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The use of lung function testing for the diagnosis and management of chronic airways disease

Demonstration data linkage project using the 45 and Up Study 2001–2014

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The use of lung function testing for the diagnosis and management of chronic airways disease

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2001–2014

Australian Institute of Health and Welfare
Canberra
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Contents

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Abbreviations

COPD	chronic obstructive pulmonary disease
FEV_1	forced expiratory volume in 1 second
ICS	inhaled corticosteroid
LABA	long-acting beta-agonist
LAMA	long-acting muscarinic antagonist
LTRA	leukotriene-receptor antagonist
MBS	Medicare Benefits Schedule
NSW	New South Wales
PBS	Pharmaceutical Benefits Scheme
SABA	short-acting beta-agonist
SAMA	short-acting muscarinic antagonist

Summary

This demonstration project highlights the value of data linkage for addressing population health questions related to chronic airways disease. It includes data from the Sax Institute's *45 and Up Study*, a cohort study of people aged 45 and over living in New South Wales. Baseline questionnaire data from this study were linked to health-care utilisation data from the Medicare Benefits Schedule (MBS) and to medication dispensing data from the Pharmaceutical Benefits Scheme (PBS).

The study examined MBS and PBS claims for lung function testing as a potential indicator of the use of these tests in the diagnosis and management of chronic airways disease and also investigated these tests in primary (versus specialist) care.

Rationale

Spirometry is a type of lung function test that assesses how well the lungs are working. It forms an essential part of the diagnosis and ongoing management of chronic airways disease, since it measures expiratory airflow limitation. Australian guidelines for asthma recommend that spirometry be performed to confirm a diagnosis of asthma, preferably before treatment has started or soon after treatment has commenced. Spirometry is recommended every 1–2 years for most people with asthma as a tool in the ongoing management of the condition. Similarly, international and Australian guidelines for chronic obstructive pulmonary disease (COPD) consider objective testing with spirometry essential for the diagnosis of COPD and for assessing the need for inhaled corticosteroid therapy.

This project hypothesised that most people with asthma and COPD did not have their lung function measured to confirm the diagnosis or as a component of the ongoing management of their chronic airways disease, contrary to guideline recommendations.

Findings

Most people (81.6%) in the *45 and Up Study* who were initiated on medications used in the management of chronic airways disease between June 2005 and December 2013 *did not* have lung function testing performed within 12 months, either before or after their initial prescription. Furthermore, among those respondents who reported having current asthma, lung function testing was only claimed for about one-quarter (26.2%) in a recent 3-year period and 12.3% had only 1 lung function test claim during that time.

Conclusions

Bringing together health-care utilisation and prescribing information with questionnaire data from the *45 and Up Study* enabled exploration of research questions that were unachievable by analysing 1 data source in isolation. This investigation supports the hypothesis that lung function tests are under-used in New South Wales for the purposes of diagnosis and management of chronic airways disease. This may lead to inaccurate diagnoses of chronic airways disease and possibly to inappropriate prescribing of medications used in its everyday management. The under-use of spirometry observed in this study may, in part, reflect barriers to its use in primary care, including costs and difficulties in interpreting results.

With suitable linkage keys, similar methods could be used to explore anonymised linked data on a national level and could also be used to fill evidence gaps associated with other high-burden chronic diseases such as diabetes, cardiovascular disease, arthritis and cancer. This could provide valuable evidence for health policy and the quality use of medicines.

1 Background

In Australia, significant morbidity and mortality are associated with chronic airways disease, including COPD and asthma. Previous work by the Australian Centre for Airways disease Monitoring (ACAM) identified significant issues with the use of medications for treating asthma and COPD in Australia. This includes evidence of over- and under-use of certain respiratory medications, contrary to Australian guidelines, and of their use in patients who appear not to have asthma or COPD (AIHW: Correll et al. 2015; Poulos et al. 2013). Data relating to asthma (Reddel et al. 2015) and to COPD (Vestbo et al. 2009) suggest that these deficiencies in treatment are likely to have adverse effects on respiratory health.

For diagnosis of asthma and COPD, accurate measurement of respiratory function through lung function testing is essential. This is preferably performed before treatment is started, but in cases of clinical urgency, treatment may be started and confirmation of the diagnosis sought within a few weeks or months. However, there is evidence from Australian (Dennis et al. 2010; Zwar et al. 2011) and international studies (Gershon et al. 2012) that spirometry is under-utilised in general practice, contributing to both under- and over-diagnosis of these diseases (Jose et al. 2014; Toelle et al. 2013), and potentially affecting health outcomes due to under- or over-treatment. Currently, the proportion of Australians with a diagnosis of chronic airways disease who have had confirmatory lung function testing is not known.

At present there is no single, large-scale data source in Australia that can be used to show the extent medicines for chronic respiratory conditions are used appropriately and lung capacity tests are used as recommended in treatment guidelines. The ability to link data sets helps provide valuable information to fill important data gaps, thereby providing the evidence to assist in the design of health policies that improve health outcomes.

This project was set up as a demonstration project to highlight the utility of data linkage to answer population health questions related to chronic airways disease. It includes data from the *45 and Up Study* baseline questionnaire linked to PBS and MBS data. The *45 and Up Study* is a population health survey involving approximately 267,000 residents of NSW aged 45 and over, representing approximately 10% of the general population in this age range in NSW.

By bringing together clinical and prescribing information, as well as questionnaire data from the *45 and Up Study,* this project investigated the use of lung function tests in people aged 45 and over in NSW who have reported being diagnosed with asthma or who were prescribed medications used for the treatment of chronic airways disease.

The principal goals of this demonstration linkage study are to:

1. explore the relationship between claims for lung function testing and the diagnosis and ongoing management of chronic airways disease in a cohort of adults
2. demonstrate the utility of data linkage for filling evidence gaps about management and outcomes of chronic disease, and thus inform planning for potential further data linkage work.

Lung function testing

Lung function testing assesses how well the lungs work. It is often used in the diagnosis and assessment of chronic airways disease. Spirometry, a simple form of lung function test, measures how much and how fast air is blown out of the lungs. Spirometry can be performed on most adults and children over the age of 6. It is used to measure the degree of airflow limitation compared to predicted normal values, and can also be used to assess variability of airflow limitation, particularly by being measured before and after the patient is given a bronchodilator (a type of medication that dilates the airways, hence increasing airflow to and from the lungs—see Glossary). More complex lung function testing, performed in a respiratory function laboratory, can be used to assess features such as how much air is left in the lungs, how well the lungs exchange gases, and the strength of respiratory muscles.

Guidelines for asthma state that spirometry is 'the best lung function test for diagnosing asthma and for measuring lung function when assessing asthma control' (NACA 2015). Guidelines for COPD state that: 'because COPD is defined by demonstration of airflow limitation which is not fully reversible, spirometry is essential for its diagnosis' (Abramson et al. 2016). The current inaccuracy of diagnosis of COPD in community settings and the importance of using spirometry was demonstrated by an Australian study in which only 58% of general practice patients being treated for COPD were confirmed to have the diagnosis on post-bronchodilator spirometry (Zwar et al. 2011). Australian asthma guidelines (NACA 2015) recommend measuring lung function using spirometry when:

- making or confirming asthma diagnosis
- assessing future risk
- the person has been experiencing worsening asthma control or a flare-up
- monitoring response after dose adjustment
- periodically reviewing asthma (every 1–2 years for most patients).

Australian COPD guidelines (Yang et al. 2015) state that spirometry should be used to:

- make the diagnosis of COPD in patients with risk factors such as exposure to tobacco smoke, occupational dusts and chemicals, and/or symptoms such as breathlessness, frequent sputum production or intermittent cough, or a strong family history of COPD
- assess the severity of COPD and to predict prognosis
- assess eligibility for treatment with inhaled corticosteroids (ICS)
- assess response to treatment.

International guidelines for asthma (GINA 2016) and COPD (Global Initiative for Chronic Obstructive Lung Disease 2015) also recommend measuring lung function when diagnosing and managing these conditions.

Research questions

The research questions investigated in this report, using the *45 and Up Study* linked data, relate to the use of lung function testing as a diagnostic tool and as an aid in managing chronic airways disease. The 2 specific research questions addressed in this report are:

- What proportion of participants in the *45 and Up Study,* with or without asthma, had lung function testing?
  - What proportion of these tests could have been done in primary care?
- What proportion of people starting medications indicated for chronic airways disease had diagnostic lung function testing performed within +/- 12 months?
  - What proportion of these tests could have been done in primary care?

Primary care physicians play a central role in the management of asthma and COPD in the community. For this reason, this investigation had a particular interest in the proportion of lung function tests that could have been performed in primary care.

The objectives and hypotheses for these research questions are listed in Table 1.1.

Table 1.1: Objectives and hypotheses of the Respiratory Outcomes Linkage Study using *45 and Up Study* data

Question	Objective	Hypothesis	Data to be linked
1	To determine the proportion of people with asthma in the *45 and Up Study* cohort who have had lung function testing	There is low usage of lung function testing in people with ever-diagnosed asthma	• *45 and Up Study* baseline • MBS
2	To determine the proportion of people starting medication indicated for chronic airways disease who have had lung function testing within 12 months	That lung function testing is under-utilised as a diagnostic tool in people commencing treatment with medications used in the management of chronic airways disease	• *45 and Up Study* baseline • MBS • PBS

This demonstration data linkage study provides valuable information to fill current evidence gaps and also improve understanding of patterns of health care for people with chronic airways disease. The evidence gained will inform initiatives to help improve appropriate prescribing and health outcomes for people with chronic airways disease. The data linkage project also provides a demonstration of methods that could also potentially be used to fill evidence gaps associated with other chronic diseases such as diabetes, arthritis and cancer.

2 Methods

This study used MBS and PBS data, linked to baseline *45 and Up Study* data, to examine claims for lung function testing as an indicator of the use of these tests in the diagnosis and management of chronic airways disease. The potential use of these tests in primary care was also investigated by examining the MBS code for lung function testing that can only be claimed when it is administered outside a specialist or hospital setting.

Data sources

The data sources used in this data linkage project and their roles are:

- the *45 and Up Study* baseline questionnaire: to identify participants with asthma
- the PBS database: to identify participants with chronic airways disease (asthma and/or COPD)
- the MBS database: to provide data on lung function testing including in participants with chronic airways disease.

These data sources are briefly described below.

The *45 and Up Study*

The Sax Institute's *45 and Up Study* is Australia's largest longitudinal study investigating healthy ageing. Participants completed a questionnaire upon recruitment to the study, with the first wave commencing in 2006. They also provided consent for follow-up surveys and for linkage to a range of health databases. The study coordinators and data custodians allow those with research credentials and the necessary ethics approval to access the data for a cost-recovery fee.

Linked data from the *45 and Up Study* allow research questions to be answered in a more timely fashion than by using data linked through national processes, since the linkage processes for the *45 and Up Study* are already in place, together with the administrative data sets relevant to broader policy requirements (namely, hospital admissions, mortality, PBS and MBS data sets).

A further advantage of using the *45 and Up Study* linked data is that self-reported diagnoses of asthma are available from the baseline questionnaire. This information is not available at present from primary care, PBS or MBS data.

Recruitment and response rates

Most participants in the *45 and Up Study* were recruited based on random selection from the Medicare enrolment database with the assistance of the Department of Human Services. It was also possible for participants to actively volunteer for the study by calling a study helpline to request an invitation pack. Each of the *45 and Up Study* participants completed a baseline questionnaire between January 2006 and December 2009 and provided signed consent for their questionnaire data to be linked with routinely collected data from the PBS, the MBS, hospital records and death records, and for their de-identified data to be used for the purposes of research.

In the *45 and Up Study,* individuals residing in rural areas, and those aged 80 and over, were over-sampled by a factor of 2 to ensure adequate statistical power to focus on these groups. Participants included about 11% of the population of NSW aged 45 and over.

The response rate to the *45 and Up Study* was approximately 18%, and as such, there may be a limit to how much the findings from this study can be generalised outside of the study cohort. However, in discussing the generalisability of findings from the *45 and Up Study*, Mealing et al. (2010) commented that a higher level of generalisability can be assumed when studying the parameters of an association between 2 variables from the *45 and Up Study* questionnaire, or between a data item from a linked data set and a variable from the *45 and Up Study* questionnaire.

Ethical approval

The conduct of the *45 and Up Study* was approved by the University of New South Wales Human Research Ethics Committee (HREC). The conduct of this specific project was approved by the NSW Population and Health Services Research Ethics Committee.

45 and Up Study questionnaire data used in this report

Variables of interest from the *45 and Up Study* baseline questionnaire for this project were those which revealed information about demographics and relevant current illnesses.

The study investigated research questions among people with asthma as defined by positive responses to the following questions in the *45 and Up Study* baseline questionnaire:

- Has a doctor ever told you that you have asthma?
- In the last month have you been treated for asthma?

Population groups examined in this study

Ever-diagnosed asthma: This population was defined as those who gave a positive response to the question 'Has a doctor ever told you that you have asthma?'

Current asthma: This population was defined as those who gave a positive response to the question 'In the last month have you been treated for asthma?'

Patients initiated on respiratory medications: This population was defined using PBS data and includes patients with asthma and/or COPD (because no information is available about COPD diagnosis from the *45 and Up Study* questionnaire).

Patients initiated on ICS-containing medications: This population was defined using PBS data and includes patients with asthma and/or COPD (because no information is available about COPD diagnosis from the *45 and Up Study* questionnaire). In Australia, ICS are only indicated and subsidised under the PBS for treatment of asthma, and for patients with severe COPD as indicated by a history of exacerbations and a forced expiratory volume in one second (FEV_1) <50% predicted (see Glossary entry for FEV_1). Regardless of whether they had asthma or COPD, all patients in this population (that is, initiated on ICS) should therefore have had lung function testing performed to confirm eligibility for initiation of treatment with ICS.

Linked data sets

For the purposes of this study, baseline information from participants in the *45 and Up Study* was linked to:

- the dispensing of medications in the PBS to identify patients initiated on respiratory medications including ICS
- claims for lung function testing in the MBS to assess the frequency of such testing among the whole sample and among people prescribed respiratory medications.

Linked PBS and MBS data were supplied by the Department of Human Services. Linkage of the *45 and Up Study* cohort data to the MBS and PBS data was done by the Sax Institute using a unique identifier that was provided to the Department of Human Services.

Data access

For this project, it took about 6 months from the initial preparation of the ethics application until full access was available to the linked data sets (Details of the timeline are outlined in Table A.1). It is important to note that the processes required for accessing linked data can vary substantially and can impact on the timeliness of data access—for example, differing requirements for approvals, data preparations and ethics. These processes are constantly changing and timelines are expected to improve in the future as processes for data linkage are further refined.

Prescription medication data

To assess medication use among people in the *45 and Up Study*, baseline questionnaire data were linked to records in the PBS data. The purpose of the PBS is to provide timely, reliable and affordable access to necessary medicines for Australians. Under the PBS, the Australian Government subsidises the cost of approved medicines for most medical conditions. Most of the PBS listed medicines are prescribed by medical practitioners, dispensed by pharmacists, and used by patients at home.

Medications dispensed through the scheme are recorded on the PBS database. Although the database is primarily designed to facilitate the administration of the program, it is also a potentially valuable source of information for understanding the epidemiological patterns of medication usage in Australia. The PBS data are managed by Medicare Australia in the Department of Human Services.

Medications dispensed to active participants in the *45 and Up Study* were available from the PBS database for the period 1 June 2004 to 19 December 2014. Participants were identified who had been dispensed medications used in the management of chronic airways disease. In this report, medications defined as 'respiratory medication' include:

- inhaled corticosteroids (ICS)
- ICS/long-acting beta-agonist (ICS/LABA) combination inhalers
- long-acting beta-agonists (LABA)
- long-acting muscarinic antagonists (LAMA)
- LAMA/LABA combination inhalers
- Anti-IgE
- cromones

- leukotriene-receptor antagonists (LTRA)
- short-acting muscarinic antagonists (SAMA)
- xanthines
- short-acting beta-agonists (SABA) (see Box 1).

Box 1: Medications used in the treatment of chronic airways disease and defined in this report as 'respiratory medication'

Classes of medication that are indicated for management of chronic airways disease and included as 'respiratory medication' in this report are:

- **inhaled corticosteroids (ICS):** These medications are intended for everyday use to minimise symptoms and reduce the likelihood of episodes or 'flare-ups'. For treatment of asthma, ICS-containing medications are referred to as 'preventers'. For COPD, ICS are only indicated for patients with a history of exacerbations and with severe airflow limitation assessed from spirometry as 'forced expiratory volume in 1 second (FEV_1) <50% predicted', and only in combination with a long-acting beta-agonist.
- **long-acting beta-agonists (LABA):** A class of long-acting bronchodilator medications that reduce bronchoconstriction and respiratory symptoms. For asthma, guidelines recommend that LABA should only be used in combination with ICS. In COPD, LABA medications are approved for use with or without ICS.
- **long-acting muscarinic antagonists (LAMA):** A class of long-acting bronchodilator medications that reverse bronchoconstriction and, hence help to control chronic airways disease symptoms. Approved in Australia for asthma and COPD, but currently subsidised only for COPD.
- **short-acting muscarinic antagonists (SAMA)** (also known as short-acting anticholinergics): Sometimes used to relieve symptoms in asthma or COPD, with a slower onset but longer duration of effect than SABA.
- **short-acting beta-agonists (SABA):** A class of medications called 'relievers' that are generally prescribed for as-needed use by people with chronic airways disease to rapidly reverse bronchoconstriction and, hence, relieve symptoms. These medications are usually inhaled, by metered dose inhaler, dry powder inhaler, or nebuliser.
- **leukotriene-receptor antagonists (LTRA):** An oral non-corticosteroid preventer medication for asthma, mainly used in children. This medication is also approved for treatment of asthma in adults, but—unlike the used in children—not subsidised by PBS and therefore not captured by the PBS database.
- **cromones:** A class of medications that are administered by inhalation and occasionally used as prophylactic treatment of asthma. They may also be used to prevent exercise-induced bronchoconstriction.
- **xanthines:** A class of medications (which include theophylline) that are bronchodilators administered orally. Their main indication now is as add-on treatment for some patients with severe COPD.
- **anti-immunoglobulin E (anti-IgE) monoclonal antibody therapy:** A relatively new class of synthetic biological agent available through the Highly Specialised Drugs Program of the PBS for the management of severe allergic asthma that is not responsive to other medications. Currently there is 1 approved medication in this class: omalizumab.

Medicare claims data

Medicare is Australia's universal health insurance scheme, and has been since 1984. Medicare provides access to a range of medical services, lower cost prescriptions and free care as a public patient in a public hospital. All eligible Australian residents and certain categories of visitors to Australia can enrol in Medicare and access these services.

The Department of Human Services administers the Medicare program and maintains records of claims and benefit payments. As with PBS data, these data can be used to describe the patterns of health-care services provided in Australia. In this report, MBS data have been used to examine claims for lung function tests. The MBS provides reimbursement for different lung function tests, according to what type of test is performed and the location. These are:

Item 11506: Spirometry before and after administration of a bronchodilator. This is the only lung function test performed in primary care for which a reimbursement may be claimed; it is also reimbursable when performed by specialists. In this report, this is called 'simple lung function testing'.

Items 11503, 11509, 11512: Complex lung function testing, including spirometry with a permanent tracing and written report. All of these tests must be performed under the supervision of a specialist or consultant physician or in the respiratory laboratory of a hospital in order for a reimbursement to be claimed. In this report, these investigations are called 'complex lung function testing'.

Medicare claims for active participants in the *45 and Up Study* were available from the period 24 January 2001 to 31 December 2014.

Claims for MBS item number 11500 (bronchospirometry for measuring lung function) were not analysed in this report since bronchospirometry, a procedure that usually requires anaesthetic, is a procedure which is not performed in clinical practice. It was deleted from the MBS in July 2016 as an obsolete item.

Analyses

Question 1: What proportion of participants in the *45 and Up Study*, with or without asthma, had lung function testing?

In this analysis, baseline information from the *45 and Up Study* was linked to MBS claims data.

Study population

The 3 different study populations for question 1 were:

- All participants in the *45 and Up Study*
- *45 and Up* participants identified at baseline as ever being diagnosed with asthma (that is, a positive response to the question 'Has a doctor ever told you that you have asthma?')
- *45 and Up* participants identified at baseline as having 'current asthma' (that is, a positive response to the question 'In the last month have you been treated for asthma?').

Outcome

The outcome data included in the analyses were claims for lung function tests (that is, MBS codes 11503, 11506, 11509 and 11512), which were obtained from linked MBS data.

The frequency distribution of patients with and without a claim for lung function testing in the relevant period was calculated for patients with and without 'ever-diagnosed asthma' and with and without 'current asthma'.

In order to assess the potential utilisation of spirometry in general practice, the data on lung function testing were stratified by simple spirometry (MBS code 11506)—as distinct from lung function testing that can only be performed under the supervision of a specialist or in the respiratory function laboratory of a hospital, which are referred to as 'complex lung function tests' (MBS codes 11503, 11509 and 11512).

Question 2: What proportion of people starting medications indicated for chronic airways disease had diagnostic lung function testing performed within +/- 12 months?

Study population

The population initiated on respiratory medications was identified by a first dispensing of a respiratory medication in the PBS data set, preceded by a period of 12 months or more without any respiratory medications. Respiratory medications included ICS, ICS/LABA, LABA, LAMA, Anti-IgE, cromones, LAMA/LABA, LTRA, SAMA, xanthines or SABA (see Box 1). Oral corticosteroids or other systemic corticosteroids were not included in these analyses as they are used for conditions other than asthma (for example, arthritis).

Also investigated was the subset of the population identified by an initial dispensing of any ICS-containing medication in the PBS data set: these people may be assumed to have chronic airways disease, since these medications are only approved in Australia for treatment of asthma and COPD.

Outcome

Figure 2.1 provides details of the relevant time periods where the outcome (lung function testing) was assessed in relation to the first dispensing of respiratory medication. The outcome was defined as a Medicare claim for lung function testing (MBS codes 11503, 11506, 11509, 11512), within the following periods, in relation to the incident dispensing of respiratory medication (any respiratory medication or any ICS-containing medication):

- 7 days before or after (essentially, reflecting lung function testing performed at or around the time of incident dispensing, and allowing for time lags in processing claims)
- 12 months before or after (representing lung function testing that may have been carried out as a part of the diagnostic process and/or treatment decision)
- more than 12 months before or after (lung function testing at any other time).

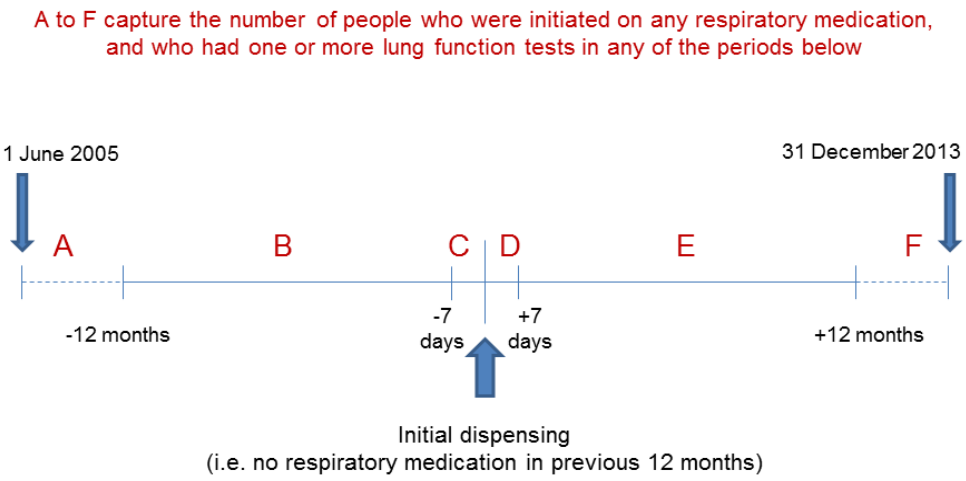
Study start date

The linked PBS data set contained records from 1 June 2004. This project included all records where a respiratory medication was dispensed for the first time on or after 1 June 2005. This allowed a 12-month period:

- in which no respiratory medication was dispensed, to ensure that the people captured in the data were starting on respiratory medication for the first time, rather than already taking the medication regularly (or intermittently)
- of MBS data before the first dispensing of respiratory medication to assess lung function testing up to 12 months prior to the patient being initiated on respiratory medication. The linked MBS data contained records from 2001.

Study end date

The last recorded date of service in the linked MBS data was on 31 December 2014 and so all individuals with an initial dispensing of a respiratory medication up to 31 December 2013 were included. This allowed capture of all respiratory medications up to a time where we could assess lung function being performed within 12 months after the initial respiratory medication was dispensed.



Notes

A includes people who were initiated on respiratory medication but had a claim for a lung function test more than 12 months prior to their initial dispensing.

B includes people who were initiated on respiratory medication and had a claim for lung function testing more than 7 days but less than 12 months prior to their initial dispensing.

C includes people who were initiated on respiratory medication and had a claim for a lung function test within 7 days prior to their initial dispensing.

D includes people who were initiated on respiratory medication and had a claim for a lung function test within 7 days after their initial dispensing.

E includes people who were initiated on respiratory medication and had a claim for lung function testing more than 7 days but less than 12 months after their initial dispensing.

F includes people who were initiated on respiratory medication but had a claim for a lung function test more than 12 months after their initial dispensing.

G includes people who were initiated on respiratory medication but did not have a claim for a lung function test at any time during the study period.

Figure 2.1: Timeline of lung function testing relative to initial dispensing of respiratory medication

3 Use of lung function testing in people with chronic airways disease

The use of lung function testing in the *45 and Up Study* cohort was examined and results were analysed for the overall study cohort, those who had ever-diagnosed asthma and those who had current asthma. The use of lung function testing was also investigated in study participants who were initiated on treatment with medicines used in the management of chronic airways disease. Patterns of lung function testing were also explored by types of lung function tests: namely, simple lung function tests (spirometry) and complex lung function tests.

Question 1: What proportion of participants in the *45 and Up Study*, with or without asthma, had lung function testing?

Lung function testing among all *45 and Up Study* participants

Of all participants in the *45 and Up Study*, 266,727 (99.9%) had at least 1 MBS claim during the period 24 January 2001 to 31 December 2014. Among those who had MBS claims, 57,919 participants had a record of either a simple or complex lung function test being claimed (that is, a claim for MBS item numbers 11503, 11506, 11509 or 11512). This represents 21.7% of the *45 and Up Study* cohort having had a least 1 claim for a lung function test during this time.

A total of 150,351 MBS claims for lung function tests were lodged by the 57,919 participants who had at least 1 MBS claim. Around half (52.6%) had only 1 claim for lung function testing in this 14-year period, while a further 19.5% had 2 claims and the remaining 27.8% had 3 or more claims (see Table 3.1).

Table 3.1: Number of claims for any lung function test among *45 and Up Study* participants, 2001 to 2014

Number of lung function test claims	Frequency (%)	Proportion of all *45 and Up Study* participants (n=266,989)
1	30,481 (52.6)	11.4%
2	11,311 (19.5)	4.2%
3 or more	16,127 (27.8)	6.0%
Any (1 or more)	**57,919 (100.0)**	**21.7%**

Note: All MBS claims for item numbers 11503, 11506, 11509 and 11512 are included for the period 24 January 2001 to 31 December 2014.

Sources: 45 and Up Study participants (baseline questionnaire) and linked MBS data.

What proportion of these tests may have been performed in primary care?

Simple lung function tests (MBS item number 11506) are the only lung function tests that are reimbursable if performed in primary care—therefore, claims for MBS item number 11506 represent the maximum possible number of reimbursed lung function tests that could have been performed by GPs in their surgery/consulting rooms.

Between 2001 and 2014, a total of 38,446 participants from the *45 and Up Study* had an MBS claim for at least 1 simple lung function test—that is an MBS claim for item number 11506 (Table 3.2). Almost two-thirds (64.1%) of these people had only 1 claim for such a test during this time. Around 18% had 2 claims for simple lung function tests and a further 18% had 3 or more claims during this time (Table 3.2). An analysis by provider type showed that 30% of simple lung function tests were billed by thoracic specialists and around 60% were billed by GPs. The remaining 10% were billed by other health professionals, including specialists in fields such as general medicine and cardiology.

Table 3.2: Number of simple lung function test claims between 2001 and 2014 among *45 and Up Study* participants

Number of simple lung function test claims	Frequency (%)	Proportion of all *45 and Up Study* participants (n=266,989)
1	24,645 (64.1)	9.2%
2	6,921 (18.0)	2.6%
3 or more	6,880 (17.9)	2.6%
Any (1 or more)	**38,446 (100.0)**	**14.4%**

Note: All MBS claims for item number 11506 are included for the period 24 January 2001 to 31 December 2014.

Sources: 45 and Up Study participants (baseline questionnaire) and linked MBS data.

There were fewer *45 and Up Study* participants who had a claim for a complex lung function test compared to those who had a simple lung function test (30,998 and 38,446 people respectively). However, a higher proportion of the people who had a claim for a complex lung function test had 3 or more such tests between 2001 and 2014, compared to those who had a claim for a simple lung function test. Specifically, 24.4% of the people who had a complex lung function test claim had 3 or more complex tests (Table 3.3) while 17.9% of those who had a simple lung function test had 3 or more simple lung function tests (Table 3.2) between 2001 and 2014.

Complex lung function tests are more likely to be requested by a respiratory physician than by a GP. Furthermore, patients seeing a specialist more than once are likely to have more severe disease than those seen in primary care and may require more frequent monitoring of lung function. These findings are consistent with patients with more severe respiratory disease being more likely to have seen a specialist, and to have had more frequent monitoring of lung function than patients with milder disease.

Table 3.3: Number of complex lung function test claims between 2001 and 2014 among *45 and Up Study* participants

Number of complex lung function test claims	Frequency (%)	Proportion of all *45 and Up Study* participants (n=266,989)
1	17,587 (56.7)	6.6%
2	5,849 (18.9)	2.2%
3 or more	7,562 (24.4)	2.8%
Any (1 or more)	**30,998 (100.0)**	**11.6%**

Note: All MBS claims for item numbers 11503, 11509 and 11512 are included for the period 24 January 2001 to 31 December 2014.

Sources: 45 and Up Study participants (baseline questionnaire) and linked MBS data.

Lung function testing among *45 and Up Study* participants with ever-diagnosed asthma or current asthma

The usage pattern of lung function testing among people from the *45 and Up Study* who reported ever being diagnosed with asthma and being treated in the preceding month for asthma (that is, reported having current asthma) was investigated.

Lung function tests among people ever diagnosed with asthma: 2001–2014

Among the 27,160 people from the *45 and Up Study* who reported ever being diagnosed with asthma, less than half (42.1%) had an MBS record of lung function testing between January 2001 and December 2014 (Table 3.4) and 17.0% had only 1 lung function test claim (Table 3.5). A further 8.3% of those ever diagnosed with asthma had 2 claims of lung function testing recorded, while 16.7% had 3 or more lung function tests during the study period. People who reported ever being diagnosed with asthma were more than twice as likely as other *45 and Up Study* participants to have had a lung function test claim (42.1% compared with 18.8%) (Table 3.4).

Participants who had MBS lung function test claims but who had not been diagnosed with asthma will include people with other conditions, such as COPD or pulmonary fibrosis, or people who were being investigated for non-specific respiratory symptoms such as shortness of breath or wheeze.

Table 3.4: Number of *45 and Up Study* participants with an MBS lung function test claim between 2001 and 2014, by whether or not they reported ever being diagnosed with asthma

	Lung function test claim (row %)				
Ever-diagnosed asthma	***Simple***	***Complex***	**Any**	**None**	**Total**
Yes	*8,475*	*6,022*	11,425	15,735	**27,160**
	(31.2)	*(22.2)*	(42.1)	(57.9)	**(100)**
No	*24,479*	*20,481*	38,200	164,520	**202,720**
	(12.1)	*(10.1)*	(18.8)	(81.2)	**(100)**
Total	***32,954***	***26,503***	**49,625**	**180,255**	**229,880**
	(14.3)	***(11.5)***	**(21.6)**	**(78.4)**	**(100)**

Notes

1. Participants who gave a positive response to the question 'Has a doctor ever told you that you have asthma?' were included as having 'ever-diagnosed asthma'. We excluded 37,109 participants who did not have information about their asthma status. This represented 13.9% of the total number of people in the *45 and Up Study* cohort (266,989 participants).
2. 'Any' lung function test claim includes people who had a claim for MBS item number 11506, 11503, 1509 or 11512. A 'simple' lung function test claim includes people who had a claim for MBS item number 11506. A 'complex' lung function test includes people who had a claim for MBS item numbers 11503, 11509 or 11512.
3. Some participants may have had both simple and complex lung function tests. Therefore, the number of participants listed in the 'any' column cannot be calculated by simply adding the 'simple' and 'complex' test claim totals.

*Sources: 45 and Up Study p*articipants (baseline questionnaire) and linked MBS data.

Table 3.5: Number of MBS lung function test claims between 2001 and 2014 among *45 and Up Study* participants who reported ever being diagnosed with asthma

	Type of lung function test claim		
Number of lung function test claims	**Simple (%)**	**Complex (%)**	**Any (%)**
None	18,685 (68.8)	21,138 (77.8)	15,735 (57.9)
1	4,336 (16.0)	2,921 (10.8)	4,622 (17.0)
2	1,753 (6.5)	1,156 (4.3)	2,259 (8.3)
3 or more	2,386 (8.8)	1,945 (7.2)	4,544 (16.7)
Any (1 or more)	*8,475 (31.2)*	*6,022 (22.2)*	*11,425 (42.1)*
Participants with ever-diagnosed asthma			**27,160 (100.0)**

Notes

1. Participants who gave a positive response to the question 'Has a doctor ever told you that you have asthma?' were included as having 'ever-diagnosed asthma'. We excluded 37,109 participants who did not have information about their asthma status. This represented 13.9% of the total number of people in the *45 and Up Study* cohort (266,989 participants).
2. 'Any' lung function test claim includes people who had a claim for MBS item number 11506, 11503, 1509 or 11512. A 'simple' lung function test claim includes people with an MBS claim for item number 11506. A 'complex' lung function test includes people with an MBS claim for item numbers 11503, 11509 or 11512.

Sources: 45 and Up Study participants (baseline questionnaire, 2005–2009) and linked MBS data.

Lung function tests among participants ever diagnosed with asthma: 2012–2014

The number of lung function test claims in a standardised, shorter 3-year period was also investigated to provide a better indication of people who were having regular lung function tests as part of ongoing management of chronic airways disease.

Among participants ever diagnosed with asthma, only 20% (5,460 people) had at least 1 lung function test claim in the 3-year period from 2012–2014. About half of these (2,757 people) had at least 1 claim for a complex lung function test, while almost two-thirds (3,519 people) had at least 1 claim for a simple lung function test during this time.

There were 1,531 people, representing 5.6% of those ever diagnosed with asthma, who had 3 or more lung function tests in the 3-year period 2012–2014 (Table 3.6). Among participants ever diagnosed with asthma, those who received complex lung function tests were more likely than those who received simple lung function tests to receive 3 or more tests; of the 2,757 people who had a claim for a complex lung function test, 762 (27.6%) had 3 or more tests, while 584 out of 3,519 people who had a claim for a simple lung function test had 3 or more tests (16.6%). Patients with multiple lung function tests may represent those with more severe asthma, who are more likely to be followed up by a respiratory physician and also to require more regular lung function monitoring.

Table 3.6: Number of lung function test claims between 2012 and 2014 among *45 and Up Study* participants who reported ever being diagnosed with asthma

	Type of lung function test claim		
Number of lung function test claims	**Simple (%)**	**Complex (%)**	**Any (%)**
None	23,641 (87.0)	24,403 (89.9)	21,700 (79.9)
1	2,320 (8.5)	1,432 (5.3)	2,858 (10.5)
2	615 (2.3)	563 (2.1)	1,071 (3.9)
3 or more	584 (2.2)	762 (2.8)	1,531 (5.6)
Any (1 or more)	*3,519 (13.0)*	*2,757 (10.2)*	*5,460 (20.1)*
Participants with ever-diagnosed asthma			**27,160 (100.0)**

Notes

1. Participants who gave a positive response to the question 'Has a doctor ever told you that you have asthma?' were included as having 'ever-diagnosed asthma'. We excluded 37,109 participants who did not have information about their asthma status. This represented 13.90% of the total number of people in the *45 and Up Study* cohort (266,989 participants).
2. 'Any' lung function test claim includes people who had a claim for MBS item number 11506, 11503, 1509 or 11512. A 'simple' lung function test claim includes people who had a claim for MBS item number 11506. A 'complex' lung function test includes people who had a claim for MBS item numbers 11503, 11509 or 11512.

Sources: 45 and Up Study Participants (baseline questionnaire) and linked MBS data.

Lung function tests among people with current asthma: 2001–2014

Among the 12,584 people from the *45 and Up Study* with current asthma, just over half (53.9%) had an MBS record of lung function testing between January 2001 and December 2014 (Table 3.7) and 18.0% had only 1 lung function test claim (Table 3.8). A further 10.2% of those with current asthma had 2 claims of lung function testing recorded, while 25.6% had 3 or more lung function tests during the study period. People with current asthma were 2.7 times as likely as other *45 and Up Study* participants to have had a lung function test claim in this period (53.9% and 20.1% respectively: see Table 3.7).

Not surprisingly, a higher proportion of people with current asthma had a lung function test claim (53.9%) (see Table 3.7) than those with ever-diagnosed asthma (42.1%) (see Table 3.4).

Table 3.7: Number of *45 and Up Study* participants who had a claim for a lung function test between 2001 and 2014, by whether or not they had current asthma

	Lung function test claim (row %)				
Current asthma	***Simple***	***Complex***	**Any**	**None**	**Total**
Yes	*5,182 (41.2)*	*3,789 (30.1)*	6,782 (53.9)	5,802 (46.1)	**12,584 (100)**
No	*33,264 (13.1)*	*27,209 (10.7)*	51,137 (20.1)	203,268 (79.9)	**254,405 (100)**
Total	***38,446 (14.4)***	***30,998 (11.6)***	**57,919 (21.7)**	**209,070 (78.3)**	**266,989 (100)**

Notes

1. Participants who gave a positive response to the question 'Have you been treated in the last month for asthma?' were included as having current asthma.
2. 'Any' lung function test claim includes people who had a claim for MBS item number 11506, 11503, 1509 or 11512. A 'simple' lung function test claim includes people who had a claim for MBS item number 11506. A 'complex' lung function test includes people who had a claim for MBS item numbers 11503, 11509 or 11512.
3. Some participants may have had both simple and complex lung function tests. Therefore, the number of participants listed in the 'any' column cannot be calculated by simply adding the 'simple' and 'complex' test claim totals.

Sources: 45 and Up Study participants (baseline questionnaire) and linked MBS data.

Table 3.8: Number of lung function test claims between 2001 and 2014 among *45 and Up Study* participants who reported having current asthma

	Type of lung function test claim		
Number of lung function test claims	**Simple (%)**	**Complex (%)**	**Any (%)**
None	7,402 (58.8)	8,795 (69.9)	5,802 (46.1)
1	2,350 (18.7)	1,654 (13.1)	2,269 (18.0)
2	1,074 (8.5)	707 (5.6)	1,288 (10.2)
3 or more	1,758 (14.0)	1,428 (11.3)	3,225 (25.6)
Any (1 or more)	*5,182 (41.2)*	*3,789 (30.1)*	*6,782 (53.9)*
Participants with current asthma			**12,584 (100.0)**

Notes

1. Participants who gave a positive response to the question 'Have you been treated in the last month for asthma?' were included as having current asthma.
2. 'Any' lung function test claim includes people who had a claim for MBS item number 11506, 11503, 1509 or 11512. A 'simple' lung function test claim includes people who had a claim for MBS item number 11506. A 'complex' lung function test includes people who had a claim for MBS item numbers 11503, 11509 or 11512.
3. Some participants may have had both simple and complex lung function tests. Therefore, the number of participants listed in the 'any' column cannot be calculated by simply adding the 'simple' and 'complex' test claim totals.
4. Percentage totals for complex lung function tests do not add up to 100 due to rounding.

Sources: 45 and Up Study participants (baseline questionnaire, 2005–2009) and linked MBS data.

Lung function tests among people with current asthma: 2012–2014

Building on the analysis for lung function tests between 2001 and 2014 among participants with current asthma, the number of lung function test claims in a shorter, 3-year period was examined to provide a better indication of people who were having regular lung function tests as part of ongoing management of chronic airways disease.

The following results provide a better indication of people who were having regular lung function tests as part of the ongoing management of current asthma.

Among people with current asthma, only 26.2% (3,300 people) had at least 1 lung function test claim in the 3-year period from 2012–2014 (Table 3.9). About half of these (1,761 people) had at least 1 claim for a complex lung function test, while almost two-thirds (2,089 people) had at least 1 claim for a simple lung function test during this time. There were 1,079 people (8.6%) who had 3 or more lung function tests between 2012 and 2014.

Table 3.9: Number of lung function test claims between 2012 and 2014 among *45 and Up Study* participants who reported having current asthma

	Type of lung function test claim		
Number of lung function test claims	**Simple (%)**	**Complex (%)**	**Any (%)**
None	10,495 (83.4)	10,823 (86.0)	9,284 (73.8)
1	1,278 (10.2)	875 (7.0)	1,554 (12.3)
2	379 (3.0)	356 (2.8)	667 (5.3)
3 or more	432 (3.4)	530 (4.2)	1,079 (8.6)
Any (1 or more)	*2,089 (16.6)*	*1,761 (14.0)*	*3,300 (26.2)*
Participants with current asthma			**12,584 (100.0)**

Notes

1. Participants who gave a positive response to the question 'Have you been treated in the last month for asthma?' were included.
2. 'Any' lung function test claim includes people who had a claim for MBS item number 11506, 11503, 1509 or 11512. A 'simple' lung function test claim includes people who had a claim for MBS item number 11506. A 'complex' lung function test includes people who had a claim for MBS item numbers 11503, 11509 or 11512.

Sources: 45 and Up Study participants (baseline questionnaire) and linked MBS data.

Question 2: What proportion of people starting medications indicated for chronic airways disease had diagnostic lung function testing performed within +/- 12 months?

This section investigates the use of lung function testing prior to, or soon after, commencement of treatment indicated for chronic airways disease, since that is what is recommended in guidelines as a part of the process for diagnosing asthma and COPD. The participants 'initiated' or 'commenced' on respiratory medications were identified by a dispensing of a respiratory medication in the PBS data set, preceded by a period of 12 months or more without any respiratory medications. Lung function testing was first investigated in participants commenced on any of the respiratory medications listed in Box 1. Lung function testing was then investigated more specifically in participants commenced on any ICS-containing medication, since these medications are only subsidised in Australia for treatment of asthma or COPD.

Timing of lung function test claims relative to the first dispensing of any respiratory medication

Table 3.10 and Figure 3.1 summarise the findings for this section. There were 69,198 participants from the *45 and Up Study* cohort who were dispensed any respiratory medication between 1 June 2005 and 31 December 2013 (Table 3.10), and who had no record of any dispensed respiratory medications in PBS data in the previous 12 months. Of these, 9.9% had an MBS claim for lung function testing up to 12 months before (or within 7 days after) their initial respiratory medication was dispensed ('B', 'C' and 'D' in Figure 2.1). A further 8.5% had a claim for lung function testing within the remaining 12 months (but more than 7 days) *after* their initial respiratory medication was dispensed ('E' in Figure 2.1). The remaining 56,440 people (81.6%) started taking respiratory medications but did not have any lung function tests within a year before or after being commenced on treatment. However,

some of these (16,513 out of 56,440, or 29.3%) had a claim for a lung function test more than 12 months before or after their initial respiratory medication was dispensed ('A', 'F' and 'G' in Figure 2.1).

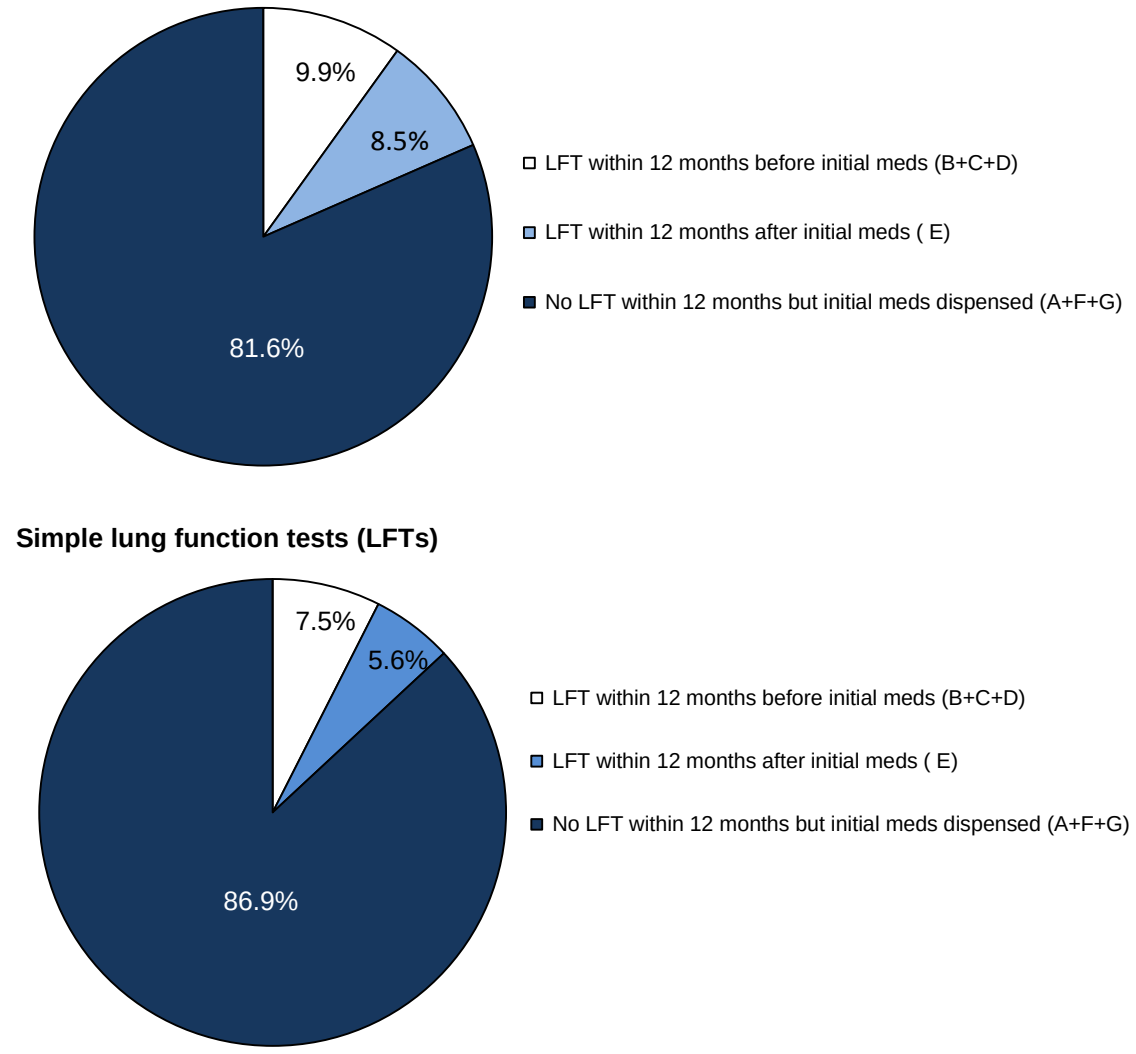
Table 3.10: Timing of lung function test for participants with initial dispensing of any respiratory medication

		Type of lung function test	
Timing of lung function test relative to initial dispensing of any respiratory medications	**Section of Figure 2.1**	**Any (%)**	**Simple (%)**
Lung function test within 12 months (but more than 7 days) before initial medication dispensed	B	3,536 (5.1)	2,304 (3.3)
Lung function test +/- 7 days from initial medication being dispensed	C + D	3,343 (4.8)	2,874 (4.2)
Lung function test within 12 months (but more than 7 days) after initial medication dispensed	E	5,879 (8.5)	3,877 (5.6)
Lung function test claimed, more than 12 months before or more than 12 months after initial medication dispensed	A + F	16,513 (23.9)	11,474 (16.6)
No lung function test claimed, but initial respiratory medication dispensed	G	39,927 (57.7)	48,669 (70.3)
Total number of people initiated on any respiratory medication	**A+B+C+D+E+F+G**	**69,198 (100.0)**	**69,198 (100.0)**

Notes

1. The population 'initiated' on any respiratory medication was defined by a dispensing of any respiratory medication in the PBS data set, preceded by a period of 12 months or more without any respiratory medication being dispensed.
2. 'Any respiratory medication': includes those who were dispensed ICS, ICS/LABA, LABA, LAMA, Anti-IgE, cromones, LAMA/LABA, LTRA, SAMA, xanthines or SABA during the study period.
3. Only members of the *45 and Up Study* cohort who were 'initiated' (as defined in note 1) on any respiratory medication between 1 June 2005 and 31 December 2013 were included.

Sources: 45 and Up Study participants (baseline questionnaire) and linked PBS data and MBS data.



Note: Only members of the *45 and Up Study* cohort who were initiated on any respiratory medication between 1 June 2005 and 31 December 2013 were included. For 'LFT within 12 months before initial medications', the period of 7 days after the initial dispensing was also included.

Sources: 45 and Up Study participants (baseline questionnaire) and linked PBS data and MBS data.

Figure 3.1: Timing of lung function test and initial dispensing of any respiratory medication

What proportion of these tests could have been performed in primary care?

As shown in Table 3.10, the majority of participants for whom lung function test claims were made within 12 months before or after initiation of respiratory medications could have had the testing performed in primary care, as the majority (71.0%) had claims for simple lung function tests (MBS item number 11506). This is consistent with the fact that diagnosis and initial management of airways disease is mostly carried out in general practice (Britt et al. 2015; Levy et al. 2006).

What is the timing of lung function test claims relative to the first dispensing of any ICS-containing medication?

ICS are generally recommended for use on a long-term basis for the management of chronic airways disease. There were 52,554 participants from the *45 and Up Study* cohort who were initiated on any ICS-containing medication between 1 June 2005 and 31 December 2013 (Table 3.11). Of these, only 11.6% had a claim for lung function testing within 12 months before (or within 7 days after) their initial ICS-containing medication was dispensed ('B', 'C' and 'D' in Figure 2.1), while 8.7% had a claim for lung function testing up to 12 months after their initial ICS-containing medication was dispensed ('E' in Figure 2.1). The remaining 79.7% of participants did not have a claim for a lung function test within a year before or after their initial ICS-containing medication being dispensed (Figure 3.2).

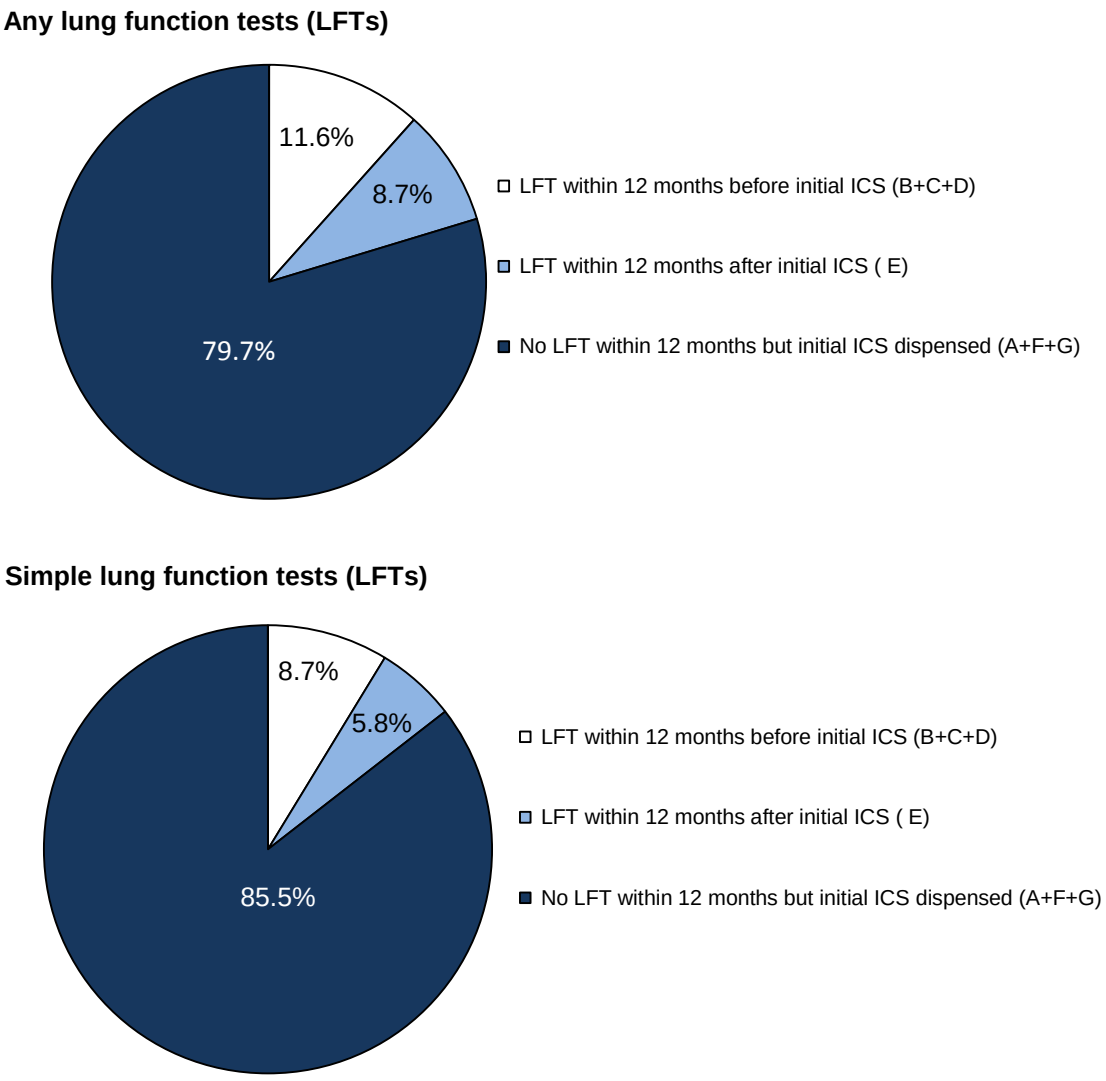
Table 3.11: Timing of lung function test and initial dispensing of any ICS-containing medication

Timing of lung function test and initial dispensing of ICS-containing medications	Section of Figure 2.1	Type of lung function test	
		Any (%)	Simple (%)
Lung function test within 12 months (but more than 7 days) before initial medication dispensed	B	3,462 (6.6)	2,368 (4.5)
Lung function test +/- 7 days from initial medication being dispensed	C + D	2,643 (5.0)	2,212 (4.2)
Lung function test within 12 months (but more than 7 days) after initial medication dispensed	E	4,570 (8.7)	3,038 (5.8)
Lung function test claimed more than 12 months before or more than 12 months after initial medication dispensed	A + F	13,650 (26.0)	9,713 (18.5)
No lung function test claimed, but initial medication dispensed	G	28,229 (53.7)	35,223 (67.0)
Total number of people initiated on ICS-containing medication	**A+B+C+D+E+F+G**	**52,554 (100.0)**	**52,554 (100.0)**

Notes

1. The population 'initiated' on any ICS-containing medication was defined by a dispensing of an ICS-containing medication in the PBS data set, preceded by a period of 12 months or more without any ICS-containing medications being dispensed.
2. 'Any ICS-containing medication': includes those who were dispensed ICS or ICS/LABA during the study period.
3. Only members of the *45 and Up Study* cohort who were' initiated' on any ICS-containing medication (as defined in note 1) between 1 June 2005 and 31 December 2013 were included.

Sources: 45 and Up Study participants (baseline questionnaire) and linked PBS data and MBS data.



Note: Only members of the *45 and Up Study* cohort who were initiated on any ICS-containing medication between 1 June 2005 and 31 December 2013 were included.

Sources: 45 and Up Study Participants (baseline questionnaire) and linked PBS data and MBS data.

Figure 3.2: Timing of lung function test and first dispensing of any ICS-containing medication

What proportion of lung function tests done within 12 months of the first dispensing of any ICS-containing medication could have been performed in primary care?

As shown in Table 3.11, testing in primary care was likely to account for the majority of lung function testing within the 12 months before or after initiation of ICS-containing medications, as the majority of participants (71.4%) had claims for simple lung function tests (MBS item number 11506). This is again consistent with the fact that diagnosis and initial treatment of airways disease is mostly carried out in general practice (Britt et al. 2015; Levy et al. 2006).

4 Discussion

How key findings relate to Australian guidelines for asthma and COPD

Spirometry, either alone or as part of more complex lung function testing, forms an essential part of diagnosis and ongoing management of chronic airways disease, since it is the best way to measure expiratory airflow limitation or how much and how fast air is blown out of the lungs. Australian guidelines for asthma (NACA 2015) recommend spirometry be performed to confirm a diagnosis of asthma, preferably before treatment is started but if not possible, soon after treatment is commenced. Australian guidelines for COPD (Abramson et al. 2016) state that spirometry is essential for diagnosis of COPD.

Our results indicate that, in NSW, the large majority of people aged 45 and over initiated on medications used in the management of chronic airways disease *do not* have spirometry performed within 12 months before or after their initial prescription. The majority (81.6%) of people from the *45 and Up Study* for whom respiratory medications were dispensed for the first time did not have an MBS claim for a lung function test within 12 months before or after their initial dispensing. Similarly, 79.7% of people for whom ICS-containing medications were dispensed for the first time had not had a claim for a lung function test within 12 months before or after the first dispensing. These medications are only subsidised in Australia for treatment of asthma or COPD. In COPD, these medications are only subsidised for a subset of patients, as identified by exacerbations plus a specific spirometric criterion. Thus, to be consistent with current guidelines and medication subsidy arrangements, objective confirmation of the diagnosis of asthma or COPD should have been obtained before, or within a reasonable time after, these medications were commenced.

Of those *45 and Up Study* participants for whom spirometry (MBS item 11506) was performed, a sizable proportion were billed by medical specialists (including 30% by thoracic specialists and 10% by other specialists) while GPs accounted for 60% of the billing. These data indicate that substantially fewer lung function tests are being performed in primary care than might otherwise be assumed.

It is recommended that patients who are diagnosed with asthma begin treatment on short-acting beta-agonists (SABA), as needed, or regular treatment with an ICS (plus SABA as needed) (NACA 2015). It was not possible to examine lung function testing in people initiated on SABA (by themselves or by a clinician) and who purchased this medication over the counter. Published studies indicate that approximately 40% of people with asthma obtain their SABA over the counter without a prescription (Douglass et al. 2012). A 2015 survey of people aged over 16 years with asthma found that 56% of general beneficiaries and 21% of concession card holders obtained most of their SABA over the counter (Reddel & Foster 2016).

Among those respondents from the *45 and Up Study* who reported ever being diagnosed with asthma, there was evidence of spirometry for fewer than half in a 14-year period. Among those with current asthma, around half had evidence of spirometry over the same 14-year period and just over one-third of these had 2 or more spirometry claims from 2001 to 2014.

In Australia, the proportion of adults who report ever being diagnosed with asthma is about double the proportion of those who have ongoing symptoms or treatment in adult life consistent with current asthma (ACAM 2011). This may be due to remission of asthma after

childhood; to the difficulty of making a firm diagnosis of asthma in young children; to misdiagnosis; or to inaccurate recall. This is reflected in the *45 and Up Study* participants, of whom 27,160 reported ever having been given a diagnosis of asthma, and 12,584 who reported having current asthma. This may also explain the lower proportion of people (20.1%) reporting ever-diagnosed asthma who had a spirometry claim in a recent 3-year period compared with those with current asthma (26.2%): clinicians are more likely to request lung function testing in patients who are symptomatic enough to take treatment. However, since only around one-quarter of people with current asthma had any spirometry claims over the 3 years observed (from 2012–2014), it is evident that spirometry is being used infrequently in this population for the ongoing management of asthma.

It is noted that only a small proportion (20.3%) of participants starting ICS-containing medication had lung function testing within the recommended 12-month period. Although these medications are intended for long-term use, there is evidence suggesting that they are sometimes prescribed for people who do not appear to have chronic airways disease (Poulos et al. 2013). In the case of the ICS/LABA medications approved for treatment of COPD, the PBS restriction specifies that a spirometric criterion should be satisfied *before* the treatment is commenced.

These results demonstrate that, in this study population, spirometry is almost certainly under-used for the purposes of diagnosis and management of chronic airways disease. A study in the Netherlands found that providing spirometry in primary care led to a change in diagnosis for half of all patients with apparent respiratory disease (Poels et al. 2009). In a Victorian study, 31% of patients with either a recorded diagnosis and/or a record of current pharmaceutical treatment for COPD were found to have been incorrectly diagnosed when the diagnosis was checked by spirometry (Walters et al. 2011). Findings from the Australian Burden of Obstructive Lung Disease (BOLD) study also confirmed inconsistency between spirometric evidence of COPD (found in 7.5% of participants aged 40 years or over) and a pre-existing diagnosis of COPD (5.2%) (Toelle et al. 2013).

Australian studies have shown that multiple factors contributed to under-use of spirometry for diagnosis of asthma or COPD in primary care, including not only a lack of knowledge and skills in the performance of spirometry, and difficulty in interpretation of the results, but also cost and maintenance of equipment; funding arrangements; net cost to the practice after reimbursement; time constraints; and over-confidence in clinical diagnostic skills (Abramson et al. 2012; Dennis et al. 2010; Zwar et al. 2011).

Limitations of the study

One limitation of the study is the lack of self-reported data for diagnosis of COPD—so apart from participants with self-reported asthma diagnosis or treatment, analysis was restricted to *45 and Up Study* participants who had been prescribed respiratory medications.

This study excluded 37,109 *45 and Up Study* participants who did not have any information about their asthma status from the ever-diagnosed analyses. There was no missing data for the current asthma group who were selected based on their response to being treated for asthma in the last month. Interestingly, of the 12,584 participants who said that they had been treated for asthma in the last month, only 80.5% reported that they had ever been told by a doctor that they had asthma. A further 5.5% did not tick the box for ever having been told by a doctor that they had asthma and 14% had missing data for that question.

Another potential limitation is that this study only had information on spirometry for which an MBS claim had been submitted. It is possible that, in some cases, spirometry was performed but not billed or claimed. There are no data on the extent of this practice, but it could be quite common since the current MBS reimbursement can only be claimed for spirometry performed before and after administration of a bronchodilator. Settings or population groups in which spirometry could have been performed but a claim not submitted may include some public hospital clinics, hospital inpatients, some refugee groups and remote Aboriginal clinics.

With regard to medication data analysed for this study, under co-payment prescriptions for general beneficiaries were not recorded in the PBS prior to April 2012 and therefore were excluded from the study before this time. However, this is not likely to have a major impact on the results presented here, since only some low-dose ICS-only formulations fell into this category. While the majority of prescribed low-dose ICS-only inhalers are for children, there also is the potential for under-reporting of this class of medication in the present study population; however, the association between initial ICS dispensing and lung function testing is not expected to differ between patients prescribed low-dose ICS and those prescribed other ICS-only or (more commonly) ICS/LABA formulations.

The results presented in this report relate only to clinical management and prescribing practices for residents in NSW and only to people aged 45 years and over. It is uncertain if the findings are representative of current practice across Australia. Since some of the results presented here involve a variable in the *45 and Up Study* questionnaire and data items from a linked data set, a reasonable level of generalisability can be assumed for this age-group (Mealing et al. 2010). It is unknown if these findings would apply for children, adolescents and young adults. Furthermore, PBS data analysed in this report included patients who were initiated on ICS from 2005 to 2014, and clinical practice may have changed over the period covered by the analysis, and also beyond that time.

The value of linked data—how this study will help

In the absence of national data that include both diagnosis and treatment information, this study has demonstrated the value of linked data in informing health policy and the quality use of medicines.

The clinician-led MBS review currently underway in Australia aims to assess how specific MBS items can be aligned with contemporary clinical evidence and practice and can improve health outcomes for patients. The thoracic medicine component of this review is specifically examining the MBS items for respiratory function tests that were investigated in the present report (Department of Health 2016) and the data from this linkage study will provide information that is highly relevant to the MBS review.

Policies aimed at increasing the availability of good quality spirometry for patients managed in general practice would benefit people with chronic airways disease since accurate diagnosis, coupled with regular management and review, may improve the appropriateness of prescribing of respiratory medications. In addition to improving outcomes and reducing adverse effects and patient costs, this may reduce PBS costs for inappropriate use of respiratory medications.

It took about 6 months to acquire the relevant data for this linkage project for which all the relevant linkage processes were already in place and established. Considerably more time would be required for a national project of the same nature at this point in time.

The methods used for this linkage project could be used to explore data on a national level and help fill evidence gaps associated with other high-burden chronic diseases such as diabetes, cardiovascular disease, arthritis and cancer. The Australian Government is currently involved in developing processes to facilitate national data exchange and linkage in a manner consistent with privacy legislation and with community expectations regarding confidentiality and security of information. Work is in progress to scope the feasibility of conducting national linkage with key data sources that would provide valuable evidence for health policy, future health spending and investment, and the quality use of medicines.

Appendix A: Data acquisition timeline

Table A2.1: Data acquisition timeline

Date	Data acquisition milestone
2 October 2015	Submitted ethics application and project application
21 October 2015	Ethics application reviewed by the NSW Population & Health Services Research Ethics Committee meeting, at the Cancer Institute NSW
28 October 2015	Received notification that there were some questions that needed to be addressed before ethics approval would be granted
5 November 2015	These concerns were addressed and forwarded a response to the ethics executive committee
16 November 2015	An approval letter received (AU RED Reference: HREC/15/CIPHS/48, Cancer Institute NSW reference number: 2015/10/614. Project Title: Respiratory Outcomes Linkage Study (ROLS) – data linkage study using the *45 and Up Study*)
5 November 2015	Access to online Secure Unified Research Environment (SURE) training modules received
21 December 2015	Access to baseline *45 and Up Study* data linked to PBS and MBS records received
28 January 2016	Access to linked health outcome data (hospitalisations and deaths) received

Glossary

anti-IgE: Anti-immunoglobulin E monoclonal antibody: a new class of synthetic biological agent available through the Highly Specialised Drugs Program of the PBS for the management of severe allergic asthma that is not responsive to other medications. Currently there is 1 approved medication in this class: omalizumab.

asthma control: The extent to which the manifestations of asthma have been reduced or removed by treatment. The aim is to achieve good asthma control. The assessment of asthma control includes assessment of the patient's current status (symptoms, reliever use, lung function), and their risk of future adverse outcomes (exacerbations, decreasing lung function, medication side-effects) (Reddel et al. 2009).

asthma: A common chronic inflammatory condition of the airways, which can be controlled but not cured. People with asthma experience episodes of wheezing, shortness of breath, cough and chest tightness due to widespread narrowing of the airways. The symptoms of asthma vary over time and may be present or absent at any point in time (NACA 2015). Asthma affects people of all ages and has a substantial impact on the community.

***Australian asthma handbook*:** Australia's national guidelines for asthma management. This clinically-focused online resource provides practical, evidence-based guidance for health professionals, for diagnosing and managing asthma in adults and children in primary care.

The current version 1.1, published by the National Asthma Council Australia in April 2015, is available at <www.asthmahandbook.org.au>.

Australian Centre for Airways disease Monitoring (ACAM): Formerly the Australian Centre for Asthma Monitoring (ACAM)—the name was changed in 2014 in recognition of the broadened scope of the monitoring activities being conducted by the centre.

bronchodilator: A type of medication that dilates the airways, hence increasing airflow to and from the lungs. Bronchodilators can be either short-acting or long-acting; short-acting bronchodilators are often referred to as 'relievers'. See also **long-acting beta-agonist**, **short-acting beta-agonist**, **reliever**.

chronic airways disease: This encompasses asthma and chronic obstructive pulmonary disease (COPD) as well as other, poorly defined, but related, conditions.

chronic obstructive pulmonary disease (COPD): A serious long-term lung disease that mainly affects older people, but also affects people of working age. It is characterised by airflow limitation that is not fully reversible with bronchodilator medications. The main cause of COPD is smoking. In everyday language, the terms COPD, emphysema and chronic bronchitis tend to be used interchangeably.

combination inhalers: Medications that contain more than 1 type of drug. In this report, 'combination inhalers' includes inhalers which contain, for example, ICS and LABA. See also **long-acting beta-agonists (LABA)**, and **inhaled corticosteroids (ICS)**.

COPD-X: Acronym for the key goals of COPD management and used as the title for the current Australian COPD management guidelines: **C**onfirm diagnosis; **O**ptimise function; **P**revent deterioration; **D**evelop support; manage e**X**acerbations

cromones: A class of medications that are administered by inhalation and used as prophylactic treatment of chronic airways disease. Cromones must be taken regularly to produce optimal effect but they will not relieve acute symptoms. Although the mechanism of action of these drugs is not fully understood, they are thought to block allergen-induced bronchoconstriction, and may be useful in asthma associated with allergic factors. They may also be used to prevent exercise-induced bronchoconstriction.

data linkage: The bringing together (linking) of information from 2 or more different data sources that are believed to relate to the same entity—for example, the same individual or the same institution. This can provide more information about the entity and, in certain cases, provide a time sequence, helping to 'tell a story', show 'pathways' and perhaps unravel cause and effect. The term is used synonymously with 'record linkage' and 'data integration'.

dispense: This term is used to refer to a prescription medication being dispensed through a pharmacy. When this occurs under the Pharmaceutical Benefits Scheme a record of this is added to the PBS database.

exacerbation: See **flare-up**.

FEV_1: Forced expiratory volume (FEV) is an important test of lung function, that measures the volume of air that the patient can force out in 1 second after taking a deep breath. It is often expressed as a percentage of the patient's 'predicted' value, which, based on study of large reference populations, is calculated from the patient's age, height, and ethnic origin. FEV_1 is one of the most commonly reported metrics for lung function in asthma and COPD, and it forms part of the criteria for PBS-subsidised treatment with some respiratory medications. (For example, the FEV_1 must be less than 50% of predicted in order for a patient with COPD to be eligible for PBS-subsidised treatment with ICS/LABA.)

flare-up: Worsening of asthma control (increase in asthma symptoms) (NACA 2015). Other terms that have been used in the past to refer to these events include 'attack', 'exacerbation', 'acute asthma' and 'episode', but the preferred terminology in the 2015 *Australian asthma handbook* is 'flare-up', as described above.

health outcome: A change in the health of an individual or population due wholly or partly to preventive or clinical intervention.

inhaled corticosteroids (ICS): A class of anti-inflammatory respiratory medication that is typically used as a preventer to control asthma symptoms and reduce the risk of flare-ups.

leukotriene-receptor antagonists (LTRA): A class of medication recommended for children with asthma that provides an oral non-steroid alternative to ICS.

long-acting beta-agonists (LABA): A class of long-acting medications that reverse bronchoconstriction and, hence, help to control chronic airways disease symptoms. Their use can result in reduced doses of ICS being required. See also **short-acting beta-agonist** and **bronchodilator**.

long-acting muscarinic antagonists (LAMA): A class of long-acting medications that reverse bronchoconstriction and, hence, help to control chronic airways disease symptoms. Recommended only for people with COPD and may reduce the use of ICS.

maintenance treatment: See **preventer**.

Medicare: A national, government-funded scheme that subsidises the cost of personal medical services for all Australians and aims to help them afford medical care.

oral corticosteroids (OCS): A class of medication used for a wide range of conditions. When used for chronic airways disease, it is usually to manage flare-ups by reducing acute airway inflammation. Administered orally for short periods to regain control of the disease during acute phases.

PBS item: A specified drug at a given strength classified on the Pharmaceutical Benefits Scheme (PBS) by a unique code.

Pharmaceutical Benefits Scheme (PBS): A national, government-funded scheme that subsidises the cost of a wide range of pharmaceutical drugs for all Australian citizens and residents to help them afford standard medications.

preventer: Preventer medications are those used regularly on an ongoing basis to control symptoms and prevent exacerbations. In international asthma literature, these medications are sometimes called 'controller' medications. As these medications need to be used every day, the term 'maintenance treatment' is also sometimes used, and this is the preferred term in relation to COPD.

reliever: Relievers are bronchodilator medicines used for rapid reversal of bronchoconstriction in asthma or COPD. They can also be used pre-emptively to prevent exercise-induced bronchoconstriction. See also **short-acting beta-agonists** and **bronchodilator**.

respiratory medication: A drug that is commonly used to treat chronic airways disease. In this report, respiratory medication includes ICS, ICS/LABA, LABA, LAMA, Anti-IgE, cromones, LAMA/LABA, LTRA, SAMA, xanthines or SABA.

short-acting beta-agonist (SABA): A class of medications that are taken as needed by people with chronic airways disease to rapidly reverse bronchoconstriction and, hence, relieve symptoms. These medications are usually inhaled, either by metered dose inhaler or nebuliser and are sometimes referred to as 'reliever' medications. See also **reliever** and **bronchodilator**.

short-acting muscarinic antagonists (SAMA): A class of medication also known as short-acting anticholinergics, used to relieve symptoms, with a slower onset but longer duration of effect than SABA.

spirometry: A measure of lung function performed by a spirometer. Spirometry is used to establish the presence of airflow limitation and its reversibility in response to a bronchodilator, which is an important feature in the diagnosis of asthma.

xanthines: A class of medications (which include theophylline) that are bronchodilators administered orally and have a highly variable half-life of approximately 8 hours in adults and 4 hours in children.

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Related publications

This report, *The use of lung function testing for the diagnosis and management of chronic airways disease in Australia 2001–2014*, can be downloaded for free from the AIHW website <www.aihw.gov.au>. The website also includes information on ordering printed copies.

The following AIHW publications relating to asthma, COPD and medication use might also be of interest:

- ACAM (Australian Centre for Asthma Monitoring) 2007. Patterns of asthma medication use in Australia. Cat. no. ACM 11. Canberra: AIHW.
- ACAM 2008. Asthma in Australia 2008. AIHW asthma series no. 3. Cat. no. ACM 14. Canberra: AIHW.
- ACAM 2011. Asthma in Australia: with a focus chapter on chronic obstructive pulmonary disease 2011. AIHW asthma series no. 4. Cat. no. ACM 22. Canberra: AIHW.
- AIHW: ACAM 2012. Medications prescribed for people with obstructive airways disease: antibiotics and inhaled corticosteroids. Cat. no. ACM 24. Canberra: AIHW.
- AIHW: Correll PK, Poulos L, Ampon R, Reddel H & Marks G 2015. Respiratory medication use in Australia 2003–2013: treatment of asthma and COPD. Cat. no. ACM 31. Canberra: AIHW.

This demonstration data linkage study investigates the use of lung function testing in the diagnosis and management of chronic airways disease. The study shows that, contrary to recommended guidelines, most study participants (82%) initiated on medications for managing their chronic airways disease did not have lung function testing performed within 12 months, either before or after their initial prescription.

The evidence from this study will inform initiatives to help improve appropriate prescribing and health outcomes for people with chronic airways disease. This project also provides a demonstration of methods that could also potentially be used to fill evidence gaps associated with other chronic diseases such as diabetes, arthritis and cancer.