Deloitte Access Economics

The Hidden Cost of Asthma

Asthma Australia and National Asthma Council Australia

November 2015

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Contents

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Charts

Tables

Figures

Glossary

AA	Asthma Australia
ABS	Australian Bureau of Statistics
AHS	Australian Health Survey
AIHW	Australian Institute of Health and Welfare
AUD	Australian dollars
AWE	average weekly earnings
COPD	chronic obstructive pulmonary disease
CPI	Consumer Price Index
CURF	confidentialised unit record file
DALY	disability-adjusted life year
DCIS	Disease Costs and Impact Study
DHS	Department of Human Services
DOH	Department of Health
DSP	disability support pension
DSS	Department of Social Services
DWL	deadweight loss
FEV_1	forced expiratory volume over one second
FVC	forced vital capacity
GINA	Global Initiative for Asthma
GP	general practitioner
HACC	Home and Community Care Program
HCPP	Home Care Packages Program
MBS	Medicare Benefits Schedule
MEPS	Medical Expenditure Panel Survey
NAC	National Asthma Council Australia
NAS	National Asthma Strategy 2016-2020
NHS	National Health Survey
NPV	net present value
NRCP	National Respite for Carers Program
PBS	Pharmaceutical Benefits Scheme
PIP	Practice Incentives Program

PPP	purchasing power parity
PYLD	prevalent years lived with disability
OECD	Organisation for Economic Cooperation and Development
RPBS	Repatriation Pharmaceutical Benefits Scheme
SDAC	Survey of Disability, Ageing and Carers
SKA	Sickness Allowance
SSAHOS	Spring South Australian Health Omnibus Survey
US	United States
VSL	value of a statistical life
USD	US dollars
VSLY	value of a statistical life year
WHO	World Health Organization
WTP	willingness to pay
YLD	years of healthy life lost due to disability
YLL	years of life lost due to premature death

Executive Summary

This report has been commissioned by Asthma Australia (AA), in partnership with the National Asthma Council Australia (NAC), as part of broader ongoing consultations to develop the National Asthma Strategy 2016-2020 (NAS).

Asthma is a chronic respiratory disease that affects approximately 1 in 10 Australians, including children. Although awareness and treatment of the disease has advanced considerably over the past few decades with mortality rates comparatively low relative to other chronic conditions, asthma still incurs significant costs to the Australian community, in terms of both economic burden and diminished quality of life.

In this report, Deloitte Access Economics estimates the total cost of asthma to Australia, including health, productivity and other financial costs ("economic costs") and "burden of disease" costs (the loss of healthy life). To provide context to this analysis, the report provides an overview of the epidemiology of asthma, a discussion of prevalence and mortality and, finally, a list of recommendations for future asthma funding and research.

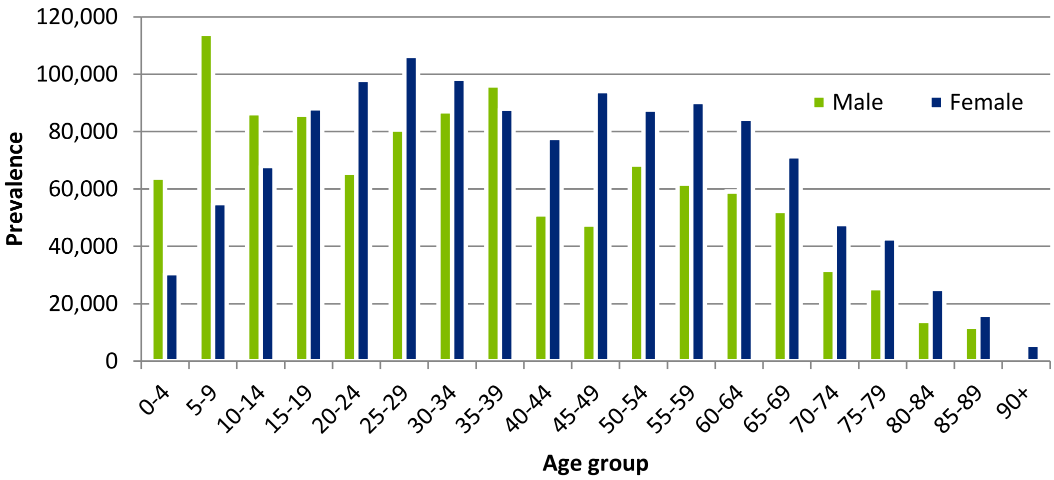
Asthma is a chronic, non-progressive, incurable and complex respiratory condition. Although the underlying causes of asthma are still not widely known, asthma can result from genetic, lifestyle and environmental factors and may be catalysed by triggers such as diet, exercise, infection and exposure to allergens. Patients with asthma can experience a range of symptoms that differ in severity, including wheezing, chest tightness and difficulty with breathing. Although asthma exacerbations can be fatal, they can be prevented with proper management, control of triggers and the administration of drug therapy. It is vital that patients are properly diagnosed with asthma to ensure suitable medication and treatment, most appropriately with the use of spirometry.

Prevalence and mortality

> It is estimated that there are 2.4 million Australians with asthma in 2015 (9.9% of the population), of which 54% are female and 46% are male. The highest prevalence rate for asthma is reported among males aged 5-9 years at 14.6%. It is estimated that the number of deaths, for which asthma is the underlying cause, is 407 in 2015. The prevalence of asthma in Australia is projected to reach 3.0 million in 2030.

Between 2000 and 2009, prevalence rates among adults have been relatively stable, while prevalence rates among children have decreased (AIHW, 2011). Among children, asthma is more prevalent in males than in females. In the adult age groups, asthma is more prevalent in females than males. Prevalence of asthma among Australians in 2015 is depicted in Chart i.

Chart i: Prevalence of asthma (2015)



Source: Deloitte Access Economics calculations.

In comparison to other OECD countries, Australia has a relatively high level of prevalence, given its population. In terms of prevalence rates, Australia ranks second (behind New Zealand). Although the rates of death in Australia have plateaued in recent years, they remain relatively high compared to countries such as Japan, France, Germany, Spain and Poland.

Mortality rates due to asthma are relatively low at all age groups, with the exception of people aged 75 years and over. **In 2013, 77% of all underlying asthma deaths occurred in this age group**. Mortality rates are worse for females with asthma, with 64% of deaths occurring in females (and 36% occurring in males).

Deaths associated with asthma are commonly accompanied by heart, stroke and vascular disease, acute respiratory infections and chronic respiratory conditions, chronic obstructive pulmonary disease or bronchiectasis. Comorbidities also include hypertension and diabetes mellitus.

Costs of asthma

The costs of asthma comprise both economic costs, as well as burden of disease costs. The components of economic costs are:

- health system costs ($1.2 billion): prescription pharmaceuticals, hospitalisations, and out of hospital expenditure;
- productivity losses ($1.1 billion): time away from work, the opportunity cost of informal care, and administrative costs;
- other financial costs ($246.4 million): including government programs, formal care, and travel; and
- deadweight efficiency losses ($635.9 million), which accrue as a result of government transfers and lower taxation revenue receipts due to asthma.

In addition to economic costs, the burden of disease, which measures the suffering and premature death experienced by people with asthma, is estimated to cost an additional

133,555 disability adjusted life years (DALYs). **The net value of the burden of disease is estimated to be $24.7 billion in 2015.** The DALYs comprise 128,463 years of healthy life lost due to disability and 5,092 years of life lost due to premature death, reflecting the fact that while mortality rates are low, asthma has a long-term impact on quality of life.

The total costs of asthma are summarised in Table i.

Table i: Total costs of asthma (2015)

Component	Value ($m)
Health system costs	1,245.5
Productivity costs	1,130.2
Other financial costs	246.4
Deadweight losses	635.9
Total economic costs	*3,258.0*
Total burden of disease costs	*24,671.6*
Total costs	**27,929.6**

Source: Deloitte Access Economics calculations.

Government cost forecasts

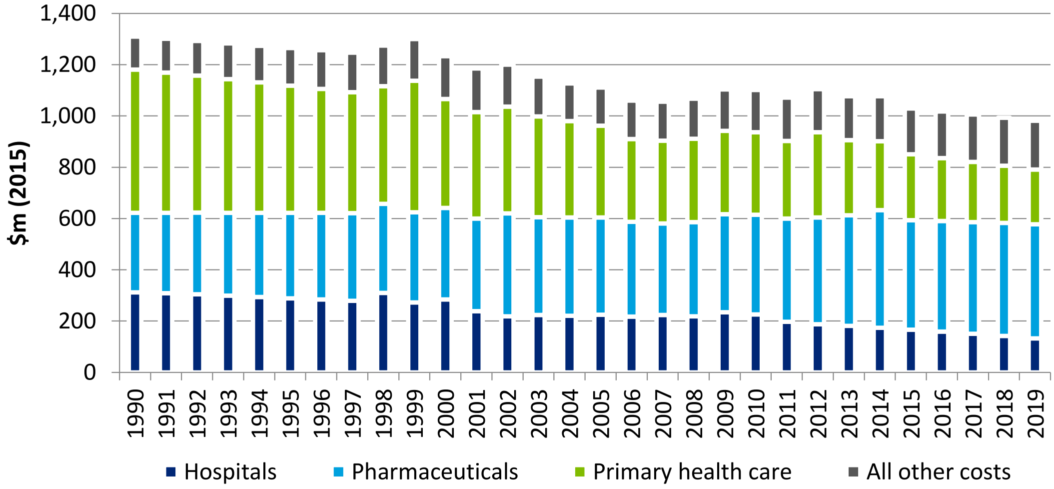
The total government costs of asthma were estimated for 1990-2015, and forecast for the next four years from 2016 to 2019. In 2015 constant dollars, the cost components are:

- total cost of hospitalisations due to asthma, which was $6.4 billion over 1990-2015;
- total cost of pharmaceutical prescriptions for asthma, which was $9.6 billion over 1990-2015;
- total cost of primary health care due to asthma, which was $10.5 billion over 1990-2015;
- total cost of other government costs due to asthma, which was $4.0 billion over 1990-2015.

Total government costs due to asthma for 1990-2015 were $30.6 billion. Total government costs for 2016-2019 are projected to be $4.0 billion.

The total government costs due to asthma are shown in Chart ii.

Chart ii: Total government costs due to asthma (1999-2019)



Source: Deloitte Access Economics calculations.

Recommendations

During the development of this report, Deloitte Access Economics consulted with stakeholders who are involved with asthma in Australia. This consultation arrived at similar conclusions to what was developed by NAC and AA as part of the NAS, which was commissioned by the Australian Government's Development of Health.

Based on issues raised in consultation with stakeholders, together with research and analysis conducted for this report, recommendations were developed regarding asthma funding and research priorities in Australia. Given the high prevalence of the disease and persisting issues concerning its diagnosis and management, patients and practitioners alike may benefit from further consideration of the following recommendations:

- improved diagnosis of asthma through greater uptake of spirometry in general practice, potentially through improved financial incentives for use;
- improved adherence to clinical care guidelines for asthma by medical practitioners, to ensure best-practice management of the disease and suitable treatment via appropriate prescriptions of drugs;
- greater roles for pharmacists in asthma management via the potential implementation of a standardised Pharmacy Asthma Care Program; and
- more targeted approaches to asthma interventions and care to ensure that asthma management is focussed on simple but effective treatment options such as improved patient education, including appropriate inhaler technique, research into the development of better medication and greater consideration of multidisciplinary modes of care.

Deloitte Access Economics

1 Introduction

Deloitte Access Economics was commissioned by Asthma Australia (AA) and the National Asthma Council Australia (NAC) to undertake an analysis of the economic and burden of disease costs of asthma to individuals, Commonwealth and State and Territory Governments, and the broader Australian community.

This report has been structured in the following manner:

- **Section 2** provides an overview of asthma in Australia, including the causes, symptoms, prognosis and current treatment options;
- **Section 3** presents prevalence and mortality estimates for asthma, which includes projections for the five years to 2020 and for 2030 for each state and territory, and a comparison of prevalence across Organisation for Economic Cooperation and Development (OECD) countries;
- **Section 4** discusses the approach taken to estimate the economic costs of asthma;
- **Section 5** documents the costs of asthma to the health system by type of cost and affected stakeholder;
- **Section 6** discusses the productivity costs of asthma, including a literature review of relevant studies and a summary of productivity loss estimates;
- **Section 7** outlines other financial costs that arise from asthma;
- **Section 8** summarises transfer costs associated with asthma and calculates the resultant deadweight loss;
- **Section 9** discusses and estimates the burden of disease costs of asthma;
- **Section 10** summarises the total costs of asthma; and
- **Section 11** presents recommendations for future action on asthma, including addressing data gaps and international health imperatives for asthma management and investment.

2 Asthma in Australia

The following chapter provides a brief overview of asthma, including its causes and symptoms, and discusses the prognosis and current treatment options for asthma.

2.1 The National Asthma Strategy 2016-2020

The National Asthma Strategy 2016–2020 (NAS) builds on the considerable progress made in asthma over the past three decades and leverages our strengths as a nation to continue the attack against asthma – one of Australia's most widespread chronic health conditions.

Within the airways disease, respiratory and lung health, and chronic conditions frameworks, the NAS outlines a targeted and comprehensive approach to optimise asthma diagnosis and management, with a focus on vulnerable groups and frequent users of health services. These are areas where the biggest gaps between evidence and practice lie, and where the biggest gains in improving patient quality of life and reducing asthma morbidity and its associated costs can be achieved.

The NAS is underpinned by a whole-of-system approach with the person with asthma and their caregivers at the centre. Support for research into the causes of asthma and the finding of a cure are an integral component of the strategy.

As at November 2015 the NAS is in its penultimate draft undergoing review by the Department of Health

2.2 What is asthma?

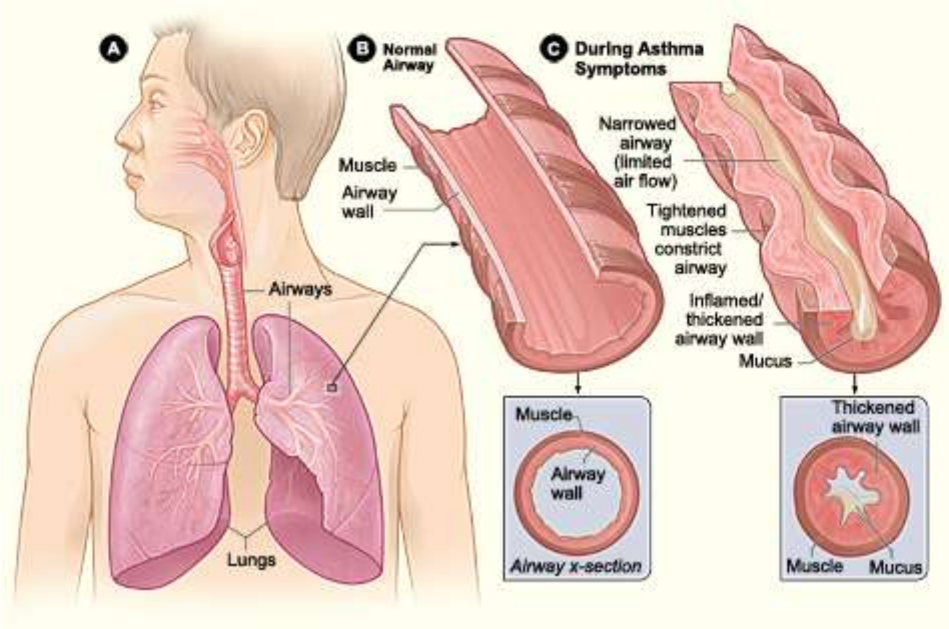
Asthma is a chronic pulmonary inflammatory disease that can result in the narrowing of the airways and reversible airflow obstruction when triggered by a variety of stimuli. The narrowing of the airways in the lungs can be caused by one, or a combination, of the following changes (GINA[1], 2015):

- swelling of the airways;
- tightening of the muscles surrounding the airways (known as bronchoconstriction);
- production of excess mucus, which can obstruct the airways; and
- long-term damage to the walls of the airways, which prevents them from opening as widely as normal.

A comparison of a normal airway with an airway that is experiencing asthma symptoms is illustrated in Figure 2.1.

[1] Global Initiative for Asthma.

Figure 2.1: Impact of asthma on airways



Source: Reproduced with permission from the NAC.
Note: Figure A shows the location of the lungs and airways in the body. Figure B shows a cross section of a normal airway. Figure C shows a cross-section of an airway during asthma symptoms.

As a result of these changes to the airways, people with asthma may experience recurring episodes of wheezing, chest tightness and dyspnoea[2]. Symptoms may differ depending on the severity of a person's condition, ranging from asymptomatic between exacerbations to more severe episodes of wheezing, chest tightness and dyspnoea, but can usually be easily resolved, either spontaneously or with treatment.

2.2.1 Classification of asthma

Asthma has typically been classified according to severity. However, the approach is no longer recommended and classification using the level of asthma control is now considered a more accurate guide to treatment (NAC, 2014). Asthma control is assessed in terms of patient impairment, which refers to the frequency and intensity of a patient's symptoms and functional limitations, and risk, which describes the likelihood of future adverse outcomes. Classification falls into the categories of well-controlled, not well-controlled and very poorly controlled.

Classifications of asthma control are summarised in Table 2.1.

[2] Dyspnoea refers to shortness of breath, difficulty with breathing

Table 2.1: Classification of asthma control

Good control	Partial control	Poor control
All of:	One or two of:	Three or more of:
• Daytime symptoms ≤2 days per week	• Daytime symptoms >2 days per week	• Daytime symptoms >2 days per week
• Need for reliever ≤2 days per week*	• Need for reliever >2 days per week*	• Need for reliever >2 days per week*
• No limitation of activities	• Any limitation of activities	• Any limitation of activities
• No symptoms during night or on waking	• Any symptoms during night or on waking	• Any symptoms during night or on waking

Source: NAC (2015).

Note: Recent asthma symptom control is based on symptoms over the previous four weeks. * This does not include short-acting $beta_2$ agonists taken prophylactically before exercise.

2.3 Causes of asthma

Although the underlying causes of asthma are still not widely known, it has been established that development of asthma is multifactorial and can result from the interaction of different genetic, environmental and lifestyle factors (AIHW[3], 2011).

Possible causes of asthma have been identified as follows (AIHW, 2011; Miles and Peters, 2014; Newman, 2014):

- **Genetic predisposition** – genetic factors such as an allergic tendency are likely to contribute to the risk of developing asthma. Susceptibility genes have been thought to include those which stimulate airway smooth muscle and wound healing, or regulate cell production.
- **Allergen exposure** – although sensitisation to allergens (for example, house dust mites, pollens, mould spores and animal dander) is associated with development of allergic asthma, it is unclear whether exposure to these allergens actually causes asthma. Prolonged exposure and subsequent sensitisation to allergens encountered in the workplace can result in a variation of asthma development known as occupational asthma.
- **Perinatal factors** – asthma has been linked to a number of perinatal factors that exacerbate the likelihood of developing asthma such as young maternal age, poor maternal nutrition, prematurity and low birthweight.
- **Rhinitis** – asthma is closely associated with allergic rhinitis, also known as hay fever, although it is uncertain whether allergic rhinitis contributes to the development of asthma or whether this association reflects a common allergic cause. Non-allergic rhinitis is also a predictor of adult-onset asthma.
- **Smoking** – exposure to tobacco toxins in utero or in infancy is associated with increased risk of developing asthma.

[3] Australian Institute of Health and Welfare.

2.4 Symptoms of asthma

Symptoms of asthma can vary widely from person to person and also over time. People with mild asthma may exhibit no symptoms between exacerbations, also known as asthma flare-ups, while people with more severe asthma may have regular breathing problems.

Flare-ups are usually precipitated by exposure to one or more triggers. Symptoms can follow a circadian rhythm and worsen during sleep, often resulting in asthma flare-ups in the early morning hours and general disturbance of sleep (Miles and Peters, 2014).

The most common symptoms of asthma are:

- **wheezing** – high-pitched whistling noise produced by movement of air through a compressed airway;
- **chest tightness** – feelings of constriction in the chest;
- **dyspnoea or breathlessness** – shortness of breath;
- **coughing** – alongside other symptoms; and
- **anxiety** – the patient may feel anxiety or panic as a result of other symptoms.

Noisy breathing, such as a rattling sound, is common in healthy babies and preschoolers. This is not the same as wheezing and does not mean the child has asthma.

Depending on severity, exacerbations can be brief or can last for hours or even days. Full recovery from even a severe exacerbation can be achieved through appropriate treatment. However, in the event of a severe and dangerous asthma flare-up, a patient's symptoms may not be relieved or may rapidly return even after the administration of bronchodilator medication. Patients may also have difficulty with talking. In such circumstances, emergency treatment may be required (GINA, 2015).

Asthma symptoms can be triggered by different things for different people. Common triggers include (Miles and Peters, 2014):

- respiratory tract infections (colds and flu);
- cigarette smoke;
- allergens, including house dust mites, pollens, animal dander and mould;
- exercise;
- airborne and environmental irritants, including cold/dry air, perfumes and thunderstorms;
- certain medicines, including aspirin;
- physiological and psychological changes, including extreme emotions, laughter and pregnancy; and
- comorbid medical conditions, including allergic rhinitis and gastro-oesophageal reflux disease.

2.5 Prognosis for asthma

Asthma is a chronic disease with a life-long tendency to develop symptoms. Although there is currently no cure for asthma, prognosis for asthma is good with proper management of the condition and adherence to treatment. Children with asthma often enter into remission with the condition resolving in many children (GINA, 2015).

However, for as many as in one in four patients with childhood asthma, symptoms may persist into adulthood or reappear in later years (Miles and Peters, 2014). Identified risk factors include being female, smoking, earlier age of onset, sensitisation to household dust mites and airway hyper responsiveness. In their longitudinal study of factors influencing asthma remission in Tasmanian schoolchildren, Burgess et al (2011) similarly associated earlier age of onset with the likelihood of remission but also found that remission was less likely in females, in those whose mother had asthma and those with allergic rhinitis or eczema.

While asthma can be fatal, most deaths attributable to asthma are preventable with treatment. Mortality risks have been largely attributed to disruption in the administration of anti-inflammatory medication, with dependence on bronchodilators in lieu of anti-inflammatory medication failing to address the underlying inflammation (GINA, 2015). Other mortality risk factors include (Miles and Peters, 2014):

- increasing requirements for oral corticosteroids before hospitalisation;
- previous hospitalisation for acute exacerbations; and
- lower peak expiratory flow (a person's maximum speed of expiration) at presentation.

Meanwhile, studies have shown that the use of conventional or low-dose inhaled corticosteroids has been associated with a significant reduction in hospitalisations and deaths due to asthma (Suissa et al, 2001; Miles and Peters 2014).

While asthma is not a progressive disease, the condition may worsen with age if poorly treated (GINA, 2015). Asthma may also result in physical changes in patients with long-standing asthma. Some patients have been shown to undergo permanent structural changes to their airways that may prevent a return to normal lung functioning, while others have been known to experience a reshaping of their chest wall, resulting in a barrel-shaped thorax, due to recurrent hyperinflation of the lungs. Early and aggressive treatment has been recommended to prevent these developments from occurring (Miles and Peters, 2014).

2.6 Current treatment for asthma

This section discusses the diagnosis of asthma and the management options for people with asthma.

2.6.1 Diagnosis

Due to similarities with other conditions that are not always clinically apparent, and variations in symptoms over time, diagnosis of asthma in primary care can be difficult and requires a multifaceted process for confirmation. Diagnosis is based on medical history, physical examination, administration of a pulmonary function test such as spirometry to observe variable airflow limitation, and consideration of other diagnoses (Miles and Peters, 2014).

2.6.1.1 Diagnosis in adults

The recommended process for diagnosis of asthma in an adult is as follows (NAC, 2015):

- **Medical history** – a practitioner is advised to consider asthma in adults who have had a history of episodic breathlessness, wheezing, chest tightness or cough and who demonstrate indicative factors such as a history of smoking, past history of allergies and genetic disposition.
- **Physical examination** – a physical examination should include listening to a patient's chest and inspection of their upper respiratory tract for signs of allergic rhinitis.
- **Assessing lung function** – spirometry should be performed for every patient with suspected asthma. Spirometry is performed before and after the administration of a bronchodilator to measure the frequency and severity of airflow obstruction by observing reversibility of airflow limitation. The ratio of FEV_1 (forced expiratory volume over one second) to FVC (forced vital capacity) is recorded and compared to normal age-based cut-points to determine likelihood of asthma. Where necessary, performance of spirometry may be repeated after a treatment trial with medication to confirm the nature of the patient's condition or further investigation undertaken, including consideration of a bronchial provocation test.
- **Consideration of other diagnoses** – practitioners may consider other causes of the patient's respiratory symptoms including poor cardiopulmonary fitness, other respiratory conditions (for example, chronic obstructive pulmonary disease (COPD) or an inhaled foreign body), cardiovascular disease, comorbid conditions and lung cancer.

Based on the observations and information collected during this process, the NAC (2015) recommends that a diagnosis of asthma be made if all of the following apply:

- the patient has a history of variable symptoms such as cough, chest tightness, wheeze and shortness of breath;
- expiratory airflow limitation has been demonstrated by spirometry (that is, FEV_1/FVC is less than the lower limit of normal for the patient's age);
- expiratory airflow limitation has been shown to be variable; and
- there are no findings that suggest an alternative diagnosis.

2.6.1.2 Diagnosis in children

As asthma-related symptoms such as cough and wheeze are common in children and may be induced by common conditions other than asthma, such as bronchiolitis, diagnosis of asthma in babies and young children can be difficult to ascertain (AA, 2015). As such, while diagnosis of asthma in children follows a similar process to that of adults, the process is distinguished by a number of differences (NAC, 2015):

- **Medical History** – a practitioner is advised to investigate any respiratory symptoms in children with asthma-like symptoms by asking about the pattern of their symptoms, observing physical changes during episodes of noisy breathing or wheezing, noting whether the child is alert and responsive, and noting factors such as family history, allergies and home environment.

- **Physical examination** – a practitioner is advised to conduct an examination, including height and weight, inspection of chest for deformity, inspection of upper airway for signs of allergic rhinitis, auscultation of chest, inspection of fingers for clubbing and skin inspection for indicative signs.
- **Assessing lung function** – spirometry can be reliably performed in most children aged six and older to measure bronchodilator reversibility.
- **Consideration of other diagnoses** – practitioners are advised to consider alternative diagnoses before making a clinical diagnosis of asthma such as bronchiolitis, tracheobronchitis, inhaled foreign body, infections, congenital heart disease and pulmonary oedema.

Based on the information collected during this process, the NAC (2015) recommends that a provisional diagnosis can be made if the child has all of the following:

- wheezing accompanied by breathing difficulty or cough;
- other features that increase the probability of asthma such as a history of allergic rhinitis, atopic dermatitis or a strong family history of asthma;
- no signs or symptoms that suggest a serious alternative diagnosis; and
- clinically important response to bronchodilator demonstrated on spirometry performed before and after the medication has been administered (if child is able to perform spirometry).

Depending on the child's age, a treatment trial may be conducted to confirm the diagnosis.

2.6.1.3 Further discussion

Given the difficulties associated with diagnosing asthma, there exists a significant body of research on the potential prevalence of asthma misdiagnosis in Australia. Evidence suggests that asthma is often overdiagnosed in children and young adults and underdiagnosed in older adults (Gibson et al, 2010). Diagnosis is particularly difficult in older people due to the existence of comorbid conditions, cognitive or sensory impairment and a lack of recognition of respiratory symptoms as asthma (Wilson et al, 2005). Diagnosis is further complicated by the similarity between symptoms of asthma and symptoms of COPD and the convergent development of both conditions in older people, resulting in potential misdiagnosis (Abramson et al, 2012).

Misdiagnosis of asthma has been primarily attributed to the underuse of spirometry in general practice, which is the generally accepted 'gold standard' for distinguishing asthma from alternative diagnoses, such as COPD. In a national survey of spirometer ownership and usage in Australia, Johns et al (2006) found that while spirometer ownership was high in general practice, frequency of utilisation was low. The common reasons cited by general practices for not owning a spirometer included the cost of the equipment and insufficient remuneration for performing tests[4].

[4] The National Asthma Council Australia has produced a purchase guide to assist with purchasing spirometers. Of the 33 spirometers in the guide, the prices ranged from $699 - $6,500, with an average price of $2,741. Disposable equipment (such as mouthpieces, filters and nose clips) is used for each patient and costs less than $5 (depending on the spirometer used) (Johns et al, 2013). On average, a spirometer will need to be replaced

Greater adherence to clinical guidelines regarding the proper diagnosis of asthma, including the mandatory use of spirometry to gauge airflow limitation, is likely to improve the accuracy and appropriateness of asthma diagnosis and treatment.

2.6.2 Management

A number of options exist for the treatment and management of asthma that may differ according to the severity of a patient's condition. Treatment objectives are predominantly concerned with minimising impairment and risk so as to avoid exacerbations, emergency department visits or hospitalisations and adverse treatment effects.

Given the significant level of variability associated with asthma's causes and symptoms and the severity and frequency of their manifestation, there has been increasing focus on the concept of asthma as a collection of heterogeneous diseases. Evidence suggests that asthma consists of a series of individual phenotypes, characterised by unique interactions between genetic and environmental factors (Borish and Culp, 2008). As such, asthma treatment should be tailored to the individual patient.

Asthma management in adults and children is based on the following (NAC, 2015):

- confirming the diagnosis;
- assessing the pattern of symptoms and asthma control (recent asthma symptom control and risk factors);
- identifying management goals in collaboration with the patient/parent;
- choosing initial treatment appropriate to recent asthma symptom control, risk factors and patient/parent preference;
- reviewing and adjusting drug treatment periodically;
- providing information, skills and tools for self-management by the patient/parent, including:
    - training in correct use of medicines, including inhaler technique;
    - information and support to maximise adherence;
    - a written asthma action plan; and
    - information about avoiding triggers, where appropriate;
- managing flare-ups when they occur;
- managing comorbid conditions that affect asthma or contribute to respiratory symptoms; and
- providing advice about tobacco smoke, healthy eating, physical activity, healthy weight and immunisation.

2.6.2.1 Drug therapy

Medicines are essential to manage asthma well. These should be prescribed at the lowest strength that works for the patient. Each patient's asthma drug therapy should be adjusted

every 7-15 years (Biomedical Engineering Advisory Group, 2004). A Medicare rebate of $17.50 (item 11506), or $35.65 when undertaken as part of a broader respiratory function test (item 11509, is paid for spirometry tests conducted by GPs (DOH, 2015).

up and down if necessary to achieve the best possible control of symptoms and avoid flare-ups (NAC, 2015).

Asthma medicines are classified by their role in asthma management (preventers and relievers) as well as by their pharmacological and chemical classes. Preventers include combination preventers such as inhaled corticosteroid and long-acting $beta_2$ agonist combinations). Everyone with asthma needs to have a reliever to use when they have asthma symptoms. Most adults with asthma, and some children with asthma, also need to take a low dose preventer medicine every day.

Relievers are bronchodilator medicines used for rapid resolution of bronchoconstriction. They can also be used pre-emptively to prevent exercise-induced bronchoconstriction. Relievers contain rapid-onset $beta_2$ receptor agonists, which include:

- short-acting $beta_2$ agonists (salbutamol and terbutaline); and
- the combination of an inhaled corticosteroid (budesonide) and long-acting $beta_2$ agonist (eformoterol) in a single inhaler. This option only applies to patients using combination budesonide/eformoterol in a maintenance-and-reliever regimen.

Preventers are used in maintenance treatment to reduce airway inflammation. These need to be taken every day, even when the person feels well. They include:

- inhaled corticosteroids (beclomethasone, budesonide, ciclesonide, and fluticasone propionate);
- combination inhaled corticosteroid/long-acting $beta_2$ agonist medicines (budesonide or eformoterol, fluticasone furoate or vilanterol, fluticasone propionate or eformoterol, and fluticasone propionate or salmeterol);
- leukotriene receptor antagonists (montelukast); and
- cromones (cromoglycate and nedocromil sodium).

Systemic corticosteroids are used in short courses to manage flare-ups and acute asthma. Oral prednisone/prednisolone is most commonly used. Parenteral corticosteroids are sometimes used to manage severe acute asthma in emergency departments. Occasionally, longer-term use of oral corticosteroids is necessary to manage difficult-to-treat asthma under specialist supervision.

Other agents are occasionally used to manage asthma in specific circumstances, for example, for management of difficult-to-treat asthma or as add-on options for management of severe acute asthma. They include:

- anti-immunoglobulin E (omalizumab);
- anticholinergic bronchodilators (ipratropium bromide and tiotropium);
- magnesium sulfate; and
- theophyllines (aminophylline and theophylline).

Most asthma medicines are inhaled using an inhaler or puffer. Some medicines can be taken directly from the inhaler device and others should be taken through a spacer. A spacer is a specially designed plastic tube that attaches to an inhaler and has its own mouthpiece to breathe through. Using a spacer reduces the risk of side-effects and helps increase the amount of medicine reaching the small airways in the lungs.

2.6.2.2 Monitoring

As asthma symptoms can vary in frequency and severity, depending on a variety of different factors, and may change over time, close monitoring of a patient's condition is conducive to the successful treatment and management of their asthma (NAC, 2015).

Asthma monitoring includes both self-monitoring by patients and periodic assessments by the clinician. Asthma management in primary care should include periodic reassessment of (NAC, 2015):

- recent asthma symptom control based on reported symptoms, limitation of daily activity and need for reliever medicine;
- lung function using spirometry (for adults and children old enough to perform the test);
- adherence to treatment;
- inhaler technique;
- whether the written asthma action plan is up to date;
- modifiable environmental factors; and
- risk factors that predict poor asthma outcomes (for example, flare-ups, accelerated decline in lung function, or treatment-related adverse effects) independent of the person's level of recent asthma symptom control.

Planned asthma check-ups should be made at intervals determined by both the individual's level of recent asthma symptom control and risk factors.

2.6.2.3 Patient education

Given the highly patient-specific nature of asthma and its symptoms, patient education is crucial to the treatment of asthma. Personal awareness of common triggers, appropriate drug therapy and proper inhaler technique can be vital for managing the disease and addressing it in the event of an exacerbation. As such, patients are advised to have a written action play for day-to-day management, including management of acute flare-ups and customised treatment.

3 Prevalence and mortality

This chapter outlines the prevalence and mortality estimates for asthma in Australia. The analysis is based on results from the 2011-12 Australian Health Survey (ABS[5], 2012), and updated to 2015 based on changes in population demographics and prevalence rates over this period.

Key findings:

- In 2015, the estimated prevalence of asthma in Australia is 2.4 million people, or 9.94% of the population. Prevalence is higher among females (1.3 million) than males (1.1 million).
- The highest prevalence rate occurs in males aged 5-9 years (14.6%).
- In comparison to other OECD countries, Australia has a relatively high level of prevalence with the third highest prevalence rate for asthma.
- By 2030, the prevalence of asthma is projected to be 3.0 million people in Australia.
- Asthma is projected to be the underlying cause of 407 deaths in Australia in 2015. People aged over 75 years have the highest mortality rate from asthma.

3.1 Prevalence

This section outlines the methodology and results of the prevalence modelling that was undertaken for this report.

3.1.1 Methods

The 2011-12 Australian Health Survey (AHS) represents the most recent source of prevalence rates for asthma in Australia. According to the AHS, 2.3 million people, or 10.2% of the Australian population, experienced asthma in 2011-12 (ABS, 2012). While it is likely that prevalence rates have since changed from 2011, analysis of data collected by the AHS (formerly known as the National Health Survey, NHS) in previous years and recent studies in the literature suggest that no clear trend in prevalence rates can be discerned in Australia.

According to the AIHW (2011), prevalence rates of asthma among adults have been relatively stable while prevalence rates in children have decreased between 2000 and 2009. However, regional variability, as demonstrated by increasing prevalence rates in South Australia (Wilson et al, 2006), and a lack of more recent data preclude any certainty over the trend in prevalence. In addition, changes in the way asthma has been defined in the AHS and the NHS prior to 2007-08 suggest differences in reported data. As such, in the absence of any rigorous data that can inform how prevalence has changed in 2015, the 2011-12 AHS has been used as the primary source of information for prevalence estimates in this report.

To derive age-gender prevalence rates for asthma, prevalence microdata was extracted from the AHS, and applied against ABS population estimates from 2011-12 (ABS, 2015d) to

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[5] Australian Bureau of Statistics.

generate prevalence rates. These rates have been applied to population projections from the ABS for 2015 (ABS, 2013d) to derive estimates of prevalence by age and gender.

While the AHS provides the most comprehensive data on asthma available, it may not provide a perfectly accurate estimate of prevalence in Australia due to self-reporting (people may not have asthma but think they do, or they may have asthma but not know it or not report it, for a range of reasons such as not remembering or fully understanding what they have been told by a health practitioner). It is also important to note that, while detailed investigation of this issue is beyond the scope of this report, reported prevalence may suffer from inaccuracy due to problems with the over and under diagnosis of asthma in Australian children and adults respectively (Towns and van Asperen, 2009; Gibson et al, 2010). Thus, even if someone has been told by a doctor they have asthma, it might be a different condition. Or they may have been told by a doctor they have a different condition, but in fact have asthma.

Please note that the ABS randomly adjusts continuous variables in its microdata, to avoid the release of confidential data. As a result, discrepancies may occur between sums of the component items and totals. Where possible, Deloitte Access Economics has adjusted figures to publicly-available data, which has not been randomly adjusted.

3.1.2 Results

The estimated prevalence of asthma in Australia by age and gender is shown in Table 3.1.

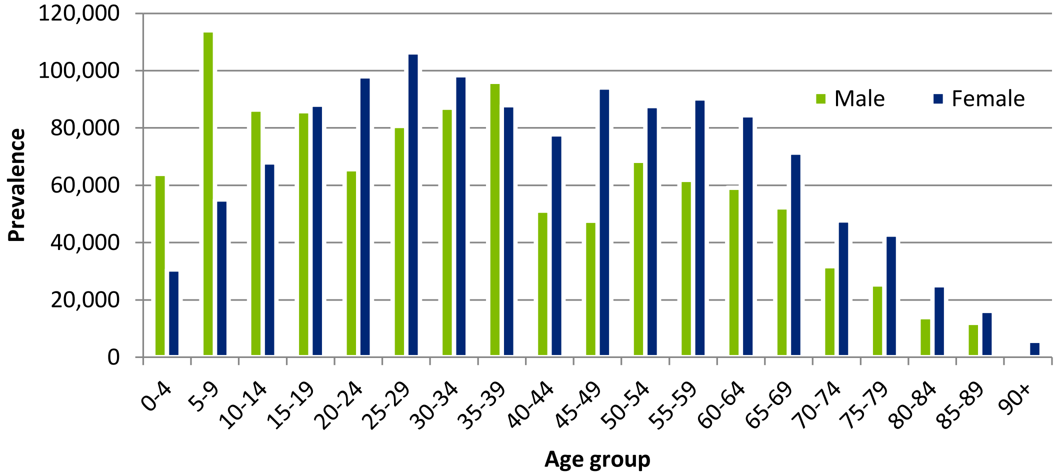
Table 3.1: Asthma prevalence (2015)

Age	Male ('000)	Female ('000)	Total ('000)
0-4	64.0	30.7	94.6
5-9	114.1	55.0	169.1
10-14	86.4	68.0	154.4
15-19	85.8	88.1	173.9
20-24	65.6	98.0	163.5
25-29	80.7	106.4	187.1
30-34	87.1	98.4	185.5
35-39	96.1	88.0	184.1
40-44	51.1	77.8	128.9
45-49	47.6	94.1	141.7
55-54	68.5	87.6	156.2
55-59	61.9	90.3	152.2
60-64	59.1	84.4	143.5
65-69	52.3	71.4	123.7
70-74	31.8	47.7	79.5
75-79	25.3	42.7	68.1
80-84	14.0	25.1	39.1
85-89	12.0	16.2	28.2
90+	0.0	5.7	5.7
Total	**1,103.4**	**1,275.5**	**2,378.9**

Source: Deloitte Access Economics calculations.
Note: numbers may not add due to rounding. Please note that, due to small sample sizes, the relative standard error for females aged 85-89 is greater than 50%.

The prevalence of asthma is estimated to be 2.4 million people in 2015, or 9.94% of the population. Chart 3.1 shows that the highest prevalence is among 5-9 year old males; 114,100 Australian boys of this age have asthma. Among children (0-14 years) with asthma, males outnumber females. However, for most of the adult age groups females outnumber males.

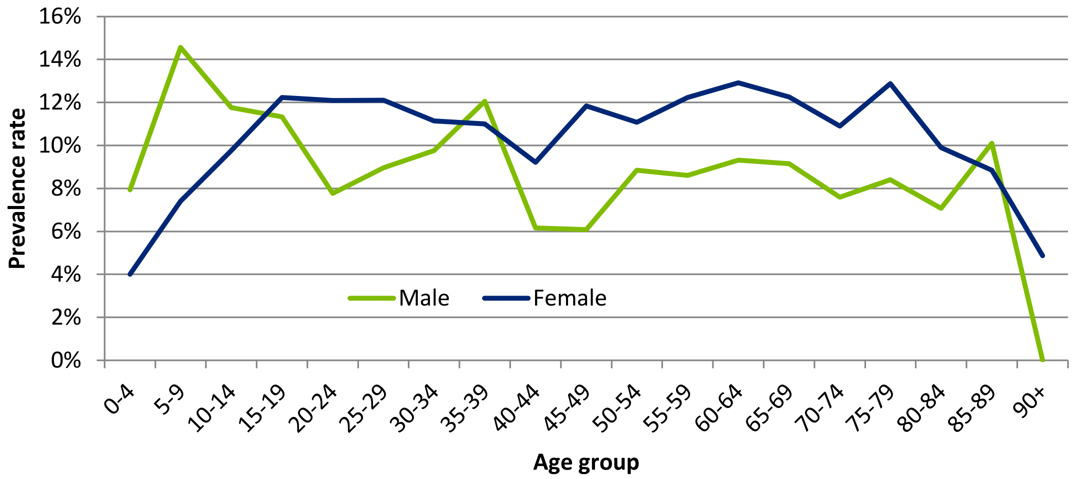
Chart 3.1: Prevalence of asthma (2015)



Source: Deloitte Access Economics.

The prevalence rate of asthma (shown in Chart 3.2) shows a similar pattern, with prevalence rates among young males with asthma higher than for young females, however after this point the rate is generally higher for females.

Chart 3.2: Prevalence rate of asthma (2015)



Source: Deloitte Access Economics.

3.2 Projections

To project the prevalence of asthma by state and territory, and for Australia, microdata was extracted from the 2011-12 AHS. The methodology used was the same as for the overall Australian prevalence in Section 3.1. The results of the projection are shown in Table 3.2, with a detailed breakdown of results by five year age group and gender provided in Appendix A.

Table 3.2: Asthma prevalence by state and territory (2015-2020, and 2030)

	Rate (%)	2015 ('000)	2016 ('000)	2017 ('000)	2018 ('000)	2019 ('000)	2020 ('000)	2030 ('000)
Males								
NSW	8.8	332.8	337.2	341.6	346.0	350.3	354.6	395.4
VIC	10.6	311.3	263.8	268.4	273.0	277.6	282.2	326.3
QLD	9.2	224.0	218.5	222.9	227.3	231.7	236.1	279.3
WA	7.5	101.2	123.2	126.8	130.5	134.1	137.8	174.5
SA	10.2	86.4	75.6	76.4	77.2	78.0	78.8	85.8
TAS	9.5	24.6	23.0	23.1	23.2	23.3	23.5	24.4
ACT	8.6	17.0	17.8	18.2	18.5	18.9	19.2	22.5
NT	6.3	8.2	11.6	11.8	12.0	12.2	12.4	14.2
Australia	9.3	1103.4	1122.8	1142.4	1162.3	1182.2	1202.0	1379.0
Females								
NSW	10.0	384.3	389.4	394.5	399.7	404.7	409.8	458.3
VIC	10.9	326.3	332.1	338.0	343.9	349.8	355.6	412.5
QLD	10.7	259.6	264.9	270.3	275.6	281.0	286.3	339.6
WA	10.8	143.1	147.3	151.5	155.7	159.9	164.2	207.0
SA	10.8	93.3	94.2	95.2	96.2	97.1	98.0	106.8
TAS	13.2	34.3	34.5	34.7	34.9	35.2	35.4	37.1
ACT	10.8	21.5	22.0	22.4	22.8	23.2	23.6	27.8
NT	11.9	14.2	14.4	14.7	15.0	15.2	15.5	18.1
Australia	10.6	1280.2	1303.1	1326.0	1348.7	1371.2	1393.5	1614.2

Source: Deloitte Access Economics calculations.
Note: The sum of prevalence across the states and territories is not equal to the Australian prevalence. This is due to the fact that the sum of populations across all eight states and territories is not equal to the population of Australia. The ABS (2015d) notes that the rounding of figures may lead to discrepancies occurring between the sum of component items and totals. In addition, the population estimates for Australia include people living in Australian jurisdictions that do not form part of the eight states and territories.

As shown in Table 3.2, asthma prevalence is projected to reach 3.0 million in 2030. The state with the largest prevalence is New South Wales, followed by Victoria and Queensland, due to population size. The lowest prevalence of asthma is recorded in the Northern Territory. Prevalence rates are highest among females in Tasmania, and lowest among males in the Northern Territory.

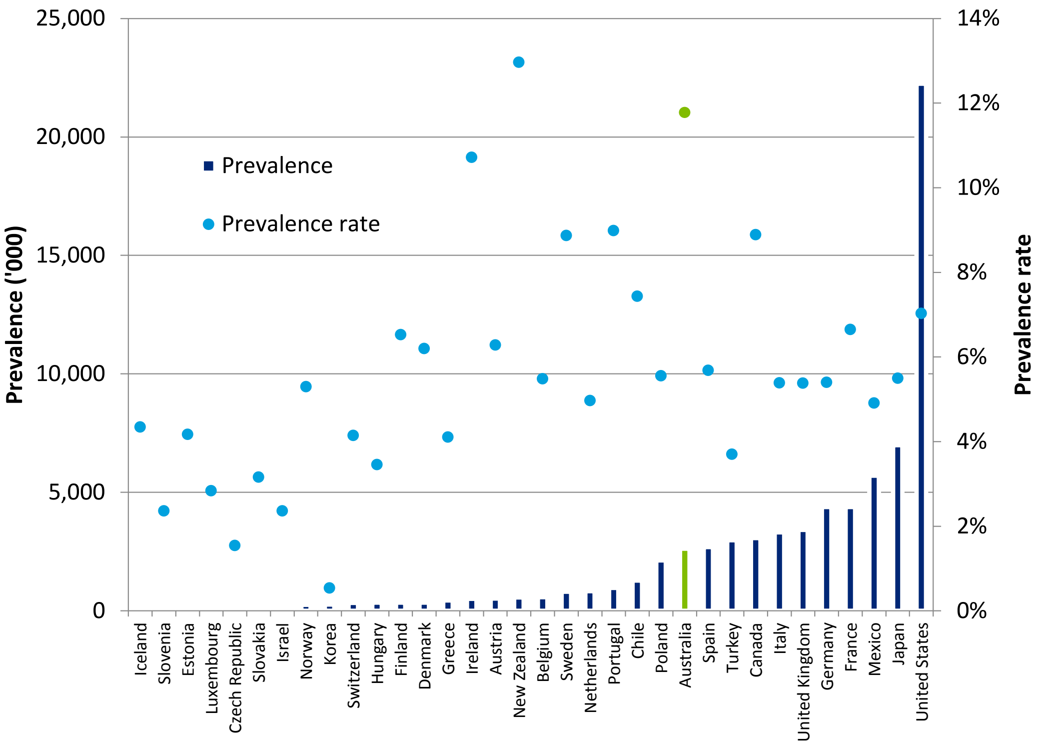
3.3 OECD prevalence

Asthma prevalence and prevalence rates from 2013 for each OECD country are presented in Chart 3.3. Prevalence estimates were obtained from the 2013 Global Burden of Disease publication (Vos et al, 2015), while population estimates were sourced from the 2013 World Factbook (Central Intelligence Agency, 2013).

In 2013, Iceland had the lowest prevalence of asthma of all OECD countries, reporting only 13,700 cases of asthma, due to its small population size. The United States (US) had the highest prevalence due to its large population, with a reported figure of 22.3 million cases of asthma. With regards to prevalence rates, however, Korea had the lowest prevalence rate of 1% while New Zealand had a significantly higher rate at the other end of the spectrum of 13%.

The disparity between each country's prevalence and prevalence rate can be explained by the relative size of their respective populations. With accurate data, rates indicate the likelihood of developing asthma, while absolute numbers of people are needed for service planning. However, data accuracy and diagnosis/reported rates can vary across countries, as well as real differences in population and in the risk profile in each country.

Chart 3.3: Asthma prevalence and prevalence rate by OECD country



Source: Vos et al (2013); Central Intelligence Agency (2013); Deloitte Access Economics calculations.

As demonstrated in the chart, Australia represents one such example. Australia's prevalence rate is disproportionately high[6], ranking second behind New Zealand. This discrepancy may be attributed to a number of different factors. Australia's high prevalence of asthma is likely due to the variability of weather in Australia and the high prevalence of allergenic risk factors, including natural events such as thunderstorms and winds that distribute allergenic pollen, grasses and particles (Erbas et al, 2012). Given the level of awareness in Australia surrounding asthma and its environmental influences, it is likely that strong medical awareness and attention has been responsible for more diagnoses of cases that may have otherwise gone unreported.

[6] Please note that all prevalence estimates were obtained from a single publication (Vos et al, 2015), to ensure that a consistent methodology had been used to calculate each estimate. The estimated prevalence for Australia (2.6 million) and resultant prevalence rate (12%) are higher than the estimates which have been used in Deloitte Access Economics' calculations (2.4 million prevalence cases, and a prevalence rate of 10%).

3.4 Mortality

This section outlines the methodology and data that were used to estimate the number of deaths due to asthma in 2015.

3.4.1 Methods

The primary source for estimating deaths to due asthma in 2015 is the ABS' 2013 publication on the causes of death in Australia (ABS, 2013c). From this publication, in 2013 asthma was the underlying cause of death in 389 people (141 males and 248 females), and the associated cause of death in 1,524 people (561 males and 963 females).

This data shows that underlying deaths due to asthma represent 26% of total asthma deaths[7], which indicates that asthma is associated with many other causes of death. In addition, the proportion of underlying deaths among males (36%) compared to females (64%) is similar to the proportion of associated deaths among males (37%) compared to females (63%)[8].

> The **underlying cause of death** is the medical condition which is "deemed to have started the train of events that led to death" (ABS, 2003). The **associated causes of death** are all causes of death which were listed on the death certificate. The associated causes can include the immediate cause of death, as well as conditions which contributed to the death, but were not related to the underlying cause of death (ABS, 2013c).

Each death that occurs will have a single underlying cause of death, but may have multiple associated causes of death. As such, when estimating the economic costs associated with mortality due to a medical condition, Deloitte Access Economics' preferred approach is to use the underlying causes of death, rather than the associated cause of death. This means that underlying deaths of other conditions are not attributed as asthma deaths, and hence asthma costs.

A special data request submitted to the ABS by the NAC provides further information on the numbers of deaths in each age group. This is shown in Table 3.3.

[7] Calculated as 389/1,524 = 26%

[8] Calculated as 141/389 = 36%, and 561/1,524 = 37%.

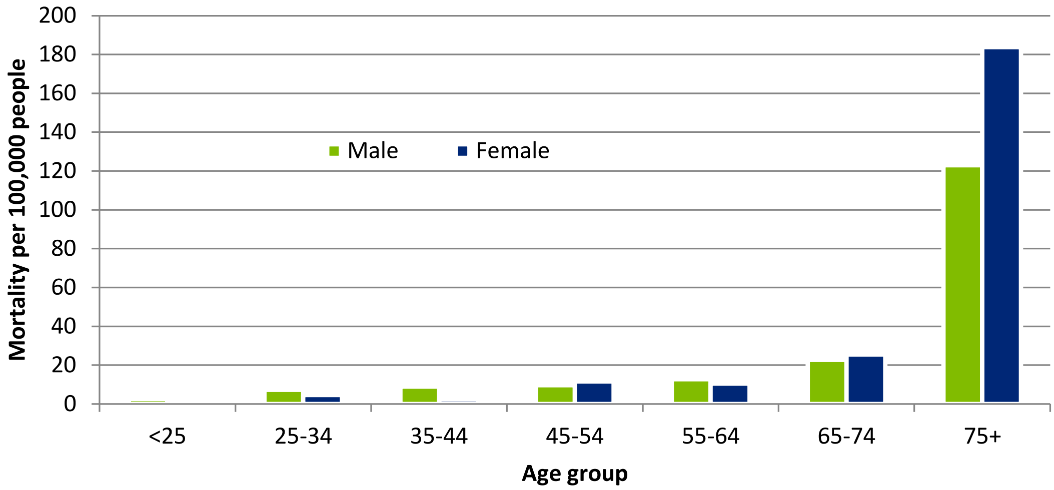
Table 3.3: Asthma deaths (2011-2013)

Age	Male			Female			Total			Mortality rate*		
	2011	*2012*	*2013*	*2011*	*2012*	*2013*	*2011*	*2012*	*2013*	*Male*	*Female*	***Total***
Under 25	7	14	10	6	10	6	13	24	16	0.002	0.002	**0.002**
25-34	3	6	12	4	5	9	7	11	21	0.002	0.002	**0.002**
35-44	10	5	13	8	9	4	18	14	17	0.007	0.005	**0.006**
45-54	11	6	11	24	14	21	35	20	32	0.010	0.014	**0.012**
55-64	12	20	15	24	15	18	36	35	33	0.010	0.015	**0.013**
65-74	13	17	19	30	26	29	43	43	48	0.017	0.028	**0.024**
Over 75	59	65	61	166	181	161	225	246	222	0.127	0.193	**0.170**
Total	**115**	**133**	**141**	**262**	**260**	**248**	**377**	**393**	**389**	**0.002**	**0.002**	**0.002**

Source: NAC special data request.
Notes: * the mortality rate is calculated for 2011, by dividing the number of underlying deaths due to asthma by the prevalence of asthma from the AHS. This year was chosen as the prevalence estimates for 2011 are more robust than 2012 or 2013.

The difference in mortality rates across age and gender is shown in Chart 3.4, which has converted the mortality rates into rates per 100,000 people to allow for easy comparison between age groups and genders. Mortality rates are relatively low at all age groups; however in the 75 years and over age group they are significantly higher, with the mortality rate among females higher than for males. In 2013, 77% of all underlying asthma deaths occurred in the 75 years and over age group.

Chart 3.4: Asthma mortality per 100,000 people with asthma (2011)



Source: Deloitte Access Economics.

The AIHW (2008) notes that rates of death in Australia have plateaued in recent years, having decreased from much higher levels in previous years. However, the rate of death from asthma in Australia (which is similar to the US, United Kingdom and New Zealand) remains high compared to countries such as Japan, France, Germany, Spain and Poland.

3.4.2 Results

The 2011 mortality rates by age and gender were applied to 2015 prevalence estimates to provide an estimate of the number of underlying deaths due to asthma in 2015. The results of this are provided in Table 3.4.

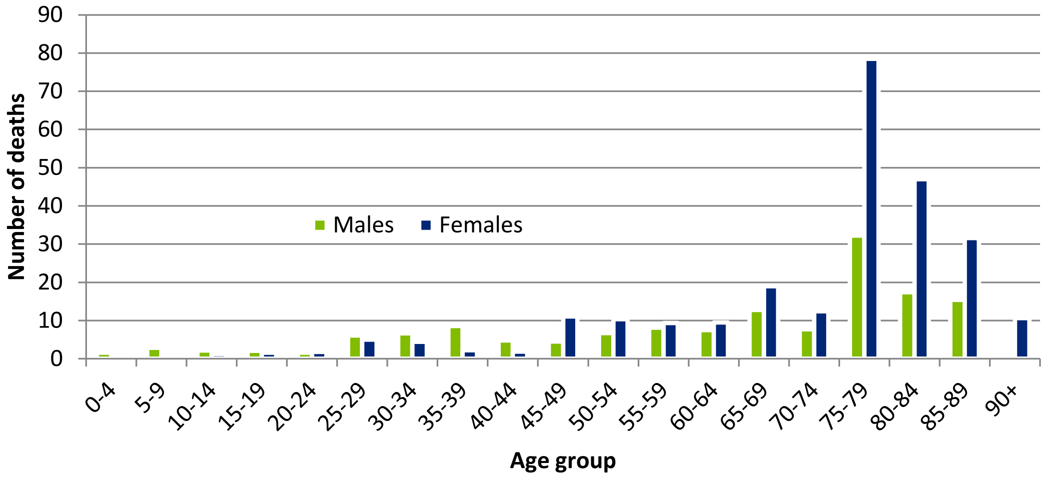
Table 3.4: Asthma deaths (2015)

Age	Male	Female	Total
0-4	2	1	2
5-9	3	1	4
10-14	2	1	3
15-19	2	2	4
20-24	2	2	3
25-29	6	5	11
30-34	7	4	11
35-39	9	2	11
40-44	5	2	7
45-49	4	11	16
55-54	7	10	17
55-59	8	9	17
60-64	7	10	17
65-69	13	19	32
70-74	8	12	20
75-79	32	78	111
80-84	17	47	64
85-89	15	32	47
90+	0	11	11
Total	**148**	**259**	**407**

Source: Deloitte Access Economics calculations.
Note: numbers may not add due to rounding.

As shown in Table 3.4, the number of deaths due to asthma remains relatively constant among people aged 0-24 years old, increases slightly over the 25-74 age group, and then increases significantly in the 75-79 years age group, before decreasing for the remaining age groups.

Chart 3.5: Asthma deaths (2015)



Source: Deloitte Access Economics.

3.4.3 Deaths associated with asthma

The AIHW (2010) has conducted an analysis of underlying and associated deaths due to asthma for people aged 45 and over[9]. The most common associated cause of death for people aged over 45 were heart, stroke and vascular disease (38%), followed by acute respiratory infections (35%) and chronic respiratory conditions, COPD or bronchiectasis (34%). Comorbidities such as hypertension (high blood pressure) and diabetes mellitus were also often listed as associated causes of death.

For people aged 55 and over, COPD, bronchiectasis and acute respiratory infections were more commonly associated with asthma deaths than with non-asthma deaths. The association with COPD and bronchiectasis was particularly evident in people aged 55-69 years, where these conditions were noted in 13.2% of asthma deaths, but only 4.9% of non-asthma deaths. These findings confirm the results of similar analysis conducted by AIHW (2008) and Welte & Groneberg (2006).

The association with acute respiratory infections (such as influenza and pneumonia) was similar, with these conditions associated with 4.7% of asthma deaths, compared to 3.0% of non-asthma deaths (for the 55-69 years age group). However, this difference was more apparent in the 70 years and over age group, with these conditions associated with 13.8% of asthma deaths compared to 5.2% of non-asthma deaths. This association is likely to be due to these infections exacerbating asthma (Singh and Busse, 2006).

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[9] The small number of asthma deaths for younger age groups means that robust statistical analysis could not be conducted (AIHW, 2010).

4 Estimating the economic costs of asthma

This chapter describes the approach taken to estimate the economic costs of asthma in Australia, and outlines some of the key economic terms, how costs are borne by members of society, and some of the underlying methodology present throughout the following chapters. Specific methodologies for each of the costs associated with asthma are outlined further in the chapter where they are discussed.

4.1 Incidence and prevalence approaches

This report utilises a **prevalence (annual costs) approach** to estimate the costs of asthma in Australia for the year 2015. The alternative approach is the incidence (lifetime costs) approach. The difference between incidence and prevalence approaches is illustrated in Figure 4.1.

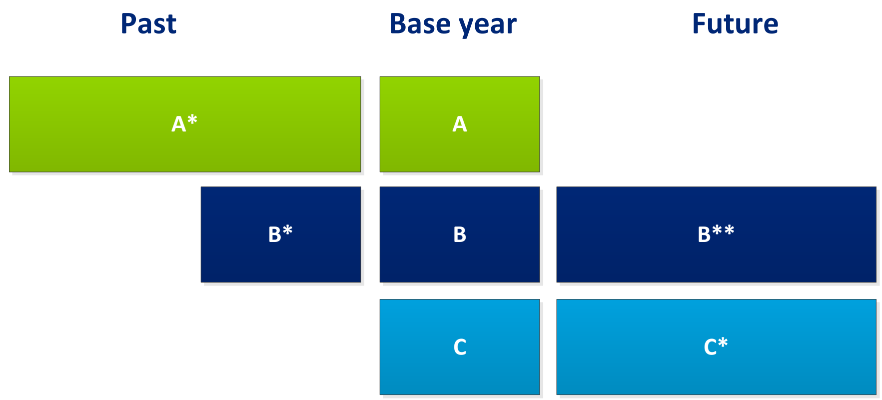
Consider three different cases of people with asthma:

- a, who was diagnosed with asthma in the past and has incurred the associated costs up to the year in question, with associated lifetime costs of A + A*, shaded in green;
- b, who was diagnosed with asthma in the past and has incurred the associated costs in 2015 as well as in the past and future, with associated lifetime costs of B + B* + B**, shaded in dark blue; and
- c, who was diagnosed with asthma in 2015, with lifetime costs of C + C*, shaded in light blue.

All costs should be expressed as present values relative to 2015:

- Annual prevalence-based costs in the base year = Σ(A + B + C);
- Annual incidence-based costs in the base year = Σ(C + present value of C*)

Figure 4.1: Incidence and prevalence approaches to measurement of costs



Note that Figure 4.1 also defines the lifetime costs of asthma for each person, as follows:

- Lifetime cost for person c (= Incidence cost) = C + present value of C*
- Lifetime cost for person b = B + present values of B* and B**
- Lifetime cost for person a = A + present value of A*

Using an incidence approach, only cases like 'c' would be included, with the total cost estimate equivalent to the sum of all the costs in the base year (ΣC) plus the present value of all the future costs (ΣC*). Costs associated with people with asthma diagnosed in an earlier year would be excluded.

Using a prevalence approach, costs in 2015 relating to a, b and c would all be included, with total costs equal to Σ(A + B + C). Costs in all other years are excluded.

4.2 Classification of costs

Conceptual issues relating to the classification of costs include the following.

- **Direct and indirect costs**: Although literature often distinguishes between direct and indirect costs, the usefulness of this distinction is dubious, as the specific costs included in each category vary between different studies, making comparisons of results somewhat difficult.
- **Real and transfer costs**: Real costs use resources such as capital or labour, which thus reduces the economy's capacity to produce and consume goods and services. Transfer payments, however, are payments from one party to another which do not use up real resources. For example, the real cost associated with someone losing this job is their lost production, while the associated fall in income taxation paid to the government (due to not having an income) is a transfer.
- **Economic and non-economic costs**: Economic costs encompass loss of goods and services that have a price in the market or that could be assigned an approximate price by an informed observer. 'Non-economic' costs include the loss of wellbeing of the individual as well as of their family members and carers. This classification is ill-defined, since 'non-economic' costs are often ascribed values and the available methodologies are becoming more sophisticated and widely accepted. We acknowledge that controversy still surrounds the valuation of 'non-economic' costs and that the results should be presented and interpreted cautiously.
- **Prevention and case costs**: We distinguish between: the costs following from, and associated with a disease; and costs directed towards preventing the disease. Prevention activities include public awareness and education about asthma. In a similar vein, costs of insuring against impacts of the disease are excluded, but the study includes the gross costs of the impacts themselves.

There are six types of costs associated with asthma.

- **Direct financial costs to the Australian health system** include the costs of running hospitals and residential aged care facilities (buildings, care, consumables), general practitioners (GPs) and specialist services reimbursed through Medicare and private funds, the cost of pharmaceuticals (Pharmaceutical Benefits Scheme (PBS) and private) and of over-the-counter medications, allied health services, research and "other" direct costs (such as health administration).

- **Productivity costs** include productivity losses of the people with asthma, premature mortality and the value of informal care (including lost income of carers).
- **Administrative costs and other financial costs** include government and non-government programs such as respite, community palliative care, out-of-pocket expenses (such as formal care, aids, equipment and modifications that are required to help cope with illness, and transport and accommodation costs associated with receiving treatment), and funeral costs.
- **Transfer costs** comprise the deadweight losses (DWLs) associated with government transfers such as taxation revenue foregone, welfare and disability payments.
- **Non-financial costs** are also very important — the pain, suffering and premature death that result from asthma. Although more difficult to measure, these can be analysed in terms of the years of healthy life lost, both quantitatively and qualitatively, known as the "burden of disease".

Different costs of disease are borne by different individuals or sectors of society. Clearly the people with asthma bear costs, but so do employers, government, friends and family, co-workers, charities, community groups and other members of society.

It is important to understand how the costs are shared in order to make informed decisions regarding interventions. While the people with asthma will usually be the most severely affected party, other family members and society (more broadly) also face costs as a result of asthma. From the employer's perspective, depending on the impact of asthma, work loss or absenteeism will lead to costs such as higher wages (that is, accessing skilled replacement short-term labour) or alternatively lost production, idle assets and other non-wage costs. Employers might also face costs such as rehiring, retraining and workers' compensation.

While it may be convenient to think of these costs as being purely borne by the employer, in reality they may eventually be passed on to end consumers in the form of higher prices for goods and services. Similarly, for the costs associated with the health system and community services, although the Government meets this cost, taxpayers (society) are the ultimate source of funds. However, for the purpose of this analysis, a 'who writes the cheque' approach is adopted, falling short of delving into second round or longer term dynamic impacts.

Society bears both the resource cost of providing services to people with asthma, and also the 'deadweight' losses (or reduced economic efficiency) associated with the need to raise additional taxation to fund the provision of services and income support.

Typically six groups who bear costs and pay or receive transfer payments are identified, namely the:

- people with asthma;
- friends and family (including informal carers);

} The household

- employers;
- Federal government;
- State and local government; and
- the rest of society (non-government, not-for-profit organisations, private health insurers, workers' compensation groups, and so on).

Classifying costs by five cost categories and allocating them to six groups enables a framework for analysis of these data to isolate the impacts on the various groups affected by asthma. This includes different levels of government, the business sector and community groups.

4.3 Net present value and discounting

Where future costs are ascribed to the year 2015 throughout the report the formula for calculating the net present value (NPV) of those cost streams is:

$$NPV = \Sigma C_i/(1+r)^i \text{ where } i=0,1,2....n$$

Where:

C_i = *cost in year i*

n = years that costs are incurred

r = discount rate.

Choosing an appropriate discount rate is a subject of some debate, as it varies depending on what type of future income or cost stream is being considered. The discount rate should take into consideration risks, inflation and positive time preference.

Generally, the minimum option that one can adopt in discounting future expected healthy life streams is to set future values on the basis of a risk free assessment about the future that is assuming the future flows would be similar to the almost certain flows attaching to a long-term Government bond. Another factor to consider is inflation (price increases[10]), so that a real rather than nominal discount rate is used. If there is no positive time preference, the real long term government bond yield indicates that individuals will be indifferent between having something now and in the future. In general, however, people prefer immediacy, and there are different levels of risk and different rates of price increases across different cost streams.

> Taking inflation, risk and positive time preference into consideration, a real discount rate of 3% is traditionally used in discounting healthy life, and is also used in discounting other cost streams in this report, for consistency.

[10] The Reserve Bank has a clear mandate to pursue a monetary policy that delivers 2% to 3% inflation over the course of the economic cycle. This is a realistic longer run goal and a consumer price inflation rate of around 2.5% per annum on average has been achieved over recent years.

5 Health system costs

This chapter outlines the total health system costs associated with asthma, and provides a breakdown by type of cost into in-hospital, out-of-hospital, and pharmaceuticals.

Key findings:

- In 2015, the health system costs of asthma are estimated to be $1.2 billion. The average health system cost per person with asthma is $524 over the year 2015.
- Per person costs in 2015 are slightly higher for females ($579) compared to males ($459).
- Health system expenditure on the average person with asthma in 2015 will be spent on prescription pharmaceuticals ($263 per person), admitted hospital costs ($102 per person) and out-of-hospital medical services ($159 per person).
- Governments bore around two thirds of the health system costs (68.3%), while individuals bore 17.8%, and other parties (private health insurance, charities) bore the remaining 13.9%.

5.1 Total health system costs

Health expenditure data for asthma was sourced from the AIHW. The most recent estimates for health expenditure on asthma are from 2008-09, and are published on the AIHW website (AIHW, 2015)[11]. These are disaggregated by gender and ten-year age groups, and are reproduced in Table 5.1.

Table 5.1: Health system costs ($m in 2008-09)

Age	Males	Females	Total
0-4	43.1	26.9	70.0
5–14	46.9	39.9	86.8
15–24	24.9	31.0	55.9
25–34	28.0	41.3	69.3
35–44	26.9	47.5	74.4
45–54	24.5	52.9	77.4
55–64	29.5	66.4	95.9
65–74	25.5	42.6	68.1
75-84	14.2	30.2	44.4
85+	3.0	9.9	12.9
Total	**266.5**	**388.6**	**655.1**

Source: AIHW (2015).

[11] The AIHW is currently in the process of updating all of the disease expenditure estimates for 2007-08 to 2012-13. This update involves substantial changes to their methodologies, which will mean the previous estimates will be heavily revised. The AIHW expects to publish the results for admitted patient hospital costs first, followed by the other areas of expenditure.

These estimates are derived by the AIHW from an extensive 'top-down' process developed in collaboration with the National Centre for Health Program Evaluation for the Disease Costs and Impact Study (DCIS). The approach measures health services utilisation and expenditure for specific diseases and disease groups in Australia. The DCIS methodology (Mathers et al, 1998) has been gradually refined to estimate a range of direct health costs from hospital morbidity data, case mix data, Bettering the Evaluation and Care of Health data, the NHS and other sources.

However, due to data limitations the AIHW's figures are only able to allocate a portion of health expenditure to each disease category. The AIHW provides the following explanation of the methodological issues that prevent all health expenditure being categorised into disease categories:

> *"It is not possible to allocate all expenditure on health goods and services by disease. Expenditure on most community and public health programs, for instance, support the treatment and prevention of many conditions and cannot be allocated to one specific disease or injury. This is also true of capital expenditure on health facilities and equipment, which has the added problem of being characterised by large outlays that fluctuate greatly from year to year. The method used to derive the estimates … ensures that the estimates add across disease, age and sex groups to the total amount of health expenditure that was able to be allocated by disease in 2004–05—around two thirds (70%) of total recurrent health expenditure" (AIHW, 2010 page 21).*

The expenditure that was not able to be allocated by disease includes: capital expenditure; non-admitted patient hospital services; over-the-counter drugs; all other health practitioner services excluding optometry; community health expenditure (except community mental health); expenditure on public health programs (except cancer screening programs); health administration; health aids and appliances; research; and patient transport (ambulance) (AIHW, 2010).

While the most recent asthma expenditure data is from 2008-09, the most recent estimate of the un-allocated component is from 2004-05[12]. This estimate of 70% has been used to estimate the total expenditure on asthma in 2008-09. To inflate the 2008-09 data to 2015, the health component of the consumer price index (CPI) from the ABS (2015e) has been used.

The estimated health system expenditure on asthma by age and gender is shown in Table 5.2

[12] The non-allocated estimates are provided in the AIHW's *Health System Expenditure* series of reports. The most recent publication was for 2004-05, and was published in 2010.

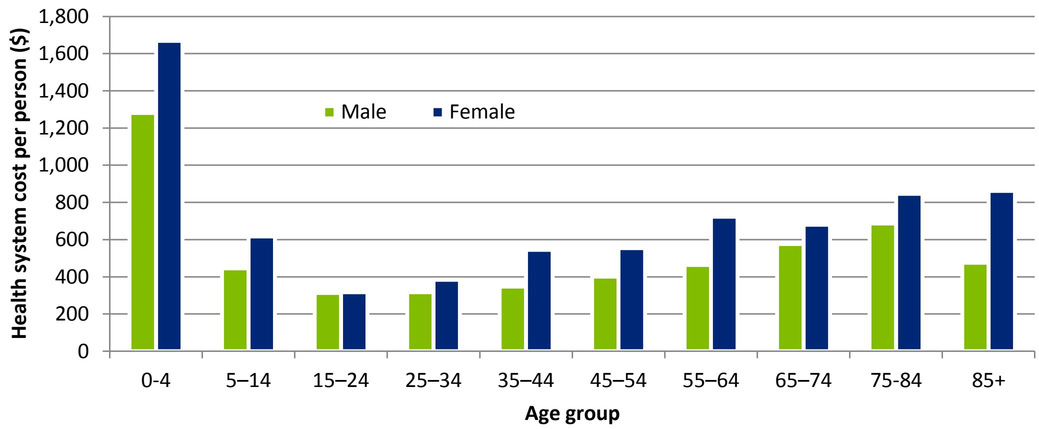
Table 5.2: Health system costs ($m in 2015)

Age	Male	Female	Total
0-4	81.9	51.1	133.1
5-9	50.8	33.9	84.7
10-14	38.4	41.9	80.4
15-19	26.8	27.9	54.7
20-24	20.5	31.0	51.5
25-29	25.6	40.8	66.4
30-34	27.6	37.7	65.3
35-39	33.4	47.9	81.3
40-44	17.8	42.4	60.1
45-49	19.1	52.1	71.2
55-54	27.5	48.5	76.0
55-59	28.7	65.3	93.9
60-64	27.4	61.0	88.4
65-69	30.1	48.5	78.7
70-74	18.3	32.4	50.8
75-79	17.4	36.2	53.6
80-84	9.6	21.2	30.9
85-89	5.7	13.9	19.6
90+	0.0	4.9	4.9
Total	**506.7**	**738.8**	**1,245.5**

Source: Deloitte Access Economics calculations based on AIHW (2015).

As shown in Chart 5.1 below, the per person health system expenditure is highest for both males and females in the 0-4 years age category. The 15-24 years age category represents the lowest per person category for both genders, and the cost steadily climbs over the subsequent age categories (with a drop for males in the 85+ year age category).

Chart 5.1: Health system costs per person (2015)



Source: Deloitte Access Economics.

5.2 Health system cost by type of cost

The AIHW's 2008-09 expenditure data provides information on the breakdown of asthma health system expenditure into prescription pharmaceuticals, admitted patient costs, and out-of-hospital medical services. These are discussed in the following sections. A detailed methodological overview of the methods that were used to derive the estimates is provided in AIHW (2011).

5.2.1 Prescription pharmaceuticals

Expenditure on prescription pharmaceuticals is **$263 per person with asthma in 2015.** This includes all pharmaceuticals that are listed in the schedule under the PBS and the Repatriation Pharmaceutical Benefits Scheme (RPBS) for which pharmaceutical benefits have been paid or are payable. It also includes costs for under-copayment[13] and private prescriptions. The types of prescription pharmaceuticals used to treat and manage asthma are covered in Section 2.6.2.

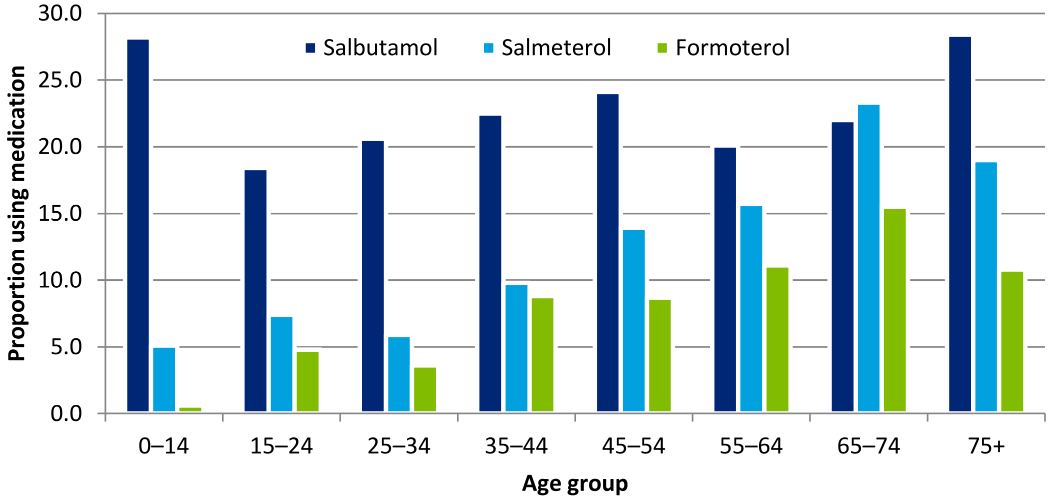
In the 2011-12 AHS (ABS, 2013a) 42.6% of people with asthma had taken respiratory system medications in the past two weeks for their asthma, with usage highest in the 65-74 years age group (57.7%), and higher for males (46.1%) compared to females (39.6%).

The most common respiratory system medications used were bronchodilators: salbutamol (22.8%), salmeterol (10.6%) and formoterol (6.9%), which serve to alleviate constriction and widen the airways (see Section 2.6.2).

Chart 5.2 shows the breakdown of these common medications by age. Among children, salbutamol is significantly higher than salmeterol and formoterol, however this high rate of usage drops off in the 15-24 years age group. From this age group, usage rates of all medication generally increase over each subsequent age groups, with a few exceptions. In all age group except the 65-74 years group, salbutamol is used at higher rates than salmeterol and formoterol.

[13] This refers to pharmaceuticals which are priced below the defined copayment for that item.

Chart 5.2: Proportion of people with asthma using medications



Source: Adapted from ABS (2013a).

5.2.2 Admitted patients

Expenditure on admitted hospital patients is **$102 per person with asthma in 2015**. This includes public and private acute hospitals, and psychiatric hospitals and expenditure on medical services provided to private admitted patients in hospital.

Emergency department visits can occur when asthma has not been sufficiently controlled and is exacerbated to the point where the person with asthma presents to an emergency department. However, some people with asthma use emergency departments as a source of primary care for their asthma (Ford et al, 2001). Among children aged 0-18 years, asthma counted for 3.5% of all emergency department presentations in 2004, which placed asthma as the 4th most frequent reason for emergency department visits (Acworth et al, 2009).

People with asthma are **admitted to hospital** when their asthma has been exacerbated to life-threatening levels, or when their asthma cannot be managed at home (AIHW, 2011). The rate of hospitalisation due to asthma is low compared to other countries. An Australian study found that over a 12 month period, 3.8% of adults and 4.9% of children with asthma had been hospitalised as a result of their condition (Marks et al, 2007). This was lower than countries across North America, Europe and Asia, where rates ranged from 7.0% in western Europe to 19.1% for central and eastern Europe (Rabe et al, 2004).

> Data from the 2011-12 AHS (ABS, 2013a) shows that while 68.7% of people with asthma did not attend the hospital or emergency department in the past year as a result of their asthma, 17.3% attended once, and 14.1% attended twice or more.

The difference in hospitalisation rates between Australia and other countries may be due to (AIHW, 2011):

- differences in the severity and prevalence of asthma in the community. In Australia, people with asthma were assessed to be in a symptomatic state only 12% of the time (Begg et al, 2007);
- cultural attitudes towards accessing health services;
- the effectiveness with which the disease is managed; and
- the tendency of medical practitioners to diagnose asthma. Accurate diagnosis allows for appropriate treatment to be administered, which lowers the risk of being admitted to hospital.

5.2.3 Out of hospital medical services

The average expense on out-of-hospital medical services is **$159 per person with asthma in 2015**. This includes expenditure for services provided by, or on behalf of, registered medical practitioners that are funded by the Medicare Benefits Schedule (MBS), Department of Veterans' Affairs, compulsory motor vehicle third-party insurance, workers compensation insurance, private health insurance funds, Australian Government premium rebates allocated to medical services, Medicare co-payments and other out-of-pocket payments. It also includes non-MBS medical services, such as the provision of vaccines for overseas travel, as well as some expenditure by the Australian Government under funding arrangements that are alternatives to the fees for service (AIHW, 2015).

People with asthma may **attend their GP** for a variety of reasons, which include (AIHW, 2011):

- management of asthma symptoms;
- review of progress since an acute episode of asthma; and
- undertaking maintenance activities, such as monitoring the impact of regular medications.

> The 2011-12 AHS (ABS, 2013a) estimated that 57.1% of people with asthma had consulted a GP in the past year. This rate is highest among children (73.2%) and lowest among people aged 25-34 (47.7%). Among people with asthma who had not visited a GP in the past year, 70.2% said that it had been more than two years since their asthma had been managed by a GP (Britt et al, 2008).

Compared to Europe, the proportion of people with asthma who have their condition regularly managed by their GP are lower than Denmark (96%) and the United Kingdom (80%), but higher than Georgia (20%) and Greece (10%) (Roberts et al, 2009).

The most common procedure provided by GPs for asthma management is spirometry (see Section 2.6), and developing an asthma action plan. Spirometry is performed for children in 3.0% of GP encounters for the management of asthma, while for adults the rate is 5.7%. Potential barriers to spirometry testing may be a lack of suitable equipment, lack of self-confidence in their ability to perform and interpret spirometry tests, and lack of time required to undertake the procedure (AIHW 2011, Dennis et al, 2010).

Over 2007-08, asthma action plans were developed for 5.4% of children, while for adults it was 1.9% (AIHW, 2011). Ownership of asthma action plans remain low (20% of people with asthma, and 41% of children with asthma (ABS, 2013a)).

Most asthma is and can be managed by GPs. Referral to outside services is therefore low. Outside services can include acute care when people are experiencing an exacerbation of their asthma or symptoms, or specialists for care and respiratory function tests. Children are referred to acute care in 0.9% of encounters compared to adults (0.4%), and are also referred to a specialist more frequently (2.9% compared to 1.5%) (AIHW, 2011). Data from the 2011-12 AHS (ABS, 2013a) shows that 6.0% of people with asthma had consulted a specialist in the past 12 months.

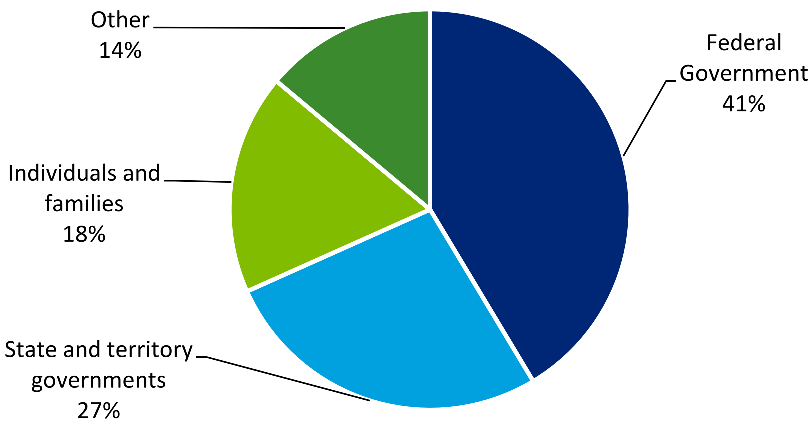
5.3 Who bears the cost

An analysis was conducted into which sections of society bear the health system costs of asthma, based on data from the AIHW (2015). In 2015, asthma cost:

- the Federal Government (through programs such as the MBS and PBS) $515.6 million;
- state and territory governments (for example, hospital funding) $335.0 million;
- individuals and families (through expenses such as co-payments and out-of-pocket hospital expenditure) $221.7 million; and
- other parties (such as private health insurers and charities) $173.1 million.

The breakdown of these costs is shown in Chart 5.3.

Chart 5.3: Breakdown of health system costs (2015)



Source: Deloitte Access Economics calculations using AIHW (2015).

6 Productivity costs of asthma

This section describes the approach that was used to estimate productivity costs associated with asthma in Australia.

Key findings:

- In 2015, the estimated productivity cost of asthma is around $1.1 billion, of which the most expensive source of productivity loss is temporary absenteeism.
- The productivity cost of asthma borne by workers is around $198.9 million ($84 per person with asthma).
- The productivity cost of asthma borne by employers is around $526.7 million ($221 per person with asthma).
- The productivity cost of asthma borne by the government is around $404.6 million ($170 per person with asthma).

6.1 Approach

Asthma can affect individuals' capacity to work. **They may work less than they otherwise would, retire early, be absent from work more often, have lower productivity while at work, or die prematurely**. If employment rates are lower for people with asthma, this loss in productivity represents a real cost to the economy. Additionally**, informal carers may also work less or not work entirely in order to care for their loved one with asthma**, and this represents an additional productivity loss.

Initially, asthma may result in reduced hours, restricted activities or changed responsibilities or occupations. Health concerns associated with asthma may cause people with asthma to be temporarily absent from paid employment more often than the general population. Furthermore, these health concerns may result in reduced productivity while at work, lower employment rates, premature workforce separation or retirement. This is often influenced by economic needs, the workplace environment, and work-life balance factors and sense of worth in the current role. Finally, each of these factors lead to administrative costs, which are covered in Section 6.5.

This report measures the lost earnings and production due to health conditions using a 'human capital' approach. The lower end of such estimates includes only the 'friction' period until the worker can be replaced, which would be highly dependent on labour market conditions and unemployment/underemployment levels. In an economy operating at near full capacity, a better estimate includes costs of temporary work absences plus the discounted stream of lifetime earnings lost due to early retirement from the workforce, reduced working hours (for example, part-time rather than full time) and premature mortality, if any. These approaches are outlined in Section 6.2 and Section 6.3.

6.2 Short run productivity losses

The **economic cost of short run productivity losses (absenteeism) are estimated using the friction method**. This approach estimates production losses for the time period required to restore production to its pre-incident state, which is when the person with asthma returns to work, or is replaced. **This method generally assumes that there is unemployment**, and that a person who was previously not earning an income replaces the person not working due to asthma.

In the meantime, employers often choose to make up lost production through overtime or employment of another employee that attracts a premium on the ordinary wage. The overtime premium represents lost employer profits. On the other hand, the overtime premium also indicates how much an employer is willing to pay to maintain the same level of production. Thus, if overtime employment is not used, the overtime premium also represents lost employer profits due to lost production. While productivity remains at the same level, the distribution of income between wages and profits changes. For this study it is assumed that the overtime rate is 40%.

The following sections outline the findings form the literature review that was conducted to provide parameters for the short run productivity losses, as well as the data inputs that were used.

6.2.1 Literature review

Asthma can impact upon an individual's ability to work, potentially incurring significant productivity costs. Absenteeism is one such effect of asthma, which is defined in the literature as the number of days per year an employee is unable to work due to their asthma. Another measure, known as presenteeism, identifies the impact asthma may have on diminishing an individual's productivity while at work and is presented as the average hours of productivity lost per working day. This is covered in Section 6.3.

The 2011-12 AHS contains an estimate of absenteeism due to asthma. Survey respondents are asked to identify the number of days in a fortnight that they stayed away from work as a result of illness or injury. The mean number of absent days for people with asthma is 0.4. However, the mean number of days across the entire population is 0.3, which means that 0.3 days of work would have been missed even in the absence of asthma. Therefore, 0.1 *additional* days of work were missed as a result of asthma. This is equivalent to **2.6 days per employed person with asthma per year.**

To triangulate the findings from the AHS, a literature review was conducted to identify relevant studies on the impact of asthma on absenteeism in the workplace and to extract parameters for use in our analysis**.** Table 6.1 provides a summary of the studies on absenteeism associated with asthma that were identified in this review. All studies were cross-sectional studies.

Table 6.1: Studies on absenteeism associated with asthma

Reference	Area	Population	Average number of absent days per employee per year*
Lee and Jung, 2008	Korea	Workers who received a group occupational health service	0.6
Lamb et al,	US	US employees at 46 different employer locations	1.1
Sullivan et al, 2008	US	Recruited sample of asthma patients	1.3
Collins et al, 2005	US	US workforce for the Dow Chemical Company	1.5
Barnett and Nurmagambetov, 2011	US	Survey respondents with asthma	2.6
Hansen et al, 2012	Denmark	Random sample of 20-44 year olds	2.6
Thanh et al, 2009	Canada	People of working age in Alberta who reported having an asthma diagnosis	2.8
Serra-Batlles et al, 1998	Spain	Asthma patients who sought medical care for asthma control in Osona county, Barcelona	3.5
Wang et al, 2003	US	Workers in four occupations – reservation agents, customer service representatives, executives and railroad engineers	10.6
Goetzel et al, 2004	US	Employees	12.0
Sadatsafavi et al, 2014	Canada	Population-based random sample of adults with asthma	13.0
Ojeda et al, 2013	Spain	Patients selected by 120 allergists nationwide	14.0

Source: Deloitte Access Economics research.
Note: * This refers to additional days of absence as a result of asthma.

A total of twelve studies were identified for the purpose of this review, all of which shared the consensus that people with asthma experienced higher rates of absenteeism than people without asthma in the workplace. As results differed according to severity, further research was conducted to identify the proportion of the asthmatic population made up by people with severe asthma. While proportions are likely to differ for different countries, international health experts have estimated that approximately 5-10% of people with asthma suffer from severe asthma (Chanez et al, 2007; Hekking et al, 2014). As such, an average estimate of 7.5% has been derived from these studies and used to calculate a weighted average for studies, which included participants with varying severity of asthma in their samples.

In their study of data from the Medical Expenditure Panel Survey (MEPS), Barnett and Nurmagambetov (2010) sought to estimate the incremental direct costs of asthma and productivity days lost because of asthma for the years 2002-07 in the US. In addition to surveying patients and their families, the MEPS also surveyed medical providers and employers, enabling the collection of data regarding medical expenditure and insurance coverage. **Based on a sample that ranged from 30,964 to 39,163 people, Barnett and Nurmagambetov found that people with asthma lost, on average, 2.62 incremental days of work per year due to their condition**.

Collins et al (2005) conducted a similar study on the estimate of total costs for chronic health conditions in the US workforce for the Dow Chemical Company, using self-reported data from workers at five locations as well as data on employee demographics, medical and pharmaceutical claims, smoking status, biometric health risk factors, payroll records, and job types. **Absenteeism for different chronic conditions was reported over a 4-week recall period with asthma accounting for an average of 0.9 hours of absence**. When adjusted to encompass the working year, the estimate in Collins et al (2005) is equivalent to an average of 1.5 days of absence per employee per year.

In their study of the cost estimates of ten physical and mental health conditions, Goetzel et al (2004) also looked at productivity losses in a US context. Goetzel et al utilised a range of data sources, including estimates from a large medical/absence database in conjunction with several productivity surveys, to identify a range of estimates pertaining to absenteeism and presenteeism. **Based on this data, the study found that asthma contributed to an average of 12 absent days per year**.

In their study of consequences of asthma on job absenteeism and job retention, Hansen et al (2012) identified fairly similar estimates for asthma-associated absenteeism in Denmark. Researchers analysed data from participants' responses to the European Community Respiratory Health Study, in conjunction with information regarding transfer incomes from a study-independent national database to determine differences between people with and without asthma. **Hansen et al found that, on average, employees took 2.6 days of absence per year due to their asthma**.

In Lamb et al (2006), workplace productivity losses were estimated for allergic rhinitis for comparison against a variety of other medical conditions, including asthma, for US employees at 47 employer locations. The study was based on data obtained from participant responses to the Work Productivity Short Inventory questionnaire and found that asthma was associated with $225,872 in absenteeism costs. When adjusted for the 7.5 hour working day unit that is used in this report, **an estimate of 1.1 days of absence due to asthma per employee per year can be extracted from the figure**.

Lee and Jung (2008) conducted a similar study to estimate economic impacts of various health problems of Korean workers. The study sample consisted of 301 workers who received a group occupational health service and collected data for two months in 2006. Based on data collected from a questionnaire, using the Stanford Presenteeism Scale, Lee and Jung found that **asthma was responsible for 0.64 days of absence per employee per year**.

In Ojeda et al (2013), costs relating to workdays lost and utilisation of health care resources, due to asthma, were estimated using a sample of asthmatic patients selected by 120 allergists across the country. The study encompassed data that had been collected by participants over the past month, including health care utilisation information and spirometry values, with differing levels of asthma severity. Based on this information, the study found that **asthma contributed to a weighted average of 1.2 days of absence per employee per month, or 14 days of absence per employee per year**.

In Sadatsafavi et al (2014), a population-based study was conducted to determine the preventable burden of productivity loss associated with suboptimal asthma control. The study included 300 employed adults with varying levels of control of their asthma. Cross-sectional data was obtained from a longitudinal study known as the Economic Burden of Asthma study to gauge prevalence of asthma in Canada. **A weighted average of 1.95 hours of absence per week was derived from the findings. This figure was extrapolated to obtain an estimate of 13 days of absence per year**. For the purposes of this report, estimates for absenteeism reported by people who did not have controlled asthma were not included in this analysis to avoid potential inflation of the estimate.

In their study on the costs of asthma according to severity, Serra-Batlles et al (1998) looked at asthma patients in Osona County, a semirural area in the province of Barcelona. Data was obtained through interviews of the patients by the same researcher at the general hospital using a specifically designed questionnaire and, where relevant, checked against information in the medical record. Serra-Batlles identified the number of working days lost according to severity of asthma over the course of the year. **A weighted average of their findings results in an estimate of 3.5 days of absence due to asthma per employee per year**.

In Sullivan et al (2008), the economic burden of severe or difficult-to-treat asthma was estimated for patients with varying levels of control of asthma. Baseline data was obtained from the Epidemiology and Natural History of Asthma: Outcomes and Treatment Regimens study and assessments performed at baseline, month 12 and month 24 of the three-year study. Based on their analysis, a weighted average of **1.3 days of absence per year was calculated for each employee**.

In their study on asthma-related productivity losses in Alberta, Canada, Thanh et al (2009) utilised data from the 2005 Canadian Community Health Survey to derive their estimates in addition to other data from Alberta or Canadian published literature. The study focused on people of working age (18-64 years) who reported having an asthma diagnosis. From their findings, Thanh et al estimated that **an average of 2.8 days per employee per year was due to asthma**.

In Wang et al (2003), the impact of chronic medical conditions on work performance was assessed for participants in the US across four different occupations - reservation agents, customer service representatives, executives and railroad engineers. Participants were surveyed using the World Health Organisation's (WHO's) Health and Work Performance Questionnaire. Based on their responses, **the study found that asthma was associated with 10.6 annual excess absenteeism days**.

While all studies identify an increase in the number of absent days associated with having asthma, the results differ in their respective magnitudes. **The studies appear to be in two groups – eight studies which identify a smaller number of absent days (ranging from 0.6 days to 3.5 days), and four studies which identify a much larger number of missed days (ranging from 10.6 days to 14.0 days)**. It is not known whether design issues may have affected the findings of the latter studies, which do not appear to align well with lived experience in Australia.

The results from the 2011-12 AHS were considered to present the best estimate of missed work days due to asthma in Australia. As none of the studies identified through the literature search were from Australia, and the majority of studies corroborate the findings from the AHS (2.6 missed days due to asthma), an average was taken of the lower studies and the AHS, as a conservative approach. **This results in an overall estimate of 2.1 days of missed work per person as a result of asthma**.

6.2.2 Data inputs

In addition to the findings from the literature review, additional data parameters were sourced from ABS publications:

- The proportion of males and females that have access to paid sick leave arrangements (ABS 6342.0 *Working Time Arrangements*).
- The average weekly earnings (AWE) of males and females, by age (ABS 6310.0 *Employee Earnings, Benefits and Trade Union Membership*).
- The workforce participation rates of males and females, by age (ABS 6105.0 *Australian Labour Market Statistics*).

6.3 Long run productivity losses

The economic cost of long run productivity losses (premature workforce separation, reduced productivity while at work (presenteeism) and premature mortality) are estimated using the human capital method. The human capital method estimates production losses based on the remaining expected lifetime earnings for the individual.

A full economic analysis of the effects of a disease on the economy would also examine the long-run situation where the lost productive capacity of the labour force (incurred via the worker or the employer) is passed onto society through adjustments in wages and prices. **However, this study assumes that, in the absence of the disease, people with asthma would participate in the labour force and obtain employment at the same rate as the general Australian population, and earn the same AWE**. The implicit and probable economic assumption is that the numbers of such people would not be of sufficient magnitude to substantially influence the overall clearing of the labour market.

The following methodologies are used to estimate lost long run productivity costs.

The **expected retirement age** by the current age of the worker is calculated based on the participation rates at each age group. Similar to life expectancy, the older the person, the less time it is expected the person will remain in the workforce but the older they are when they do leave the workforce. Note that this methodology takes into account the probability that the person with asthma is working.

The **reduction in productivity at work (presenteeism)** is calculated based on the findings from the literature review (see Section 6.3.1.1). The methodology assumes that the AWE of people in the economy is equal to their productivity output. As such, reduced productivity of people with asthma at work will translate into a reduction in AWE over the long run.

As the person ages, the annual income (based on AWE) is multiplied by the average employment rate at each age group while alive. Income earned at each age is then summed to calculate the expected total income over a person's lifetime (discounted back to present values).

6.3.1 Literature review and data extraction

A literature review was conducted to identify relevant studies on the impact of asthma on presenteeism in the workplace, and data was extracted from SDAC confidentialised unit record files[14] (CURFs) from the 2012 Survey of Disability, Ageing and Carers (SDAC) to identify any reduction in employment rates associated with asthma.

> The SDAC is a national survey conducted by the ABS, from April to December. The primary objective of the survey is to collect detailed information about three population groups (ABS, 2014a). They are: **people with a disability** (such as asthma); **older people** (those aged 60 years and over); and **people who provide assistance** to older people and people with disabilities.

6.3.1.1 Presenteeism

Despite its prevalence in the workplace, presenteeism has only recently emerged as a subject of study in management literature. As such, there is relatively limited literature on presenteeism rates associated with asthma with the majority of presenteeism estimates covered by studies on absenteeism. **Due to the limited literature on the impacts of asthma on presenteeism, the estimated cost of presenteeism due to asthma is not included in the total economic costs calculated for this report. The methods and results of the presenteeism estimates are presented in Appendix B to provide insight into these costs. Further investigation is needed before a more conclusive cost can be established.**

6.3.1.2 Workforce participation

Ultimately it would be best to use large Australian studies of the general community to identify the impact of asthma on productivity. The application of results of the international studies to the Australian context is often limited due to differences in the social security system and access to health care, which impact on the ability for people with asthma to continue working.

Data was extracted from the 2012 SDAC CURFs to compare the levels of workforce participation of people with asthma, compared to the rest of the population. These results of this analysis are shown in Table 6.2.

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[14] CURFs are data sets that contain detailed information for each individual response to ABS surveys or censuses, which have had specific identifying information about respondents made confidential for their privacy.

Table 6.2: Workforce participation rates (ages 15-64)

	People with asthma (%)	People without asthma (%)
Employed full-time	52.5	51.8
Employed part-time	23.1	22.6
Unemployed, seeking full-time work	3.3	2.5
Unemployed, seeking part-time work	2.9	1.5
Not in labour force	18.2	21.6
Total	**100**	**100**

Source: Deloitte Access Economics analysis of SDAC CURFs.

From this data, it was calculated that 75.6% of people with asthma were employed, compared to 74.4% of people who do not have asthma. This result seems to suggest that people with asthma have higher rates of employment, compared to people without asthma. It is considered unlikely that asthma has a positive impact on employment rates, and so a literature search was undertaken to attempt to gain a clearer understanding of whether asthma reduces workforce participation rates. While most of the literature concentrates on the workforce participation of people with occupational-induced asthma, the literature on non-occupational induced asthma returned a mixed set of results.

Yelin et al (2006) surveyed people aged 55 to 75 who reported a physician's diagnosis of either COPD, asthma or rhinitis, as well as people without any of these conditions. The study estimated the duration of work life among persons with and without the conditions. The study found that **persons with asthma had an elevated risk of leaving work prior to age 65, and only 40% of people with asthma were employed compared to 56% with no chronic conditions. However, many of these people with asthma may also have had COPD and/or rhinitis**, and the study does not provide a breakdown of the results for people who only had asthma.

A different study by Yelin and colleagues (Yelin et al, 1999) returned different results. This study surveyed a panel of 601 persons with a diagnosis of asthma from random samples of northern California pulmonologists and allergy-immunologists to determine the employment rates of the panel population. These employment rates were compared to a matched sample from the US Bureau of the Census Current Population Survey. **The study found that the employment rate of persons with asthma were similar to the matched sample**.

Ross et al (1992) undertook a 25 year follow up study of three groups of subjects who had been identified in a random community survey in 1964: those who had asthma in childhood, those who wheezed only in the presence of upper respiratory tract infections, and a comparison group who had no respiratory symptoms as children. **The study found that there was no difference between people with asthma and the comparison group** in regards to the proportions who were either employed (both full time and part time) or unemployed.

Sauni et al (2001) surveyed 76 Finnish construction workers with asthma (against a control group of 145 construction workers without asthma) on their work ability and quality of life. The study found that there was **no significant difference in unemployment rates between construction workers with or without asthma**.

Thaon et al (2008) presented results from survey results of 12,233 subjects pertaining to medical data, self-perceived health status, sick leave, occupational social class and employment characteristics in a French longitudinal study. Of the 398 people with asthma, the study found that **employment rates were negatively affected at the start of working life for people diagnosed with asthma in childhood, and for people with adult-onset asthma at the end of their working life. However, employment rates were not negatively impacted otherwise.**

> As the results of the SDAC do not suggest a negative impact on employment rates due to asthma, and the literature review failed to identify a clear indication to the contrary, Deloitte Access Economics has not included productivity losses from lower employment rates due to asthma.

6.3.1.3 Premature mortality

To calculate premature mortality, the mortality rate for asthma (see Section 3.4) and the expected remaining lifetime earnings of people with asthma (weighted against the probability of being employed by age and gender) are used to calculate the productivity losses that arise in 2015 for all premature deaths due to asthma.

6.3.2 Data inputs

In addition to the findings from the literature review, additional data parameters were sourced from ABS publications:

- The proportion of males and females that have access to paid sick leave arrangements (ABS 6342.0 *Working Time Arrangements*).
- The AWE of males and females, by age (ABS 6310.0 *Employee Earnings, Benefits and Trade Union Membership*).
- The workforce participation rates of males and females, by age (ABS 6105.0 *Australian Labour Market Statistics*).
- The mortality rates of males and females with asthma, by age (see Section 3.4).
- The mortality rates of the Australian population (see Section 3.4).

6.4 Informal carer productivity losses

This section describes the approach that was used to estimate the costs of informal care for people with asthma in Australia. Carers are people who provide care to others in need of assistance or support. An informal carer provides this service free of charge and does so outside of the formal care sector. **An informal carer will typically be a family member or friend of the person receiving the care, and usually lives in the same household as the recipient of care.** As such, many people receive informal care from more than one person. The person who provides the majority of informal care is known as the primary carer.

While informal carers are not paid for providing this care, informal care is not free in an economic sense. Time spent caring involves forfeiting time that could have been spent on paid work or leisure. As such, informal care can be valued as the opportunity cost associated with the loss of economic resources (labour) and the loss in leisure time valued by the carer.

There are three potential methodologies which can be used to place a dollar value on informal care.

- The **replacement cost method** measures the cost of 'buying' an equivalent amount of care from the formal sector if the informal care were not supplied.
- The **opportunity cost method** measures the formal sector productivity losses associated with caring, as time devoted to caring responsibilities is time which cannot be spent in the paid workforce.
- The **self-valuation method** measures how much carers themselves feel they should be paid for undertaking their responsibilities.

In this study, Deloitte Access Economics has adopted the opportunity cost method.

Deloitte Access Economics extracted data from the SDAC to determine the demographic profile of the informal carers for people with asthma. **Two key issues** emerged from this analysis:

- the data indicated that only 5,221 people were a carer for a person with asthma in Australia; and
- these results were based on a sample of population of fewer than 30 people[15].

While it is acknowledged that many adults with asthma would not require a carer, **it was considered unlikely that there were only 5,221 people who provided informal care to a person with asthma in 2012**, as the prevalence of asthma among children is many times higher than this amount.

It is possible that survey respondents to the SDAC did not consider themselves to be a carer, as defined by the SDAC. For the purposes of the SDAC, the ABS (2013a) defines primary carers as "those people who provide the most informal assistance to someone else … and meet the following criteria:

- have been providing help, or are likely to provide help, for at least six months;
- provide help with one or more tasks associated with the core activities of mobility, self-care and communication; and
- feel they provide the most care to the recipient for those activities."

A further examination of the SDAC showed that:

- The age range for people with asthma who received care was 1-19 years old
- The age range for people who provided care to a person with asthma was 45-49 to 80-84 for males, and 25-29 to 75-79 for females.

While these results are based on a sample size of fewer than 30 people, they indicate that it is only children in Australia who receive care for their asthma. While adults or elderly people with asthma may also receive care, they are likely to receive this care as a result of

[15] The confidential nature of CURF data means that the exact number of respondents in the sample population cannot be included in this report.

other comorbidities that are present, and as such the care provided to these people cannot be attributed to asthma.

> The typical approach to estimating the opportunity cost of informal care is to use data extracted from the SDAC. However, the data on asthma carers was unsuitable due to a small sample size. As such, additional sources were used.

A study by Toelle et al (1995) examined children with asthma aged between 8-12 years old in New South Wales, who were representative of the population in regards to asthma severity. The study derived an estimate of the amount of time that the parents of these children spent each year on taking the children to medical practitioners and the hospital as a result of their asthma. Across the 238 children in the study, it was calculated that their **parents spent 13.4 hours each year taking their children to medical practitioners and the hospital**.

This estimate of time (equivalent to 0.26 hours per week) may be a reason why survey respondents did not identify themselves as a carer in the SDAC. A weighted average of results from the SDAC showed that each carer had provided 18.09 hours of care in the past week. Survey respondents in the SDAC who had not indicated that they were a carer may have considered that the amount of time spent caring (0.26 hours per week) did not qualify as providing care.

A literature search did not identify more recent estimates of the time spent by parents caring for children with asthma which were relevant to the Australian context. The estimate of 13.4 hours per year from the Toelle et al study was used as an estimate of the amount of time spent providing care to children with asthma[16], and it was assumed that the time spent caring for children in the study could be applied to all children aged up to 19 years (as this was the highest age group who received care in the SDAC).

Based on the findings from the SDAC and the academic literature, it was assumed that the providers of care were aged between 45-49 and 80-84 for males, and between 25-29 and 75-79 for females. Each person with asthma aged to 19 years had one "carer" who spent 13.4 hours per year providing care to them.

Overall in 2015, it is estimated that the opportunity cost of informal care is $113.6 million. This was split into:

- Losses to carers in the form of lost income: $72.9 million
- Losses to government in the form of lost taxes: $40.7 million.

6.5 Administrative costs

The employer also incurs administrative costs associated with short run and long run productivity costs.

Each day a person with asthma is temporarily absent from work, it is estimated that **2.5 hours of management time is lost processing those absent employees** (Health and Safety

[16] Note that this does not include any time associated with providing care within the home.

Executive, 2011). This includes the time of line managers in rearranging work and the time of back office personnel. The value of a manager's time is $44.70 per hour (ABS, 2014b).

Premature retirement and premature mortality results in increased employee turnover costs, such as search, hiring and training costs. **These costs are estimated to be equal to 26 weeks salary of the incumbent worker** (Access Economics, 2004). However this cost is merely 'brought forward' a number of years because there would be some normal turnover of people with asthma – approximately 15% per annum (which implies that people change jobs, on average, approximately once every 6.7 years (Access Economics, 2004).

6.6 Educational impacts

Asthma has a marked impact on education, such as when children are required to take time off school to attend medical appointments, because their asthma is exacerbated to the point that they are unable to attend school, or when their asthma prevents them from studying at their full capacity.

Asthma has been identified as the most common cause of school absenteeism due to chronic conditions (Wang et al, 2005). This American study found that **asthma accounts for 2.48 days of missed school per child with asthma**. When other impacts were included (such as parents taking time off work to care for their child, and future lost earnings due to childhood mortality from asthma), the total economic costs were $791 per child with asthma. Moonie et al (2006) has identified that **up to 35% of school absences have been attributed to asthma-related symptoms among school-aged children**.

A study by Schmier et al (2007) found that children with adequately controlled asthma missed fewer days of school compared to children with poorly controlled asthma, and caregivers of children with adequately controlled asthma also missed fewer days of work, compared to caregivers of children with poorly controlled asthma. Chen et al (2008) found that severe asthma was associated with a greater percentage of impairment at school (32%) compared to mild-to-moderate asthma (18%).

However, for this report Deloitte Access Economics assumes that the impacts of disrupted education are captured in quality of life losses (as there is not considered to be an impact on future employment rates), and as such **the impacts of disrupted education are not included in this model so that there is no double counting of total costs**. Please note the impacts on parents of children with asthma are captured in Section 6.4

6.7 Summary of productivity costs

In 2015, the estimated productivity cost of asthma is $1.1 billion, of which the most expensive source of productivity loss is temporary absenteeism. The breakdown of the productivity costs are summarised in Table 6.3.

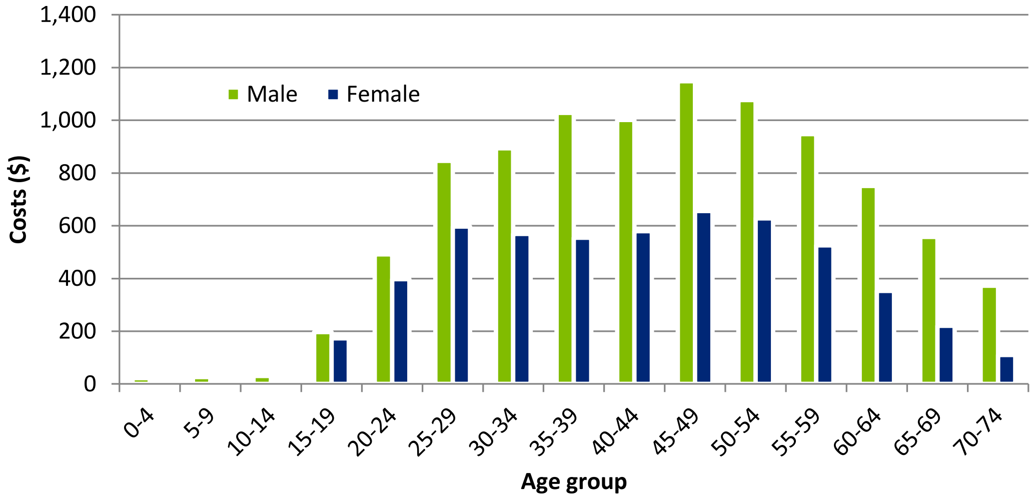
Table 6.3: Summary of productivity costs (2015)

Source of productivity loss	2015 $million
Absenteeism	909.2
Presenteeism	- ^
Premature workforce separation	0.0
Premature mortality	113.6
Informal carer costs	107.1
Search, hiring and training costs	0.3
Total	**1,130.2**

Source: Deloitte Access Economics calculations.
Note: ^ Due to the limited literature on the impacts of asthma on presenteeism, the estimated cost of presenteeism due to asthma is not included in the total economic costs calculated for this report. See Appendix B for details.

The average productivity cost per person with asthma differed by age and gender (see Chart 6.1.

Chart 6.1: Productivity costs per person with asthma (2015)



Source: Deloitte Access Economics calculations.

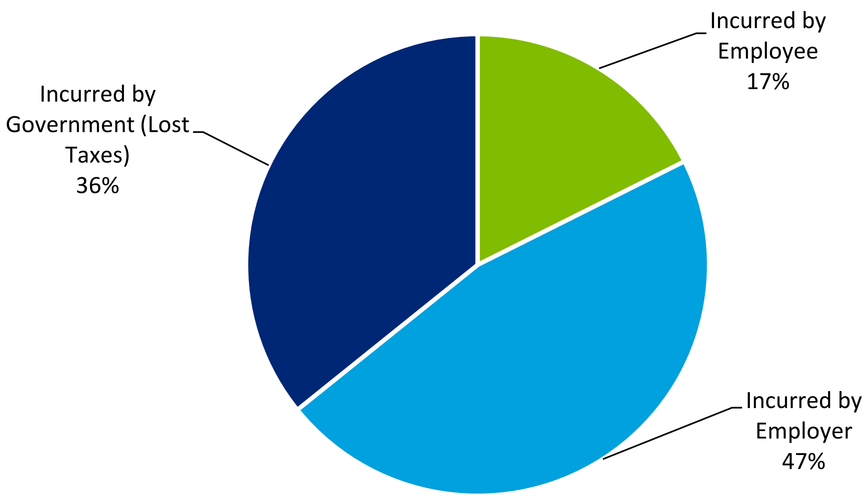
The average cost per male increases from working age (15-19) until 35-39, and it remains consistently high until the 55-59 age group. At this age group, workforce participation across the entire population starts to decrease, and so the productivity costs of asthma decrease as well. For females, productivity costs increase from working age until 25-29, and remain around the same level before decreasing in the 60-64 years age category. Average costs for males with asthma are higher than for females with asthma for all age categories, which reflects the higher workforce participation rates of males in the Australian economy.

The productivity costs are shared between workers, employers and governments (through tax losses). Post-tax, the shares of productivity losses are:

- Workers: the productivity cost of asthma borne by workers is $198.9 million – this largely consists of lost earnings as a result of temporary absenteeism and premature death.
- Employers: the productivity cost of asthma borne by employers is $526.7 million, of which the majority is from the productivity losses from temporary absenteeism.
- Government: the productivity cost of asthma borne by government is $404.6 million, which consists entirely of lost taxation revenue as a result of lower lifetime earnings of people with asthma.

The distribution of these costs is shown in Chart 6.2. Employers bore the largest share of costs (47%), followed by government (36%) and employees (17%).

Chart 6.2: Distribution of productivity costs (2015)



Source: Deloitte Access Economics calculations.

7 Other financial costs

In addition to productivity costs, there can be other less burdensome (but still material) costs, such as the costs of respite for informal carers, costs of formal care, special equipment, travel and accommodation costs to access health services, the cost of other government programs, asthma research, and funeral costs.

Key findings:

- In 2015, the total other financial costs incurred due to asthma are estimated to be $246.4 million.
- The highest component are government programs ($171.2 million).
- On a per person basis, other financial costs are $104 per person with asthma.
- The burden of other financial costs falls primarily on government (72.2%).

7.1 Equipment

It is important to note that the costs of asthma equipment (such as **peak flow meters, spacers, and nebulisers**) are already captured in the non-allocated health system costs which are outlined in Section 5, as they are considered to be a health aid or appliance. As such, the costs presented in this section are to provide insight into the costs of asthma equipment, but do not add to the overall cost of asthma.

In order to estimate the cost of these items due to asthma, **it is necessary to know the rate of ownership among people with asthma, the cost of in Australia, and the assumed life of the equipment before it needs to be replaced**. Each of these items are explored in the following sections. It is assumed for all items that they are replaced once every five years.

7.1.1 Peak flow meters

Eight studies were located which had obtained data on the proportion of people with asthma who owned a peak flow meter. These studies are summarised in Table 7.1.

A study by Marks et al (2007) conducted a random telephone interview survey in Australia, which resulted in 1,734 respondents with current asthma. Of these respondents, **30.2% owned a peak flow meter**.

Rabe et al (2004) reported on the results of the Asthma Insights and Reality surveys which had been conducted by GINA between 1998 and 2001. These surveys established that **the ownership rate of peak flow meters around the world ranged from 28.0% (US and Western Europe) through to 5.6% in Central and Eastern Europe**).

Data from the Spring South Australian Health Omnibus Survey (SSAHOS) was used in Adams et al (1997) and Ruffin et al (2001). The SSAHOS examines the health and wellbeing of South Australians (Andrews et al, 2014). The results of the survey **in 1992 showed that 10.5% of people with asthma owned a peak flow meter (Adams et al, 1997), while in 1996 this proportion had increased to approximately 15%** (Ruffin et al, 2001).

A study by Garrett et al (1994) of 352 people with asthma who attended an emergency room in New Zealand found that **54.3% owned a peak flow meter**. However, it should be noted that these people with asthma were likely to have more severe asthma (which requires closer monitoring of symptoms), and as such may not be representative of the general population with asthma.

Donald et al (2008) assessed the rate of peak flow meter ownership among adults who had attended an Australian tertiary hospital between over a two year period as a result of their asthma. Among this population, **56% owned a peak flow meter**. As with the study by Garrett et al (1994), this population was considered to not be representative of the general Australian population with asthma.

An examination of the Medical Expenditure Panel Survey by the US Department of Health and Human Services found that **26.2% of people with asthma had a peak flow meter in their home in 2004**. The rate of ownership was slightly higher for females (28.7%) compared to males (22.7%).

A study of people with asthma in socioeconomically deprived areas in Birmingham (Moudgil and Honeybourne, 1994) found that the rate of ownership of peak flow meters was similar between white European females with asthma (35.6%) and white European males with asthma (35.1%). **Across males and females, the rate of ownership of peak flow metres was 35.4%**.

Table 7.1: Rate of ownership of peak flow meters

Study	Percentage
Marks et al (2007)	30.2
Rabe et al (2004) – US	28.0
Rabe et al (2004) – Western Europe	28.0
Adams et al (1997)	10.5
Ruffin et al (2001)	15.0
Garrett et al (1994)*	54.3
Donald et al (2008)*	56.0
US Department of Health and Human Services (2004)	26.2
Moudgil and Honeybourne (194)	35.4
Average	**24.8**

Source: Deloitte Access Economics research.
Note: * excluded from calculation of average value due to non-representative population samples.

Taking an average of each study (and excluding the studies by Garrett et al (1994) and Donald et al (2008) as these were considered to not be representative of the entire population with asthma) it was estimated that **24.8% of people with asthma in Australia own a peak flow meter**.

Market research was conducted on large pharmaceutical retailers include Terry White Chemists, Chemist Warehouse, Amcal, and Pharmacy Online. Across eight products, **the average price of a peak flow meter was found to be $25.09.**

7.1.2 Spacers

Four studies were located that estimated the rate of ownership of spacers for asthma treatment. However, only two of the studies were able to be included as the other two studies had populations that were considered to not be representative of the general Australian population with asthma.

A study of patients with asthma and/or who presented to an academic emergency department in the US were surveyed on a range of factors, including whether they owned a spacer device for treating their condition. Among people with asthma (and excluding people with asthma who also had COPD), **45.1% reported that they owned a spacer** (Guss et al, 2008).

In 1997, Blue Cross and Blue Shield implemented a telephone-based asthma management program in the US (O'Connell et al, 1999). As part of the program, a nurse educates and counsels participants about asthma management and symptom management. Baseline data collected at the start of the program showed that **31.4% of enrolees owned a spacer**. This number increased to 48.6% by the end of the program. The baseline rate has been used as this is considered to be more representative of the general population with asthma, who are unlikely to have participated in a similar program.

Vella and Grech (2005) surveyed 200 paediatric patients of an outpatient clinic in Malta in order to improved inhaled therapy for treating bronchial asthma. Among the survey population, **99.0% owned a spacer**. This result was not used in the economic modelling as no estimate was available on the rate of ownership among adults.

A study by Guss and Youdim (2002) surveyed people with asthma and/or COPD who presented to an emergency department in the US due to exacerbating their condition. Among the population with asthma, **43% owned a spacer**. The results of this study were not used as the population sample is not representative of all people with asthma.

Across the two studies used, **the average rate of ownership of spacer devices was 38.3%.**

Market research was conducted on large pharmaceutical retailers include Terry White Chemists, Chemist Warehouse, Amcal, and Pharmacy Online. Across 20 products, **the average price of a spacer was found to be $17.67.**

7.1.3 Nebulisers

The use of home nebulisers has decreased in recent years. In addition, nebuliser use appears to be concentrated among children with asthma, and no recent studies were located.

As such, the **majority of literature located for this report concerns the rate of nebuliser ownership among children with asthma. Among this population, the estimated rate of ownership varies widely**, from 18.3% in Hilliard et al (2000) – though the authors of this study note that this is a "surprisingly high proportion" (p. 1,104) – through to 84% (Dawson et al, 1992).

Butz et al (2000) conducted a survey of inner-city children with asthma in Chicago to assess nebuliser ownership, frequency of use, describe patterns of morbidity and patterns of medication administration, and assess the impact of nebuliser usage across a range of clinical outcomes. **Among this population, 45.5% owned a nebuliser**.

A study of children admitted to hospital with acute asthma in New South Wales found that the rate of nebuliser ownership among all the children was 71.0%. However, among children who had previously had recognisable asthma symptoms (and thus had been diagnosed with asthma), **the rate of ownership was 84.0%** (Dawson et al, 1992).

Henry et al (1995) assessed the impact of parental asthma knowledge on the rate of hospital readmission of children with asthma in Newcastle, Australia. As part of this study, data on the rate of home ownership of nebulisers among these families was collected. Among children admitted to hospital for the first time due asthma exacerbations, **the rate of ownership of nebulisers was 66.4%**.

Hilliard et al (2000) collected data on 1,352 children in the United Kingdom who were admitted to hospital as a result of acute asthma. The study found that **18.3% of these children had a home nebuliser**. However, only 34.6% of these nebulisers were supplied by the child's parents, with 35.5% supplied by the child's GP, 19.3% supplied by a hospital, and 10.5% supplied from other sources.

Two Australian studies were located which estimated the rate of nebuliser ownership among the general population with asthma. Data from the SSAHOS was used to report on the rate of nebuliser ownership among people with asthma in South Australia. In 1992, 21.0% of people with asthma owned a nebuliser (Adams et al, 1997) and this had fallen slightly to approximately 19.0% in 1996 (Ruffin et al, 2001).

Advice from the expert stakeholder consulted during the development of this report (see Appendix A) was that the rate of nebuliser ownership in Australia has decreased in recent years. As no recent estimates of ownership in Australia were located, the estimates from the SSAHOS data were combined with findings from the AIHW on the decreased usage of short-acting bronchodilators that were supplied by medical wholesalers in nebulised form (AIHW, 2008). **Changes in the production of the nebulised form of these drugs were assumed to be a proxy for the overall usage of nebulisers in Australia**.

Between 1996 and 2000, the proportion of short-acting bronchodilators in nebulised form was approximately one quarter of the supply of all short-acting bronchodilators. However by 2006 this proportion had decreased to 15% (AIHW, 2008). Applying this trend to 2015, Deloitte Access Economics calculated that this proportion would have fallen to 6.8% in 2015.

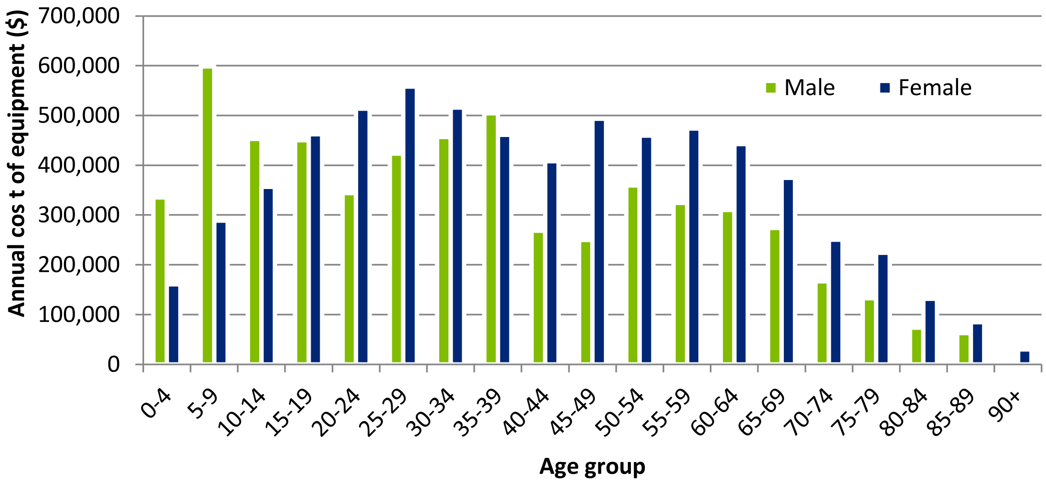
A decrease from 25% in 1996 to 6.8% in 2015 is equivalent to a 72.7% reduction in nebuliser ownership over this period, which is applied to the ownership rate of 19.0% from Ruffin et al (2001) to give an **estimated rate of nebuliser ownership among all people with asthma in 2015 of 5.2%**.

Market research was conducted on large pharmaceutical retailers include Terry White Chemists, Amcal, and Pharmacy Online (no nebulisers where supplied by Chemists Warehouse). Across 18 products, **the average price of a nebuliser was found to be $203.33.** Please note that the cost of medication that is used with the nebuliser is assumed to have been captured in the health system costs in Section 5.2.

7.1.4 Summary of equipment costs

Using the results of the analysis in the preceding sections, the estimated cost of asthma equipment in 2015 is $12.5 million. **Across all people with asthma, this is an annual cost of $5.25**. The age-gender breakdown of the total annual cost is shown in Chart 7.1.

Chart 7.1: Annual equipment costs (2015)



Source: Deloitte Access Economics.

7.2 Use of formal care, accommodation and travel costs

This section presents an overview of the available literature that was used to assess the formal care, accommodation and travel costs, and presents the results of the economic modelling.

7.2.1 Literature overview

The costs associated with formal care, accommodation and travel, are important for people with asthma. **Formal care involves additional assistance that is provided to supplement informal care that is already provided by family and friends. The additional assistance can include help with childcare, housekeeping, gardening, shopping and private nursing** that is not covered by private health insurance or the government. These costs are out-of-pocket expenses borne by the individual and their family.

Travel and accommodation costs are incurred as people with asthma travel to attend appointments or obtain medications. These costs can involve nights away from home.

Depending on the level of disability, a carer may also need to accompany the person. Examples of travel costs incurred may include petrol, maintenance, accommodation, meal costs and luggage costs.

One study was located that provided separate estimates of formal care and travel costs associated with asthma, one study that estimated travel costs only, and one study that that estimated travel and formal care costs together. No studies were located that estimated accommodation costs, and as such these costs were not estimated.

Cisternas et al (2003) used cross-sectional survey data of 401 adults with asthma in California to estimate the direct and indirect costs of asthma. Among the direct costs, the study estimated that transportation for medical care was $17 per person per year (in US Dollars (USD)), and that housekeeping assistance and help with household chores as result of the asthma was USD $305 per person per year**.** In total, these costs equal USD $322 per year, in 1998 dollars. Inflated to 2015 using historical US CPI data (Bureau of Labor Statistics, 2015), and converted to Australian dollars (AUD) using OECD purchasing power parity (PPP) data for private consumption[17], **the estimated per person costs of formal care and travel are AUD $687.59 and AUD $38.32, respectively**.

Lee et al (2011) conducted an economic evaluation of the burden of asthma in South Korea, by using the Korean National Health Insurance claims database to estimate the healthcare services provided to asthma patients in South Korea. As a proportion of total costs, transportation costs associated with asthma were estimated to be 2.4%, which was equivalent to USD $8.62 per person with asthma per year, which in 2015 is equivalent to **AUD $14.72 per person per year**. The transportation costs were based on a one-way trip with one caregiver for both inpatient and outpatient visits. However, this study did not include estimates of formal care.

Kim et al (2011) estimated the cost of direct non-medical care to be USD $302.80 per person per year in South Korea. The study defined direct non-medical costs to include expenditure on medical-related services such as transport to the hospital and private nursing personnel, with the direct costs of asthma including formal medical, informal medical and non-medical costs. As with the previous study, these amounts were converted to 2015 AUD, and the estimated cost of transport and formal care is AUD $518.07 per person. The average per person cost of travel from Cisternas et al (2003) and Lee et al (2011) were subtracted from this figure to provide an estimate of formal care costs only. **This resulted in a per person cost of formal care of AUD $547.87.**

A longitudinal study of people with asthma in New South Wales (Kenny et al, 2005) found that 0.4% of people with asthma had accessed home care, and 0.4% had accessed home nursing services in the past year. The mean number of home care services accessed by these people was 24.0, while for home nursing it was 4.0. **No estimate was provided in the study of the cost of these services**.

Ungar et al (1998) assessed the annual cost of asthma per adult in south central Ontario across 945 patients with asthma. Of the people surveyed, 15.3% of people with asthma

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[17] Purchasing power parity is used (instead of exchange rates) as it reflects difference in real costs between countries, rather than differences in nominal costs. OECD data is available at http://stats.oecd.org/Index.aspx?datasetcode=SNA_TABLE4.

incurred transportation costs as a result of receiving medical treatment for asthma. Of these people, the average number of trips each year was 4.8, with an average cost per trip of between $0.25 and $32.0 (Canadian dollars). However, **the final estimate of transport costs was not provided in the study**.

Taking an average of the results from Cisternas et al (2003), Lee et al (2011) and Kim et al (2011), it was estimated that **the per person costs of formal care and travel were $617.73 and $26.51, respectively, in 2015.**

> It is important to note that these three studies were undertaken overseas. In Australia, the Home and Community Care (HACC) program (discussed further in Section 7.3.1) provides government-funded services to people aged over 65[18] that can include nursing and allied health care, personal care, meals, household assistance, transport, day centres and respite care (Jorm et al, 2010). These services align with the definition of formal care that is provided at the start of this section. For people aged under 65, the Home Care Packages Program (HCPP) provides a similar range of services (this is covered in Section 7.3.1).

The results of Kenny et al (2005), which was conducted in Australia, suggest that 0.4% of people with asthma purchased formal care services. These purchased services are assumed to be outside of any government-funded services that they receive, such as HACC or HCPP.

As such, the cost estimates for formal care are assumed to apply to 0.4% of adults with asthma. The remaining 99.6% of adults with asthma are assumed to be accessing any necessary services from within HACC or HCPP funding. So as to not double count costs, these costs are included in Section 7.3.1.

No Australian estimate of the percentage of people with asthma who purchase transport was located. As most people with asthma would need to make several trips to the doctor and pharmacy each year to manage and treat their condition, it is conceivable that the estimated per year cost of $26.51 could readily be incurred during these trips. Thus, it is assumed that this estimate applies to all people with asthma.

7.2.2 Summary of formal care and travel costs

Many people with asthma are older and already receive help in an aged care residential setting and thus do not pay for equipment, formal care, accommodation, and travel costs. Therefore, to estimate the proportion of people incurring these types of costs by age and gender (and to avoid double counting with health system costs) the proportion of people receiving care in an aged care residential setting must be excluded.

The proportion of people likely to be receiving care in an aged care residential setting is estimated based on the age-gender distribution of the proportion of people with asthma who are living in accommodation for the retired or aged from the 2012 SDAC. The remaining adults with asthma not in an aged care residential setting incur the estimated

[18] Please note that HACC is not age limited in Victoria and Western Australia.

costs of formal care and travel. Travel costs are assumed to apply to all people with asthma (noting that the parents of children with asthma are likely to bear the cost of travel).

Overall, the total costs of formal care and travel that resulted from asthma in 2015 are estimated to be $67.9 million.

7.3 Government programs

Government assistance programs relating to asthma include home assistance programs, the National Carer Respite Program, the Asthma Management Program, and other programs. These are discussed in the following sections.

7.3.1 Home assistance programs

There are government programs that provide assistance to frail older people and to people with a disability, aimed at allowing them to stay in their homes longer and preventing premature admissions to residential aged care. The two main programs are the HACC and HCPP. According to the Steering Committee for the Review of Government Service Provision (2015), funding for these programs was $2.06 billion and $1.27 billion in 2014 respectively. Adjusted to 2015, these amounts are $2.09 billion and $1.29 billion.

A study by Jorm et al (2010) surveyed 4,978 New South Wales residents aged 45 years and over who had accessed HACC services in the past month. The 4,978 HACC users reported a total of 7,618 chronic health conditions[19] that had been treated within the past month, which indicates that each HACC user has on average 1.53[20] chronic health conditions. Of the 4,978 users, 450 users reported they had been treated for asthma. Thus, based on 9.0%[21] of HACC users being treated for asthma, and each of these users having an additional 0.53 conditions on average, **the attributable cost of the HACC due to asthma is $123.4 million in 2015.** As the HACC is largely used by people aged 65 and over, these costs are applied to people with asthma aged 65 and over.

No data was located that provided an estimate of the proportion of HCPP users who had asthma. As a result, asthma-related costs associated with this program were excluded.

7.3.2 National Respite for Carers Program

Respite for carers of people with asthma is often required when:

- the carer is undergoing hospital in-patient treatment;
- the burden of caring psychologically overwhelms the carer or person with asthma;
- home modifications are being undertaken; and/or
- the carer needs time to shop, socialise, or undertake recreational activities as a break from the burden of caring.

[19] The conditions included depression/anxiety, cancer, asthma, blood clot, heart attack/angina, osteoarthritis, osteoporosis, other heart disease, thyroid problems, high blood pressure, and high cholesterol.

[20] 7,618/4,978 = 1.53.

[21] 450 / 4,978 = 9.0%.

The National Respite for Carers Program (NRCP) enhances the quality of life for older people, people with disabilities, and their carers. The NRCP provides services for at-home carers of people who are unable to look after themselves due to frailty, disability, or chronic illness. There are four components of the NRCP (DSS[22], 2014a):

- Commonwealth Respite and Carelink Centres, which provide information, support and assistance to carers to arrange respite services in the short term;
- Respite Services, which provide ongoing and planned respite for carers and care recipients;
- National Carer Counselling Programme, which provides counselling, emotional and psychological support services to carers; and
- Carer Information Support Service, which provides information and support to carers surrounding the community care system.

Funding for the NRCP was $212.3 million in 2013-14, which adjusted to 2015 using CPI is $215.5 million (Steering Committee for the Review of Government Service Provision, 2015). According to the 2012 SDAC, there were a total of 749,016 primary carers in Australia, of which 5,222 were carers of people with asthma (0.7%). The survey also reported that the rate of accessing respite in the last three months for carers. A total of 23,350 primary carers accessed respite in the last three months, including all of the primary carers of people with asthma (5,222 carers). Applying this proportion to the total NRCP expenditure in 2015, **the expenditure on respite for carers of people with asthma is $47.8 million**.

Please note that the analysis in this section was restricted to primary carers of people with asthma who were recorded in the SDAC. As discussed in Section 6.4, this may not include all people who were carer of a person with asthma. However, the average number of hours of care provided by the primary carers in the SDAC was 18.9 hours per week, while the average number of hours of care provided by all carers of a person with asthma was assumed to be 0.3 hours per week. It is likely that carers who provided this smaller amount of hours of care would not access carer respite programs.

7.3.3 Other programs

The Federal Government provides funding for a number of additional asthma-related programs. Data was obtained from the Department of Health (DOH) in relation to:

- Asthma Best Practice for Professionals: this provides funding for the NAC to provide best-practice asthma and linked chronic respiratory conditions, including training in the performance and interpretation of spirometry to primary care health practitioners such as practice nurses, pharmacists and Aboriginal and Torres Strait Islander health workers.
- Asthma Child and Adolescent Program: this provides funding for AA to deliver asthma information and emergency training for staff in preschools and schools and support self-management for adolescents through state and territory Asthma Foundations.
- Community Support Program: this provides funding for AA to deliver community training education workshops and information online through state and territory Asthma Foundations. The program focuses on prevention and social inclusion,

[22] Department of Social Services

targeting older Australians, people of culturally and linguistically diverse backgrounds, Aboriginal and Torres Strait Islanders and people in rural and remote communities.

- Practice Incentives Program (PIP) Asthma Incentive: encourages GPs to better manage the clinical care of people with moderate to severe asthma.

In total, the estimated funding for these programs in 2015 is $6.6 million.

Please note that the funding associated with asthma surveillance conducted under the Health Surveillance Fund was not included, as it is not possible to separate the funding for asthma monitoring from the funding for monitoring of other chronic respiratory conditions.

7.4 Research programs

The research that is conducted into asthma is already captured as a non-allocated expense in the health system costs outlined in Section 5. As such, the costs presented in this section do not represent additional costs, and are presented here to provide insight into the research costs of asthma. Research has been divided into government and non-government research programs. Please note that this is not intended to capture all research that is conducted into asthma in Australia, such as that undertaken by pharmaceutical organisations. However, this data is commercial-in-confidence, and so was not included in this report. Research undertaken by pharmaceutical organisations is captured in the health system expenditure in Section 5.

7.4.1 Government research programs

The Australian Government has provided funding for asthma research through:

- The Australia Research Council: $2.1 million in 2015[23] (ARC, 2015); and
- The National Health and Medical Research Council: $18.7 million in 2014, which is estimated to be $19.0 million in 2015 when adjusted using CPI[24].

Thus, it is estimated that the cost of government-funded asthma research in 2015 is $21.1 million in 2015.

7.4.2 Non-government research programs

The two sources of non-government research into asthma that were included in this report are:

- AA: $401,303 in 2013-14 (AA, 2014), which adjusted to 2015 is $407,323;
- The NAC is responsible for the development and dissemination of the Australian Asthma Handbook (the national treatment guidelines for asthma), which the NAC funds at an annual cost of $180,000; and

[23] This figure was derived through an analysis of new and ongoing grants provided under the National Competitive Grants Program for asthma-related research (Projects FT110100372, FT130100166 and FT130100518).

[24] Data was provided by the DOH.

- The Thoracic Society of Australia and New Zealand awards various research grants for asthma each year, which total $75,400[25].

Based on these figures, **it is estimated that the cost of non-government funded asthma research in 2015 is $662,723**.

7.5 Funeral expenses

The 'additional' cost of funerals borne by family and friends of people with asthma is based on the number of deaths due to asthma. However, some people with asthma would have died during this time anyway, and eventually everyone must die, and thus incur funeral expenses – so the true cost is the cost brought forward (adjusted for the likelihood of dying anyway). The Bureau of Transport Economics (2000) calculated a weighted average cost of a funeral across all States and Territories, to estimate an Australian total average cost of $3,200 per person for 1996, or $5,166 per person in 2015. **The discounted value of funeral costs associated with premature deaths is $0.6 million, or $1,434 per death due to asthma**.

7.6 Other financial costs summary

Overall, the total other financial costs for people with asthma are estimated to be $246.4 million in 2015. A breakdown of these costs is provided in Table 7.2.

Table 7.2: Other financial costs of asthma (2015)

Component	Cost ($million)
Formal care and travel	67.9
Home assistance	123.4
Carer respite	47.8
Other government programs	6.6
Funeral expenses	0.6
Total	**246.4**

Source: Deloitte Access Economics calculations.

These costs are borne entirely by governments (72.2%) and individuals (27.64%), with family representing 0.2%.

[25] This is based on unpublished data provided to Deloitte Access Economics for this report.

8 Transfers

Transfer payments represent a shift of resources from one economic entity to another, such as raising taxes from the entire population to provide welfare payments to people with asthma. The act of taxation and redistribution creates distortions and inefficiencies in the economy, so transfers also involve real net costs to the economy, known as deadweight losses (DWLs).

Transfer costs are important when adopting a whole-of-government approach to policy formulation and budgeting. Transfer costs also allow us to examine the distribution of the costs of asthma across different parts of society.

Key findings:

- Around $778.8 million in welfare payments will be paid to people with asthma and the carers of people with asthma in 2015.
- Government lost $404.6 million in tax revenue as a result of asthma's negative impact on employee productivity, and the amount of hours of informal care that will be provided to people with asthma.
- The DWL associated with health system costs borne by government, lost taxes, welfare payments and other costs borne by government is estimated to be $635.9 million in 2015.

8.1 Income support for people with asthma

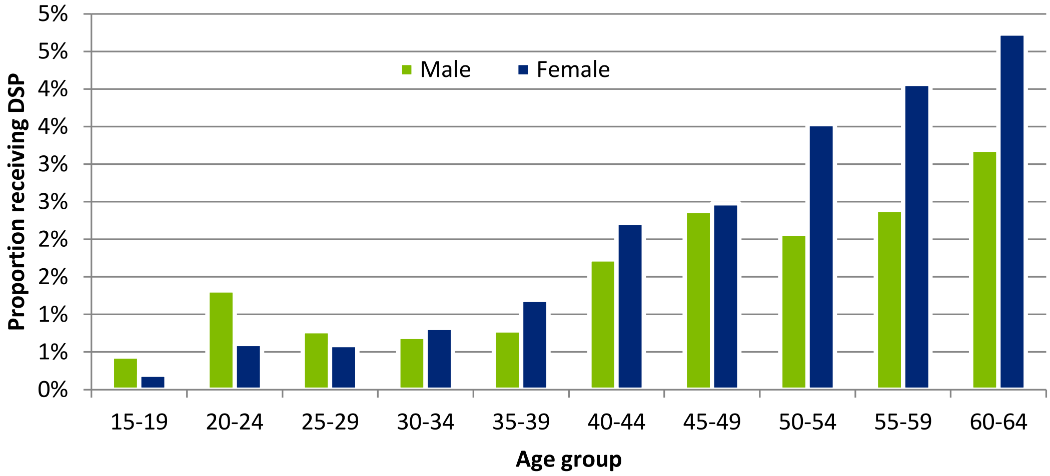
The main source of income support for people with asthma is the Disability Support Pension (DSP), which is payable to people aged less than 65 years. People aged 65 years and above are eligible for the age pension, however, following Deloitte Access Economics' standard methodology this section will focus only on people aged less than 65 who are receiving the DSP.

DSP is an income support payment for people who are unable to work for 15 hours or more per week at or above the relevant minimum wage, independent of a Program of Support, due to permanent physical, intellectual or psychiatric impairment. A DSP claimant must be aged 16 years or over and under Age Pension age at date of claim, however once in receipt of DSP, a person can continue to receive DSP beyond Age Pension age.

A special data request was submitted to the DSS to obtain information on the number of people who received the DSP as a result of their asthma[26]. Across all people with asthma aged 15-64, 1.7% received the DSP, with this amount slightly lower for males (1.4%) and slightly higher for females (2.0%). The age gender breakdown of these figures is shown in Chart 8.1.

[26] Data for population groups with less than 20 people were suppressed. For these groups, it was assumed that the number of recipients in these groups was equal to 10. DSS has advised that the DSP data refers to DSP recipients who have asthma, rather than DSP recipients who receive the DSP as a direct result of their asthma. Data are not available to identify whether asthma is the primary condition of these recipients.

Chart 8.1: People with asthma receiving the DSP (2015)



Source: Deloitte Access Economics calculations using DSS data.

As shown in Chart 8.1, the percentage of people with asthma who receive the DSP increases by age. From age 50, the percentage of females with asthma who receive the DSP is significantly higher than the percentage of males with asthma who receive the DSP.

According to the DSS annual report, as of June 2014, there were 830,454 people in Australia who were listed to have received the DSP, at a total cost of $16.11 billion over 2013-14, or $19,387 per person (DSS, 2014). This amount was adjusted to 2015 using CPI, which results in a per person cost of $19,678. Using this estimate**, approximately $563.3 million will be paid in DSP payments to people with asthma in 2015**.

However**, some of these people would have received DSP payments even in the absence of asthma**, which must be netted out to estimate the *additional* welfare payments due to asthma. A University of Melbourne study (Tseng and Wilkins, 2002) estimates that the ‘reliance’ of the general population (aged 15-64 years) on income support is 10.2% for males and 14.9% for females. Weighting these results by the number of males and females with asthma who accessed the DSP in 2015, the weighted average is 13.2% (see Table 8.1).

Table 8.1: Recipiency rates by payment type for DSP

	Males (%)	Females (%)	Weighted average (%)
Other pensions (includes DSP)	10.2	14.9	13.2

Source: Tseng and Wilkins (2002); Deloitte Access Economics calculations.

Thus, **approximately $488.7 million in additional DSP payments will be paid to people of working age with asthma in 2015, which is approximately $302 per person.**

8.2 Sickness allowance

Sickness Allowance (SKA) is a payment made to people who are temporarily unfit, due to illness or injury, to perform their usual work or study, and have a job to return to or intend to resume studying when fit to do so. Data includes recipients who are determined to be current (that is, entitled to be paid) on the Centrelink payment system and not in receipt of a zero rate of payment.

A small number of people with asthma (20 males and 32 females) were receiving the SKA due to their asthma as at March 2015[27]. The assumed fortnightly payment for people with asthma receiving the SKA is $528, which is calculated as the average of each of the rates of SKA published by the Department of Human Services (DHS, 2015). **Using these estimates, approximately $0.7 million will be paid in SKA payments to people with asthma in 2015**.

However, some of these people would have received SKA payments even in the absence of asthma, which must be netted out to estimate the *additional* welfare payments due to asthma. Using the Tseng and Wilkins study as per the calculations in Section Table 8.1, the weighted average of reliance on the SKA by the general population is 2.8%.

Table 8.2: Recipiency rates by payment type for SKA

	Males (%)	Females (%)	Weighted average (%)
Other allowances (includes SKA)	2.7	2.9	2.8

Source: Tseng and Wilkins (2002); Deloitte Access Economics calculations.

Thus, **approximately $0.7 million in additional SKA payments will be paid to people of working age with asthma in 2015, which is approximately $0.43 per person.**

8.3 Income support for carers of people with asthma

There are two main income support measures available to primary carers:

- **Carer Payment** is a means-tested income support payment payable to people who cannot work full time because they provide home-based care to an adult or child who has a severe and long-term disability or health condition, or the equivalent amount of care to a number of less disabled people[28].
- **Carer Allowance** is a non-means tested income supplement for people who provide daily care to an adult or child with a severe and long-term disability or health condition.

Information on income support for carers of people with asthma was specially requested from the DSS. Data is based on recipients caring for a person with asthma as the primary medical condition. The average weekly payment and the number of recipients were recorded as at 31 March 2015, and are reproduced in Table 8.3.

[27] DSS has advised that the SKA data refers to SKA recipients who have asthma, rather than SKA recipients who receive the SKA as a direct result of their asthma. Data are not available to identify whether asthma is the primary condition of these recipients.

[28] The person with asthma must also be in receipt of an income support payment.

Table 8.3: Income support for carers of people with asthma (2015)

Payment type	Average weekly payment ($)	Number of recipients	Annual cost ($m)
Carer Payment	347.77	11,429	206.7
Carer Allowance	60.85	26,128	82.7
Total			**289.4**

Source: DHS administrative data; Deloitte Access Economics calculations.
Note: DSS has advised that the Carer Payment and Carer Allowance data refers to Carer Payment and Carer Allowance recipients who care for someone who has asthma, rather than Carer Payment and Carer Allowance recipients who provide care as a direct result of the care recipient's asthma. Data is not available to identify whether asthma is the primary condition of the people who are cared for.

As shown in Table 8.3, **income for support for carers of people with asthma is estimated to be $289.4 million in 2015.**

The most recently available data on the number of carers who access income support show that 243,856 people accessed the Carer Payment, and 590,181 people accessed the Carer Allowance, in 2013. Based on these results, carers of people with asthma represent approximately 5% of Carer Payment recipients, and 4% of Carer Allowance recipients. Carers of people with asthma also received the same proportions (5% and 4%) of total outlays on carer support payments (DHS, 2014).

8.4 Taxation revenue

People with asthma and their carers in paid employment, who have left the workforce temporarily due to caring responsibilities, or permanently due to premature retirement or death, will contribute less tax revenue to the government.

- People with asthma lost $309.8 million in wage income due to absenteeism and premature death;
- Carers lost $113.6 million in wage income due to caring for a person with asthma; and
- Employers lost $196.1 million in productivity on account of absenteeism of the person with asthma, lost management productivity in managing the absenteeism, and direct worker hiring and retraining costs.

Consistent with Deloitte Access Economics' standard methodology, in terms of allocating these losses to either personal income or company income, only the employer losses were included as lost company revenue, with the remainder allocated as lost personal income in one form or another. The average personal income tax rate is 22.8% and the average indirect tax rate is 13.0%, based on the Deloitte Access Economics Macroeconomic model. Furthermore the vast majority of company income is distributed to domestic shareholders (as franked dividends) and thus the income is charged at the relevant personal tax rate.

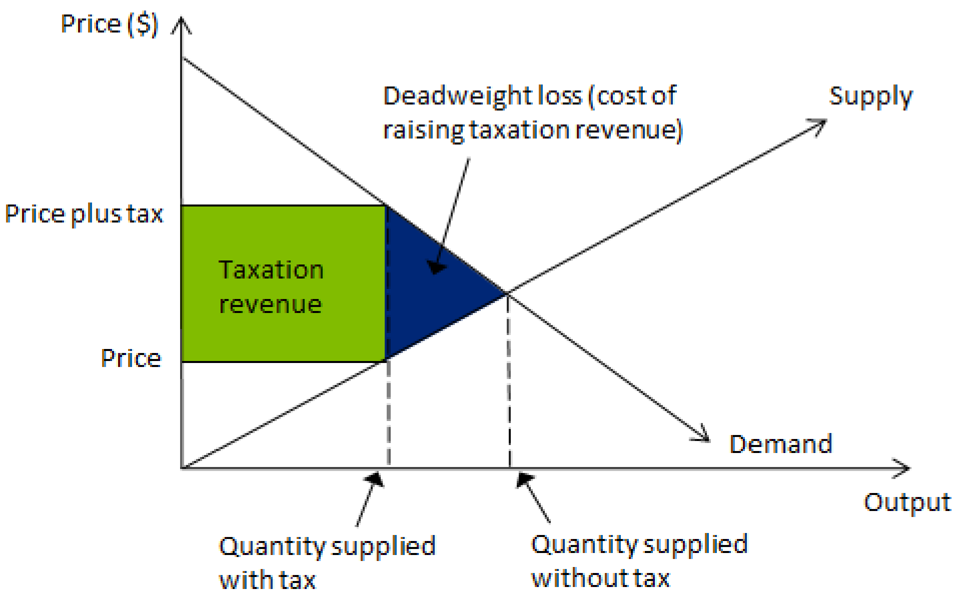
Together these calculations generate a total loss of tax revenue of $404.6 million. This represents taxation lost that must be collected from remaining citizens (given no change in expenditure – that is, small tax changes are unlikely to change the level of demand for expenditure).

8.5 Deadweight loss of taxation payments and administration

Transfer payments (government payments and taxes) are not a net cost to society, as they represent a shift of consumption power from one group of individuals to another in society. If the act of taxation did not create distortions and inefficiencies in the economy, then transfers could be made without a net cost to society. However, through these distortions taxation does impose a DWL on the economy.

DWL is the loss of consumer and producer surplus, as a result of the imposition of a distortion to the equilibrium (society preferred) level of output and prices (Figure 8.1). Taxes alter the price and quantity of goods sold compared to what they would be if the market were not distorted, and thus lead to some diminution in the value of trade between buyers and sellers that would otherwise be enjoyed. The principal mechanism by which a DWL occurs is the price induced reduction in output, removing potential trades that would benefit both buyers and sellers. In a practical sense, this distortion reveals itself as a loss of efficiency in the economy, which means that raising $100 dollars of revenue, requires consumers and producers to give up more than $100 of value.

Figure 8.1: Deadweight loss of taxation



Source: Deloitte Access Economics.

In line with Deloitte Access Economics' standard methodology, **the rate of DWL used in this report is 27.5 cents per $1 of tax revenue raised, plus 1.25 cents per $1 of tax revenue raised for Australian Taxation Office administration** (Productivity Commission, 2003). The DWL rate is applied to:

- lost tax revenue from foregone earnings of people with asthma, their carers and employers (which must be raised from another source);

- welfare payments made to people with asthma and their carers; and
- government services provided (for example, the public health system, grants and programs), since in a budget neutral setting government expenditures require taxation to be raised and thus also have associated distortionary impacts.

8.6 Transfer costs summary

Using the rate of DWL (28.75%), the expected total DWL associated with asthma is estimated to be $635.9 million in 2015. This is summarised in Table 8.4.

Table 8.4: Components of deadweight loss (2015)

	2015 ($million)
Health system costs borne by government	850.7
Lost taxes	404.6
Welfare payments	778.8
Other costs borne by government*	177.9
Total transfers	2,211.9
Resulting deadweight loss	**635.9**

Source: Deloitte Access Economics calculations.
Note: * these include the cost of government programs. Numbers may not add due to rounding

9 Burden of disease costs

This chapter adopts the 'burden of disease' methodology in order to quantify the impact of asthma on wellbeing. The approach is non-financial, where pain, suffering and premature mortality are measured in terms of disability-adjusted life years (DALYs).

Key findings:

- The total DALYs arising from asthma in 2015 are 133,555, comprising 128,463 YLDs and 5,092 YLLS.
- The associated economic burden totals $24.7 billion in 2015.

9.1 Valuing life and health

The burden of disease as measured in DALYs can be converted into a dollar figure using an estimate of the **value of a 'statistical' life** (VSL). As the name suggests, the VSL is an estimate of the value society places on an anonymous life. Since Schelling's (1968) discussion of the economics of life saving, the economic literature has focused on **willingness to pay** (WTP) – or, conversely, willingness to accept – measures of mortality and morbidity, in order to develop estimates of the VSL.

Estimates may be derived from observing people's choices in situations where they rank or trade off various states of wellbeing (loss or gain) either against each other or for dollar amounts, for example stated choice models of people's WTP for interventions that enhance health or willingness to accept poorer health outcomes or the risk of such states. Alternatively, risk studies use evidence of market trade-offs between risk and money, including numerous labour market and other studies (such as installing smoke detectors, wearing seatbelts or bike helmets, and so on).

The extensive literature in this field mostly uses econometric analysis to value mortality risk and the 'hedonic wage' by estimating compensating differentials for on-the-job risk exposure in labour markets; in other words, determining what dollar amount would be accepted by an individual to induce him/her to increase the probability of death or morbidity by a particular percentage.

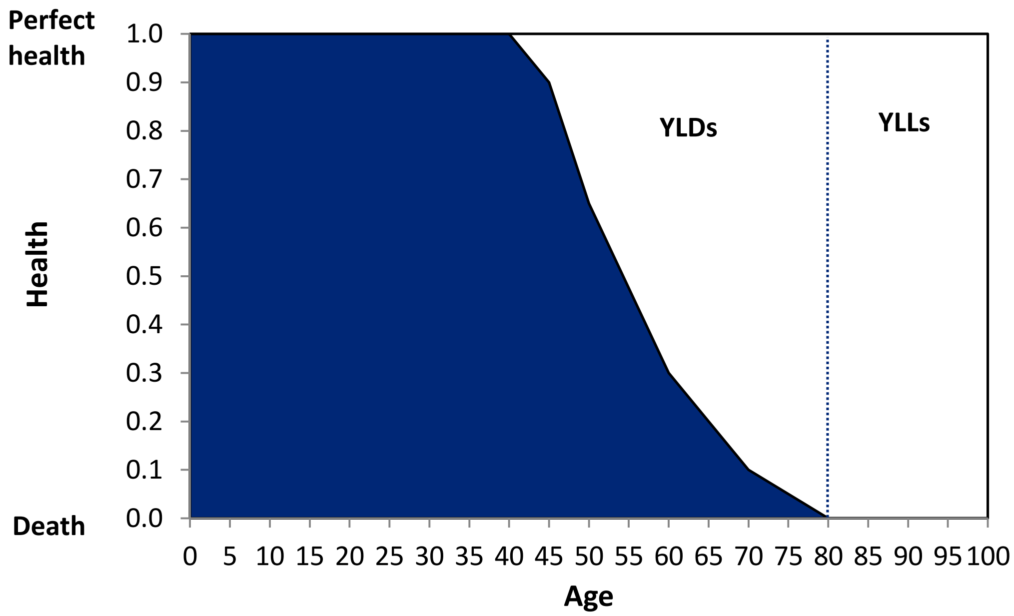
In an attempt to overcome some of the issues in relation to placing a dollar value on a human life, a non-financial approach to valuing human life is used. Pain, suffering and premature mortality are measured in terms of DALYs, with 0 representing a year of perfect health and 1 representing death – this is represented by the white shaded areas in Figure 9.1. This approach was developed by the World Health Organization, the World Bank and Harvard University (Murray and Lopez, 1996). Methods and data sources are detailed further in Murray et al (2001).

The DALY approach has been adopted and applied in Australia by the AIHW. Mathers et al (1999) included separate identification of the premature mortality (years of life lost due to premature death – YLL) and morbidity (years of healthy life lost due to disability – YLD) components:

DALYs = YLLs + YLDs

In any year, the disability weight of a disease (for example, 0.18 for a broken wrist) reflects a relative health state. In this example, 0.18 would represent losing 18% of a year of healthy life because of the inflicted injury.

Figure 9.1: Graphical representation of disability-adjusted life years



Source: Deloitte Access Economics.
Note: YLLs = years of life lost due to premature death, YLDs = years of healthy life lost due to disability.

The DALY approach has been successful in avoiding the subjectivity of individual valuation and is capable of overcoming the problem of comparability between individuals and between nations, although nations have subsequently adopted variations in weighting systems. For example, in some countries DALYs are age-weighted for older people although in Australia the minority approach is adopted – valuing a DALY equally for people of all ages.

As DALYs are enumerated in years of life rather than in whole lives it is necessary to calculate the **value of a 'statistical' life year (VSLY)** based on the VSL. This is done using the formula:[29]

$$VSLY = \frac{VSL}{\Sigma_{i=0,\ldots,n-1}(1+\ +r)^{i}}$$

Where:
n = years of remaining life, and
r = discount rate

The Department of Prime Minister and Cabinet (2014) provided an estimate of the 'net' VSLY (that is, subtracting financial costs borne by individuals). This estimate was $151,000 in 2007, which inflates to around **$184,730 in 2015 dollars for the VSLY**.

9.2 Estimating the burden of disease from asthma

A critical parameter in estimating the burden of disease from asthma is the disability weight. In Australia, the current disability weight for asthma comes from the AIHW (Begg et al, 2007), who arrived at a disability weight of 0.054[30] by assuming that people with asthma in Australia are symptomatic only 12% of the time, and not symptomatic the remaining 88% of the time, based on the results of Bauman et al (1998). The symptomatic disability weight was estimated to be 0.229, based on the severity distribution in the ABS' 1998 SDAC and the results of a disability weight regression model. The non-symptomatic disability weight of 0.03 was obtained from Stouthard et al (1997), which is a Dutch burden of disease study that is relied on by the WHO.

The YLLs are based on the number of deaths from asthma (see Section 3.4), and the years of remaining expected life at the age of death are based on the Standard Life Expectancy Table (West Level 26). A discount rate of 3% has been applied to the calculations, and no age weighting has been applied.

In total, asthma resulted in 133,555 DALYs (61,673 for males, and 71,882 for females), which included 5,092 YLLs and 128,463 YLDs. **The associated loss in quality of life has thus been estimated to be $24.6 billion**. The age-gender breakdown of these figures are provided in Table 9.1.

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[29] The formula is derived from the definition:
VSL = ΣVSLYi/(1+r)^{i} where i = 0,1,2 …. n
where VSLY is assumed to be constant (that is, no variation with age).

[30] The AIHW has been funded to update burden of disease estimates for Australia and for the Aboriginal and Torres Strait Islander population, with results expected to be published in early 2016. The study is building on methodological developments in recent global burden of disease studies, which will be tailored to the Australian context. This will potentially include a revision to the disability weight(s) that is/are used for asthma. At this stage, the AIHW is planning to use disability weights from the 2013 Global Burden of Disease study, which was published in Vos et al (2015).

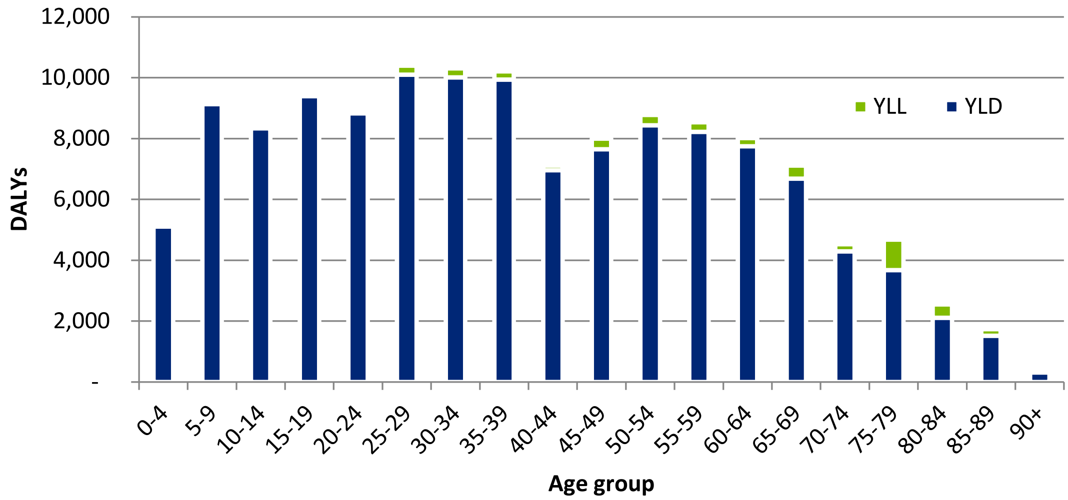
Table 9.1: YLDs, YLLs, DALYs and value by age and gender (2015)

	YLDs		YLLs		DALYs		Value ($m)	
	Male	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*
0-4	3,453.8	1,655.8	47.6	16.8	3,501.3	1,672.6	646.8	309.0
5-9	6,162.2	2,969.9	83.5	29.7	6,245.7	2,999.5	1,153.8	554.1
10-14	4,664.5	3,671.5	61.9	36.0	4,726.4	3,707.6	873.1	684.9
15-19	4,634.1	4,758.3	60.1	45.6	4,694.2	4,804.0	867.2	887.4
20-24	3,541.1	5,290.0	44.6	49.5	3,585.7	5,339.5	662.4	986.4
25-29	4,357.0	5,746.6	162.0	133.7	4,519.0	5,880.3	834.8	1,086.3
30-34	4,702.8	5,311.5	167.8	119.1	4,870.6	5,430.7	899.8	1,003.2
35-39	5,191.6	4,749.3	210.9	54.0	5,402.5	4,803.4	998.0	887.3
40-44	2,761.2	4,198.9	105.6	45.3	2,866.8	4,244.2	529.6	784.0
45-49	2,571.2	5,080.7	97.7	247.4	2,668.9	5,328.1	493.0	984.3
55-54	3,701.2	4,732.2	128.4	213.2	3,829.6	4,945.4	707.4	913.6
55-59	3,340.8	4,876.8	138.3	182.3	3,479.0	5,059.1	642.7	934.6
60-64	3,191.5	4,558.0	114.8	151.3	3,306.3	4,709.3	610.8	869.9
65-69	2,822.1	3,857.3	160.8	269.8	2,982.8	4,127.1	551.0	762.4
70-74	1,717.3	2,578.1	79.0	149.0	1,796.3	2,727.1	331.8	503.8
75-79	1,368.6	2,307.7	255.2	744.6	1,623.8	3,052.3	300.0	563.9
80-84	756.3	1,355.6	105.7	327.5	862.0	1,683.1	159.2	310.9
85-89	647.3	872.9	64.7	151.5	712.0	1,024.4	131.5	189.2
90+	-	307.0	-	37.3	-	344.2	-	63.6
Total	**59,584.5**	**68,878.1**	**2,088.5**	**3,003.8**	**61,673.0**	**71,881.9**	**11,392.9**	**13,278.7**

Source: Deloitte Access Economics calculations.

Chart 9.1 shows YLDs, YLLs and total DALYs by age group for 2015. As can be seen, in the earlier years when mortality rates are lower, YLLs are much lower than YLDs. However, in the older age groups, YLLs start to become more apparent as mortality due to asthma increases.

Chart 9.1: Burden of disease by age (2015)



Source: Deloitte Access Economics.

9.3 Comparison of results

This section compares the results in terms of YLLs, YLDs, and DALYs, with the most recent estimates of the burden of disease due to asthma in Australia. The most recent Australian-produced estimates are contained in Begg et al (2007), which estimated the burden of disease due to asthma in Australia in 2003. The most recent estimates are contained in Vos et al (2015) and are part of the 2013 Global Burden of Disease report.

9.3.1 2003 Australian Burden of Disease estimates

The headline results from the 2003 study were that asthma resulted in 63,100 DALYs in Australia, of which YLDs comprised 59,054, and YLLs comprised 4,045. At face value, the results for DALYs and YLD are significantly different to the results in Section 9.2, which estimated that DALYs and YLDs due to asthma were 133,555 and 128,463 respectively. Note that the two estimates of YLLs – 5,092 in 2015, and 4,045 in 2003, are not considered to be significantly different, and are to be expected given the growth in population, prevalence and case fatality that has occurred over this period.

The key underlying reason for the marked difference in YLD estimates (and noting that the difference in YLD estimates are the key driver of the difference in DALYs) is the methods that were used to generate each of the estimates.

The 2003 methodology differed from Deloitte Access Economics' methodology in two main ways:

- **an incident approach was used to estimate YLDs in 2003**, while a prevalence approach (prevalence years lived with disability, PYLD) was used by Deloitte Access Economics; and
- **the prevalence used in the 2003 estimation was significantly lower** than the official prevalence of asthma.

Each of these methodological differences are explored in the following paragraphs.

As discussed in Section 4.1, there are two approaches that can used for estimating economic burden. A **prevalence approach (the type used in this report) relies on estimates of the prevalence of asthma in a particular year**. These estimates are readily available from surveys of the Australian population, such as the AHS. **An incidence approach requires an estimation of the number of new cases of asthma that have occurred in a particular year**. This is typically more difficult to estimate than prevalence, as it relies on the results of academic studies that have been conducted on a selective sample of the population, and frequently requires epidemiological modelling software which can "solve" for missing variables.

The 2003 report used epidemiological software called DisMod, and applied age-specific remission rates for asthma and mortality rates due to asthma, in conjunction with estimates of the prevalence of current asthma (AIHW, 2009). The relevant parameters are contained in Bronnimann and Burrows (1986), ABS (2005), Bauman et al (1992), Peat et al (1992, 1994, 1995) and Toelle et al (2004).

The age specific remission rates for asthma were based on self-completed questionnaires administered to people with asthma in Arizona between 1972 and 1973, and then again between 1981 and 1983. From the results of these surveys, 22% of respondents were in remission by the second survey. **The AIHW (2009) notes that it is not clear how applicable these remission rates are to the Australian context**.

The resulting estimates from DisMod were that the prevalence of asthma in Australia in 2003 was 1.356 million people, which is significantly lower than the established prevalence of asthma in Australia from the 2004 AHS, which was 2.014 million people – 48.4% higher than the lower estimate. **Due to these estimates, the YLDs calculated based on prevalence would be approximately 48.4% lower than if the official prevalence rate of asthma was used**. If the prevalence estimates from the 2004 AHS had been used, then the estimated YLD would have been approximately 87,709. This is considered to be broadly comparable with Deloitte Access Economics' estimates (allowing for population growth).

9.3.2 2013 Global Burden of Disease estimates

The 2013 Global Burden of Disease (Vos et al, 2015), using a similar methodology to the 2003 study but different parameter inputs, estimates the prevalence of asthma in Australia in 2013 as 2,622,300, with a resulting 95% confidence interval of 2,505,900 to 2,736,200. This appears to be broadly in line with the prevalence estimate from the AHS. **The estimated YLDs of asthma in Australia in 2013 are 114,800, with a 95% confidence interval of 75,600 to 162,500.** The DALYs and YLLs are not calculated in the report.

The publication provides much fewer methodological details than the 2003 study, as it is calculating the disease burden across all countries in the world for 301 conditions. However, prevalence estimates were calculated using DisMod, and it appears that an updated rate of remission publication that is more relevant to the Australian context was used (Burgess et al, 2011). The disability weights used were based on whether asthma was either (Salomon et al, 2012):

- controlled: has wheezing and cough once a month, which does not cause difficulty with daily activities (disability weight 0.009);

- partially controlled: has wheezing and cough once a week, which causes some difficulty with daily activities (disability weight 0.027); or
- uncontrolled: has wheezing, cough and shortness of breath more than twice a week, which causes difficulty with daily activities and sometimes wakes the person at night (disability weight 0.132).

Overall, the results of the 2013 estimates appear to be broadly in line with Deloitte Access Economics' estimates.

10 Summary and further analysis

This section summarises the total costs of asthma, performs sensitivity analysis on these estimates, estimates the financial costs to the Australian Government, and compares the estimates to other studies.

Key findings:

- The total cost of asthma in Australia in 2015 is $27.9 billion, comprised of $3.3 billion in economic costs and $24.7 billion in burden of disease costs[31].
- The total cost of asthma in Australia in 2015 is $11,740 on a per person basis.
- Sensitivity analysis gives an upper and lower bound to these estimates of $27.95 billion and $27.89 billion, respectively.
- Asthma is projected to cost the Australian Government $4.0 billion over 2016-2019 in direct costs.

10.1 Total costs of asthma

Deloitte Access Economics has **estimated the total cost of asthma in 2015 to be $37.6 billion in 2015**. The breakdown of these costs is provided in Table 10.1.

Table 10.1: Total costs of asthma (2015)

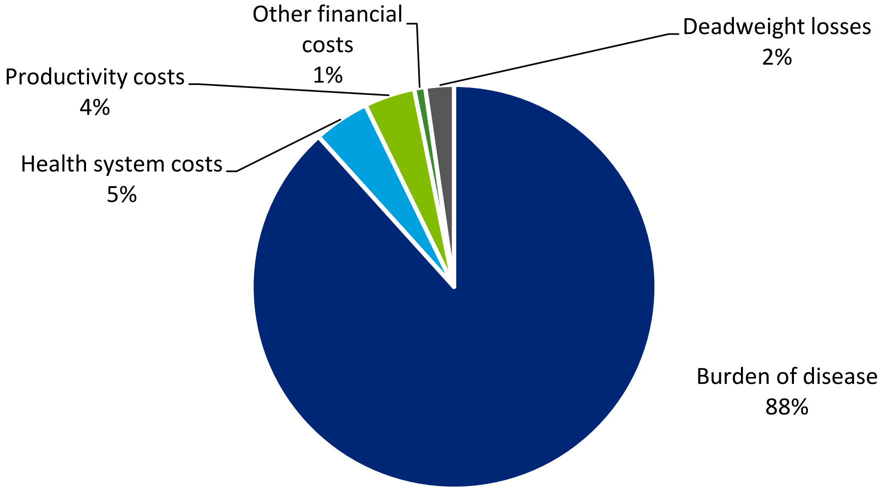
Component	Value ($m)
Health system costs	1,245.5
Productivity costs	1,130.2
Other financial costs	246.4
Deadweight losses	635.9
Total economic costs	*3,258.0*
Total burden of disease costs	*24,671.6*
Total costs	**27,929.6**

Source: Deloitte Access Economics calculations.

The relative value of these costs is shown in Chart 10.1.

[31] Numbers do not add due to rounding.

Chart 10.1: Share of total cost (2015)



Source: Deloitte Access Economics.

As shown in Chart 10.1, the burden of disease comprises the largest amount (88%), followed by health system costs (5%) and productivity costs (4%).

The age-gender breakdown of the total costs is shown in Table 10.2.

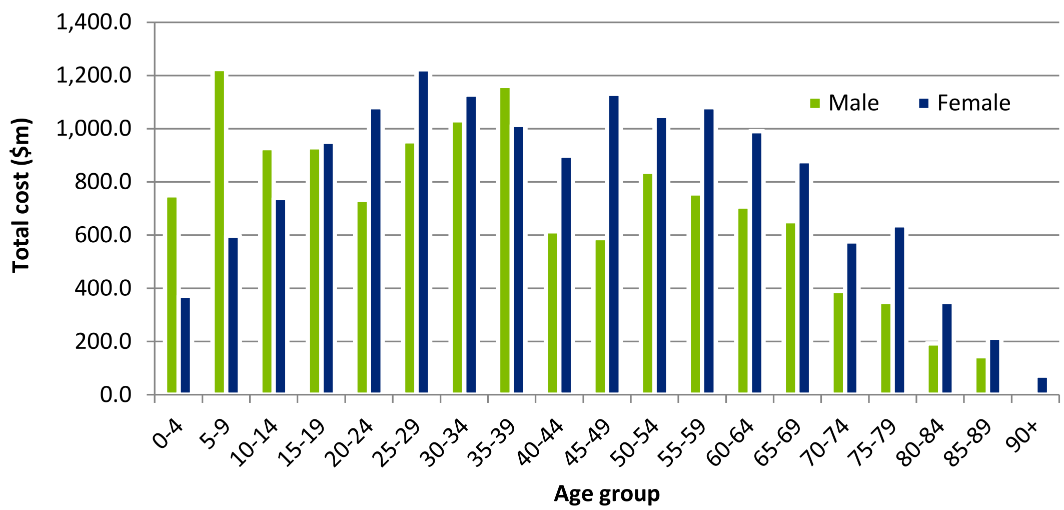
Table 10.2: Total costs of asthma by age and gender (2015)

Age	Male ('000)	Female ('000)	Total ('000)
0-4	750.0	372.2	1,122.2
5-9	1,224.2	598.4	1,822.6
10-14	926.8	739.8	1,666.6
15-19	930.3	950.5	1,880.9
20-24	732.0	1,080.7	1,812.7
25-29	952.5	1,223.8	2,176.3
30-34	1,031.4	1,127.5	2,158.9
35-39	1,161.0	1,014.4	2,175.4
40-44	614.7	898.8	1,513.5
45-49	589.3	1,131.5	1,720.7
55-54	837.8	1,048.1	1,886.0
55-59	756.9	1,081.2	1,838.1
60-64	707.3	991.1	1,698.4
65-69	652.6	878.1	1,530.6
70-74	389.6	576.3	965.9
75-79	349.4	637.2	986.5
80-84	193.4	349.4	542.9
85-89	144.6	214.3	358.9
90+	0.0	72.4	72.4
Total	**12,943.8**	**14,985.8**	**27,929.6**

Source: Deloitte Access Economics calculations.
Note: numbers may not add due to rounding.

As shown in Chart 10.2, total costs of asthma are highest in the 5-9 year old male age group. This reflects the relatively high prevalence in this age group, which drives up the burden of disease costs.

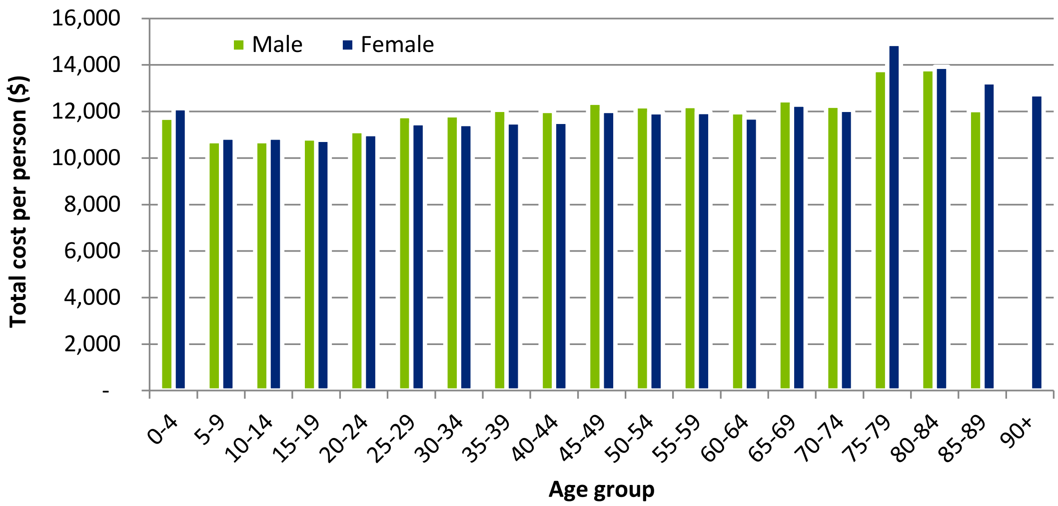
Chart 10.2: Total costs of asthma by age and gender (2015)



Source: Deloitte Access Economics.

On a per person basis, asthma is estimated to cost $11,740 in 2015 - $1,370 in economic costs, and $10,371 in burden of disease costs[32]. As shown in Chart 10.3, there is a relatively small amount of variation in per person costs by age and gender. The higher costs among working age males (compared to females) reflects the relatively higher productivity losses that occur in this age group.

Chart 10.3: Total per person costs of asthma by age and gender (2015)



Source: Deloitte Access Economics.

10.2 Sensitivity analysis

In order to provide an upper and lower bound estimate of the results from the economic modelling, sensitivity analysis was performed through varying the discount rate that is used throughout the model to discount economic losses that occur in future years.

Deloitte Access Economics follows standard methodology and uses a 3% discount rate to discount economic losses that occur in future years – for example, funeral costs that are brought forward from future year, or productivity losses due to premature mortality. This approach is also used by the AIHW. Please refer to Section 4.3 for additional discussion of discount rates.

Sensitivity analysis was conducted using two alternative discount rates:

- 7%, as recommended by the Office of Best Practice Regulation when undertaking cost-benefit analysis; and
- 2%, which allows for a potential lower bound for inflation in future years.

The results of the sensitivity analysis are shown in Table 10.3.

[32] Numbers do not add due to rounding.

Table 10.3: Discount rate sensitivity analysis

	Upper bound: 2%		**Baseline: 3%**		**Lower bound: 7%**	
	Result ($m)	*Change from baseline*	*Result*	*Change from baseline*	*Result*	*Change from baseline*
Economic costs	3,275.0	-0.52%	3,258.0	0	3,218.0	1.24%
Burden of disease	24,671.6	0.00%	24,671.6	0	24,671.6	0.00%
Total costs	**27,946.6**	**-0.06%**	**27,929.6**	**0**	**27,889.6**	**0.14%**

Source: Deloitte Access Economics calculations.

As can be seen, the results of the sensitivity analysis indicate the choice of discount rate has a small impact on the overall results of the economic modelling. In terms of total costs, the sensitivity analysis provides upper and lower bound estimates of $27,946.6 million and $27,889.6 million, respectively.

10.3 Government cost forecasts

The total government costs of asthma were calculated over a 30 year period, from 1990 to 2019. Total costs consisted of the following four components:

- total cost of hospitalisation due to asthma;
- total cost of pharmaceutical prescriptions for drugs taken for asthma;
- total primary health care costs due to asthma; and
- other direct costs, including government programs and research.

10.3.1 Government costs for 1990-2015

The total cost of hospitalisation was calculated using estimates for the average cost of hospitalisation per patient with asthma in 2015, and historical growth rates calculated from data on the number of hospital separations due to asthma per year. Estimates for the number of encounters were based on population data and data taken from the AIHW's (2011) report on asthma hospitalisations in Australia. Where data was not available, estimates were derived based on historical trends. **It is estimated that the total government cost of hospitalisation due to asthma for 1990-2015 is $6.4 billion, in 2015 dollars.**

The total cost of pharmaceutical prescriptions was calculated using estimates for the average cost of pharmaceutical prescriptions per patient with asthma in 2015, and historical growth rates calculated from data on the number of prescriptions for drugs for obstructive airway diseases per year (the growth rate for this category of pharmaceuticals was considered to be a reasonable proxy for the growth rate in consumption of asthma medications). Data on the number of prescriptions were taken from Expenditure and Prescriptions statistics reported annually by the PBS for the years 2002-2014 (DOH, 2014). For the years prior to 2002, estimates were derived according to historical trends. **It is estimated that the total government cost of pharmaceutical prescriptions for asthma for 1990-2015 is $9.6 billion, in 2015 dollars.**

The total cost of primary health care due to asthma was calculated using estimates for the average primary health care costs incurred per patient with asthma in 2015, and historical growth rates calculated from data on the number of asthma-related GP encounters per year (Britt et al, 2014). Where data was unavailable for certain years, estimates were derived using historical trends. **It is estimated that the total government cost of primary health care due to asthma for 1990-2015 is $10.5 billion, in 2015 dollars.**

The total cost of other direct costs due to asthma was calculated using estimates from 2015 of costs from government programs and asthma-associated research, and historical growth rates of asthma prevalence in Australia. Prevalence rates for asthma were taken from the 2011 Australian Health Survey and the 1995, 2001, 2004 and 2007 National Health Surveys. Where prevalence rates were unavailable for certain years, estimates were derived using interpolation and historical trends

Total costs to government for asthma expenses for 1990-2015 are estimated to be $30.6 billion in 2015.

10.3.2 Government cost projections

To estimate the costs to government over 2016-2019, results from Section 10.3.1 were combined with the prevalence projections for Australia (see Section 3.1) and historical growth trends. The total government cost of each component for each year, and the four-year total, is summarised in Table 10.4.

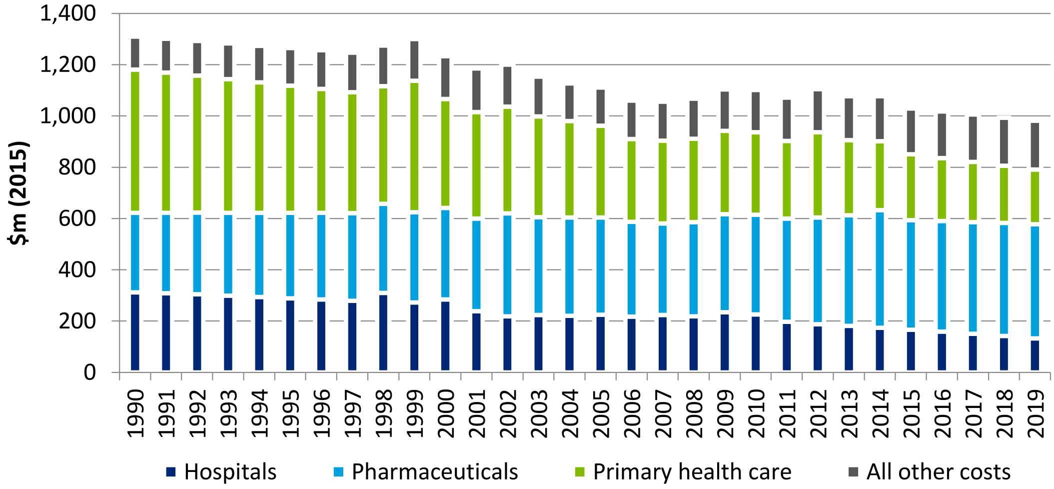
Table 10.4: Forward estimates of government costs (2016-2019)

Cost item	2016 ($m)	2017 ($m)	2018 ($m)	2019 ($m)	Total ($m)
Hospitalisations	158.6	150.3	141.7	132.7	583.3
Pharmaceuticals	431.3	436.0	440.7	445.4	1,753.4
Primary healthcare	246.2	234.9	223.7	212.5	917.4
Other	181.0	184.1	187.3	190.4	742.7
Total	**1,017.1**	**1,005.4**	**993.4**	**981.0**	**3,996.9**

Source: Deloitte Access Economics calculations.
Note: costs are expressed in constant 2015 dollars.

Total government costs for 2016-2019 are projected to be $4.0 billion. Total government costs for each component of expenditure for 1990-2019 are depicted in Chart 10.4.

Chart 10.4: Total government costs due to asthma (1990-2019)



Source: Deloitte Access Economics calculations.

As shown in Chart 10.4, total government costs due to asthma have decreased over the past 20 years, and this trend is expected to continue over the next four years. This trend is driven by decreases in the number of hospital separations due to asthma and the number of primary healthcare consultations due to asthma. The other costs of asthma have increased as a result of increases in the prevalence of asthma. The overall downward trend is partially offset by growth in the number of pharmaceutical prescriptions for obstructive airway diseases.

10.4 Comparison to other estimates

This section compares the cost of asthma estimated in this study with other studies that have estimated the cost of asthma, and other Deloitte Access Economics studies which have quantified the economic cost and burden of disease from other medical conditions.

10.4.1 Comparison with other cost estimates of asthma

While the financial costs of asthma are well documented, the economic burden of asthma has been less commonly estimated. A number of studies exist that provide estimates of economic costs in an Australian context as well as an international context. However, many of these are outdated or adopt significantly different methodologies and approaches. As such, it is important to exercise caution when comparing the figures that have been arrived at by these different studies.

Studies which were considered relevant to the Australia context, and which provided sufficient information to calculate per person costs, are summarised in Table 10.5. The per person estimate has been inflated to 2015, and converted to AUD where necessary. **Please note that these estimates only include economic costs, and no costs associated with the burden of disease.**

Table 10.5: Economic cost of asthma studies

Reference	Country	Cost parameters	Per person estimate*
Birnnbaum et al, 2002	US	Direct costs – medical and pharmacy costs. Indirect costs – work absence costs and disability claims.	$12,009
Cisternas et al, 2003	US	Direct costs – ED visits, hospitalisations, medication, ambulatory visits and outpatient medical procedures. Indirect costs – transportation for medical care, housekeeping assistance, help with special household chores and household allergy control measures.	$10,954
Smith et al, 1997	US	Direct costs – prescribed medicines, ambulatory visits and hospitalisations. Indirect costs – housekeeping loss, work loss, and restricted activity loss.	$6,338
Deloitte Access Economics, 2015	**Australia**	**Direct costs – pharmaceuticals, hospitalisation, primary care and other health system expenditure, government welfare programs, funeral expenses, formal care and travel** **Indirect costs – absenteeism, premature mortality, informal care**	**$1,370 (not including burden of disease costs)**
Kenny et al, 2005	Australia	Direct costs – medication, hospital services, non-hospital medical services, diagnostic tests and other health and community services. Indirect costs – asthma equipment, home equipment and modification, and alternative therapies.	$1,941
Boston Consulting Group, 1992	Australia	Direct costs – pharmaceuticals, primary health care, hospitalisations, indirect medical, ambulances and allied treatments. Indirect – absenteeism, caregiver absenteeism, presenteeism, travel time	$597 - $735

Source: Deloitte Access Economics research and calculations.
Note: * All estimates have been converted to 2015 dollars and, where necessary, into Australian currency.

As demonstrated in Table 10.5, estimates vary considerably between studies. Costs estimated for the US, by Birnbaum et al (2002), Cisternas et al (2003) and Smith et al (1997) are larger than those estimated by Deloitte Access Economics. This is likely due to the significantly higher costs of healthcare in the US compared to Australia.

Compared to the Australian studies, the Deloitte Access Economics is considered to be similar to the estimate in Kenny et al (2005). The other Australian study, conducted by the Boston Consulting Group in 1992, included very low estimates for absenteeism (0.5 days – the study noted that this was a very conservative estimate). It is important to note that the academic study of absenteeism was still in its very early stages at the time that this study was undertaken, and so more reliable estimates were not available.

A number of studies, which estimated the total costs of asthma but did not provide sufficient information to calculate per person costs, have been briefly summarised below:

- In 1991, Mellis et al estimated the economic cost of asthma in 1989 in New South Wales to be $209 million, or $627 million for the whole of Australia. Direct costs included inpatient and outpatient hospitalisations, ED visits, visits to GPs and specialists and costs of pharmaceuticals and devices such as nebulisers and peak-flow meters. Indirect costs included the cost of time spent attending medical visits, and loss of productivity due to asthma-associated absences from work.
- In 1996, Krahn et al estimated the cost of asthma to Canada to be $504 million in 1990. Direct costs included costs incurred by inpatient care, emergency visits, physician services, nursing services, ambulance use, devices, drugs, outpatient diagnostic tests and research and education. Indirect costs included morbidity costs, workers' compensation and disability payments, school days lost, travelling and waiting time, and asthma-related death.
- In 1992, Weiss et al estimated the cost of asthma to the US to be $6.2 billion in 1990. Direct costs included hospital care, physicians' services and medication. Indirect costs included school days lost, loss of work outside of employment, housekeeping costs and mortality.

10.4.2 Comparison with cost estimates of other diseases

Estimates of the costs of other diseases to Australia have been collected and summarised in Table 10.6 below. Cost estimates have been taken from other Deloitte Access Economic reports and as such, can be accurately compared as a consistent methodology and approach was applied in each study.

Table 10.6: Cost estimates of other diseases

Year	Disease	Total cost ($b)*	Cost per person ($)
2011	Chronic kidney disease	1.3	757.8
2009	Vision loss	18.7	32,645.6
2015	**Asthma**	**27.9**	**11,740.4**
2007	Allergies	35.4	8,669.6
2011	Sleep disorders	38.8	26,445.2
2013	Stroke	55.9	133,107.5
2012	Eating disorders	73.4	80,289.0
2008	COPD	113.2	95,599.1

Source: Deloitte Access Economics.
Note: * costs have been expressed in 2015 dollars.

As shown in Table 10.6, the total costs of asthma in Australia are estimated to be higher than for chronic kidney disease and vision loss, but lower than for allergies, sleep disorders, stroke, eating disorders and COPD.

11 Recommendations

As demonstrated in this report, asthma represents a significant cost to individuals, Commonwealth and State and Territory governments, and the broader Australian community. The high prevalence of the disease, accompanied by persisting issues concerning diagnosis and management, suggest that patients and practitioners alike may benefit from further consideration of the priorities of asthma funding and research.

During the development of this report, Deloitte Access Economics consulted with stakeholders who are involved with asthma in Australia. This consultation arrived at similar conclusions to what was developed by NAC and AA as part of the NAS, which was commissioned by the Australian Government's Development of Health.

This chapter presents recommendations for AA, the NAC and Australian governments, as well as for policymakers in areas of health research and management. Recommendations have been based on issues raised in consultation by stakeholders, as well as on issues that have emerged from the research and analysis conducted for this report. As such, this section of the report does not present a comprehensive policy discussion but notes some of the concerns that should be taken into consideration by policymakers.

11.1 Improved diagnosis of asthma

Concerns over the misdiagnosis of asthma, and the resultant impact on appropriate treatment, were a recurring issue in stakeholder consultations with **a number of stakeholders attributing misdiagnosis to low spirometer use in general practice**. As discussed earlier in this report, spirometry is recommended as the gold standard for asthma diagnosis in order to distinguish the condition from a range of other similar respiratory symptoms and conditions, including COPD. In their study on spirometer ownership and use in Australia, Johns et al (2006) identified high levels of ownership but underutilisation of spirometry as a diagnostic tool. **Low use has been attributed to a number of factors, including the high cost of equipment and low MBS remuneration for performing these services** (Johns et al, 2006)[33], and is also a result of lack of training in performance and interpretation of spirometry. Anecdotal evidence from stakeholders supports this, suggesting that high costs and insufficient PBS remuneration provides GPs with a low financial incentive to perform the test.

The misdiagnosis of asthma as COPD or vice versa, or a lack of diagnosis altogether, can have serious implications for patient care and management, resulting in inappropriate or delayed administration of treatment. The distinction is particularly important to make in older patients, for whom other symptoms and conditions can obscure clear diagnosis (Wilson et al, 2005). In their study of the misdiagnosis of COPD in primary care, Walters et al (2011) noted that misdiagnosis was associated with higher rates of health conditions such as obesity, nasal obstruction and hay fever. **On a larger scale, misdiagnosis may also have adverse implications for health system administration by skewing prevalence and**

[33] Since the study by Johns et al in 2006, the NAC, with DOH support, has been conducting spirometry workshops throughout Australia. Based necessarily on small group learning for hands on experience, considerable time is needed to train significant numbers of practice nurses and GPs.

mortality rates for conditions. In addition, inappropriate medication use may impose extra costs on the health system by incurring unnecessary expenditure.

> As such, it is recommended that improvements in diagnosis of asthma, through greater uptake of spirometry in general practice, be considered as one of the priorities of future asthma funding.

One stakeholder suggested that **greater remuneration for spirometry performance could help address underutilisation as the result of poor financial incentives**.

11.2 Greater adherence to guidelines

In consultations for this report, a number of stakeholders expressed their concerns that while **clinical care guidelines regarding asthma management in Australia had been expertly developed, anecdotal evidence suggested minimal adherence in actual practice**. Concerns were largely related to inappropriate medication prescriptions, with one stakeholder pointing to instances of GPs prescribing inhaled corticosteroids and long-acting $beta_2$ agonists to patients without a proper diagnosis.

Management of asthma in Australian general practice has been shown to display suboptimal adherence to standards established by the NAC clinical care guidelines (Barton et al, 2008; Seddon et al, 2001). In their study of 247 GPs from 97 practices across Australia, Barton et al (2008) found that while GPs reported sufficient access to necessary resources, they demonstrated uniformly poor adherence to guidelines in asthma management and assessment of patients for behavioural risk factors. **Only 23.1% of surveyed GPs had assessed their patients for asthma severity while only 11.7% had conducted a spirometry test**. Less than one third of GPs had reviewed inhaler use while only 13% had provided their patients with a written action plan. In Poulos et al (2013), researchers found that the **majority of people receiving one-off prescriptions for medications containing inhaled corticosteroids did not appear to have airways disease** and were being inappropriately prescribed medication.

Given the multifaceted nature of asthma care and the continuous development of the condition, minimal adherence to clinical care guidelines for asthma represent a significant risk to proper management and care. As such, **improvements to guideline adherence pose a strong opportunity for lasting improvements in health outcomes for patients with asthma**.

While research has shown that adherence to clinical care guidelines can be improved, further investigation is required to better understand why adherence is suboptimal and how greater adoption can be encouraged. Current government initiatives such as the PIP, administered by the DHS in conjunction with the DOH, aim to support general practice activities and improve quality of care. The Asthma Incentive Program is one such PIP dedicated to encouraging the better management of people with moderate to severe asthma. An evaluation of the program's efficacy and its long-term impacts on changing clinical care behaviours may provide a significant contribution to future outcomes.

> It is recommended that further initiatives to improve awareness of and adherence to clinical care guidelines be undertaken to increase best practice asthma treatment. Analysis of the findings from the PIP may provide greater insight into the incentives behind guideline adherence and clinical behaviour, with a view to modifying incentives as needed to enhance health outcomes.

11.3 Greater roles for pharmacists in asthma management

The role of pharmacists in asthma management and care was raised by a number of stakeholders in consultations. One stakeholder noted that pharmacists often represented the first point of contact or intervention for patients experiencing asthma symptoms and were instrumental in providing patient education on medication adherence. The stakeholder suggested that pharmacists were insufficiently remunerated for the amount of time that they expended in this role. Another stakeholder noted that the role of a pharmacist in asthma management could be further expanded and incorporated into care management models to improve the continuum of care and to progress models of care in asthma.

A significant body of literature exists on the impacts of pharmacist interventions on asthma management and care. The role of pharmacists in asthma self-management represents a particular focus in the potential expansion of their care provision. Patient knowledge of asthma care and management is commonly agreed to be sub-optimal.

As noted in Saini et al (2011), **the nature and frequency of their encounters with patients place pharmacists in a unique position to deliver asthma education**. In their study of the impact of pharmacist-delivered interventions on patient knowledge, conducted over six months, Saini et al (2011) found that the additional educational component of their interactions resulted in a sustained increase in asthma knowledge across subjects.

In Armour et al (2007), researchers studied the impact of a Pharmacy Asthma Care Program on asthma control in fifty Australian pharmacies. **The study found that the intervention resulted in improved asthma control, with higher rates of adherence to preventer medication and improved asthma knowledge**. Similar results pertaining to pharmacists' capacity for effective delivery of interventions have been reported in Smith et al (2007).

The suggestion that pharmacists have an important role to play in asthma management and care is not a new one. Previous programs, such as the 2009 Pharmacy Asthma Management Service, point to existing attempts to trial service delivery by pharmacists to asthma patients (Emmerton et al, 2012). **The positive findings of relevant studies suggest that a more widely-instituted program of asthma care for pharmacists could deliver significant benefits** in terms of a more streamlined approach to medication prescription and education. In addition, a greater shift in asthma service delivery to pharmacists could help alleviate the burden on GPs.

It is recommended that the health system may benefit from further investigation into the feasibility of a standardised Pharmacy Asthma Care Program and research into the necessary development required for its implementation.

11.4 Improved approaches to asthma interventions and care

Another issue that was frequently raised in consultation concerned better treatment of asthma through improved interventions and models of care. **A number of stakeholders cited increased uptake of low-cost interventions such as improved inhaler technique as a simple way to achieve better health outcomes**. Another stakeholder emphasised the importance of better medication adherence so as to avoid the over or under treatment of asthma. Another stakeholder proposed that multi-disciplinary care models could help improve asthma treatment.

Inappropriate treatment of asthma represents a significant barrier to achieving optimal health outcomes. While poor adherence to guidelines, as previously discussed, relates to failures in proper treatment in primary care, **inappropriate treatment can also be attributed to a lack of patient knowledge and education about the necessary management required for their condition**. In Reddel et al (2015), researchers noted significant gaps between the potential level of control and the level actually experienced in almost half of the study's participants, due to a number of different factors, including poor adherence to therapy and inappropriate inhaler technique.

Research shows that **incorrect inhaler use is relatively common among patients with asthma but can be remedied to achieve immediate clinical improvements** (Melani et al, 2011; Basheti et al, 2007). In addition to further research into how medication adherence techniques could be improved, **further research into developing innovative new medicines and devices could provide significant benefits to asthma-related health outcomes**.

Further consideration could also be given to alternative approaches to asthma care. A greater focus on preventive medication interventions, as well as recognition of behavioural risk factors, could help minimise asthma prevalence and severity. A greater consideration of multi-disciplinary models of care, which take advantage of collaborative opportunities afforded by other practitioners such as pharmacists, could also yield more efficient and effective approaches to asthma management in Australia.

It is recommended that ongoing national patient campaigns are conducted on inhaler technique, medication adherence and the importance of preventer medications. Researchers should investigate novel therapies and effective interventions to achieve improved patient outcomes.

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Appendix A: Detailed projections

This appendix contains the detailed results of the Australian, state and territory projections of asthma prevalence by gender and five-year age groups for 2015 to 2020, and 2030. These projections were generated using microdata from the AHS, combined with ABS population projections (ABS, 2015d). Deriving population estimates for each state, broken down into gender and 5-year age groups, presents issues in regards to small sample sizes. Most of the sub-groups have relative standard errors between 25% and 50% (and should therefore be treated with caution), while some of the sub-groups have relative standard errors of more than 50%, and as such the ABS does not consider these to be reliable. A small number of sub-groups have relative standard errors of less than 25%. The aggregated results by jurisdiction and gender (see Table 3.2) have relative standard errors of less than 25%.

In addition to relative standard errors, there are two issues with the ABS microdata which should be noted.

The ABS performs randomly adjusts continuous variables in its microdata, to avoid the release of confidential data. As a result, discrepancies may occur between sums of the component items and totals. Where possible, Deloitte Access Economics has adjusted figures to publicly-available data, which has not been randomly adjusted.

The sum of prevalence across the states and territories is not equal to the Australian prevalence. This is due to the fact that the sum of populations across all eight states and territories is not equal to the population of Australia. The ABS (2015d) notes that the rounding of figures may lead to discrepancies occurring between the sum of component items and totals. In addition, the population estimates for Australia include people living in Australian jurisdictions that do not form part of the eight states and territories.

Table A.1: Asthma prevalence by age and gender for Australia

	2015 ('000)	2016 ('000)	2017 ('000)	2018 ('000)	2019 ('000)	2020 ('000)	2030 ('000)
Males							
0-4	64.0	65.3	66.2	67.1	68.0	68.8	73.4
5-9	114.1	115.6	118.0	120.1	122.2	124.1	138.0
10-14	86.4	88.1	90.2	92.5	94.6	96.6	111.7
15-19	85.8	86.3	86.6	87.0	87.8	88.9	106.3
20-24	65.6	66.0	66.5	66.9	67.1	67.1	75.7
25-29	80.7	81.6	82.3	83.0	83.5	83.8	87.6
30-34	87.1	89.4	91.2	92.5	93.9	95.4	100.3
35-39	96.1	99.2	102.7	106.9	110.6	114.2	128.2
40-44	51.1	50.5	50.1	50.1	50.6	51.5	65.8
45-49	47.6	49.2	50.6	51.5	51.8	51.8	61.2
55-54	68.5	68.1	67.7	67.7	68.4	69.7	76.4
55-59	61.9	63.2	64.5	65.5	66.1	66.2	73.3
60-64	59.1	60.4	61.7	62.9	64.4	65.7	71.9
65-69	52.3	53.6	53.4	54.0	54.9	55.9	67.1
70-74	31.8	33.4	35.8	37.9	39.3	40.5	49.1
75-79	25.3	26.3	27.4	28.4	29.8	31.3	43.9
80-84	14.0	14.3	14.9	15.6	16.3	17.1	28.1
85+	12.0	12.3	12.5	12.7	12.9	13.1	21.2
Females							
0-4	30.7	31.3	31.8	32.2	32.6	33.0	35.2
5-9	55.0	55.8	56.9	57.9	58.9	59.9	66.6
10-14	68.0	69.4	70.9	72.7	74.4	76.1	88.1
15-19	88.1	88.7	89.0	89.6	90.3	91.3	109.2
20-24	98.0	98.4	99.1	99.6	100.2	100.5	113.1
25-29	106.4	108.0	109.2	110.1	110.7	111.1	115.9
30-34	98.4	100.9	103.0	104.6	106.2	107.8	113.8
35-39	88.0	90.5	93.4	96.9	100.3	103.5	116.6
40-44	77.8	76.6	75.7	75.6	76.2	77.4	98.0
45-49	94.1	97.3	100.3	102.0	102.6	102.5	118.5
55-54	87.6	87.1	86.6	86.5	87.4	89.0	96.4
55-59	90.3	92.5	94.4	95.9	96.9	97.1	107.2
60-64	84.4	86.4	88.5	90.5	92.7	94.7	103.6
65-69	71.4	73.7	73.9	75.2	76.9	78.6	95.1
70-74	47.7	50.1	53.9	56.9	59.0	61.1	76.1
75-79	42.7	44.0	45.8	47.5	49.9	52.5	75.0
80-84	25.1	25.4	26.0	26.7	27.6	28.5	46.0
85+	26.5	27.2	27.6	28.0	28.4	28.9	39.8

Source: Deloitte Access Economics calculations.

Table A.2: Asthma prevalence by age and gender for New South Wales

	2015 ('000)	2016 ('000)	2017 ('000)	2018 ('000)	2019 ('000)	2020 ('000)	2030 ('000)
Males							
0-4	8.5	8.6	8.6	8.7	8.8	8.8	9.1
5-9	33.3	33.5	34.0	34.4	34.8	35.1	37.2
10-14	30.0	30.5	31.0	31.6	32.1	32.7	35.8
15-19	24.9	24.9	24.9	25.0	25.1	25.3	28.8
20-24	12.0	12.0	12.1	12.1	12.1	12.1	13.2
25-29	13.2	13.4	13.5	13.7	13.7	13.8	14.1
30-34	19.7	20.0	20.2	20.4	20.7	21.0	21.8
35-39	37.4	38.4	39.4	40.7	41.7	42.7	46.7
40-44	12.7	12.5	12.3	12.3	12.3	12.5	15.1
45-49	11.5	11.8	12.1	12.3	12.4	12.4	13.9
55-54	24.8	24.5	24.1	23.8	23.8	24.1	25.8
55-59	29.7	30.3	30.8	31.1	31.3	31.2	32.9
60-64	20.6	21.0	21.5	21.8	22.3	22.7	23.3
65-69	20.8	21.2	21.1	21.2	21.6	21.9	25.6
70-74	16.7	17.5	18.7	19.7	20.3	20.8	24.6
75-79	6.3	6.5	6.7	6.9	7.3	7.6	10.3
80-84	5.8	6.0	6.2	6.4	6.7	7.0	11.0
85+	5.5	5.8	5.9	6.1	6.3	6.4	9.7
Females							
0-4	6.6	6.7	6.7	6.8	6.9	6.9	7.1
5-9	8.3	8.4	8.5	8.6	8.7	8.8	9.3
10-14	23.5	23.9	24.3	24.8	25.3	25.7	28.2
15-19	27.0	27.1	27.1	27.2	27.3	27.5	31.4
20-24	22.8	22.8	23.0	23.0	23.1	23.1	25.1
25-29	36.8	37.3	37.6	37.9	38.1	38.2	39.0
30-34	36.4	37.0	37.5	37.8	38.2	38.7	40.3
35-39	22.8	23.3	23.9	24.6	25.2	25.9	28.2
40-44	16.5	16.2	15.9	15.8	15.9	16.1	19.2
45-49	21.8	22.5	23.1	23.6	23.7	23.6	26.1
55-54	30.7	30.2	29.9	29.6	29.6	30.0	31.8
55-59	24.8	25.3	25.8	26.1	26.3	26.2	27.8
60-64	28.2	28.8	29.5	30.1	30.8	31.4	32.6
65-69	21.7	22.3	22.3	22.7	23.2	23.7	28.0
70-74	19.0	19.9	21.3	22.4	23.1	23.8	29.2
75-79	21.5	22.0	22.8	23.5	24.7	25.9	35.9
80-84	5.9	6.0	6.1	6.2	6.4	6.6	10.2
85+	11.3	11.5	11.7	11.8	11.9	12.1	16.0

Source: Deloitte Access Economics calculations.

Table A.3: Asthma prevalence by age and gender for Victoria

	2015 ('000)	2016 ('000)	2017 ('000)	2018 ('000)	2019 ('000)	2020 ('000)	2030 ('000)
Males							
0-4	26.2	26.8	27.2	27.6	27.9	28.3	29.7
5-9	34.3	34.8	35.6	36.4	37.1	37.8	41.8
10-14	16.4	16.7	17.2	17.6	18.0	18.4	21.6
15-19	12.9	13.0	13.0	13.1	13.2	13.4	16.3
20-24	35.3	35.4	35.6	35.8	35.9	35.9	40.6
25-29	46.1	46.5	46.6	46.7	46.8	46.8	48.7
30-34	30.1	30.9	31.5	31.9	32.4	32.8	33.8
35-39	21.9	22.7	23.5	24.5	25.3	26.1	28.8
40-44	9.1	9.1	9.0	9.1	9.2	9.4	12.0
45-49	13.1	13.5	13.9	14.0	14.1	14.1	16.9
55-54	19.1	19.1	19.0	19.1	19.5	19.9	21.9
55-59	10.7	10.9	11.1	11.3	11.4	11.4	12.8
60-64	13.7	14.1	14.4	14.7	15.1	15.4	17.2
65-69	4.2	4.3	4.3	4.4	4.4	4.5	5.5
70-74	4.7	4.9	5.3	5.6	5.8	6.0	7.3
75-79	5.3	5.5	5.7	5.9	6.1	6.4	9.0
80-84	7.1	7.3	7.5	7.8	8.2	8.5	13.7
85+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Females							
0-4	8.3	8.5	8.7	8.8	8.9	9.0	9.5
5-9	9.5	9.6	9.8	10.0	10.2	10.4	11.5
10-14	17.2	17.6	18.0	18.5	18.9	19.4	22.7
15-19	17.1	17.2	17.3	17.4	17.6	17.7	21.5
20-24	29.2	29.3	29.5	29.5	29.6	29.7	33.6
25-29	24.7	25.0	25.2	25.3	25.4	25.5	26.4
30-34	26.8	27.6	28.1	28.6	29.1	29.5	30.7
35-39	20.8	21.5	22.3	23.2	24.0	24.8	27.8
40-44	25.3	24.9	24.7	24.7	24.9	25.4	32.5
45-49	25.3	26.2	27.0	27.3	27.4	27.4	32.2
55-54	18.1	18.1	18.0	18.1	18.4	18.8	20.3
55-59	24.9	25.4	25.9	26.4	26.6	26.8	30.1
60-64	22.0	22.6	23.2	23.7	24.3	24.8	27.8
65-69	25.7	26.5	26.5	27.0	27.6	28.3	34.4
70-74	12.7	13.3	14.3	15.1	15.7	16.2	20.2
75-79	9.8	10.0	10.4	10.7	11.3	11.8	16.9
80-84	6.0	6.1	6.2	6.3	6.5	6.7	10.7
85+	3.2	3.2	3.3	3.3	3.4	3.4	4.7

Source: Deloitte Access Economics calculations.

Table A.4: Asthma prevalence by age and gender for Queensland

	2015 ('000)	2016 ('000)	2017 ('000)	2018 ('000)	2019 ('000)	2020 ('000)	2030 ('000)
Males							
0-4	7.4	7.6	7.7	7.8	8.0	8.1	9.0
5-9	18.2	18.5	18.8	19.2	19.5	19.9	22.8
10-14	22.0	22.5	23.1	23.8	24.4	24.9	29.3
15-19	18.6	18.8	19.0	19.2	19.4	19.8	24.0
20-24	11.2	11.3	11.5	11.6	11.7	11.7	13.6
25-29	5.9	6.0	6.1	6.2	6.3	6.4	6.9
30-34	14.8	15.2	15.5	15.7	16.0	16.3	17.9
35-39	24.9	25.7	26.6	27.8	28.8	29.7	34.3
40-44	8.2	8.1	8.0	7.9	8.0	8.1	10.4
45-49	16.1	16.8	17.3	17.7	17.9	17.9	21.0
55-54	17.2	17.1	17.1	17.2	17.4	17.8	19.7
55-59	20.2	20.8	21.3	21.8	22.1	22.2	25.5
60-64	11.1	11.4	11.6	11.8	12.1	12.4	14.2
65-69	14.6	15.0	15.0	15.2	15.4	15.7	19.3
70-74	2.6	2.8	3.0	3.1	3.3	3.4	4.1
75-79	8.3	8.7	9.2	9.6	10.1	10.7	15.1
80-84	1.9	2.0	2.1	2.2	2.3	2.4	4.2
85+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Females							
0-4	13.4	13.8	14.0	14.2	14.5	14.7	16.2
5-9	15.4	15.6	16.0	16.3	16.6	16.9	19.4
10-14	12.8	13.0	13.3	13.7	14.1	14.4	17.0
15-19	16.1	16.3	16.4	16.5	16.7	17.0	20.8
20-24	18.2	18.4	18.5	18.8	18.9	19.0	22.0
25-29	18.4	18.8	19.1	19.4	19.6	19.8	21.2
30-34	20.6	21.2	21.7	22.0	22.3	22.7	24.7
35-39	12.8	13.1	13.5	14.0	14.5	15.0	17.3
40-44	16.5	16.3	16.1	16.1	16.2	16.4	20.8
45-49	25.4	26.4	27.3	28.0	28.2	28.3	32.7
55-54	15.2	15.2	15.1	15.2	15.4	15.7	17.4
55-59	16.9	17.4	17.9	18.3	18.6	18.7	21.4
60-64	17.9	18.4	18.8	19.3	19.9	20.4	23.3
65-69	12.8	13.2	13.3	13.5	13.8	14.1	17.8
70-74	9.7	10.2	11.0	11.6	12.1	12.5	15.8
75-79	6.1	6.4	6.7	7.1	7.5	8.0	11.5
80-84	11.1	11.3	11.7	12.0	12.6	13.2	22.7
85+	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Deloitte Access Economics calculations.

Table A.5: Asthma prevalence by age and gender for South Australia

	2015 ('000)	2016 ('000)	2017 ('000)	2018 ('000)	2019 ('000)	2020 ('000)	2030 ('000)
Males							
0-4	8.3	8.5	8.5	8.6	8.6	8.7	8.6
5-9	7.7	7.8	8.0	8.1	8.2	8.3	8.6
10-14	6.5	6.6	6.7	6.9	7.0	7.1	7.8
15-19	8.4	8.3	8.3	8.3	8.3	8.3	9.5
20-24	4.4	4.4	4.3	4.3	4.3	4.3	4.6
25-29	7.3	7.3	7.3	7.3	7.3	7.3	7.1
30-34	9.0	9.2	9.4	9.4	9.5	9.5	9.3
35-39	5.6	5.7	5.9	6.1	6.3	6.5	6.8
40-44	2.3	2.3	2.2	2.2	2.2	2.3	2.7
45-49	5.8	5.9	6.0	6.0	5.9	5.8	6.4
55-54	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55-59	4.8	4.9	5.0	5.0	5.0	5.0	5.0
60-64	5.7	5.8	5.9	6.0	6.1	6.2	6.3
65-69	2.3	2.3	2.3	2.3	2.3	2.4	2.7
70-74	3.7	3.9	4.2	4.4	4.5	4.7	5.4
75-79	4.0	4.1	4.3	4.4	4.6	4.8	6.6
80-84	0.9	0.9	0.9	0.9	1.0	1.0	1.6
85+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Females							
0-4	3.1	3.3	3.3	3.3	3.4	3.4	3.4
5-9	6.1	6.4	6.5	6.6	6.7	6.8	6.9
10-14	1.7	1.7	1.7	1.8	1.8	1.8	1.9
15-19	6.1	6.1	6.1	6.0	6.0	6.0	6.0
20-24	9.6	9.4	9.4	9.4	9.4	9.4	9.4
25-29	9.0	9.2	9.2	9.2	9.2	9.1	9.1
30-34	4.8	5.3	5.5	5.5	5.6	5.6	5.6
35-39	4.9	5.0	5.1	5.2	5.4	5.6	5.7
40-44	5.4	5.3	5.2	5.1	5.0	5.0	5.1
45-49	10.2	10.2	10.4	10.5	10.6	10.5	10.3
55-54	8.3	8.3	8.2	8.1	8.0	8.0	8.1
55-59	5.5	5.8	5.9	6.0	6.0	6.0	6.0
60-64	5.5	5.7	5.8	5.9	6.0	6.1	6.2
65-69	5.3	6.0	6.1	6.1	6.2	6.3	6.3
70-74	2.1	2.4	2.5	2.7	2.8	2.9	3.0
75-79	1.5	1.6	1.7	1.7	1.8	1.9	2.0
80-84	1.2	1.2	1.2	1.2	1.3	1.3	1.3
85+	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Deloitte Access Economics calculations.

Table A.6: Asthma prevalence by age and gender for Western Australia

	2015 ('000)	2016 ('000)	2017 ('000)	2018 ('000)	2019 ('000)	2020 ('000)	2030 ('000)
Males							
0-4	2.3	2.4	2.4	2.5	2.6	2.7	3.1
5-9	3.5	3.6	3.7	3.9	4.0	4.1	5.1
10-14	4.9	5.1	5.3	5.5	5.7	5.9	7.7
15-19	8.0	8.1	8.2	8.3	8.4	8.5	11.3
20-24	2.2	2.3	2.3	2.3	2.4	2.4	2.9
25-29	9.4	9.5	9.6	9.7	9.8	9.9	10.8
30-34	8.1	8.5	8.9	9.2	9.5	9.7	10.7
35-39	11.0	11.6	12.3	13.1	13.9	14.6	18.0
40-44	12.8	12.9	12.9	13.1	13.5	14.0	20.9
45-49	4.7	5.0	5.2	5.3	5.4	5.4	7.4
55-54	6.7	6.8	6.8	6.9	7.1	7.3	9.0
55-59	3.9	4.0	4.1	4.2	4.3	4.3	5.3
60-64	9.5	9.8	10.1	10.4	10.7	11.0	13.5
65-69	4.4	4.6	4.7	4.8	4.9	5.0	6.5
70-74	3.9	4.1	4.5	4.8	5.0	5.2	6.9
75-79	5.8	6.1	6.4	6.6	7.0	7.4	11.4
80-84	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Females							
0-4	1.5	1.5	1.6	1.6	1.7	1.7	2.0
5-9	6.2	6.4	6.6	6.7	6.9	7.1	8.9
10-14	2.2	2.3	2.4	2.5	2.5	2.6	3.4
15-19	17.9	18.2	18.4	18.7	19.0	19.3	25.3
20-24	17.0	17.1	17.4	17.6	17.9	18.1	21.8
25-29	12.1	12.4	12.6	12.7	12.8	12.9	14.3
30-34	10.8	11.4	11.9	12.4	12.8	13.1	14.5
35-39	11.2	11.7	12.3	13.0	13.7	14.4	18.0
40-44	12.5	12.5	12.6	12.7	13.1	13.5	19.7
45-49	6.9	7.2	7.4	7.6	7.7	7.8	10.3
55-54	6.0	6.1	6.1	6.2	6.3	6.5	7.8
55-59	9.0	9.2	9.5	9.7	9.9	10.0	12.0
60-64	7.9	8.2	8.4	8.6	8.8	9.1	10.8
65-69	6.4	6.7	6.8	7.0	7.2	7.4	9.5
70-74	6.3	6.6	7.1	7.6	8.0	8.4	11.3
75-79	3.4	3.5	3.7	3.8	4.0	4.2	6.6
80-84	1.6	1.6	1.7	1.7	1.8	1.9	3.2
85+	3.9	4.1	4.2	4.3	4.4	4.5	6.7

Source: Deloitte Access Economics calculations.

Table A.7: Asthma prevalence by age and gender for Tasmania

	2015 ('000)	2016 ('000)	2017 ('000)	2018 ('000)	2019 ('000)	2020 ('000)	2030 ('000)
Males							
0-4	1.4	1.4	1.4	1.4	1.4	1.4	1.3
5-9	3.7	3.8	3.8	3.8	3.8	3.8	3.7
10-14	3.8	3.8	3.8	3.9	4.0	4.0	4.0
15-19	2.1	2.1	2.1	2.0	2.0	2.0	2.1
20-24	1.1	1.1	1.1	1.1	1.1	1.1	1.1
25-29	0.7	0.7	0.7	0.7	0.7	0.7	0.7
30-34	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35-39	2.4	2.4	2.4	2.5	2.5	2.6	2.6
40-44	2.5	2.4	2.3	2.3	2.3	2.3	2.6
45-49	0.7	0.7	0.7	0.7	0.7	0.6	0.6
55-54	2.9	2.8	2.7	2.7	2.7	2.7	2.5
55-59	0.6	0.6	0.6	0.6	0.6	0.6	0.5
60-64	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65-69	1.0	1.1	1.1	1.1	1.1	1.1	1.2
70-74	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75-79	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80-84	0.5	0.5	0.5	0.5	0.6	0.6	1.0
85+	0.6	0.7	0.7	0.7	0.7	0.7	1.2
Females							
0-4	0.6	0.6	0.6	0.6	0.6	0.6	0.5
5-9	1.4	1.4	1.4	1.4	1.4	1.4	1.4
10-14	1.9	1.9	1.9	2.0	2.0	2.0	2.0
15-19	2.1	2.0	2.0	2.0	2.0	2.0	2.1
20-24	3.7	3.7	3.7	3.7	3.7	3.6	3.6
25-29	2.6	2.6	2.7	2.6	2.6	2.6	2.4
30-34	2.1	2.1	2.1	2.1	2.1	2.1	2.0
35-39	2.2	2.2	2.3	2.3	2.4	2.4	2.4
40-44	3.0	2.9	2.8	2.7	2.7	2.7	3.0
45-49	2.5	2.6	2.6	2.6	2.6	2.6	2.5
55-54	2.4	2.4	2.3	2.3	2.3	2.3	2.1
55-59	1.5	1.5	1.5	1.6	1.5	1.5	1.5
60-64	2.4	2.4	2.5	2.5	2.6	2.6	2.5
65-69	2.1	2.2	2.2	2.2	2.3	2.3	2.6
70-74	0.8	0.8	0.8	0.9	0.9	1.0	1.1
75-79	1.4	1.5	1.5	1.6	1.7	1.8	2.5
80-84	0.9	0.9	0.9	0.9	0.9	1.0	1.6
85+	0.4	0.4	0.4	0.4	0.4	0.4	0.6

Source: Deloitte Access Economics calculations.

Table A.8: Asthma prevalence by age and gender for Northern Territory

	2015 ('000)	2016 ('000)	2017 ('000)	2018 ('000)	2019 ('000)	2020 ('000)	2030 ('000)
Males							
0-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-9	1.1	1.6	1.6	1.6	1.7	1.7	1.9
10-14	1.9	2.7	2.8	2.8	2.9	2.9	3.4
15-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-29	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30-34	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35-39	0.5	0.7	0.7	0.8	0.8	0.8	0.9
40-44	0.6	0.8	0.8	0.8	0.8	0.9	1.1
45-49	0.0	0.0	0.0	0.0	0.0	0.0	0.0
55-54	0.5	0.7	0.7	0.7	0.7	0.7	0.8
55-59	0.4	0.5	0.5	0.6	0.6	0.6	0.6
60-64	0.4	0.5	0.5	0.6	0.6	0.6	0.6
65-69	0.4	0.6	0.6	0.7	0.7	0.7	0.8
70-74	0.0	0.0	0.0	0.0	0.0	0.0	0.0
75-79	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80-84	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Females							
0-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5-9	0.6	0.8	0.8	0.8	0.8	0.9	1.0
10-14	0.9	1.2	1.2	1.3	1.3	1.3	1.5
15-19	0.4	0.6	0.6	0.6	0.6	0.6	0.8
20-24	1.5	2.0	2.0	2.0	2.1	2.1	2.4
25-29	1.0	1.4	1.4	1.4	1.4	1.4	1.5
30-34	1.3	1.9	1.9	1.9	1.9	2.0	2.1
35-39	0.9	1.2	1.3	1.4	1.4	1.5	1.6
40-44	0.4	0.6	0.6	0.6	0.6	0.6	0.8
45-49	0.6	0.8	0.8	0.8	0.9	0.9	1.0
55-54	0.8	1.0	1.0	1.0	1.1	1.1	1.2
55-59	0.7	1.0	1.0	1.0	1.0	1.0	1.1
60-64	0.6	0.9	0.9	0.9	0.9	0.9	1.1
65-69	0.4	0.6	0.6	0.6	0.6	0.7	0.8
70-74	0.4	0.6	0.6	0.7	0.7	0.7	1.1
75-79	0.0	0.0	0.0	0.0	0.0	0.0	0.0
80-84	0.0	0.0	0.0	0.0	0.0	0.0	0.0
85+	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Deloitte Access Economics calculations.

Table A.9: Asthma prevalence by age and gender for Australian Capital Territory

	2015 ('000)	2016 ('000)	2017 ('000)	2018 ('000)	2019 ('000)	2020 ('000)	2030 ('000)
Males							
0-4	0.6	0.6	0.6	0.6	0.6	0.7	0.7
5-9	1.9	1.9	2.0	2.0	2.1	2.1	2.3
10-14	1.3	1.4	1.4	1.5	1.5	1.6	1.8
15-19	0.6	0.6	0.6	0.6	0.6	0.6	0.8
20-24	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-29	1.8	1.8	1.8	1.9	1.9	1.9	2.0
30-34	0.9	0.9	0.9	0.9	1.0	1.0	1.0
35-39	1.0	1.0	1.0	1.1	1.1	1.2	1.3
40-44	1.1	1.1	1.1	1.1	1.1	1.1	1.5
45-49	1.7	1.8	1.8	1.9	1.9	1.9	2.4
55-54	0.8	0.8	0.8	0.8	0.8	0.9	1.0
55-59	1.4	1.5	1.5	1.5	1.5	1.5	1.8
60-64	1.5	1.5	1.6	1.6	1.6	1.7	1.9
65-69	0.0	0.0	0.0	0.0	0.0	0.0	0.0
70-74	0.9	1.0	1.1	1.1	1.2	1.2	1.4
75-79	0.5	0.6	0.6	0.6	0.7	0.7	1.0
80-84	1.0	1.0	1.0	1.1	1.2	1.3	2.3
85+	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Females							
0-4	1.1	1.1	1.2	1.2	1.2	1.2	1.3
5-9	1.2	1.3	1.3	1.4	1.4	1.4	1.6
10-14	2.1	2.2	2.3	2.3	2.4	2.5	3.0
15-19	0.7	0.7	0.7	0.7	0.7	0.7	0.9
20-24	0.8	0.8	0.8	0.8	0.8	0.9	1.0
25-29	3.1	3.2	3.2	3.2	3.2	3.2	3.4
30-34	2.3	2.3	2.3	2.4	2.4	2.5	2.6
35-39	1.5	1.5	1.6	1.6	1.7	1.7	1.9
40-44	1.1	1.1	1.0	1.0	1.1	1.1	1.4
45-49	2.2	2.3	2.3	2.4	2.4	2.4	2.9
55-54	1.4	1.4	1.4	1.4	1.5	1.5	1.7
55-59	1.8	1.8	1.9	1.9	1.9	1.9	2.2
60-64	0.0	0.0	0.0	0.0	0.0	0.0	0.0
65-69	0.4	0.4	0.5	0.5	0.5	0.5	0.5
70-74	1.0	1.1	1.2	1.3	1.3	1.4	1.6
75-79	0.4	0.4	0.5	0.5	0.5	0.5	0.8
80-84	0.5	0.5	0.5	0.5	0.6	0.6	1.1
85+	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Deloitte Access Economics calculations.

Appendix B: Presenteeism estimates

This appendix presents the presenteeism calculations which were discussed in Section 6.3.1.1. Due to the limited literature on the impacts of asthma on presenteeism, the estimated cost of presenteeism due to asthma is not included in the total economic costs calculated for this report. The methods and results of the presenteeism estimates are presented here to provide insight into these costs.

All studies identified were cross-sectional studies and have been summarised in Table B.1 below.

Table B.1: Studies on presenteeism associated with asthma

Reference	Country	Population	Findings
Ampon et al, 2005	Australia	Australians with asthma aged 18-64	Increase of 6.1 reduced activity days due to asthma.
Chen et al, 2008	US	Patients with severe or difficult-to-treat asthma	20% loss in productivity due to asthma
Cisternas et al, 2003	US	Adults with asthma in California	1% of respondents reported a decrease in hours worked because of asthma while 6% reported lost part work days because of asthma
Goetzel et al, 2004	US	Employees	0.9 hours lost per day
Lamb et al, 2006	US	US employees at 46 different employer locations	Productivity cost of $477,126 or 68% of total costs
Lee and Jung, 2008	Korea	Workers who received a group occupational health service	Productivity cost of 722,065 won or 99.5% of total costs
Ojeda et al, 2013	Spain	Patients selected by 120 allergists nationwide	26% of participants reported a loss in productivity ≥50%
Sadatsafavi et al, 2014	Canada	Population-based random sample of adults with asthma	2.6 hours of lost productivity per week
Wang et al, 2003	US	Workers in four occupations – reservation agents, customer service representatives, executives and railroad engineers	18.3 annual excess presenteeism days due to asthma

Source: Deloitte Access Economics research.

In their investigation into the impact of asthma on health status and quality of life, Ampon et al (2005) conducted a population based study of Australians aged 18-64 using data taken from the NHS. Based on their findings, Ampon et al identified presenteeism as one of the adverse outcomes of asthma on quality life, **noting that people with current asthma experienced 22.4 reduced activity days in 2001 in comparison to 16.3 reduced activity days for people who did not have asthma**.

In Chen et al (2008), productivity loss and activity impairment was estimated for patients in the US who had been assessed as having either severe or "difficult-to-treat" asthma. Data was taken from the Work Productivity and Activity Impairment (WPAI): Asthma questionnaire, which had been completed by participants both at the baseline and 12-month follow-up. Based on participant responses to the questionnaire, the study found that **currently employed participants experienced a 20% loss in productivity while at work due to their condition**.

In Cisternas et al (2003), a study of the direct and indirect costs of adult asthma were conducted across a randomised sample of patients in northern California. Patients were selected from a random sample of northern Californian pulmonologists, allergist-immunologists and family practice physicians and interviewed by a trained survey worker. Based on their responses, the study found that **18% of participants reported overall losses in work productivity with 1% of participants attributing a decrease in hours worked due to asthma and 6% citing lost part work days because of asthma**.

In Goetzel et al (2004), health, absence, disability and presenteeism costs were estimated for certain physical and mental health conditions in the US, including asthma. The study analysed data from the Medstat MarketScan Health and Productivity Management database as well as a variety of other surveys and found that **asthma was associated with an average of 0.9 hours lost per day**.

In Lamb et al (2006) the cost of workplace productivity losses were also estimated for a number of different health conditions, including asthma. The study used data from the Work Productivity Short Inventory to quantify the dollar impact of productivity losses resulting from impaired health and found that presenteeism associated with **asthma incurred a productivity cost of $477,126 or 68% of total costs** (absenteeism and presenteeism).

In their study on productivity costs to Korean workers, Lee and Jung (2008) also sought to quantify the economic impacts of a variety of primary health conditions. Based on participant responses to a questionnaire, assessed using the Stanford Presenteeism Scale, the study found that **presenteeism associated with asthma incurred a productivity cost of 722,065 won or 99.5% of total costs** (absenteeism and presenteeism).

In Ojeda et al (2013), costs associated with lost workdays and health care resource use was estimated for patients with asthma in Spain. Participants were selected by allergists across the country and asked to provide, in addition to other information, self-reported scores of their productivity during the previous month. **Researchers found that 26% of study participants reported productivity levels of less than or equal to 50%. Meanwhile, 57.8% of participants reported productivity levels between 60-80% while 16.1% of respondents reported levels of 90-100%**.

In Sadatsafavi et al (2014), the cost of productivity losses were estimated for suboptimal asthma control. The effect of patient's asthma on their work productivity was assessed using the WPAI questionnaire, which covered a recall period of one week. Based on its findings, the study found that **participants with controlled asthma reported an average of 2.6 hours of productivity lost per week due to their condition**.

In Wang et al (2003), the cost of productivity losses resulting from chronic medical conditions were estimated for workers across four different occupations in the US. Using data taken from the World Health Organisations' Health and Work Performance Questionnaire[34], the study found that **participants experienced an average of 18.3 annual excess presenteeism days associated with asthma**.

While a number of relevant studies were located during the literature scan, **a significant proportion of studies were ultimately not included as they did not provide necessary parameter inputs for estimating rates of presenteeism**. In the case of Chen et al (2008), the study's results were excluded as the sample only included patients with severe asthma. The two identified studies, which were included, come from North America and reported comparable estimates of the average number of hours lost per day per employee per year. Where necessary, weighted averages were calculated to account for differences in severity and units of measurement standardised. The findings of these studies are summarised in Table B.2.

Table B.2: Presenteeism findings

Reference	Average number of hours lost per day to asthma	Sample size
Goetzel et al, 2004	0.9	374,799
Sadatsafavi et al, 2014	0.8	300

Source: Deloitte Access Economics research and calculations.

Goetzel et al (2004) identified an average of 0.9 hours while Sadatsafavi et al (2014) reported an average of 0.8. A weighted average was calculated to account for different sample sizes in each study. Based on these studies, a **weighted average of 0.90 hours lost per day per employee was calculated as an estimate of the impact of asthma on presenteeism.**

While presenteeism literature is still relatively young, existing research suggests that presenteeism represents one of the biggest hidden cost components associated with health conditions. As previously demonstrated in Lamb et al (2006) and Lee and Jung (2008), presenteeism costs far outstrip productivity losses associated with absenteeism, representing 68% and 99.5% of total indirect costs (absenteeism and presenteeism) respectively. This view has been similarity echoed in other studies, which suggest that presenteeism is likely to be the largest cost component of costs relating to productivity losses associated with asthma (Bahadori et al, 2009; Akinbami et al, 2012).

[34] The Health and Work Performance Questionnaire is a self-report instrument that is designed to estimate the workplace costs of health problems, in terms of reduced job performance, sickness absence, and accidents and injuries that occur at work (Kessler et al, 2003).

Appendix C: Stakeholder consultation

During the development of this report Deloitte Access Economics consulted with stakeholders who are involved with asthma in Australia. The consultation participants provided a critique on the data and methodology that was used in the report, generated some content for Section 11, and provided feedback on the draft report. The stakeholders who were consulted are listed in Table C.1.

Table C.1: Consultation participants

Stakeholder	Organisation
Adjunct Professor Helen Reddel	The Global Initiative for Asthma
Professor Guy Marks	Australian Centre for Asthma Monitoring
Professor Nick Zwar	University of New South Wales
Ms Lisa McGlynn	Australian Institute of Health and Welfare
Ms Gloria Antonio	National Prescribing Service
Mr Mark Brooke	Asthma Australia's National Leadership Team
Mr Robin Ould	Asthma Australia's National Leadership Team
Mr David Johnson	Asthma Australia's National Leadership Team
Dr Peter Anderson	Asthma Australia's National Leadership Team
Ms Danielle Dal Cortivo	Asthma Australia's National Leadership Team
Mr David Bedson	Asthma Australia's National Leadership Team
Dr Lance Emerson	Pharmaceutical Society of Australia
Ms Kelly Gourlay	Pharmacy Guild of Australia
Ms Heather Allen	Lung Foundation Australia
Ms Tanya Buchanan	The Thoracic Society of Australia and New Zealand
Ms Alexis Hunt	Australian Primary Health Care Nurses Association
Dr Bastian Seidel	Royal Australian College of General Practitioners

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