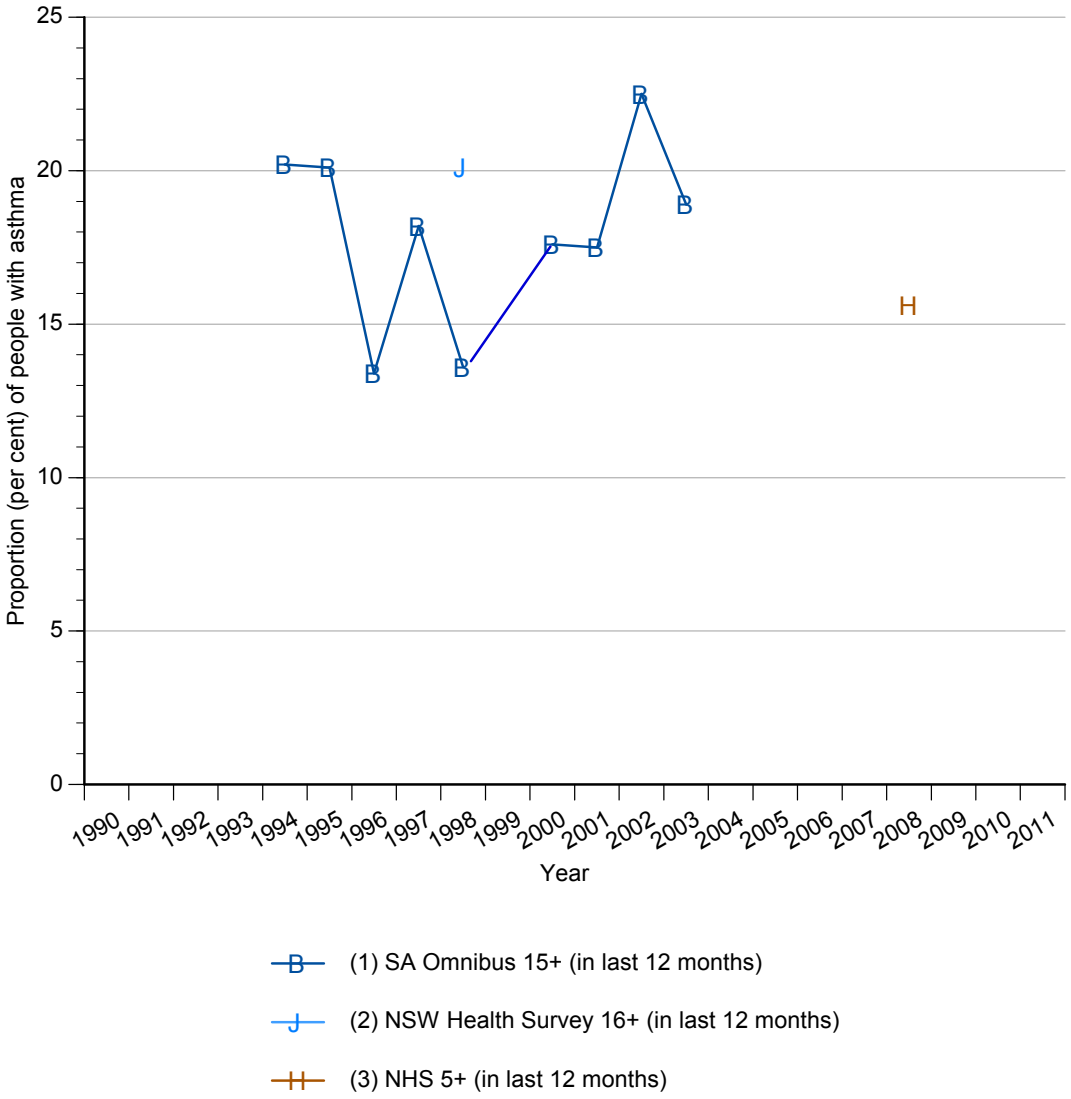
There are few trend data on days lost from work, school or study due to asthma. However, available data suggest that the proportion of people with asthma with any days lost from work/school or study remained relatively stable over the last 20 years.

In the South Australian Omnibus surveys that were conducted between 1994 and 2003, the proportion of adults aged 15 years and over who reported any days lost from work due to asthma in the previous 12 months remained relatively stable at around 20%.[47]

Higher rates were reported from the Queensland Chronic Disease survey (76% in 2000, 40% in 2006) but the results are not directly comparable to those from other surveys because the question was about whether the respondent could not work, study or manage day-to-day activities rather than days away from work.[47] Likewise, in the 2001-2 survey by Kenny and colleagues, 60% of participants reported that asthma interfered with work/study/day to day activities in the previous 6 months. Hence, these data include not only absenteeism, but also cases of 'presenteeism', that is, a person is at work but not functioning to their usual capacity.[17]

Some variation between studies may also be attributable to the recall period. In the National Health Surveys of 2001 and 2004-5, the question about time lost from work related to the previous 2 weeks whereas most other surveys including other National Health Surveys asked about time lost from work in the previous 12 months.

For data that can be combined, Figure 9 shows that there was no significant trend in the odds of reporting any days lost from work/study due to asthma over the period 1994 to 2007 (odds ratio 1.42 (95% CI; 0.971 - 2.007) per year).



Notes: NHS data are for all ages (5 years and over). All other data are for adults. Questions asked: (1) Any days lost from work due to asthma in previous 12 months. (2) Any days in the last 12 months when asthma interfered with ability to work/study/manage day-to-day activities. (3) Any days away from work/study in last 12 months due to asthma.

Sources: (1) Wilson et.al. 2002, 2006. (2) NSW Health Survey 1998. (3) NHS 2007-08.

Figure 9: Any days lost from work/school due to asthma among people with asthma, adults and all ages, 1990-2011

Selected populations

The 2007 NSW Asthma Foundation survey [35] found that, in the previous 12 months, 18% of adults with asthma had days away from study or work due to asthma (9% in the last 4 weeks[35]). Of those working full-time, 29% had lost time from work due to asthma in the last 12 months. The NSW Asthma Foundation report also revealed that 62% of parents of children with asthma had had to take time off work in the previous 12 months because of their child's asthma.[35]

In the 2010 Short on Air survey, 25% of participants reported missing time from work or study due to their asthma in the previous month. Participants reported using an average of five days of sick leave

in a year as a result of their asthma or a condition which made their asthma worse. Seventeen percent of participants believed that their asthma interfered with their career development at work, and 13% were unsure.[33]

In the 2011 Asthma Foundation Queensland survey, 49% of people with asthma reported having missed some time from work due to asthma in the previous 12 months, with 31% having missed up to 2 days work in that time.[36] Of carers for children with asthma, 61% reported that the child had missed 1-2 days of childcare due to asthma in the previous 12 months, with 24% having missed 6 or more days.[36]

GP VISITS

General practitioners provide the majority of care for people with asthma in Australia. This includes maintenance and review care for asthma in scheduled visits, as well as unscheduled visits for management of asthma exacerbations. Guidelines recommend that asthma should be reviewed every 3-6 months, depending on the clinical context.[26] While GP visits for asthma are reported from several surveys, it is not necessarily possible to distinguish between scheduled visits for asthma review, which are desirable, and unscheduled or urgent visits for management of worsening asthma, which may be appropriate for safety of the patient, but reflect the prevalence of poorly-controlled asthma in the community.[19] Changes in the number of GP visits for asthma may reflect changes in asthma control in the community and/or changes in access to, or costs of, health care services.

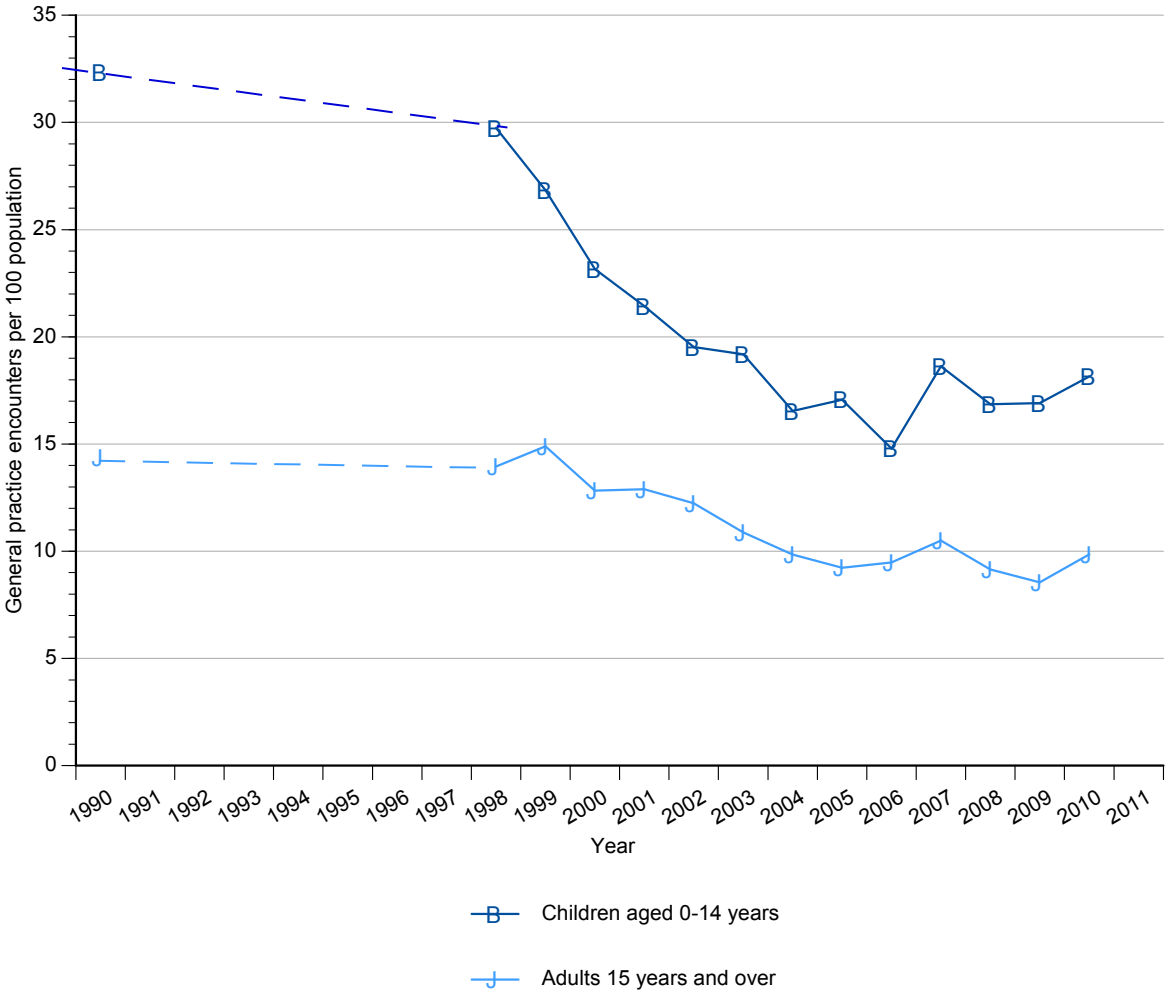
General practice population-based data

This section presents information on asthma-related general practice visits. These estimates are based on data from the Bettering the Evaluation and Care of Health (BEACH) survey,[67] which are derived from a set of encounters reported by a rolling random sample of GPs in Australia. The primary variable reported here is the proportion of all GP visits (encounters) at which asthma was a problem managed, expressed per 100 population.

Over the period between 1990 and 2011, the proportion of GP encounters at which asthma was a problem managed was consistently higher among children than adults.

Between 1990–91 and 2005–06, GP encounters where asthma was managed fell from 14.4 to 9.2 per 100 adults (Figure 10) and has remained relatively stable since. Among children, the rate decreased substantially between 1990-91 and 2006–07 (from 32.4 to 14.8 per 100 population) but has since increased to 18.2 per 100 in 2010–11 (Figure 10).

It is not known whether the decline in GP encounters where asthma was managed that was observed between 1990 and 2005-06 was due to a reduction in scheduled visits for routine review of asthma or a reduction in unscheduled visits to the GP for management of worsening asthma. Further insight could be obtained by examining the medications prescribed when asthma was a condition managed during the visit to the GP, as severe exacerbations could be identified by prescribing of oral corticosteroids.



Notes: Asthma classified according to International Classification of Primary Care, 2nd edition (ICPC-2) code R96.BEACH survey year is April to March. Data from 1990–91 were derived from the Australian Morbidity and Treatment Survey. This survey included surgery and home consultations. Data from hospital and aged care visits were not collected and account for approximately 1.5% of all BEACH encounters.

Sources: BEACH Survey of General Practice; Medicare Australia.

Figure 10: General practice encounters per 100 population where asthma was the problem managed, adults and children, 1990-2011

Population-based data

In the 2001-2 survey by Kenny and colleagues, 23% of participants age 5-75 had an asthma-related GP visit in the previous month.[49]

Unscheduled visits (Adults): In the 1997 NSW Health Survey, 9% of participants had visited a GP for an attack of asthma three or more times in the previous year.[53] In the 2001-2 survey by Kenny and colleagues, 15% of participants (adults and children) reported an asthma attack requiring a medical visit in the previous month.[49] In the 2003-4 population-based survey by Marks and colleagues, 14.3% of adults reported having at least one emergency visit to their GP for asthma in the last 12 months.[32] More than one such visit was made by 8.2% adults.

(Children): In a 1993 population survey of Melbourne primary school children, of those with any wheeze in the previous 12 months, 82.2% had visited the doctor in the previous year for a wheezy episode.[40] When a similar group was surveyed in 2002, 74.3% of children had visited the doctor in the previous year for a wheezy episode.[40] In the 2003-4 population-based survey by Marks and colleagues, 21.3% of children reported having at least one emergency visit to their GP for asthma in the last 12 months.[32] More than one such visit was made by 14.8% children.

Scheduled visits: In 1993, only 38.6% of children with wheeze in the previous 12 months went to their GP for a regular check-up. In 2002, a similar proportion (37.2%) reported having a regular checkup.[40]

In the 1999 Living with Asthma survey, it was reported that 50% of the respondents had not visited their doctor to review their asthma management or the condition of their disease in the past 12 months.[31]

Selected populations

Unscheduled visits: In the NSW Asthma Foundation survey in 2007, 25.0% of adults and 52.0% of children reported having an urgent visit to their GP for asthma in the last 12 months.[35] In the 2010 Short on Air survey, 29% patients reported having an unplanned or emergency visit to their doctor or pharmacist in the previous month.[33] In the 2011 Asthma Foundation Queensland survey, 77% people with asthma reported seeing their GP at least once in the previous 12 months for advice or assistance about their asthma, with 11% having more than five such visits.[36]

Scheduled visits: In the 2007 NSW Asthma Foundation survey, the proportion of people having a non-urgent visit with their doctor for their asthma in the previous 12 months (55% of adults and 74% of children)[35] was lower than recommended by Australian guidelines, which state that adults with asthma should have their asthma reviewed at least annually.[26] Of the 172 respondents who required urgent health care in the last 12 months (emergency visit to GP, ED, or hospitalisation), 21% reported no non-urgent visit to their GP about their asthma during the year. A similar proportion (23%) was seen for children. In the 2010 Short on Air survey, 68% of participants reported having one or more scheduled visits to a doctor, practice nurse or asthma educator, within the previous 12 months, to specifically discuss their asthma.[33]

EMERGENCY DEPARTMENT VISITS

People with asthma may visit an emergency department (ED) when they experience an exacerbation or worsening of their disease. Since exacerbations are a common feature of severe or poorly controlled asthma, rates of ED visits for asthma are often considered to reflect the prevalence of severe or poorly controlled asthma in the community.[75] However, exacerbations of any severity may also occur in patients with mild[21] or well-controlled asthma.[22]

The occurrence of ED visits for asthma may be a useful indicator of the effects of interventions to improve disease control in patients with asthma[76] or in populations,[77] and the effects of environmental exposures on asthma control.[78 79] Data on ED attendance may also be used to inform policy and guide the management of people who attend EDs frequently,[80] or to investigate asthma triggers.[81]

Going to an ED is only one of a range of alternatives available for managing exacerbations of asthma. Variation in ED visit rates for asthma may, in part, be attributable to variation in access to general practitioner care (including after hours and home visit accessibility)[82 83] and in the provision and use of asthma action plans for worsening asthma. The accessibility of ED care itself may influence the likelihood that people with worsening of asthma will seek this mode of care.

Although ED visits generally signify the occurrence of an exacerbation of asthma, not all ED visits for asthma are attributable to exacerbations. There is evidence to show that some people use EDs as a source of routine primary care.[84]

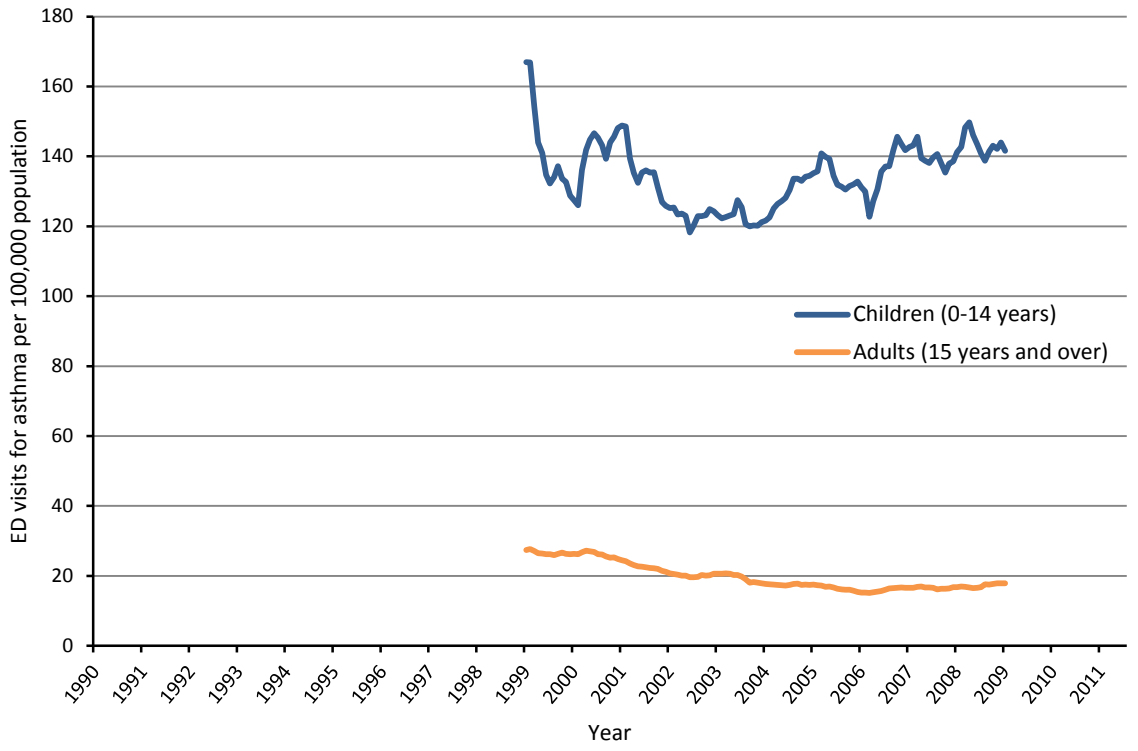
Administrative data

This section presents the time trend in data for ED presentations for asthma obtained from the New South Wales (NSW) Emergency Department Data Collection (EDDC). These data are available for NSW, Victoria and Western Australia. However, the method of data collection differs between these states and cannot be aggregated. For this reason we have described ED attendance for asthma in NSW only (Figure 11). Because of known marked seasonal fluctuations, a rolling 12-month average has been applied to the data so the long-term trends, the focus of the present report, can be seen.

In New South Wales, the ED dataset currently includes data from 90 of the 150 emergency departments in that state. Only EDs from public hospitals participate in the EDDC. This report uses only data from 43 emergency departments for which the data were complete. These EDs cover approximately 60% of the NSW population. Emergency departments in metropolitan Sydney and larger rural hospitals are more likely to be included. This incomplete coverage means that the denominator used in the calculation of the ED attendance index is an overestimate of the true population covered. Hence, the ED attendance index is an underestimate of the true population-based rate. Furthermore, the nature of the missing data means that the ED data tend to under-represent people visiting EDs in rural and remote areas. It should also be noted that the data presented here rely on an ED diagnosis of asthma. There may be a number of children and adults who visit an ED and are not diagnosed with asthma but another respiratory condition (or vice versa).

Adults: Between 1999 and 2006, the rate of ED visits for asthma in NSW steadily decreased among adults aged 15 years and over. Since then the rate of ED presentation among adults for asthma has remained relatively stable (Figure 11).

Children: Emergency Department visits for asthma by children are known to be highly seasonal, with major peaks in February shortly after school return, and other, smaller, peaks during the year.[1] Over the period covered by this review, the rate of ED visits for asthma among children (0-14 years) was substantially higher than the rate for adults, and was highly variable despite a 12-month rolling average applied to the data (Figure 11). Overall, there were no major changes in the time trend for ED visits for asthma among children, only year-to-year variability, which is largely driven by the February peak.[1] To date, the determinants of the variation in height of the February peak from year to year are not known.



Notes: As the coverage of the NSW emergency department (ED) data is less than 100%, these rates will be an underestimate of the true ED visit rate among people with asthma. Data contains a mix of diagnoses coded using International Classification of Diseases, 9th and 10th revisions (ICD-9 and ICD-10) and SNOMED-CT. Comparability factors, calculated from hospitalisation data (see Appendix 2) have been used to adjust for the changes in coding from ICD-9 to ICD-10. The NSW population was adjusted to reflect only those covered by the 43 EDs included in the data (60.13%).

Source: NSW Emergency Department Data Collection, Centre for Epidemiology and Research, NSW Department of Health.

Figure 11: Emergency department visits for asthma per 100,000 population, 12-month rolling average, by adults and children, New South Wales, 1990 to 2011

In other administrative data, the number of 5-9 year old children attending the Emergency Department of the Royal Children's Hospital Melbourne for acute asthma decreased from 728 in 1997 to 533 in 2002.[40]

Population-based data

Adults: In 2000, 20.8% of adults with current asthma reported having one or more Emergency Department visits in the previous 12 months.[85] In 2001-2, 13.8% of adults and children reported having an Emergency Department visit for asthma in the previous year.[49] In 2003 8.5% adults with asthma reported visiting an Emergency Department for asthma in the previous 12 months, with 3.5% having more than one such visit.[32]

Children: In 1993, 13.3% of a sample of 6-7 year old children with wheeze in the past 12 months living in Melbourne had attended ED because of asthma over that period. The proportion was slightly lower (11.3%) in a similar study in 2002.[40] A national study conducted in 2003 found that 15.1% children with asthma reported visiting an Emergency Department for asthma in the previous 12 months, with 5.8% having more than one such visit.[32] A further study, conducted in 2005, among

6-12 year old children with wheeze in the last 12 months found that the proportion who had attended ED for asthma within the previous 12 months ranged from 12% among 6-year olds to 4% among 12-year olds (p=0.01 for trend).[39]

Selected populations

In the 2007 NSW Asthma Foundation survey, 25% adults and 52% children with asthma reported visiting an Emergency Department for asthma in the previous 12 months.[35] The total number of such visits ranged between 1-15 for adults (median 1) and 1-4 for children (median 2).

In the 2010 Short on Air survey of adults with moderate to severe asthma, 21% of respondents reported visiting an Emergency Department visit for their asthma at least once in the previous 12 months, with 4% having 3 or more such visits. Young males (18-34 years) were significantly more likely to have ≥3 ED visits. In a separate question, 17% of respondents reported visiting an ED for their asthma in the past 30 days, with the small difference from the 12 month data suggesting the possibility of either response bias (people with a recent event may have been more likely to participate in the survey) or recall bias.[33]

In the 2011 Asthma Foundation Queensland survey, 20% of people with asthma reported using a hospital or hospital ED for asthma in the previous 12 months.[36]

HOSPITALISATIONS

Hospitalisation for asthma is required when exacerbations or 'attacks' are life-threatening or when they cannot be safely managed at home. Changes in the number of hospitalisations for asthma may be due to changes in the severity and prevalence of the disease in the community, and/or changes in the effectiveness of disease management.

Administrative data

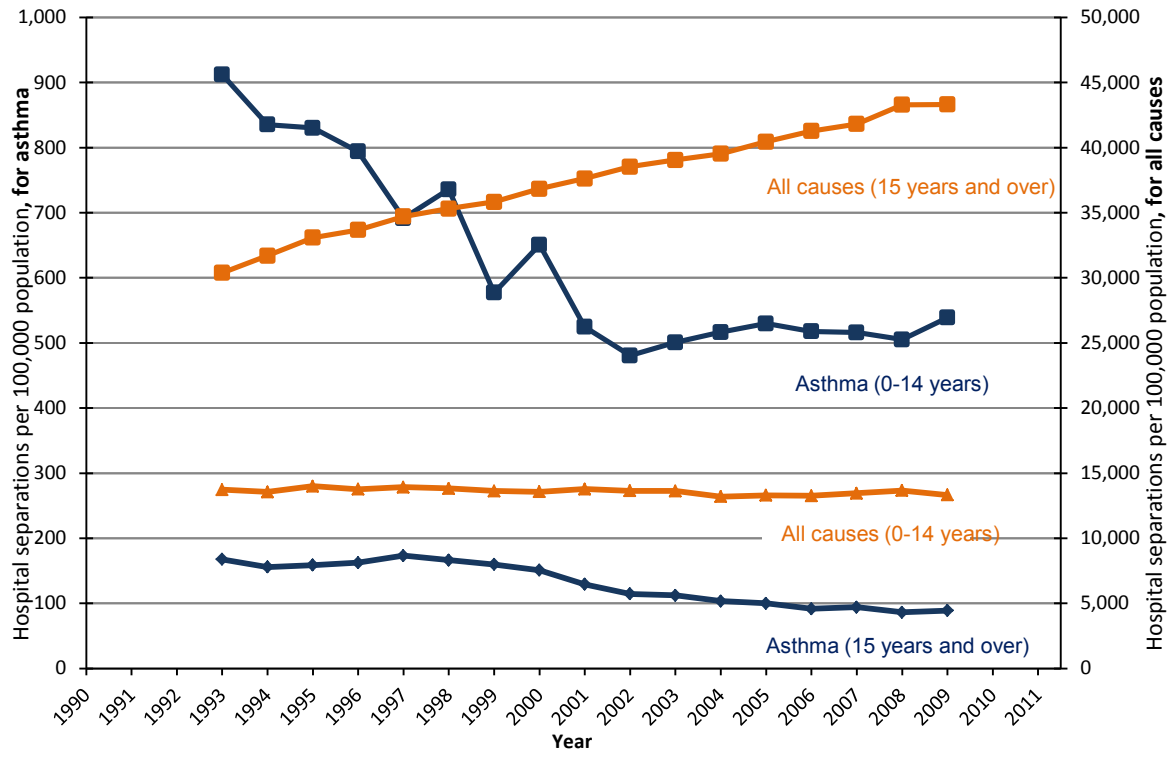
The data for this section were accessed online from the AIHW National Hospital Morbidity Database. The data recorded are hospital 'separations', largely comprising entire hospital stays from admission to discharge but with a separate record if the patient is transferred to a different type of care, e.g. to rehabilitation. For simplicity, the term 'hospitalisations' is used in this section. Hospitalisation data are dependent on the accuracy of the diagnosis recorded at the time of discharge, but hospital diagnostic labelling for asthma is considered to be far more reliable than labelling from other sources, particularly self-reported doctor-diagnosed asthma, which is all that is available in questionnaire surveys.

Adults: The rate of hospitalisations for asthma in adults was relatively stable during the 1990s but decreased between 1999-2000 and 2002-03. However, hospitalisation rates have remained relatively stable in the past 10 years (Figure 12).

Children: There was a substantial reduction in hospitalisations for asthma in children during the period between 1993–94 and 2002–03. The rate has remained relatively stable since then. In Victoria, the rate of hospital admissions for asthma for children aged 5-9 years fell from 10 per 1000 children in 1992-93 to 3.9 per 1000 in 2001-02.[40]

Comparison with all-cause hospitalisations: The time trends in rates of hospitalisation for asthma are different to the time trends for all-cause hospitalisations over the same period. (Figure 12) Since 1993–94, all-cause hospitalisations among children have remained relatively stable, while among adults the rate has increased steadily over time. These results are consistent with the overall significant increase in the number of hospitalisations between 1998–99 and 2008–09.[86]

There was no reduction in the prevalence of asthma over the period of 1992 to 2003 that could explain the decline in hospital admissions for asthma over the same period; in fact, Figures 1-2 show that during this period, the prevalence of asthma rose in adults, and was stable in children. Instead, the decrease in hospitalisations for asthma may be due to more effective long-term or preventative management of asthma or more effective out-of-hospital management of disease exacerbations. For example, the decrease in hospitalisations for asthma observed among both adults and children between 1998-99 and 2002-03 paralleled an increase in the rate of prescribing of ICS by GPs for treatment of asthma (see ICS medications prescribed in general practice). It is also possible that there was a decrease in the severity of asthma over this period, due to environmental change. However, it is not possible to attribute the observed trend with any degree of certainty to any of these factors.



Notes

1. Age-standardised to the Australian population as at 31 December 2001.
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. Asthma classified according to International Statistical Classification of Disease and Related Health Problems, 10th Revision, Australian Modification (ICD-10-AM) code J45 and J46.

Source: AIHW National Hospital Morbidity Database.

Figure 12: Hospital separations for asthma per 100,000 population, adults and children, 1990-2011

Population-based data

Adults: In the 2002 South Australian Omnibus survey, 7% of adults with asthma reported spending one or more nights in hospital for asthma in the previous 12 months.[54] In 2003 3.8% of adults reported spending one or more nights in hospital due to asthma in the previous 12 months.[32]

Children: Amongst 6-7 year old children with wheeze in the last 12 months, hospital admission for asthma was reported for 6.2% of the children in 1993, and 5.4% in 2002.[40] In 2003 4.9% of children with asthma reported spending one or more nights in hospital due to asthma in the previous 12 months.[32]

In 2001-2, 7.8% adults and children were reported to have had an asthma admission in a 12 month period.[49]

Selected populations

In the 2007 NSW Asthma Foundation survey, 8% of adults and 12% of children reported spending one or more nights in hospital because of asthma in the previous 12 months.[35] No separate data about hospitalisations were available from the other two large consumer surveys.

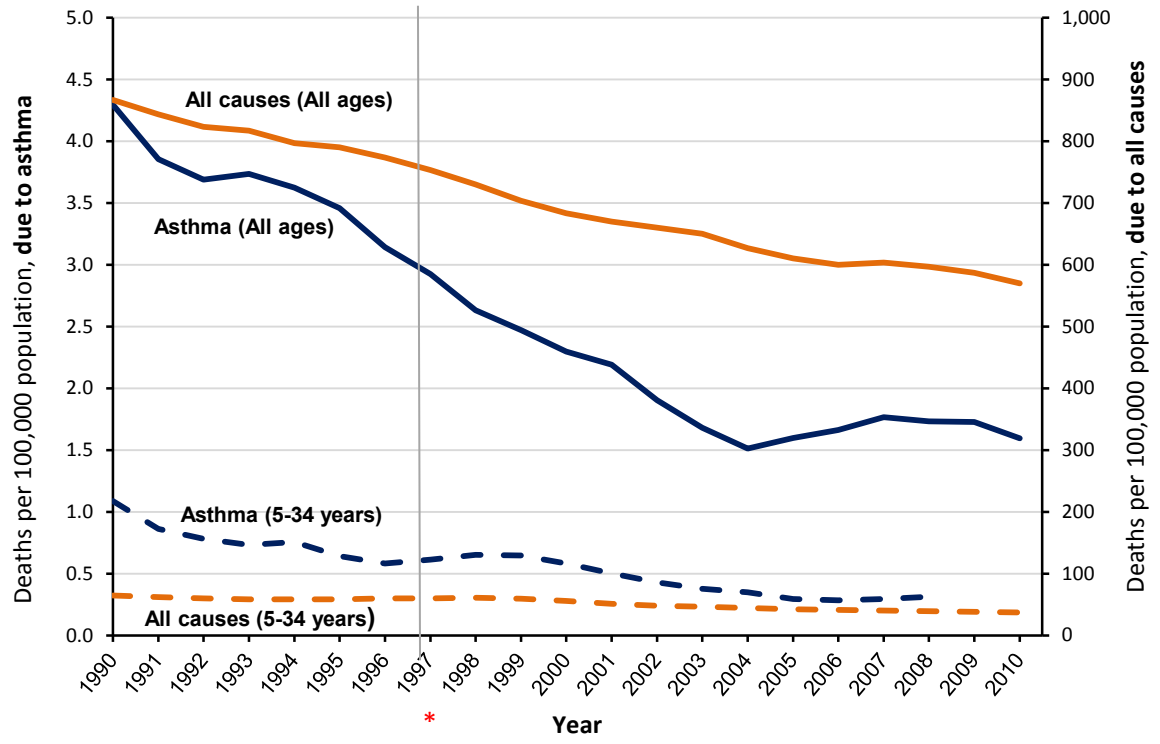
MORTALITY

Death attributable to asthma is obviously the most serious consequence of the disease. Effective management of asthma, particularly the regular use of ICS, substantially reduces the risk of death due to asthma.[87]

This section presents data from the AIHW National Mortality Database (as reported in the Australian Centre for Asthma Monitoring publications Asthma in Australia 2003, 2005, 2008, 2011) investigating time trends in asthma deaths and data from the Australian Bureau of Statistics online data cubes for trends in all cause deaths. Data are presented for people of all ages, and also for people aged 5-34 years, as attribution of death to asthma is more certain within this age group.[88 89] Due to the complexity of diagnosis of breathing problems in the elderly, other causes of death, in particular chronic obstructive pulmonary disease and cardiac disease, commonly cause difficulties in the attribution of causes of deaths in the older population.[90-92]

All ages: In 1990, the rate of deaths attributed to asthma was 4.2 per 100,000 population among people of all ages. Figure 13 shows a 3-year moving average for deaths attributed to asthma. Between 1990 and 2003, the mortality rate declined by almost 64% to 1.5 per 100,000 population. This rapid decrease in deaths due to asthma among all ages continued a trend that had begun in 1987, as shown in long-term trend data published in Asthma in Australia 2011.[1] Since 2003, the all-age rate of deaths attributed to asthma has remained relatively stable, below 2.0 per 100,000 population, with a slight increase between 2004 and 2007 that appeared to be among people aged 80 years and over (National Asthma Council analysis). In 2008, the median age at death attributed to asthma was 80.3 years in Australia, 74.3 years for males and 82.4 years for females. All-cause mortality has also decreased in Australia since 1990, but to a lesser extent than asthma mortality (Figure 13). No trend data are available for case fatality rates attributed to asthma.

Age 15-34 years: For this age-group, a similar trend was observed over 1990-2009 (Figure 13), but mortality rates were overall much lower than for all age deaths. In 1990, the rate of death attributed to asthma in those aged 5-34 years was 1.1 per 100,000 population. Between 1990 and 1996, the mortality rate for this age group declined by 52% to 0.5 per 100,000 population and remained stable during the late 1990's. Since 2000, the rate of death due to asthma has declined by a further 65%. Overall, between 1990 and 2006, the mortality rate among people aged 5–34 years declined by more than 80% (Figure 13). Compared with all-cause deaths in this age-group, deaths due to asthma among people aged 5-34 years were higher and declined more rapidly.



* indicates change to the International Classification of Diseases (ICD): ICD-10 in 1997.

Notes:

1. Age-standardised to the Australian population as at 30 June 2001.
2. Asthma classified according to International Classification of Diseases, 9th Revision (ICD-9) code 493 and 10th Revision (ICD-10) codes J45 and J46. Deaths coded to ICD-9 (1990–1996) were converted to ICD-10 (1997 onwards) using conversion factors. See Appendix 2 for conversion factors.

Source: AIHW National Mortality Database; Australian Bureau of Statistics.

Figure 13: Deaths due to asthma and all causes per 100,000, 3 year moving average, for all ages and people aged 5-34 years, 1990-2011

MEASURES OF QUALITY ASTHMA CARE

MEDICATION PRESCRIBING, SUPPLY AND DISPENSING

Drug therapy is a core component of asthma management. In general, there are three clinical contexts in which medications are used in the treatment of asthma:

1. to relieve day to day symptoms when they occur
2. to control the disease and reduce the risk of symptoms and exacerbations (or 'flare ups') occurring
3. to treat exacerbations of the disease.

For relief of symptoms, the most commonly used class of medications is short-acting beta-agonists (SABA) (salbutamol and terbutaline), with some patients also using short-acting anti-cholinergic drugs (ipratropium). There is increasing use of a rapid-onset, long-acting β_2-agonist drug (LABA) (formoterol) in combination with an inhaled corticosteroid (ICS) (budesonide) for both symptom relief and controller medication, in the single inhaler maintenance and reliever therapy (SMART) regimen.[93]

Clinical practice guidelines recommend that for regular maintenance treatment, medications and doses should generally be adjusted on the basis of assessment of the patient's level of asthma control; once asthma becomes well-controlled, guidelines recommend stepwise down-titration in order to establish the patient's minimal effective dose.[23 26] The nature and dose of treatment required to maintain good asthma control is considered to reflect the patient's underlying disease severity.[19 20] In children, a leukotriene receptor antagonist (montelukast) is often used as an alternative to ICS. In Australia, the above medications are collectively termed 'preventers', corresponding to the term 'controllers' used in many other countries.

In clinical trials, the majority of people with asthma achieve control of symptoms and prevention of exacerbations on treatment with regular low-dose ICS, with a smaller proportion requiring higher dose ICS and/or addition of LABA.[23 26] Those few patients whose asthma remains poorly controlled despite adequate adherence to therapy with high dose combination ICIS/LABA may require regular oral corticosteroids, and/or, for those with severe asthma, a trial of therapy with other more toxic or expensive medications such as theophylline, montelukast, or omalizumab.

For treatment of asthma exacerbations, the medications most commonly used in Australia are SABAs, short-acting anticholinergics, ICS with or without LABA, and systemic (usually oral) corticosteroids.

This section presents data on the prescription of medications for people with asthma in general practice, and on the supply and dispensing of these medications in the community. Where possible, we have also conducted analyses that are specific to ICS and SABA classes of medications.

These data provide an insight into how asthma is managed in Australia. However, there are some important limitations to the interpretation of these data. Some people appear to have well-controlled asthma and are taking preventer medications. It is not possible, based on cross-sectional data, to establish whether the use of preventer medications in that situation is necessary to maintain

good asthma control or, alternatively, is not necessary. On the other hand, it is possible to conclude that patients with evidence of poor asthma control who are not taking preventer medications should be doing so. The interpretation of data on the wholesale or retail supply of medications is also limited by the lack of information about the number of patients for whom the medications were purchased, or their diagnosis.

Data about prescribing and supply of SABA need to be interpreted in the light of major changes in drug dispensing policy and clinical practice guidelines in Australia over the past two decades. Firstly, inhaled SABA medications have been available for over-the-counter purchase from pharmacies in all Australian states since 1983 (since 1975 in New South Wales), whereas previously they were only available by prescription. This policy was apparently introduced in an attempt to reduce delay in access to bronchodilator treatment for patients with acute symptoms. While early studies indicated that patients accessing SABA over the counter had worse asthma control than those purchasing it on prescription,[55 56] the most recent study, conducted in 2004/5,[57] showed that levels of asthma control were similar regardless of the method of purchase of SABA. In these studies, the proportion of SABA purchases by people with asthma that were over-the-counter was 45% in 1989,[55] 60% in 1993 [56] and 60% in 2004/5.[57] Secondly, following the 1980s epidemic of asthma deaths which was generally attributed to over-use of fenoterol and other SABAs, clinical practice guidelines for asthma published in Australia in 1989,[12] recommended that in mild to moderate asthma, SABA should be used only as-needed, rather than routinely (e.g. 2 puffs four times daily) as had been previously recommended.[94] The guidelines recommendation for as-needed rather than regular use of SABA has since been expanded to apply to most patients.

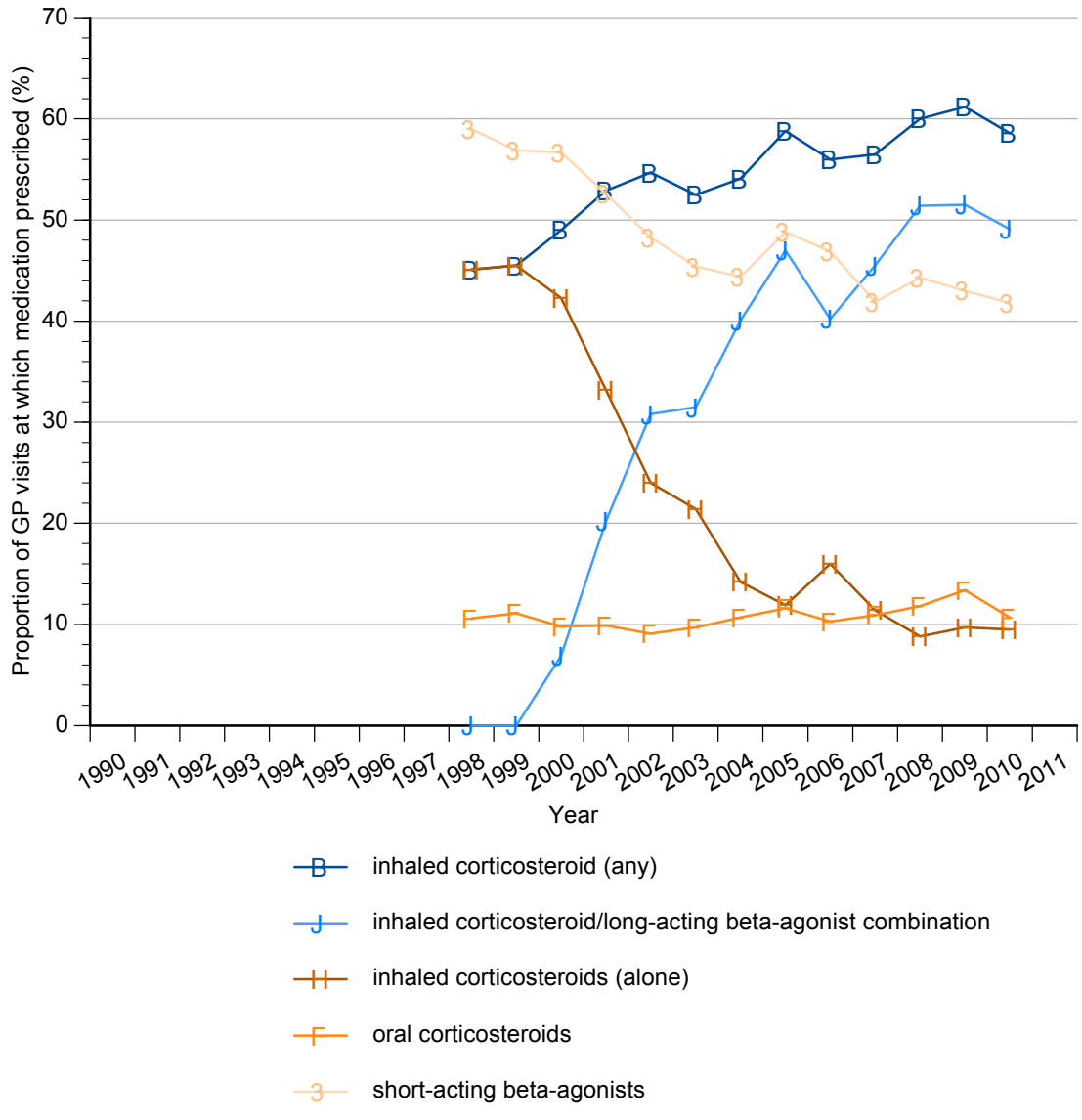
MEDICATIONS PRESCRIBED

The primary sources of Australian data about prescribing for asthma in general practice are BEACH and SAND reports. The number of prescriptions issued for a particular medication reflects two separate phenomena: first, the number of people presenting for care for the disease(s) for which the medication is used; and second, the propensity of the treating doctor to prescribe that medication for the particular patient with that disease. BEACH studies only provide data about medications prescribed at the index consultation. On the other hand, SAND studies on asthma record information on all medications being taken by patients with a diagnosis of asthma, regardless of when they were prescribed or even whether the index consultation was about asthma. There is evidence from the United States that visits for asthma are more often for the management of exacerbations than for scheduled reviews or follow-up [95] in Australia, patients also often fail to return for scheduled asthma follow-up [15] Hence, medication data from BEACH studies are more likely to include those prescribed for management of exacerbations of asthma than data from SAND studies. In addition, medications recorded in BEACH data as being prescribed may be discontinued later by the patient, so SAND data should better reflect community usage of medications, amongst patients who are attending a GP for any reason.

ADULTS

In 1990-1, salbutamol was prescribed at 53% of all asthma encounters, and at 58% of new asthma encounters (adults and children combined). In contrast, ICS was prescribed at only 25% of all asthma encounters and only 17% of new asthma encounters (data for adults and children combined).[96]

Figure 14 shows BEACH data for adults from 1998 to 2010. Over this period, there has been a decrease from 58% to 42% in the proportion of GP visits at which SABAs were prescribed, and an increase from 45% to 58% in the proportion of visits at which ICS-containing medications were prescribed.



Note: Age 15 years and older

Source: BEACH

Figure 14: Proportion of visits for asthma in general practice at which specific medications were prescribed, by class of medication, adults, 1990-2011

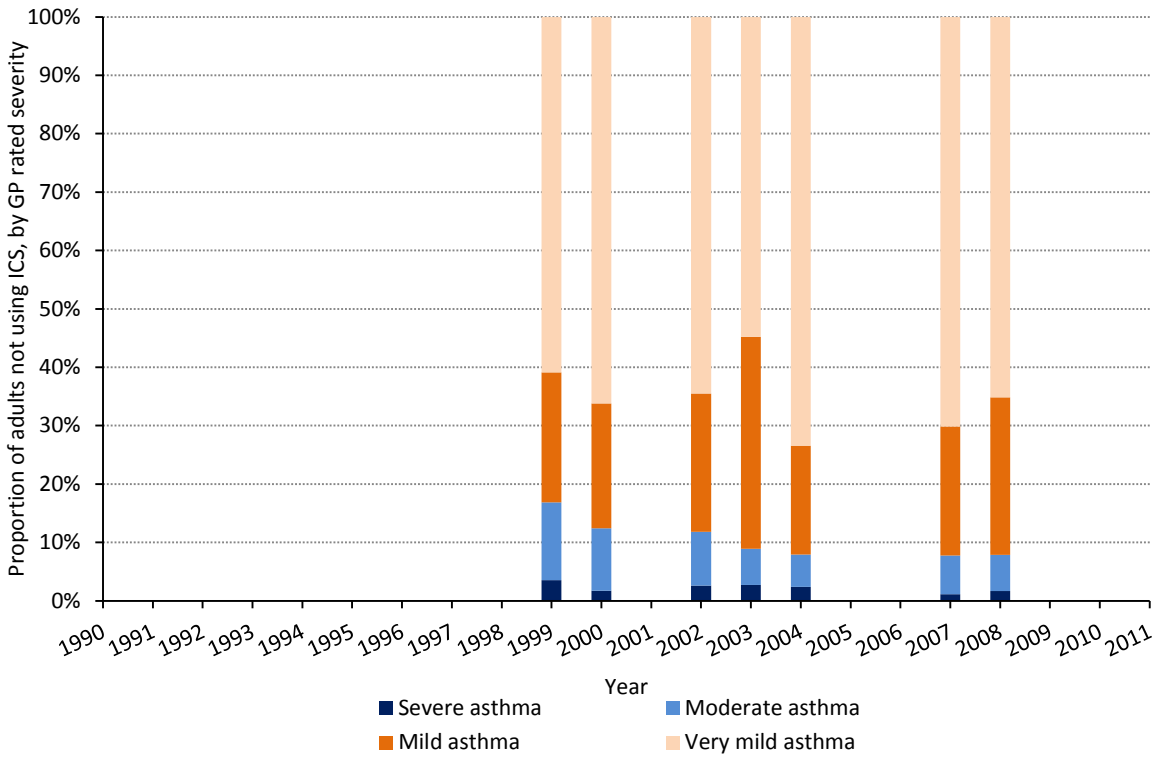
During the past 10 years, there has also been a dramatic switch in prescribing from ICS alone to combination ICS/LABA. Between 2000 and 2010, prescribing of ICS alone decreased from 45% to 9.5% of visits and combination ICS/LABA increased from 7% to 49% of visits.

Over the same period, prescribing of cromones for adults fell from 4% of visits in 1998 to <1% in 2003, and has remained at low levels since then (data not shown). Prescribing of leukotriene receptor antagonists for adults has consistently been below 1% of visits (data not shown).

The prescription of oral corticosteroids, which are generally used for treatment of exacerbations rather than for long-term maintenance therapy, remained relatively constant at around 11% of visits over the same period.

Prescribed medications and level of asthma control

From SAND surveys, it is seen that around 50% of people with asthma who visited a GP during the period 1999 to 2008-09 were being treated with ICS. However, this proportion varied markedly according to the GP's assessment of the patient's disease severity, which, as we have seen above, would reflect the patient's level of control by current criteria. In 2008, 22% of those described by the GP as having very mild asthma, 60% of those with mild asthma, 87% of those with moderate asthma, and 84% of those with severe asthma were taking ICS at the time of the index GP visit.



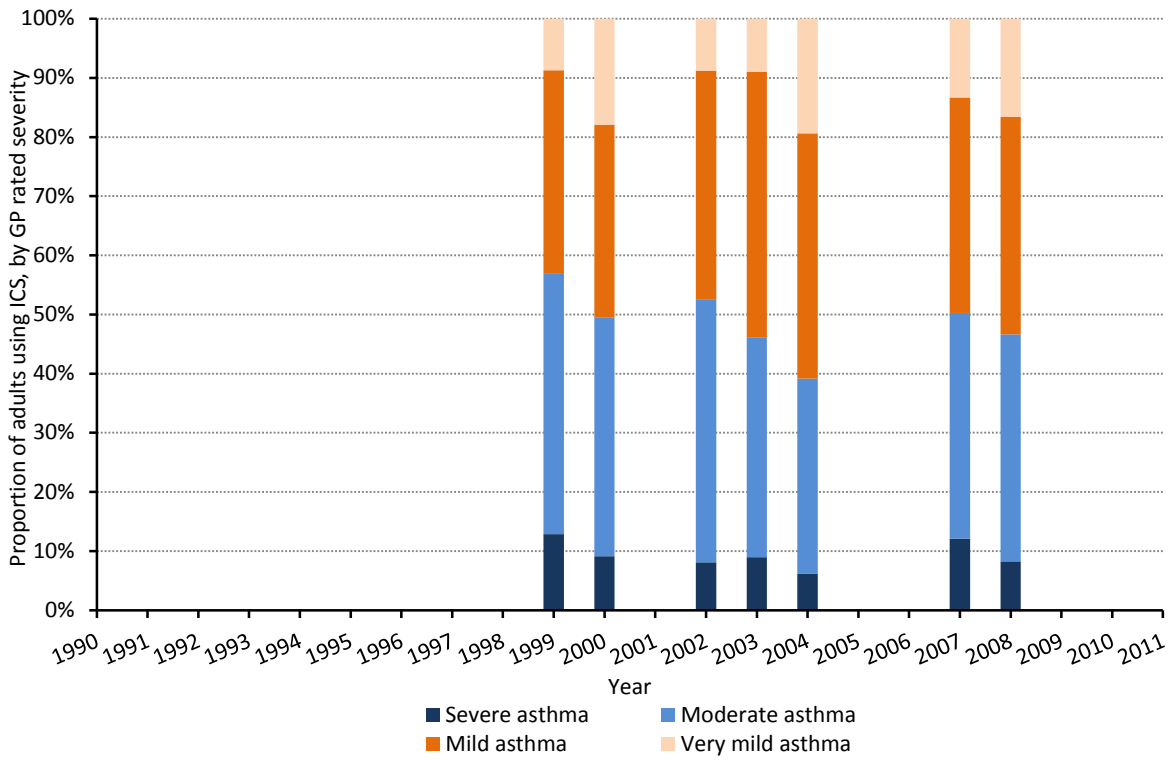
Note: Patients classified as having 'moderate' or 'severe' asthma by SAND criteria would be considered by current criteria to have poorly-controlled asthma.

Source: SAND

Figure 15: Proportion of adults (aged 18 years or over) not using inhaled corticosteroids, by GP rated 'severity', 1990-2011

Figure 15 shows that in 1999, amongst adult patients *not taking ICS* at the time of a GP visit, 17% had poorly-controlled asthma (as indicated by their classification as moderate or severe asthma by SAND criteria). This proportion had decreased to 8% by 2008-09. This suggests that, among patients with asthma who attend GPs, there were few who were not currently taking ICS who should have been doing so. However, in a population-based survey in 1997-8, among people with poorly controlled asthma living in the general community, only 43% were using preventer medications regularly.[53] The latter survey presumably included many people who do not visit their GP and hence would not have been included in a SAND survey.

Figure 16 shows that the proportion of people using inhaled corticosteroids but whose asthma appeared to be poorly-controlled (as indicated by their classification as moderate or severe asthma by SAND criteria) was 57% in 1999 and 47% in 2008.



Note: Patients classified as having 'moderate' or 'severe' asthma by SAND criteria would be considered by current criteria to have poorly-controlled asthma.

Source: SAND

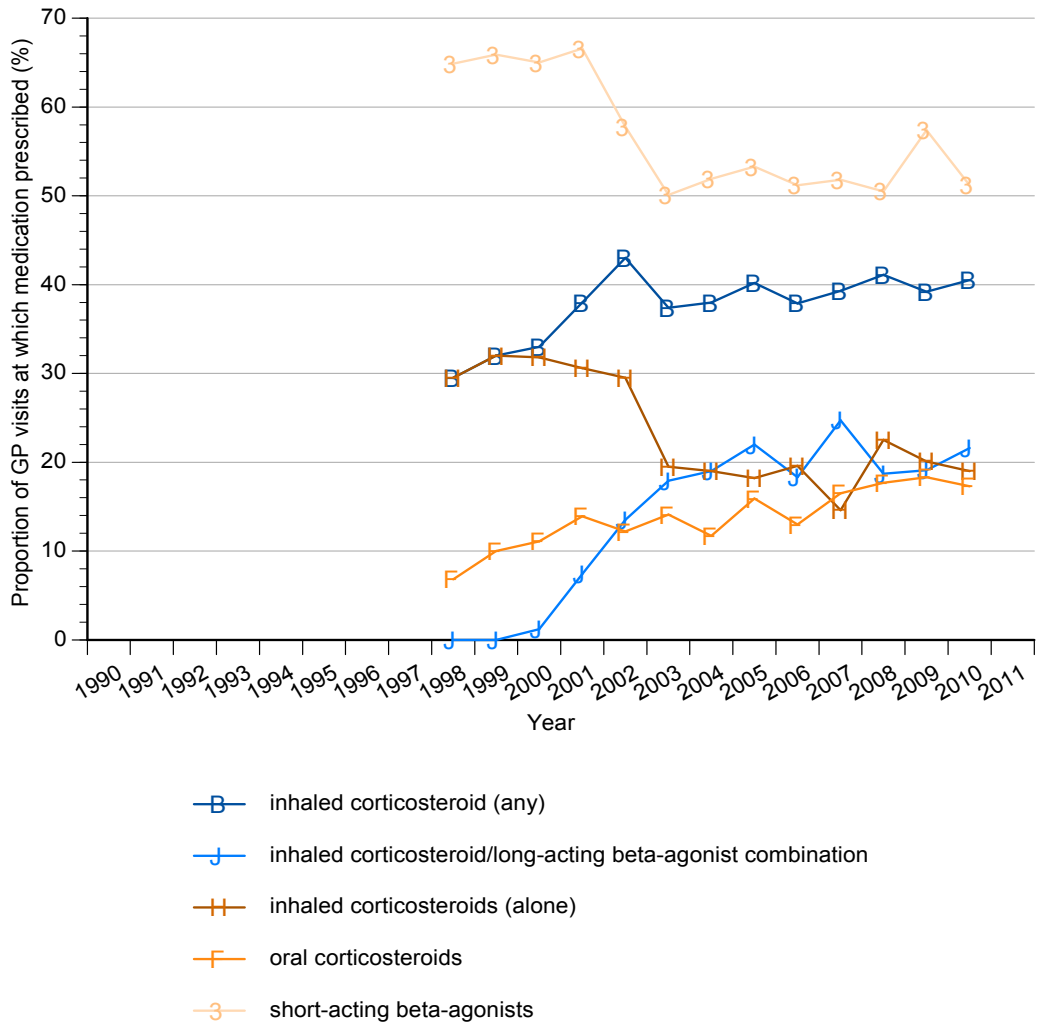
Figure 16: Proportion of adults (aged 18 years and over) using inhaled corticosteroids, by GP rated asthma 'severity', 1990–2011

Comparison between Figure 16 and Figure 15 shows that the proportion of people whose asthma appeared to be poorly controlled was much higher amongst patients *taking ICS* than in those *not taking ICS*. Possible explanations for the high prevalence of symptoms consistent with poorly controlled asthma among those taking ICS include that the prescribed ICS dose/step was too low, that poor inhaler technique or poor adherence were contributing to sub-optimal clinical effectiveness,[97] or that these patients' residual symptoms were not due to asthma.[98]

The 2004 SAND survey also gives some insight into general practitioners' expectations regarding asthma treatment. For each patient, the GP was asked whether the ICS dose was adequately controlling the patient's asthma. Although 39% of patients taking ICS were assessed by their GP as having 'moderate or severe asthma' (corresponding to current criteria for poorly-controlled asthma), the GP reported that the ICS dose was not adequately controlling the patient's asthma in only 8.4% of patients.[99] This suggests that in 2004, GPs' expectations of the effectiveness of asthma management in controlling symptoms fell far short of the stated goals of contemporaneous [100] (and current) asthma guidelines.

CHILDREN

In children, as in adults, there has been a decrease since 1999 in the proportion of general practice visits for management of asthma at which SABAs were prescribed (Figure 17). However, SABA was



Note: : Children 0 – 14 years

Source: BEACH

Figure 17: Proportion of asthma visits in general practice at which specific medications were prescribed, by class of medication, children 1990-2011

still prescribed at 51% of visits in 2010, possibly reflecting a high proportion of GP visits by children that are for management of acute respiratory symptoms.

During the same period, there was an increase in prescribing of ICS medications for children, from 30% to 41% of visits. Prescribing of ICS/LABA combination therapy began in 2000, and by 2004 this medication was prescribed as often as ICS alone, contrary to recommendations for treatment of asthma in children.[101]

Prescribing of cromones for children fell from 14% visits in 1998 to 1.2% in 2005, and has remained at low levels since then. Prescribing of leukotriene receptor antagonists rose from 0% visits in 1998 to 7.6% visits in 2010/11 (data not shown).

Between 1998 and 2010 there was a rise in the proportion of visits by children for asthma at which oral corticosteroids were prescribed, from 7% to 17.5% . Presumably these medications were being prescribed for the management of asthma exacerbations.

Prescribed medications and level of asthma control

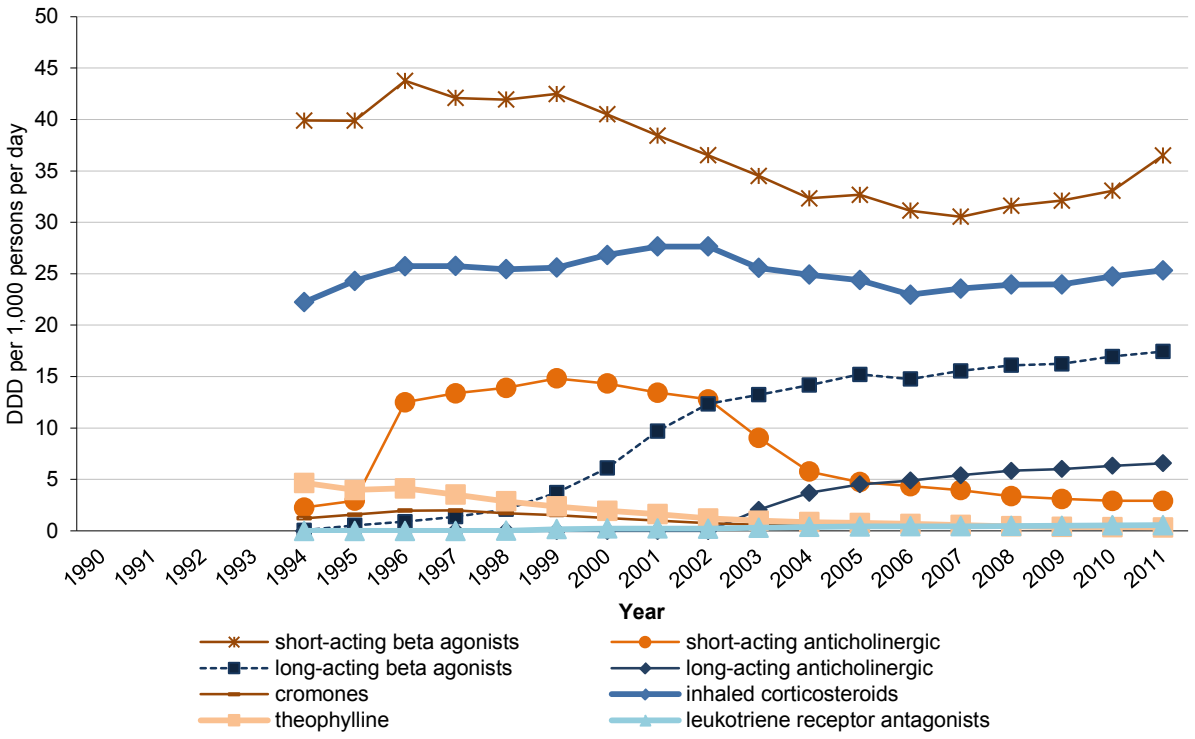
From the SAND surveys, the proportion of children with asthma who were taking ICS at the time of a GP visit increased from 26% in 1999 to 40% in 2008, and the majority of these children were classified as having frequent episodic or persistent asthma. The proportion of children classified by the GP as having' infrequent episodic asthma (i.e. with episodes 6-8 weeks or more apart and few interval symptoms) and who were taking ICS increased from 12% in 1999 to 21% in 2008. However, the numbers of children involved in these surveys was small (between 53 and 136) and there was substantial variability from year to year.

MEDICATIONS SUPPLIED

Information on the wholesale supply of medications in the community is available from IMS Health, a commercial market information company. IMS Health collects data from most Australian pharmaceutical wholesalers (see Appendix 1) about the sale of both prescription and non-prescription medications to the hospital and community sectors. Since these are wholesale supply data, they include both medications purchased with a prescription (whether or not subsidised by the PBS) and those purchased over the counter (in the present context, specifically SABA). Where data about supply of medications are not been available directly from the manufacturer, the reports are based on estimates by IMS.

Medication supply data do not include any information about the number of individuals who purchased the medications, the number of prescriptions provided to each individual, nor the diagnosis. As a result, respiratory medications supplied to fill prescriptions for treatment of asthma cannot be distinguished from those supplied for treatment of COPD.

Figure 18 shows the time trend since 1994 in the wholesale supply of medications commonly used to treat asthma and other respiratory diseases. The data are expressed in units of defined daily doses (DDDs) per 1,000 population per day. This unit of measurement represents a standardised measure of medication dosage, allowing data for different members of the same class to be combined and various classes to be compared, using a common currency. For each medication, the relevant defined daily dose was obtained from the website of the WHO Collaborating Centre for Drug Statistics



Note: Includes supply of prescription medication and over-the-counter medication to hospital and community sector. The WHO-specified defined daily dose for salbutamol assumes use of 800mcg/day. For asthma, clinical practice guidelines recommend as-needed use, optimally no more often than 400mcg/week. Use in COPD is typically 400mcg or more per day.

Source: IMS Health data

Figure 18: Respiratory medications supplied by wholesalers and manufacturers, by defined daily dose (DDD) per 1,000 people per day, 1990-2011

Methodology (<www.whocc.no/atcddd>). DDDs do not necessarily correspond to current recommendations in guidelines, but provide a way of comparing dispensing rates over time.

Time trends in medication supply are affected by changes in the prevalence of the condition for which they are used, as well as by changes in prescribing recommendations and practice, and changes in medication usage by patients. Cost is known to be a factor strongly influencing medication purchase by patients; for example, a 2005 increase in patient co-payment for PBS-subsidised medications was found to be strongly associated with a subsequent sustained reduction in per-patient dispensing of ICS/LABA,[102] that was independent of their socio-economic status.[103]

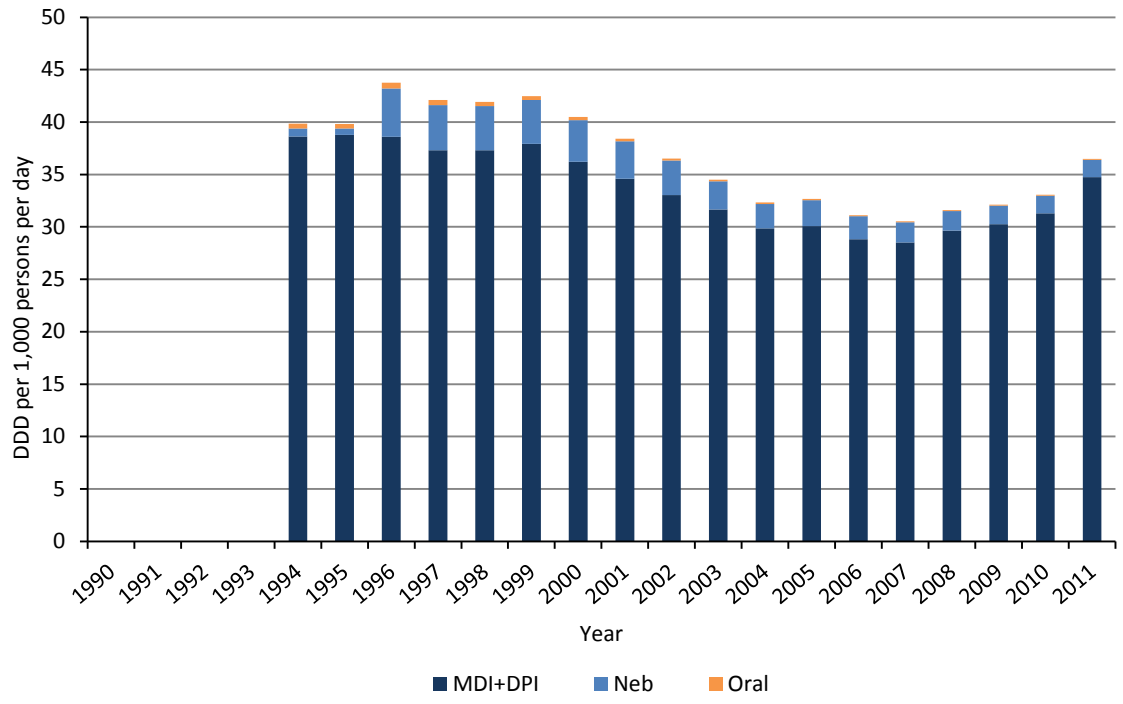
Short-acting β_2-agonists (SABA): Among medications used to treat respiratory disorders, SABAs have consistently been the most commonly supplied in Australia. The WHO-specified DDDs for salbutamol are 800 µg for pressurised metered dose inhalers, and 10mg for nebuliser solutions.

From Figure 18, the total supply of SABA in Australia, expressed as DDDs, decreased substantially between 1999 and 2004. Since 2007, supply of SABA medication has been rising again, but the increase is for one particular salbutamol product, for which earlier IMS data were estimated.

Interpretation of trends in SABA supply data is also made complex by the differing clinical conditions and contexts in which these medications are used, by the changes in clinical practice

recommendations for asthma and COPD which have occurred during this period, and by introduction of long-acting β_2-agonists into Australia. IMS data include both hospital and community supply, and the latter includes both prescribed and over-the-counter SABA. The most recent estimate in 2004-5 was that 40% of SABA dispensing in community pharmacies for asthma was over the counter.[57]

In both hospitals and community, there has been a shift since 2000 from delivery of SABA by nebuliser to pressurised metered dose inhaler and large volume spacer, in line with clinical practice guidelines (Figure 19). In the context of hospital-based management of asthma exacerbations, 12 doses of SABA by pressurised metered dose inhaler (i.e. 1.5 DDDs) are typically recommended to substitute for a single nebulisation (i.e. 0.5 DDD).[26] Clinical practice guidelines for maintenance prescribing of SABA have also changed substantially in the past 20 years. As indicated above, while 800µg/day of salbutamol would have been consistent with recommended prescribing for asthma in the 1980s,[94] guidelines from the 1990s onwards have recommended that SABA should be prescribed as-needed for asthma rather than regularly. By current criteria, patients with well-controlled asthma would be expected to receive 0.07 DDD SABA or less, and only patients with very poorly-controlled asthma would be expected to receive 1 DDD of SABA (14.4 canisters per year).



Note: Neb = Nebuliser. MDT+DPI= Metered dose inhaler, dry powder inhaler.

Source: IMS.

Figure 19: Supply of SABA by device, 1990-2011

Introduction into Australia of long-acting β_2-agonists for asthma in the late 1990s was accompanied by a substantial decline in supply of SABA (Figure 18).

Guidelines recommendations for use of SABA differ for COPD, where regular use of SABA (e.g. salbutamol 800μg/day, 1 DDD) may be beneficial. However, after commencement of long-acting β_2-agonist, SABA is recommended only for as-needed use.[104]

Given these multiple factors, even small changes in the proportion of SABA prescribed for asthma vs COPD, or in different devices, or supplied to hospitals vs community pharmacies, may affect SABA supply, so trends in SABA supply data should be interpreted with caution.

Long-acting beta-agonists (LABA) were introduced into clinical use in Australia in 1999 and were eligible for reimbursement for asthma under the PBS in 2000. Figure 18 shows that there was a rapid increase in the supply of this class of medications (either alone or combined with ICS) until 2005, and a further small increase after 2007, with some of the increase since then likely to be due to prescribing of LABA for COPD. In Australia, LABAs are now almost always prescribed in combination with ICS, regardless of the condition.

Short- and long-acting anticholinergics: These medications are mainly used for COPD. There was a progressive decline in the supply of short-acting anti-cholinergic ipratropium bromide from 2002, coinciding with the introduction of tiotropium bromide, a long-acting anti-cholinergic medication that is approved and subsidised in Australia for use by patients with COPD.

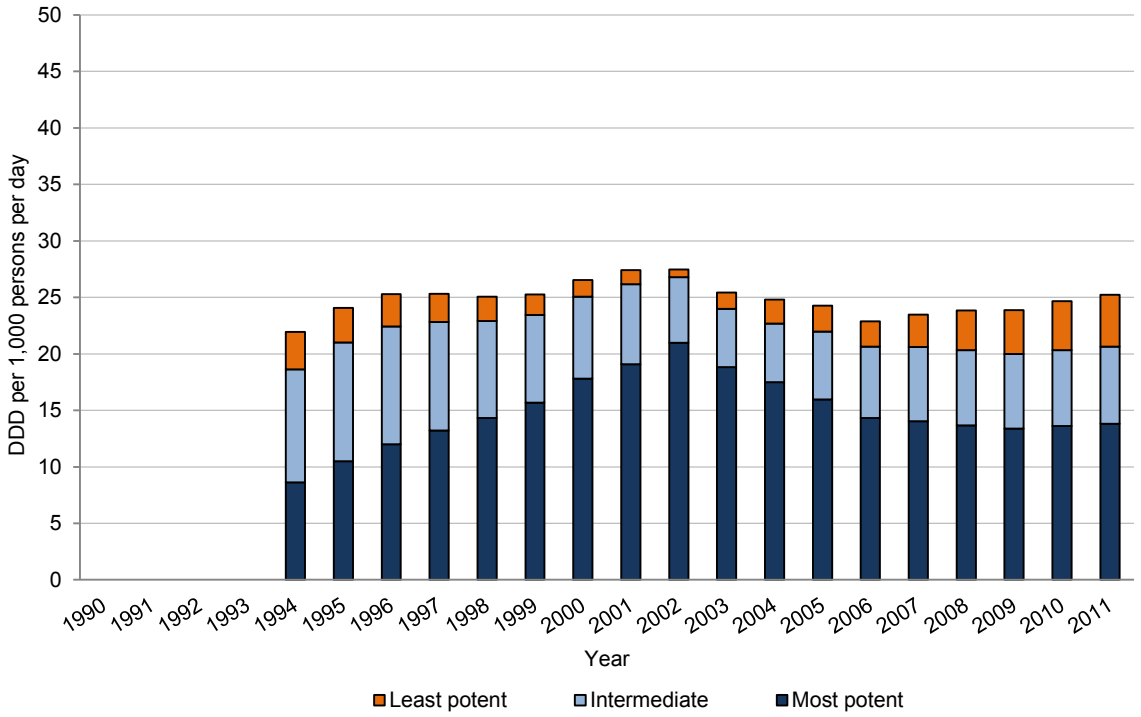
Inhaled corticosteroids (ICS): The annual total supply of ICS-containing medications, expressed as DDDs, has been relatively stable since 1996 (Figure 18).

However, there have been substantial changes in the potency of the medications supplied (Figure 20), indicating changes in prescribing habits. From the early 1990's, while there was a small increase in the overall supply of ICS-containing medications by DDDs, there was a substantial increase in the proportion supplied at the highest potency, from 39% of ICS DDDs in 1994 to a peak of 76% in 2002. The proportion supplied at the highest potency has declined since then to 55% of ICS in 2011, with supply of the lowest potency formulations increasing since 2006 (Figure 20).

These supply patterns need to be interpreted in the context of clinical recommendations about asthma treatment, which in the 1990s favoured starting with high dose inhaled corticosteroids.[105] However, following the publication of several clinical trials that showed no greater effectiveness with this strategy,[106] there has been considerable educational activity for medical practitioners about the importance of avoiding excessive doses of ICS in asthma, especially for children. In addition, the budesonide/formoterol as maintenance and reliever therapy strategy, approved in Australia in 2007, includes only low or moderate potency ICS. Nevertheless, the proportion of inhaled corticosteroids supplied at the highest potency is still inappropriately high in Australia.

Cromones and theophylline: The supply of cromones (cromoglycate and nedocromil) and theophylline was low and decreased during 1994–2011, in line with changes in clinical practice guidelines for asthma.

Leukotriene receptor antagonists: Reimbursement for prescriptions for leukotriene receptor antagonists was introduced in 2005 and only children are eligible. The overall supply of this class of medications has remained low relative to other respiratory medications.



Notes

1. Least potent includes Becotide 100, Becotide MDI 100, Qvar 50, Qvar 50 Autohaler, Pulmicort Meter Aero MDI 100 (discontinued November 2002), Pulmicort Turbuhaler 100, Alvesco 80, Flixotide Jnr Accuhaler 100, Flixotide Jnr Oral pressurised inhalation 50 micrograms per dose (120 doses) CFC-free formulation, Seretide Accuhaler 100/50, Seretide MDI 50/25, Symbicort Turbuhaler 100/6.
2. Intermediate level includes Respocort Inhaler, Becloforte MDI 250, Respocort Autohaler 250, Qvar 100, Qvar 100 Autohaler, Pulmicort Respules 500 mcg, Pulmicort Meter Aero MDI 200 (discontinued November 2002), Pulmicort Turbuhaler 200, Alvesco 160, Flixotide Accuhaler 250, Flixotide 125, Seretide Accuhaler 250/50, Seretide MDI 125/25, Symbicort Turbuhaler 200/6.
3. Most potent includes Pulmicort Respules 1 g, Pulmicort Turbuhaler 400, Flixotide Accuhaler 500, Flixotide MDI 250, Seretide Accuhaler 500/50, Seretide MDI 250/25, Symbicort Turbuhaler 400/12.
4. DDD = defined daily dose.

Source: IMS Health.

Figure 20: Relative potency of inhaled corticosteroids supplied by wholesalers separately or as part of combined therapy, by defined daily dose per 1,000 persons per day, 1990–2011

MEDICATIONS DISPENSED

Data about medications dispensed by pharmacies are available from several sources. Two companies provide dispensing data from a sample of pharmacies: Aztec, which includes prescription and over-the-counter medications, and Nostradata, which includes only prescription medications. Data from each source were analysed by DDDs, as above. The trends in medication dispensing reported by Aztec (2007-2011) and Nostradata (2006-2011) are similar to those shown in Figure 18 above from wholesale supply data, with the exception of SABA data, as below.

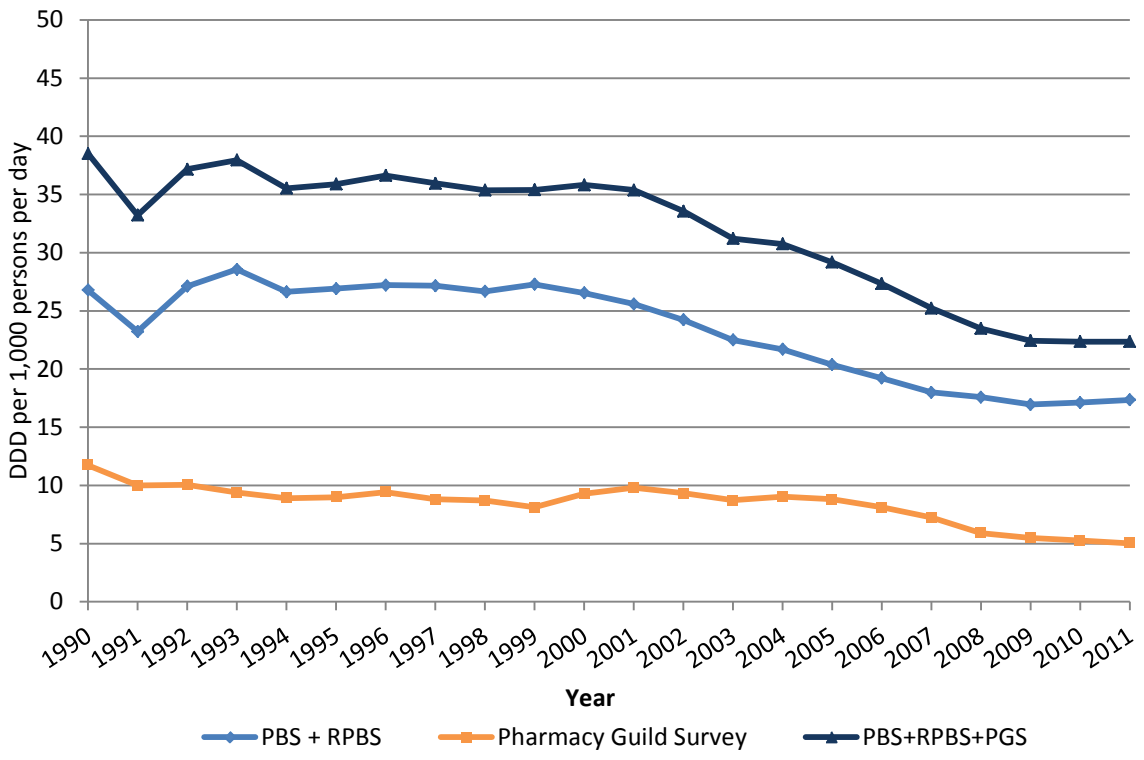
Population-level data about dispensing of prescription medicines are also provided by the Australian Statistics on Medicines. This publication combines data from PBS and RPBS for prescriptions

subsidised by the government through those schemes, together with data on dispensing of non-subsidised prescriptions (private prescriptions and those under the co-payment threshold) from a stratified random survey of community pharmacies conducted by the Pharmacy Guild of Australia.

As with other medication dispensing data, no information is available about the diagnosis for which the medications were prescribed, so the following data include medications provided for either asthma or for other respiratory conditions such as COPD.

SHORT-ACTING BETA-AGONISTS

SABA dispensing data are available from the Australian Statistics on Medicines reports. These are based on PBS/RPBS data which include SABA prescriptions dispensed to concessional patients, and those dispensed to general (non-concessional) patients under the safety net, with Pharmacy Guild data capturing remaining SABA prescriptions dispensed to general patients. Data for over-the-counter SABA dispensing (approximately 40% of SABA purchases for asthma in 2004-05[57] are not included in the Australian Statistics on Medicines publications, nor are medications supplied to hospitals. As with other dispensing data, no information is available about the diagnosis for which the SABA was dispensed.



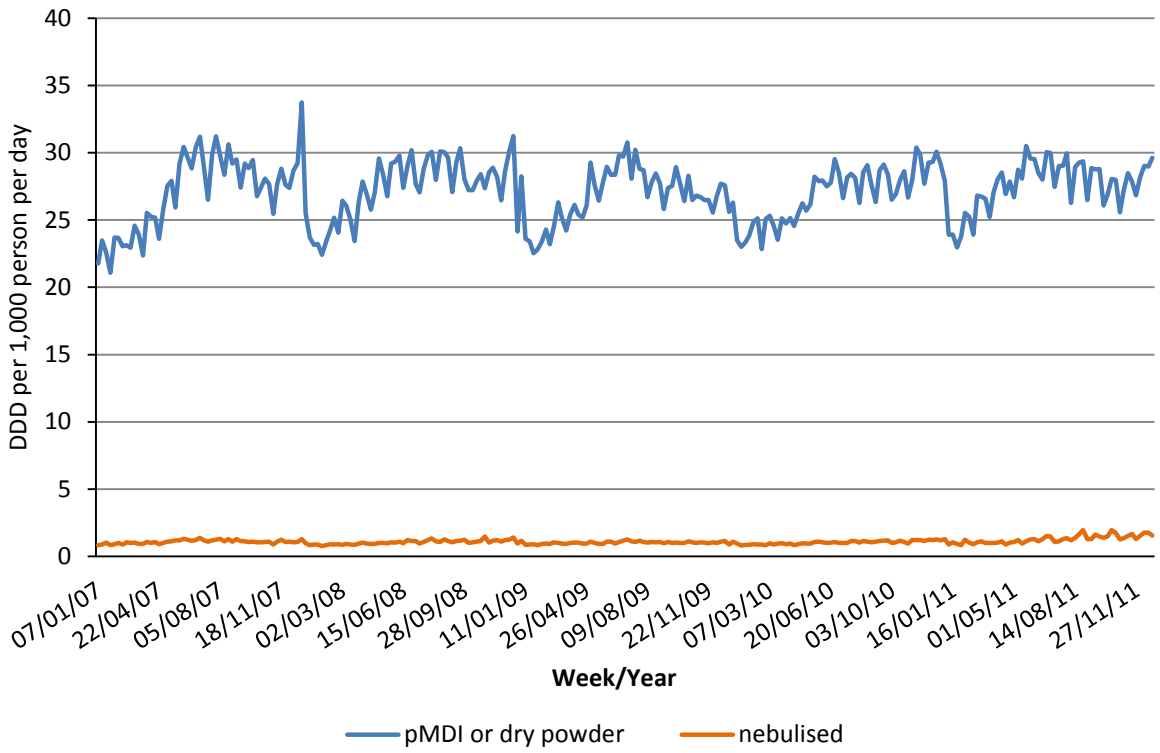
Note: Excludes over-the-counter and in-hospital dispensing of SABA.

Source: Australian Statistics on Medicines (based on Pharmacy Guild Survey, PBS and RPBS)

Figure 21: SABA medication dispensed through PBS and RPBS (subsidised) and non-subsidised prescriptions, by DDDs per 1,000 persons per day, 1990-2011

From Figure 21, Pharmacy Guild Survey data (1990 to 2011) show that non-subsidised SABA prescription dispensing remained relatively stable from 1990 to 2005, then decreased. The PBS/RPBS data for the same period show a significant downward trend in dispensing of subsidised SABA purchases since the late 1990's. The overall decrease in dispensing is consistent with the reduction in SABA supply seen in IMS data over the same period (Figure 18). In recent years, SABA *dispensing* has remained stable while *supply* of SABA medication has increased slightly.

Figure 22 shows Aztec data for SABA dispensing from pharmacies since 2007, including both prescription and over-the-counter supply. SABA dispensing shows a seasonal pattern, with a winter peak each year, and a December spike in some years, the latter likely to be due to safety-net purchases. However, by contrast with SABA *supply* data in Figures 18 and 19, Figures 21 and 22 show there has been no overall upward trend in SABA dispensing (prescribed and over the counter) from community pharmacies since 2007, suggesting that any increase in SABA supply may have related to the hospital sector.



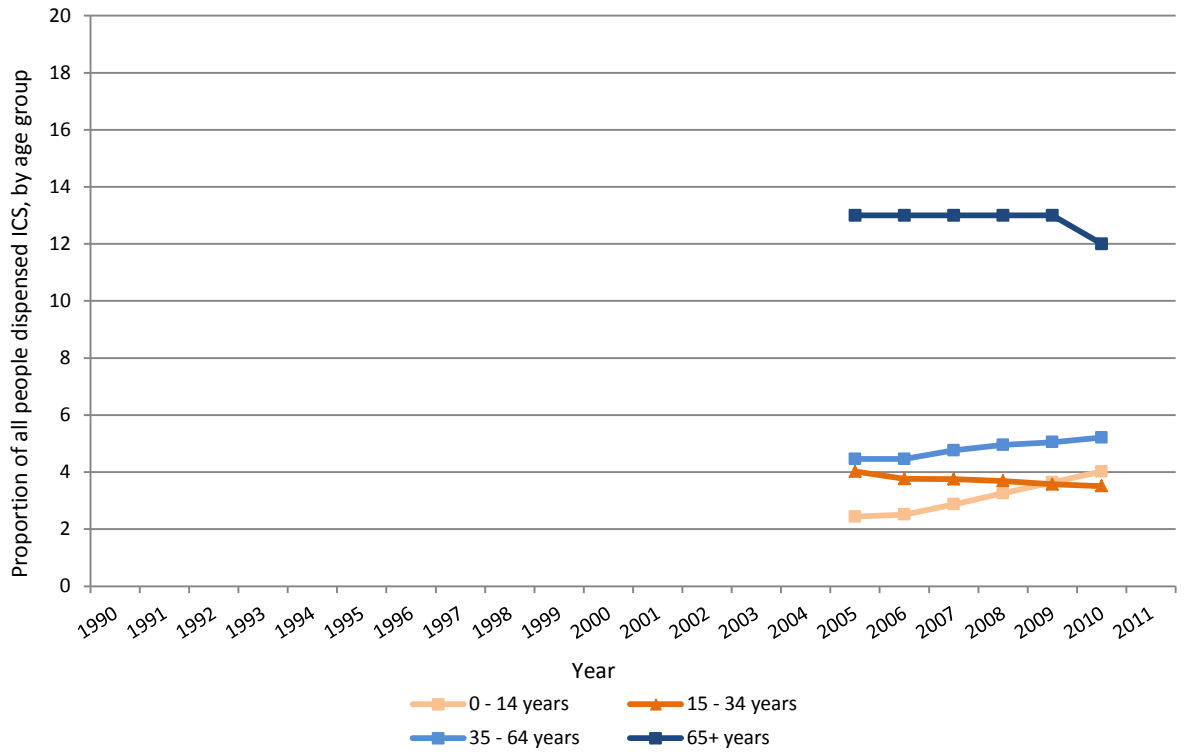
Note: MDI= Metered dose inhaler.

Source: Aztec

Figure 22: Weekly SABA medication dispensed, DDDs per 1,000 persons per day, 2007-2011

These data on time trends in SABA dispensing supplement the more direct information available from analysis of PBS data alone (Figure 5), in which the number of SABA prescriptions (not over the counter) purchased by individual patients within a 12 month period can be assessed.

The proportion of the general population who are dispensed ICS varies markedly by age. Figure 23 shows the distribution of age for people dispensed ICS during the period 2005 to 2010. This shows that the proportion of people aged 65 years or older that were dispensed any ICS-containing medication was around 2.5 times greater than the proportion in any other age group. Over this period there was an increase in the proportion of children aged 0-14 years who were dispensed ICS, a smaller increase in the 35-64 years age group, and a decrease in the proportion of older adults dispensed ICS in 2010 compared with earlier years. Changes in dispensing data may reflect changes in prevalence, in prescribing practices by clinicians and/or in adherence by patients.



Note: Includes prescriptions for inhaled corticosteroids alone or in combination with long-acting beta-agonists. Data include general and concessional patients.

Sources: Pharmaceutical Benefits Scheme.

Figure 23: Proportion of people dispensed inhaled corticosteroids (alone or in combination with long-acting beta-agonist) by year of dispensing and age group, 1990–2011

Number of ICS prescriptions dispensed per year

It has been shown that the reduction in risk of hospitalisations and death due to asthma is dependent on their regular use.[87 107] The Australian Centre for Asthma Monitoring has previously shown that only a small proportion of people receiving ICS medications have a dispensing record that is consistent with daily use.[1] Given that a typical ICS prescription provides sufficient medication for 1-2 months of treatment (depending on the frequency prescribed), a minimum of six prescriptions would need to be dispensed to sustain daily use of the medication over one year. During the period

2005 to 2010 approximately 25% of people dispensed any ICS received six or more prescriptions in a year. These data may reflect poor adherence by patients with regularly prescribed ICS and/or short-term prescribing of ICS by clinicians. One possible limitation of this analysis is that some low-potency ICS formulations that fell below the patient co-payment threshold would not have been included.

MEDICATIONS USED

Usage of SABA by individual patients is reported earlier in this report, as a direct indicator of the level of asthma control.

PREVENTER MEDICATIONS

Although preventer medications (primarily ICS-containing inhalers) are intended for regular daily use, there is overwhelming evidence of poor adherence by patients in the community.[108] However, the way in which information about patient use of preventer medications is elicited is likely to have a substantial impact on reported adherence rates, since many patients are unwilling to admit to not taking the medication as directed.[109]

Population-based data

The proportion of adults with current asthma who stated that they were currently taking ICS or other preventer medications was 38% in 1990,[38] 43% in 1993[38] and 55% in 1997.[53] In the 2003 survey by Marks and colleagues, 45% of participants said they had ever been prescribed ICS, and 66% of these said they were still taking it (29% of total).[32]

Data about the frequency of use of preventer medications were collected in some population-based surveys. In the 1997 NSW Health Survey, 28% of those prescribed preventer medications reported having used them most or all days in the previous month.[53] In 1999, 45% of adults prescribed preventer medication reported not consistently using it according to instructions, with one in five admitting to having skipped it ≥5 times, and one in ten ≥10 times, in the previous week.[31] In the 2001-02 survey by Kenny and colleagues, 58% of patients (adults and children) reported having used their preventer medication on most or all of days in the previous month.[49] In the 2002 South Australian Omnibus survey, of adults prescribed ICS, 56% reported using it daily, 9% at least weekly, and 35% only when short of breath.[54]

Information about use of preventer medications by children is difficult to interpret, since many children are prescribed these medications for intermittent use. In the Living with Asthma survey of 1999, 30% of carers of children with asthma reported that preventer medications were not used as prescribed.[31]

Selected populations

In the 2007 NSW Asthma Survey,[35] 76% of adults prescribed ICS medications reported that they used it 7 days in the previous week. In the 2010 Short on Air survey, which recruited participants who said they were currently taking both preventer and reliever medication, 71% of respondents stated that they used at least 1 puff of preventer medication every day.[33] In the 2011 Asthma Foundation

Queensland survey,[36] 49% of people with asthma who reported currently having a preventer medication reported using it every day or most days.

ASTHMA ACTION PLANS

A written asthma action plan enables people with asthma to recognise deterioration in their condition promptly and respond appropriately, by integrating changes in symptoms or peak expiratory flow measurements with written instructions to adjust medication. Use of a written asthma action plan, in combination with self-monitoring and regular clinical review reduces the need for extra medication, night waking, urgent visits to doctors and Emergency Departments, hospitalisations, and time off work.[110] In a case control study of asthma deaths in Victoria from 1994-96, ownership of a written asthma action plan was associated with a 70% reduction in the risk of death from asthma.[7]

For these reasons, written asthma action plans have formed part of national guidelines for the management of asthma since 1989,[12] and have been promoted in public education campaigns by the National Asthma Council Australia.[13 14] As asthma is a variable condition, and exacerbations can be experienced even by people with mild [21] or well-controlled asthma,[111] clinical practice guidelines recommend that every patient with asthma should have a written asthma action plan.[23 26]

ADULTS

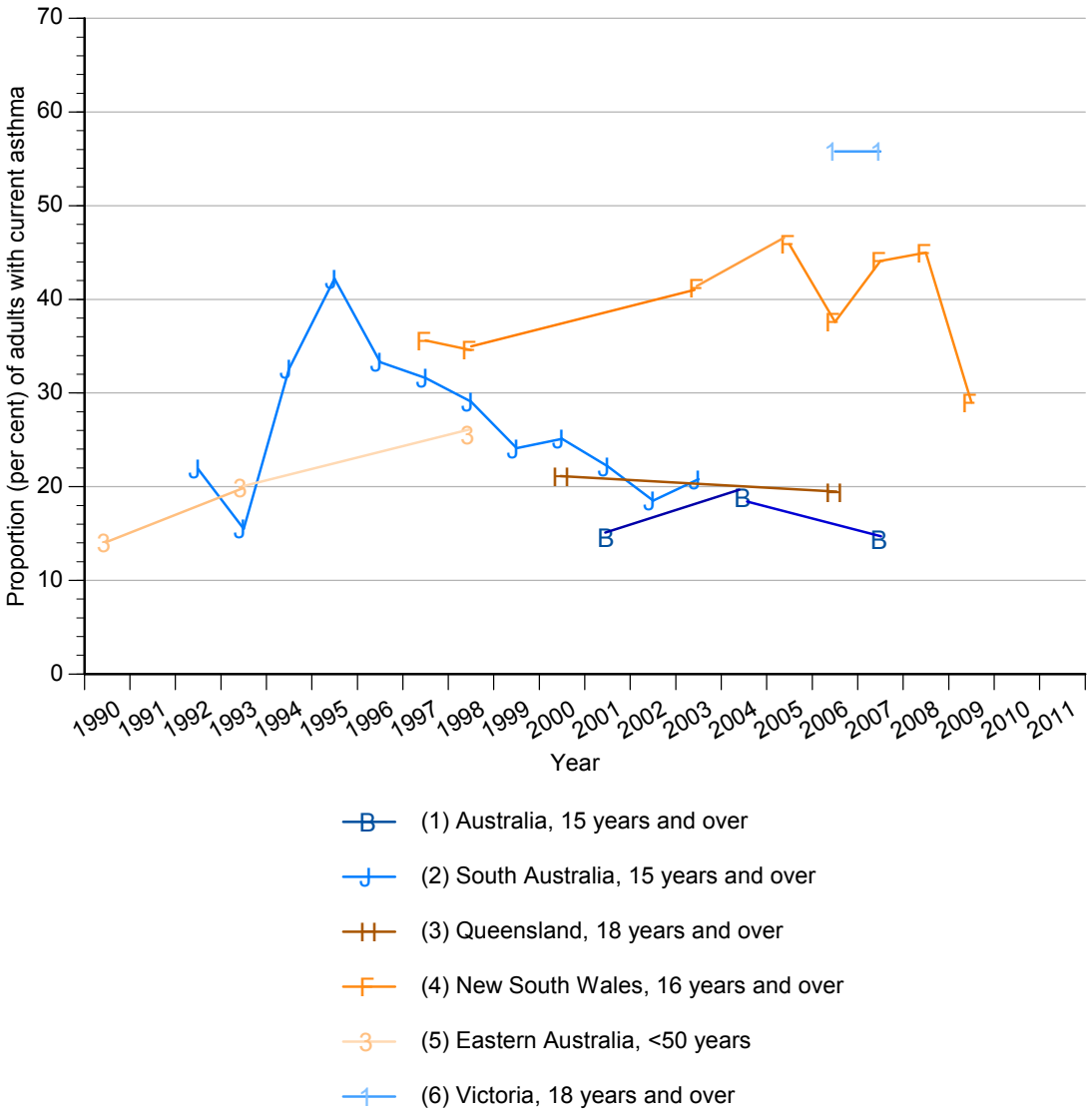
Population-based data

As reported in Asthma in Australia 2011,[1] data about ownership of written asthma action plans come from a range of national or state-based surveys (Figure 24). The most consistently collected data come from the South Australian Omnibus Survey, which showed that the proportion of people with asthma who reported owning a written action plan rose sharply between 1990 and 1995 to a peak of 42%, followed by a fall over the following 8 years to around 20%.[47] Trend analysis of all available data for adults between 1990 and 2009 showed a no significant change in the odds of adults reporting written asthma action plan ownership (odds ratio 0.873 [95% CI= 0.629 - 1.211] per year). Some of the differences between surveys are likely to be due to differences in the way asthma action plans were described to survey respondents.

It is evident that there has been substantial fluctuation in the possession of written asthma action plans over the past two decades. It is unfortunate that those people with asthma who own a written action plan remain in the minority, despite intensive efforts by professional organisation, consumer organisations, and pharmaceutical companies over the last two decades. In addition, the surveys have only asked about ownership of an action plan, whereas what is more important in determining outcomes is whether, when an exacerbation is experienced, the action plan is used.[32]

Selected populations

The proportion of people with asthma reporting that they have a written asthma action plan has also varied between surveys. Ownership of a written asthma action plan was reported by 40% of adults in the 2007 Asthma Foundation NSW survey,[35] 60% of participants in the 2010 Short on Air[33] survey, and 31% of people with asthma in the 2011 Asthma Foundation Queensland online survey.[36]



Note: Figure taken from Asthma in Australia 2011. Only people with current asthma were asked about the possession of asthma action plans. Questions asked with definitions provided (1),(2) & (3) Asthma defined as doctor diagnosed asthma plus treatment or symptoms of asthma in the last 12 months and 'Do you have an asthma action plan (written instructions of what to do if your asthma is out of control)?' (4) Asthma defined as doctor diagnosed asthma plus treatment or symptoms of asthma in the last 12 months, previous to 2009 'Do you have a written asthma action plan?', in 2009 'Do you have an asthma action plan, written instructions or what to do if your asthma is worse or out of control?' (5) Asthma defined as self-reported diagnosis of asthma and 'Do you have a written asthma action plan?' (6) Asthma defined as doctor diagnosed asthma plus symptoms in the last 12 months and 'Has your doctor given you written instructions or an asthma action plan, telling you what to do when you have asthma symptoms?

Sources: (1) ABS National Health Survey. (2) South Australian Omnibus Survey (3) Queensland Chronic Disease Survey. (4) New South Wales Population Health Survey. (5) Eastern Australia. (6) Victorian Population Health Survey

Figure 24: Possession of asthma action plans by adults with current asthma, Australia, 1990–2011

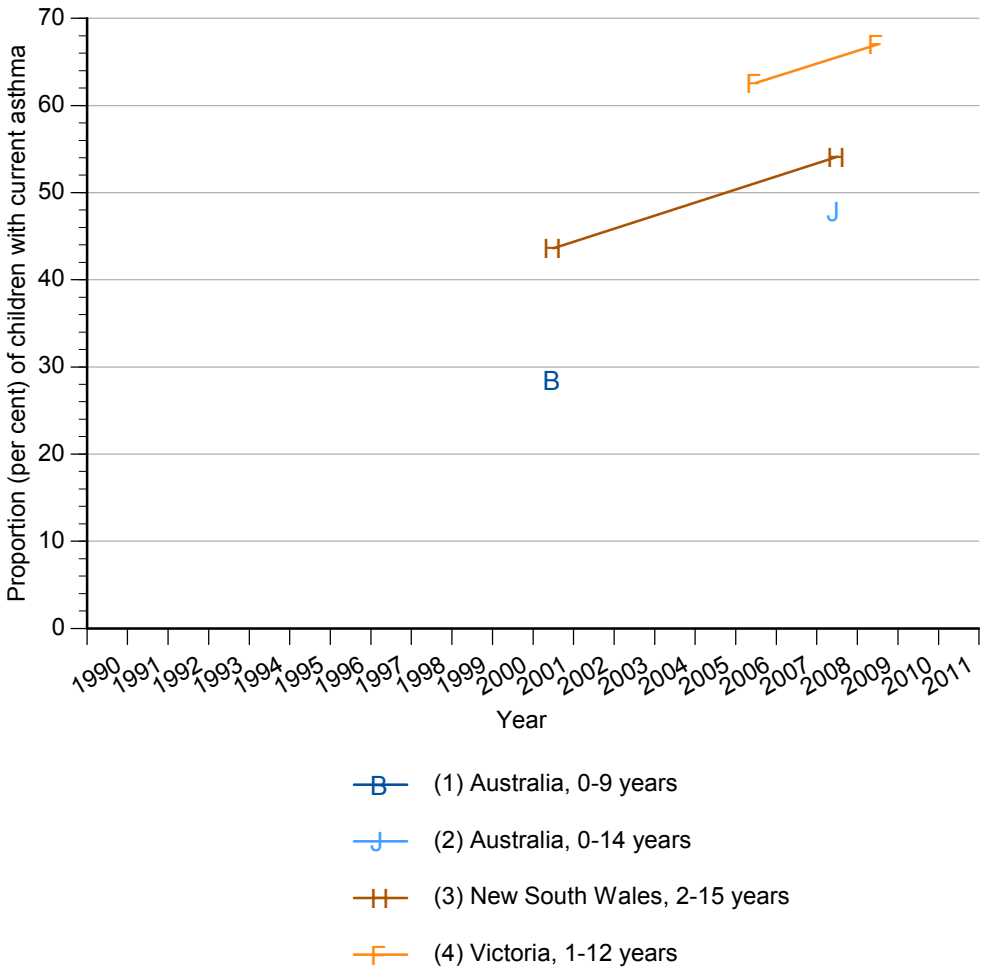
CHILDREN

Population-based data

Little information is available on the possession of written asthma action plans by children. In the 2007–08 National Health Survey, children aged 0–14 years with current asthma were significantly more likely to have a written asthma action plan than people aged 15 years and over ($p<0.0001$).[1]

The age range for the collection of national data changed from 0-9 years in 2001 to 0-14 years in 2007–08 making interpretation of these data difficult. The most recent data for ownership of a written asthma action plan are from New South Wales (54% in 2008) and Victoria (67% in 2009).

The odds of parents reporting that their child had a written asthma action plan increased by 1.104 (95% CI; 1.072-1.136, p = 0.0007) per year between 1990 and 2009 (Figure 25).



Note: Only people with current asthma were asked about the possession of asthma action plans. Asthma defined as doctor diagnosed asthma plus treatment or symptoms of asthma in the last 12 months and 'Do you have an asthma action plan (written instructions of what to do if your asthma is out of control)?'

Sources: (1-2) ABS National Health Survey (3) NSW Centre for Epidemiology and Research (4) Victorian Child Health and Wellbeing Survey.

Figure 25: Possession of asthma action plans by children with current asthma, Australia, 1990–2011

Selected populations

In the 2007 Asthma Foundation NSW survey, 63% of parents reported that their child had a written asthma action plan,[35] whereas in the 2011 Asthma Foundation Queensland online survey, 38% of carers for people with asthma reported that they had a written asthma action plan.[36] This difference may relate to different state policies and promotion, or may be due to the fact that in the Queensland survey, only half of carers were looking after a child with asthma, with the remainder taking care of an adult with asthma, e.g. elderly parents or spouse.

SUMMARY OF FINDINGS

TRENDS IN INDICATORS OF ASTHMA CONTROL, 1990 TO 2011

This report aimed to identify and review Australian data on trends in indicators of asthma control and asthma management in adults and children since the launch of the first asthma management guidelines in Australia,[12] to comment on what has been achieved since then, and to identify remaining gaps in knowledge or areas for improvement.

POPULATION-BASED INDICATORS OF ASTHMA CONTROL

Asthma control is defined as the extent to which the manifestations of asthma have been reduced or removed by treatment. It has two main domains, one being 'current control', focusing on patient-reportable measures such as symptom frequency, reliever use, night waking due to asthma, and limitation of activity, and the other being 'future risk', focusing on adverse events such as exacerbations that, while more likely in patients with poor current control, may also be independent of the patient's level of current control and may differ from current control in their response to treatment. For this report, data were sought for population-level indicators, both direct and indirect, in order to characterise trends in asthma control and asthma management in Australia over the past 21 years.

Table 4 provides a summary of observed trends for indicators described in this report, based on available data. Also included in the table are the most recent estimates (within the last 10 years) of the proportion of adults and children with asthma who would be considered by current guidelines recommendations to have poorly-controlled asthma, or who fail to meet accepted goals of treatment. Data for the prevalence of features of poorly-controlled asthma from three large consumer surveys in selected populations are also included in the table for comparison.

In the period between 1990 and 2003-05, the most striking change in asthma in Australia was the substantial reduction in asthma-related deaths and hospitalisations, and, for adults, the marked reduction in Emergency Department visits for asthma. These indicators, which are also the most reliable and routinely-documented measures of asthma status at a population level, relate to the 'future risk' domain of the assessment of asthma control.[19 20] The changes reflect a marked reduction in the most serious consequences of asthma, and they occurred despite increasing prevalence of asthma in both adults and children over the same period. Since 2003-05, deaths, hospitalisations and Emergency Room visits have remained relatively stable. However, rates of Emergency Department presentations by children, particularly in February each year, have not decreased over time. These presentations and the symptoms and risk that they reflect remain a substantial burden on children, families, the health system and the community.

One key focus of this report was to identify trend data for standardised measures of 'current control'. Patient-reported measures such as frequency of symptoms, night waking and reliever use have been recorded in clinical trials for many years, and recommendations for standardised reporting of these indicators were recently published.[19] However, for these measures, the most striking feature of the last 21 years was the paucity of population-level data. This provided very little opportunity for assessment of changes over time. For adults, assessment by general practitioners of their patients'

symptom frequency (based on a classification at the time of asthma 'severity') suggest that between 1998-2008, a decreasing proportion of adults had asthma symptom frequency consistent with poorly-controlled asthma. Data for children suggest that wheeze frequency, activity limitation and reliever use may have improved, but few relevant studies have been performed in the last 10 years.

In terms of indirect measures of asthma control, overall health status, assessed in response to a single question ('In general, would you say your health is excellent, very good, good, fair or poor?') provided the most consistently recorded indicator of the impact of asthma on the patient's well-being. For adults with asthma in Australia, there was no significant change in overall health status over the past 10-12 years, by contrast with an improvement in self-reported health status over the same period for people who did not have asthma. The proportion of people missing time from work, study or school due to asthma also remained constant, and consistently higher for people with asthma than for those without asthma.

Medication indicators showed some interesting trends over the past 21 years. Publication of the first Australian clinical practice guidelines for asthma was accompanied by extensive educational activity about asthma, directed at both clinicians and patients. During the following few years, there was a substantial increase in the proportion of people with current asthma who were taking inhaled corticosteroids or other preventer medications, from 38% in 1990 to 55% in 1997; it has remained constant at around 50% of people with current asthma in surveys since then.

Around the same time, recommendations for SABA use changed from regular to as-needed, and a marked decrease in daily SABA use was seen, particularly for children. It is difficult to disentangle reduction in SABA use resulting from improved asthma control from reduction in use due to changed SABA prescribing. The proportion of GP visits by adults and children at which ICS-containing medications were prescribed increased steadily over the period 1998 to 2010, and the proportion of visits at which SABA was prescribed decreased over the same period. However, while medication supply data (which include medications prescribed for COPD and those supplied to hospitals) showed a decrease in SABA supply, at least to 2007, ICS supply has remained fairly constant. The lack of increase in ICS supply data could potentially be explained by the documented shift towards prescribing of lower potency ICS products, by increased prescribing of ICS for short-term use, and/or by reduced medication adherence by patients.

Overall, from population-based samples within the past 10 years, approximately 15-25% of people with asthma were observed to have features consistent with poorly-controlled asthma by various guidelines-based criteria. Around 1 in 11 adults with asthma had an Emergency Department visit for asthma within the previous 12 months, and around 1 in 25 had been hospitalised for asthma within the previous 12 months. These proportions were substantially higher in children, particularly young children, although the diagnosis of asthma is more difficult in this age-group. The proportion with poor asthma control in adults is perhaps not surprising, given that in the GOAL study,[76] conducted in the early 2000s, between 20-50% participants (depending on entry ICS dose and randomisation to ICS or ICS/LABA) did not achieve well-controlled or totally-controlled asthma after 12 months of escalating treatment. However, the data collected in this report indicate a substantial ongoing burden of asthma for individuals and for the community.

Table 4 Summary of trends in measures of asthma control in AUSTRALIA, 1990 - 2011

This table summarises the trends for adults and children in measures of asthma control over the period 1990 – 2011 from population-based studies. The table also lists guidelines-based criteria for well-controlled asthma (or goals of asthma treatment, as appropriate), and the most recent estimates within the last 10 years of the proportion of adults and children, from population-based data and selected populations (see footnote), who fail to meet these criteria and therefore may be considered to have poorly-controlled asthma.

MEASURE and CRITERION or GOAL	TREND FROM POPULATION-BASED DATA 1990-2011		COMMENTS	% WITH POORLY-CONTROLLED ASTHMA*		
	Adults	Children		Adult	Child	Selected Populations†
Asthma prevalence	Decreasing since 2000	Decreasing since 2000	Lack of objective confirmation of diagnosis of asthma	-	-	-
DIRECT MEASURES OF ASTHMA CONTROL						
Symptom frequency *(criterion for well-controlled asthma: ≤2 days/week)*	Symptom frequency lower in 2003 than 1999 (2 studies)	Symptom frequency lower in 2003 than 1999 Proportion with monthly wheezing attacks decreased between 1990 and 2005	Few studies record symptom frequency in a way that allows comparison with guidelines Variation in both questions and responses	18% 2003	9% 2003	No relevant data
Sleep disturbance due to asthma *(criterion: none in 4 weeks)*	Lower in 2003 than 1997/8 (2 studies). No change in worst category (waking ≥1 nights per week)	No change	Few studies Variation in age groups studied	23% 2003	20% 2009	SOA: high rate of waking due to asthma (54% in previous week)
Reliever use *(criterion: ≤2 times/ week)*	38% used relievers ≥50% days in 1997; 37% at least twice weekly in 2002.	49% used SABA daily in 1990, 30% in 1993; no recent data	Few studies Per patient dispensing data (PBS) unhelpful as they exclude OTC, include use for COPD	Up to 37% in 2002	No recent data	AFNSW, SOA: 2/3 adults and 40-50% children used reliever more than twice/wk
Interference with daily activity *(criterion: none)*	Decreased between 2002 and 2005	Decreased between 2002 and 2005	Few studies Interpretation limited by intentional avoidance of physical activity	12% 2007	12% 2007	AFNSW: 13% 'most of the time' SOA: 25% in previous week AFQ: 8% weekly
Composite control scores, e.g. ACQ *(criterion: ACQ <0.75)*	No data	No data	No data from population studies	No data	No data	AFNSW: 40% not well-controlled (ACQ ≥1.5)

MEASURE AND CRITERION or GOAL	TREND FROM POPULATION-BASED DATA 1990-2011		COMMENTS	% WITH POORLY-CONTROLLED ASTHMA*		
	Adults	Children		Adult	Child	Selected Populations†
INDIRECT MEASURES OF ASTHMA CONTROL						
Overall health status *(goal of treatment: similar to non-asthma)*	Small improvement between 1998 – 2009	No data	Single question, global impact, easily understood; could be included in more surveys	25% poor,fair 2007/8	No data	AFNSW: poor/fair for 24% adults, 9% children
Days lost from work/ school/study in 12 months due to asthma *(goal: none)*	No change 1994-2007	No separate data	Reflects burden of asthma, could be included in more surveys	16% 2008	No data	AFNSW: 18% adults, 62% parents of children with asthma
Asthma-related GP visits *(goal: 1-2 scheduled visits, 0 urgent, per yr)*	Reduced emergency GP visits 1997-2003 Total GP visits (urgent or non-urgent) decreased between 1990-2005	Total GP visits decreased between 1990 – 2006/7; more recent trend upward	Cannot distinguish between urgent and scheduled visit from administrative data	Urgent visit 14% 2003	Urgent visit 21% 2003	Urgent visits: 25% adults, 52% chn Scheduled visit: 55%-68% in last 12 months
ED visits *(goal: none)*	Decreased from 1999 – 2006	Decreased 1999-2003 then increased, but no major trend. Highly variable within and between years	Reason for between-year variability not known. Data for younger children may include some viral-induced wheeze	8.5% 2003	6 y.o. 12%; 12 y.o. 4%	ED visit in last yr 20-25% adults, 50% children
Hospitalisations *(goal: none)*	Decreased from 1999-2002	Decreased from 1993-2002		3.8% 2003	4.9% 2003	8% adults, 12% children in last 12mo
Mortality *(goal: no asthma-related deaths)*	Marked decrease to 2003, stable since; increase 2004-08 in elderly women	Very small numbers	Difficulty confirming cause of death in elderly patients. No increase in deaths after introduction of LABAs.	-	-	-
OTHER MEASURES RELATED TO ASTHMA CONTROL						
Self-assessed asthma control or severity	2003: 4% self-rated as poorly controlled. 2002: 20% self-rated as moderate or severe	No data	This question may be useful in clinical practice as an educational tool, but adds little in population surveys	4% poor control 2003	-	SOA: 16% thought their asthma was poorly controlled
GP-reported asthma 'severity'	Decreasing proportion 1999 – 2008 had 'severity' classification consistent with poor control	Numbers too small to comment	Past classification of severity reflects current criteria for poor control.	30% 2008		-

MEASURE AND CRITERION or GOAL	TREND FROM POPULATION-BASED DATA 1990-2011		COMMENTS			
	Adults	Children		Adult	Child	Selected Populations†
SABA supply and dispensing	-	-	Supply of SABA, expressed as DDD, decreased from 1999 to 2007, but has increased since then, due to one SABA product for which previous IMS data were estimates. No overall increase in dispensing of SABA from pharmacies. Supply data difficult to interpret because they combine asthma/COPD, hospital/ community, prescription and OTC, and prescribing guidelines for acute and chronic use of SABA have changed over time.	-	-	-
ICS supply and usage	Proportion of asthmatics prescribed ICS increased from 1990-1997 then remained constant (~50%).	-	Supply of ICS stable since 1996 Potency of dispensed ICS inappropriately high Proportion dispensed as ICS/LABA inappropriately high Patient adherence poor	54% not using daily 2002	-	-
Written asthma action plans	Substantial fluctuation, but no major trend	Increased ownership of action plans 1990-2009	Standardised wording needed	15% 2007	67% 2009	30-60% depending on surveys

*Most recently available population-based data within the past 10 years, for the proportion of adults/children who fail to meet criteria for well-controlled asthma (or goals of asthma treatment) and can therefore be considered to have poorly-controlled asthma

† Selected populations: data from three large consumer surveys (See Appendix 2).

AFNSW: Asthma Foundation NSW survey of 608 adults and 81 parents of children with asthma, 2007

SOA: Short of Air report, online survey of 1000 patients with moderate to severe asthma, conducted in 2010

AFQ: Asthma Foundation Queensland online survey of 409 people with asthma, and 193 carers of adult/child with asthma, conducted in 2011

DDD: defined daily dose by WHO criteria (see section xx)

RESULTS FROM CONSUMER-BASED SURVEYS

In recent years, three large consumer-based surveys about asthma have been conducted, providing additional data about asthma control. The first of these surveys, commissioned by Asthma Foundation NSW [35] was paper-based, with participants largely recruited from pharmacies and research volunteers. The other two surveys (Short on Air 2010,[33] and Asthma Foundation Queensland 2011 [36]) were online surveys whose participants were primarily recruited from market research panels. Data from selected populations cannot be directly compared with those from population-based studies because of the likelihood of selection bias; people who are more troubled by their asthma may be more likely to volunteer for such surveys, resulting in higher proportions of participants having markers of poor asthma control. This was observed in the present analysis, with participants in the consumer surveys consistently reporting higher levels of symptoms and health care utilisation than the most recent population-based surveys.

The high level of morbidity due to asthma that was identified in these consumer-based surveys indicates that, although consumer surveys do not yield data that are representative of the general population, they can be used to reach people with troublesome or burdensome asthma.

GAPS IN ASTHMA MANAGEMENT

Several substantial gaps in asthma management are apparent from this review. Rates of dispensing of inhaled corticosteroids, of scheduled visits to general practitioners for asthma review, and of ownership of written asthma action plans by adults are still far below optimal. Overall prescribing of inhaled corticosteroid medications is inconsistent with national and international guidelines, in that the majority of these medications are dispensed in Australia at the highest potency, and as combination ICS/LABA rather than inhaled corticosteroid alone. In addition, data for general practitioner assessment of the adequacy of patients' inhaled corticosteroid dose relative to their level of asthma control, suggest that general practitioners may have low expectations for the effectiveness of asthma medications. The lack of objective confirmation of the diagnosis of asthma, not only in population surveys, but in clinical practice, means that the high levels of over- and under-diagnosis of asthma observed in other countries are also likely to be seen in Australia.

Of considerable concern is the ongoing availability of SABA in Australia for over the counter purchase without prescription, and the difficulty of monitoring such purchases. Although a pharmacy-based study in 2004 failed to identify significant differences in the level of asthma control for patients purchasing SABA over the counter vs on prescription,[57] these patients may remain outside the loop both for contact with GPs and for inclusion in data collections such as PBS and BEACH.

COMPARISON WITH OTHER COUNTRIES

Australia is not alone in lacking long-term data on trends in asthma control. Studies using ISAAC methodology allow some international comparisons over time, although the focus in these studies is more on prevalence, with symptoms used to identify children who are likely to have asthma, rather than as an indicator of the level of asthma control amongst those with known asthma; in addition,

the variables collected in ISAAC studies do not align well with current guidelines recommendations for assessment of asthma control.

In the United States, large random digit dialling telephone surveys were conducted in 1998 (Asthma in America, AIA) and 2009 (Asthma Insight and Management, AIM) each recruiting around 2500 people aged ≥12 years with a diagnosis of asthma.[112] Little difference was seen in self-reported symptom severity, but the proportion of patients waking due to asthma within the previous 4 weeks decreased from 40% in 1998 to 32% in 2009. The proportion of adults with no activity limitation increased from 36% to 45%. However, there was no change in the proportion of adults who had required acute care for asthma within the previous 12 months (36% and 34% respectively); over the same period from 1998 to 2009 in NSW, there was a reduction of about 50% in Emergency Department visits for asthma by adults. Likewise, there was no change between the AIA and AIM studies in the proportion of participants who had missed time from work or school because of asthma in the previous 12 months (22% and 20% respectively), similar to rates recorded in Australian studies. In the US studies, the proportion of patients reporting that they had been given a written asthma action plan increased from 27% in 1998 to 32% in 2009. Overall, therefore, these surveys showed that while the proportion of people with asthma in the US who had poor current control decreased between 1998 and 2009, there was still a high burden of symptoms and urgent health care utilisation due to asthma.

Conducting detailed disease-specific surveys in large representative populations is costly and time-consuming, and with increased use of mobile telephones and voice over internet, random digit dialling may not necessarily sample all segments of the population. Internet access is not yet available for all members of the community, particularly in areas of socioeconomic difficulty. Canadian researchers [113] have made use of data linkage available in Quebec for routinely collected administrative data (diagnosis, health care utilisation, physiological data and dispensing data) to construct algorithms for asthma control and asthma severity. Based on these analyses, they reported that asthma was mild, moderate and severe in 49%, 30% and 21% of the asthma population respectively. The authors concluded that asthma appeared to be uncontrolled in 46.5% of the asthma population, as evidenced by levels of health care utilisation and/or supply of SABA consistent with use of more than 3 doses per week for mild asthma and 10 doses per week for moderate or severe asthma. No direct comparisons can be made with Australia, since data linkage is not well-established, and with SABA available without prescription, a complete recording of per-patient SABA dispensing cannot be obtained.

LIMITATIONS OF DATA

As indicated above, one of the most striking findings of the present review was the paucity of data for conventional guidelines-based measures of asthma control, even from recent years. This limits the extent to which conclusions can be drawn about the current level of asthma control, and trends in asthma control, in Australia.

The data most reliably recorded over the past 21 years were for hospitalisations and deaths due to asthma, indicators that are routinely recorded and collated within the current administrative system. However, for some indicators such as deaths, there is a substantial delay in detailed data being made available for analysis. Misclassification of cause of death is likely to occur, particularly in older

patients. Emergency Department visits are recorded in different ways in different states, so the present ED data are for NSW alone.

The marked seasonality of health care utilisation for asthma and SABA dispensing data indicate that data for other indicators of asthma control may not necessarily be comparable if surveys are conducted at different times of the year. Cutpoints for age-groups have also sometimes varied between studies.

For indicators based on medications, a variety of data sources was available, but none of these provided an accurate measure of all medication use by people with asthma. In particular, for medication supply data and PBS data, no information was available about diagnosis, so changes in awareness of, and prescribing for, COPD could affect trends in medications also used to treat asthma. Reporting of medication supply as Defined Daily Doses (DDDs) allows comparison over time, but as in the case of SABA and ICS, change over time can reflect not only changes in prescribing, but also changes in guidelines for both asthma and COPD and in medication availability or reimbursement. An issue in the period covered by this report, that low-dose inhaled corticosteroid formulations were below the general patient co-payment threshold and were therefore only captured in the PBS dataset for patients with a concession card, has been removed by the inclusion of all PBS subsidised medications from April 2012 onwards.

For many measures, one of the major limitations was lack of confirmation of the diagnosis of asthma. Studies in other Western countries suggest that approximately 30% of asthma diagnoses cannot be confirmed with objective testing.[114 115]

Despite the consistent recording of measures of asthma control in clinical trials, few longitudinal population-based data were found for patient-reported indicators relevant to ‘current control’. In addition, even when specific questions were recorded on more than one occasion in different surveys, variations were sometimes seen in the population included, the wording of the question, and/or the number or wording of responses, all of which are likely to affect the results. Some key questions were asked only during one survey, and not repeated in later years. Of course, asthma is only one of amongst several chronic diseases for which data monitoring would be desirable, so there is substantial pressure on questionnaire length. Nevertheless, obtaining agreement by stakeholders at a national level on wording of questions and responses for a core set of indicators would reduce the current wastage of data and effort.

CONCLUSIONS AND RECOMMENDATIONS

This review of indicators of asthma control over the past 21 years since the launch of the first clinical practice guidelines for asthma [12] has identified very substantial improvements in mortality and morbidity attributed to asthma during the first half of this period, with a levelling off in the past 7-10 years. However, rates of Emergency Department presentations by children, particularly in February each year, have not decreased over time, indicating an ongoing burden of asthma on children, families, the health system and the community.

Despite the improvements in mortality and morbidity, the most recent data indicate that approximately 15-25% of patients still have features consistent with poorly-controlled asthma, depending on which measure is considered. The main direct indicator available at present is self-reported SABA use, and the main indirect indicators are urgent health care utilisation, impaired health status, and time off work.

The burden of poorly controlled asthma is likely to be found in three diverse groups – firstly, patients not taking (or not taking enough) regular preventer medication, who essentially have untreated asthma; secondly, patients taking preventer medications who have residual symptoms due to co-morbidities or missed diagnoses that are being mistakenly attributed to asthma; and thirdly, patients already taking preventer medications who have residual symptoms due to severe refractory asthma. These groups of patients have very different needs, but without objective measures, they are difficult to distinguish.

The paucity of data for indicators of asthma control identified in this report indicates a need for additional population-level monitoring of asthma in Australia. While there have been numerous surveys about the prevalence of asthma, few studies have provided detailed information about the impact of the disease on individuals or on the community.

From publications about past population-based surveys, it is apparent that far more data have previously been collected than have been published. With the increasing availability of online repositories, it should be possible to ensure that standard indicators, when collected, are consistently reported, even if not forming part of the main report of a survey.

Given the high prevalence of asthma in Australia (10% of the population), National and state-based health surveys can and should continue to collect basic data such as prevalence, overall health status, time off work, and urgent healthcare visits due to asthma. However, more detailed information is needed in order to identify the causes of temporal trends in these indirect measures.

Obtaining agreement on a standardised minimal set of questions and responses, suitable for inclusion in surveys when the opportunity arises, would allow more efficient use of scarce research resources and participant time. When surveys are repeated to evaluate longitudinal trends, they should be conducted at the same time of year each time, to avoid the seasonal variation that we observed in several indicators.

Self-reported level of asthma control is not recommended for inclusion in future studies, as participants interpret the term differently (self-control, or ease of relief of symptoms with SABA)

from the conventional medical meaning (symptom frequency, reliever use, night waking, exacerbations).

A proposal for a National Asthma Survey was described in 2006 by the Australian Centre for Asthma Monitoring, with the aim of regularly documenting sociodemographic and geographic variation in asthma prevalence, outcomes, risk factors and management from population-based samples. With some modifications to allow for changes in clinical practice guidelines and assessment criteria since that time, this approach is still recommended, to help to improve our understanding of the nature of this disease, and informing policy asthma services, including appropriate resource allocation within the health sector. Incorporation of objective testing would remove many of the uncertainties that apply to present indicators, particularly those based on self-report.

For surveys in the next few years, new strategies may need to be developed in order to allow representative samples to be obtained. Fewer Australians now have fixed telephone numbers, so random digit dialling may no longer reach the majority of the population, particularly for younger age groups; while at present, census data indicate that older and less socioeconomically advantaged groups still have substantially less access to the internet and are less likely to be reached by online surveys. Although purposive sampling could be used to improve participation by such groups, this may not eliminate sampling bias.

One of the challenges for Australia is to acknowledge the substantial improvements that have been made in asthma management in the past 20 years, without ignoring the fact that asthma prevalence and deaths due to asthma are still amongst the highest in the world, and that there is still a considerable burden from asthma in the community, albeit less conspicuous than when Australian asthma guidelines were first published 21 years ago.

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APPENDIX 1 DATA SOURCES FOR MEDICATIONS

Data Source	Data	Date(s)	Sample Size	Comments
IMS National data	Medications supplied through normal distributor channels including retail/hospital, and prescription/OTC	1994 to Aug 2011	National wholesaler data, excluding direct sales by manufacturers	Prior to 2007, Alphapharm data were estimated. Direct sales by manufacturers are not captured. No information about purchase or diagnosis.
NostraData	Pharmacy dispensing information captured through dispensing software.	Jan 2006 to Sep 2011	1300 pharmacies (includes metro 67%, regional 6% and regional centres 27%)	Only prescribed drugs captured (no OTC). No information about diagnosis.
Aztec	Scanned pharmacy and supermarket data. Captures all items below or above co-payment and generic products. Combination of supermarket data and pharmacy data capture all the items which are S1-S4.	Jan 2007 to Dec 2011	450 pharmacies	Small sample of pharmacies. No information about diagnosis.
PBS Data (AstraZeneca)	Patient and their PBS transactions in R3F ("anti-asthmatic") and tiotropium markets. De-identified patient and prescription information for respiratory medications.	Mar 2005 to Sep 2011	Randomly selected 10% patient samples from the total Australian population and their PBS transactions for 5 years.	No information about diagnosis. Excludes OTC and hospital medications; adjustment for PBS medications under co-payment threshold (see Appendix 2).
Australian Statistics on Medicines	An annual publication produced by the Drug Utilisation Sub-Committee of the Pharmaceutical Benefits Advisory Committee. The data provide estimates of the aggregate community use of prescription medicines in Australia. Data are derived from PBS and RPBS medications submitted for subsidy and for non-subsidised prescription medications from a Pharmacy Guild survey of a representative sample of community pharmacists.	Since 1990	3 states and one territory Pharmacy Guild Survey: a stratified random sample of member pharmacies. The sample increased in 2007 from 150 to 370 pharmacies.	Excludes hospital usage and over-the-counter SABA. No information about diagnosis.

APPENDIX 2 SURVEYS IN SELECTED POPULATIONS

Data Source	Data	Date(s)	Sample Size	Comments
Asthma NSW Survey	Self-completed paper-based questionnaire Participants with a doctor or nurse diagnosis of asthma, or carers of children with asthma. Recruited through randomly approached community pharmacies, Woolcock volunteer database, and Asthma Foundation NSW	April – September 2007	N=608 aged ≥14 years (47% database, 40% pharmacies, 13% AFNSW) N=81 parents of children aged 5-13 years (76% pharmacies, 24% AFNSW)	Participants recruited through Woolcock database had higher educational levels and lower smoking rates, and came from less socioeconomically deprived areas than other participants.
Queensland Asthma Foundation Survey	Online data survey; participants recruited online or via Asthma Foundation Queensland. Respondents were Queensland residents who were asthma sufferers or carers of someone with asthma or a related condition	May-June 2011	602 (509 recruited from online panel, 93 AFQ customers) 68% were people with asthma, 32% carer of person with asthma (15% for child, 17% for spouse, parent etc)	Minimum quotas were applied for age, gender and location (Brisbane, Other south-east QLD, Regional QLD
Short on Air	Online data survey, with participants drawn from a market-research panel. Adults age ≥18 years with asthma, using preventer medication, using reliever medication at least twice a month. Excluded people with asthma whose only symptoms were on exercise	July 2010	1000	Participants described by investigators as having moderate to severe asthma; all using preventer medication Data adjusted for M:F distribution of 40:60.

APPENDIX 3 STATISTICAL METHODS

COMPARABILITY FACTORS FOR MORTALITY DATA

Table A3.1 shows the age-group specific comparability factors calculated for converting number of asthma deaths from ICD-9 to ICD-10.

Table A3.1: Comparability factors for asthma mortality data

Age group	Conversion factor
<35 years	1.0 (i.e. no conversion)
35–64 years	0.84
65 years and over	0.68

METHODS USED FOR ADJUSTING PBS DATA TO AUSTRALIAN POPULATION

The Pharmaceutical Benefit Scheme (PBS) claims database records the claims made by pharmacies for PBS subsidy. A 10% sample, that is, all transactions for every 10th person in the whole PBS claims database from 2005 to 2011, was obtained and used for this analysis. Patients were classified as either 'General' or 'Concessional' patients (see Table A3.2 for the patient co-payment) according to the subsidy claimed. If the cost of a medication was below the co-payment for a general patient but still above the concessional co-payment, the dataset provides comprehensive coverage of concessional patients but not general patients. All analyses were performed on the data for concessional patients and adjusted by using a weighted average of the concessional proportions for proxies in each segment of the market that were above the co-payment threshold, or by using separate proxies for each category of drugs. However for short-acting beta agonists where there is no proxy, an average for the concessional proportions for all asthma drugs was used. Finally, a *pro rata* adjustment to reflect the entire population was made.

Table A3.2. Patient co-payment, PBS 2005-2010

	Patient	
Year	General	Concessional
2005	$28.60	$4.60
2006	$29.50	$4.70
2007	$30.70	$4.90
2008	$31.30	$5.00
2009	$32.90	$5.30
2010	$33.30	$5.40
2011	$34.20	$5.60

ANALYSIS OF TRENDS OVER TIME

Prevalence has been estimated in several series of surveys, some of which used different definitions. To model trends over time in the prevalence of having a condition we applied a generalised linear mixed model using a binomial error distribution and a logit link. In this model the year of study or survey and the definition or question asked were treated as fixed effects. Each survey or study was regarded as having a random intercept.

First we tested whether the linear trend in prevalence varied according definition using an interaction term. Then we refitted the model using the main effects for year and definition only. The model gave the odds ratio for each year compared to the preceding year, adjusted for the definition and accounting for correlation of measures within surveys.

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