Obstructive airway disease in 46–65-year-old people in Busselton, Western Australia, 1966–2015

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The known Smoking rates have been decreasing steadily in Australia, but their relationship with respiratory morbidity has not been mapped over a long period in a single defined population.

The new The prevalence of smoking declined markedly in Busselton between 1966 and 2010–2015, and this was associated with significant improvements in measures of lung function in the population aged 46–64 years. However, the prevalence of specific respiratory symptoms has changed little, and that of doctor-diagnosed asthma has increased.

The implications The deleterious impact of cigarette smoking on lung function in middle-aged individuals is decreasing as smoking rates decline. It is anticipated that other health effects linked to smoking will also diminish.

Abstract

Objective: To document the changing levels of tobacco smoking, respiratory symptoms, doctor-diagnosed asthma, and lung function in Busselton adults aged 46–65 years over the past 50 years.

Design, setting, participants: Repeated cross-sectional population surveys (1966 to 2010–2015) of adults registered to vote in the Busselton shire, Western Australia, including a modified version of the British Medical Research Council questionnaire on respiratory symptoms.

Main outcome measures: History of doctor-diagnosed asthma and chronic obstructive pulmonary disease (COPD), tobacco smoking history, respiratory medications used, spirometry parameters (forced expiratory volume in one second [FEV_1], forced vital capacity [FVC]).

Results: The prevalence of tobacco smoking among men declined from 53% in 1966 to 12% in 2010–2015, and from 26% to 9% among women. The prevalence of ever-smoking (ie, smokers and ex-smokers) decreased from 80% to 57% for men but increased from 33% to 50% for women. The prevalence of doctor-diagnosed asthma increased, as did the use of long-acting bronchodilator aerosol medications by people with asthma and COPD. There have been no consistent changes in the prevalence of specific respiratory symptoms, but measures of lung function have significantly improved.

Conclusions: Smoking rates declined as a result of changes in pricing, prohibitions on smoking and the feedback of survey results to Busselton participants. Significant improvements in lung function were measured, and it can be anticipated that the prevalence of other smoking-related diseases will also decline.

Busselton is a coastal city in southwestern Western Australia. Eight population prevalence studies of respiratory disease and tobacco smoking in its adult population, predominantly of European origin, have been performed over the past 50 years: in 1966, 1969, 1972, 1975, 1981, 1994–1995, 2005–2007, and 2010–2015.[1-3] These studies found that smoking was associated with accelerated age-related decline in lung function, that asthma is associated with reduced lung function present at the beginning of adult life as well as with a greater age-related decline, and that the long term effects of smoking and asthma on lung function are additive.[1] Tobacco smoking rates in the population have declined over the period covered by the studies, and treatment regimens for people with airway diseases have improved with the introduction of aerosol steroids and long-acting bronchodilator aerosols.

In this study we analysed data for people aged 46–65 years during the 2010–2015 Busselton survey. This survey was part of a multidisciplinary ageing and health project based on an initial sample of post-Second World War "baby boomers" in this age range at the time of recruitment for the survey.[4] Our aim was to document the levels of respiratory symptoms, smoking, medication use, and lung function in Busselton adults aged 46–65 years during the 2010–2015 Busselton survey, and to compare them with rates for adults of the same age group during previous surveys.

Methods

All adults registered to vote in the Busselton shire were invited to participate in the first five surveys (participation rates, 64–91%). The 1994–1995 survey included all still living participants from the earlier surveys (77% of eligible people were located and invited, of whom 74% participated); a random sample of adults was selected for the 2005–2007 survey (71% of selected voters were located and contacted, of whom 63% participated). All Busselton "baby boomers" (people aged 46–65 years) were invited to participate in the 2010–2015 survey (82% of eligible people on the electoral roll were located and contacted, 76% of whom participated). The numbers of participants in the surveys included in our analysis were 1260 (1966), 1416 (1969), 1374 (1972), 1287 (1975), 1428 (1981), 1754 (1994–1995), 820 (2005–2007), and 4680 (2010–2015). The age range in each survey was 46–65 years, and the mean age ranged from 55.5 to 57.2 years.

All participants completed a self-administered questionnaire (modified from the 1960 British Medical Research Council questionnaire on respiratory symptoms[5]) that included standardised questions about cough, sputum production, breathlessness, tobacco smoking history, history of doctor-diagnosed asthma or bronchial asthma, and history of doctor-diagnosed bronchitis or

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chronic obstructive pulmonary disease (COPD). The 2010–2015 survey questionnaire was administered online.

Dyspnoea was recorded if the participants responded that they were troubled by shortness of breath when hurrying on level ground or walking up a slight hill. Cough or sputum were recorded if they answered that they had a cough or sputum production on most days for up to 3 months each year. Current smokers were defined as those who had smoked at least one cigarette per day for at least one year; ex-smokers were defined as those who had stopped smoking at least one year before participating in the study.

A detailed medication history was recorded at each attendance from the 1994–1995 survey onwards. The medications recorded were short-acting β-agonists (SABA; salbutamol, terbutaline); long-acting β-agonists (LABA; salmeterol, eformoterol, indacaterol); short-acting anti-muscarinic agents (SAMA; ipratropium); long-acting anti-muscarinic agents (LAMA; tiotropium, aclidinium, glycopyrronium); inhaled corticosteroids (ICS; fluticasone, budesonide, beclomethasone, ciclesonide); oral bronchodilators (OBD; salbutamol, theophylline, terbutaline); oral corticosteroids (OCS; prednisolone, dexamethasone).

Body weight in light clothing was measured with calibrated scales; height was measured without shoes with a stadiometer. Forced expiratory volume in one second (FEV_1) and forced vital capacity (FVC) were measured (from 1979 according to American Thoracic Society guidelines[6-8]) with a dry bellows spirometer (McDermott) between 1966 and 1978, a dry wedge spirometer (Vitalograph) in 1981, a pneumotachograph spirometer (Welch Allyn) in 1994–1995, or an EasyOne Spirometer (NDD Medical Technologies) in 2010–2015. FEV_1 and FVC were recorded as the highest values obtained from three technically satisfactory forced expiratory flow manoeuvres when the best two were within 10% of each other for both FEV_1 and FVC. Measurements from mechanical spirometers were corrected for body temperature and pressure (saturated). Predicted levels of FEV_1 and FVC were calculated from published data for previous Busselton surveys.[9] COPD was defined by a combination of an FEV_1/FVC value below 70% and an FEV_1 value less than 80% of the predicted value.

Statistical analysis

Estimated prevalence was standardised to the age distribution of the 2010–2015 survey sample. Trends in prevalence and means across surveys were estimated in logistic or linear regression models, using generalised estimating equations with repeated measures on individuals. All analyses were conducted in SAS 9.4 (SAS Institute).

Ethics approval

All studies were approved by the Human Rights Ethics Committee of the University of Western Australia (references, RA/4/1/0841, RA/4/1/2203).

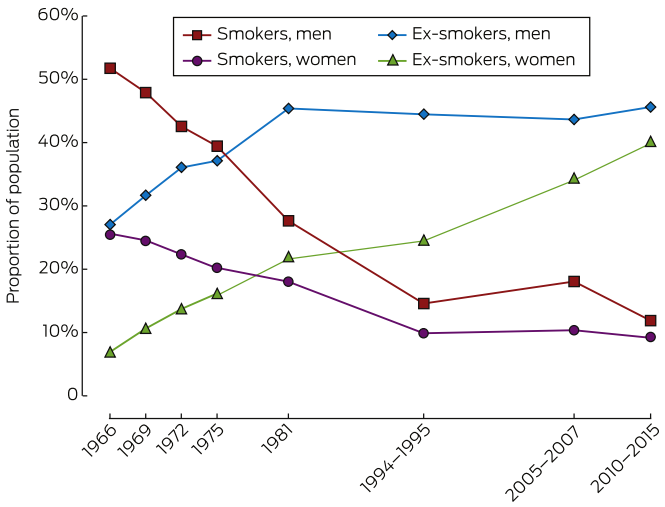
Results

Between 1966 and 2015, the prevalence of tobacco smoking declined among 46–65 year-old Busselton residents, from 53% to 12% in men and from 26% to 9% in women (Box 1). The prevalence of ever-smoking (ie, of current and ex-smokers) declined from 80% to 57% in men, but increased from 33% to 50% in women. Lung function — as indicated by FEV_1 as a percentage of the predicted normal level — improved during the same period (Box 2). Consistent with this finding, the presence of COPD diagnosed according to spirometric criteria declined significantly (Box 3). All these changes were statistically significant ($P < 0.001$).

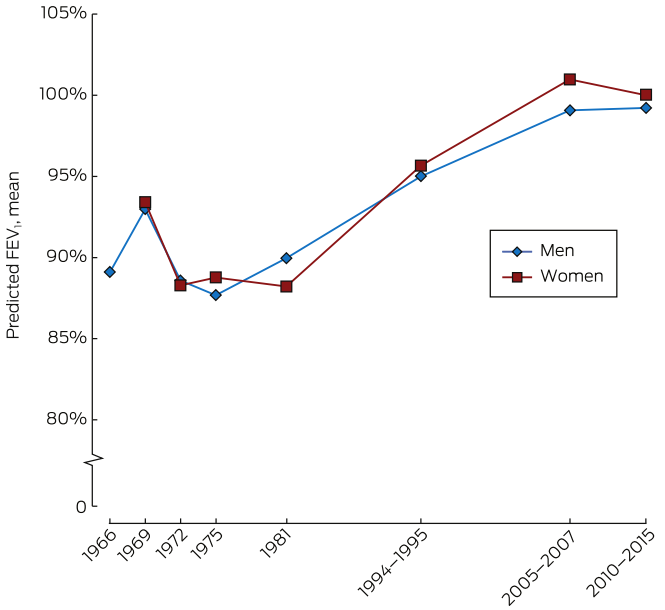
The prevalence of cough and phlegm (Box 4) and of doctor-diagnosed asthma increased after 1966 (Box 5), while the prevalence of dyspnoea increased slightly among women and decreased slightly in men (Box 6) (all $P < 0.001$).

The questionnaire responses indicated that reliance on SABAs for both asthma and COPD has declined since the 1994–1995 survey (when medications were first recorded); the use of oral agents (OBDs, OCSs) also declined, while the use of long-acting

1 Age-standardised proportions of 46–65-year-old smokers and ex-smokers in the Busselton Health Study surveys, 1966–2015

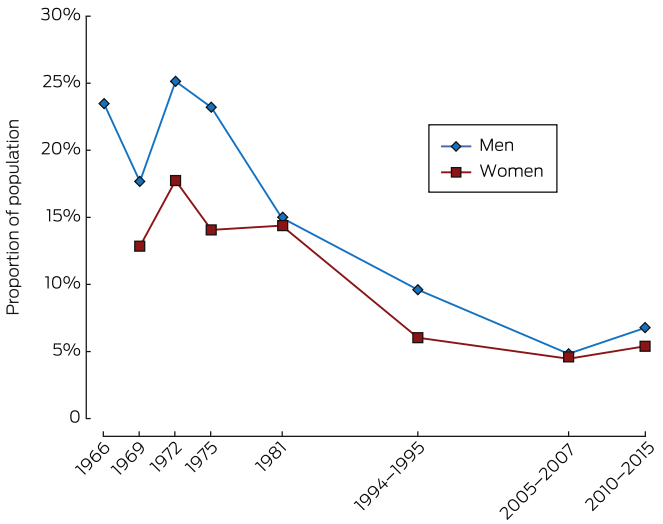


2 Mean percentage predicted FEV_1 for 46–65-year-old participants in the Busselton Health Study surveys, 1966–2015*



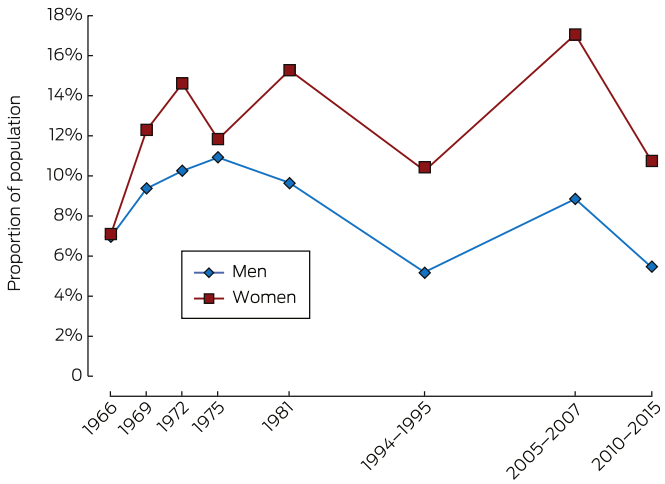
FEV_1 = forced expiratory volume in one second. * Spirometric assessment of women was not undertaken in the 1966 survey. ◆

3 Prevalence of spirometry-defined chronic obstructive pulmonary disease among 46–65-year-old participants in the Busselton Health Study surveys, 1966–2015*



* Spirometric assessment of women was not undertaken in the 1966 survey.

5 Age-standardised prevalence of doctor-diagnosed asthma among 46–65-year-old participants in the Busselton Health Study surveys, 1966–2015



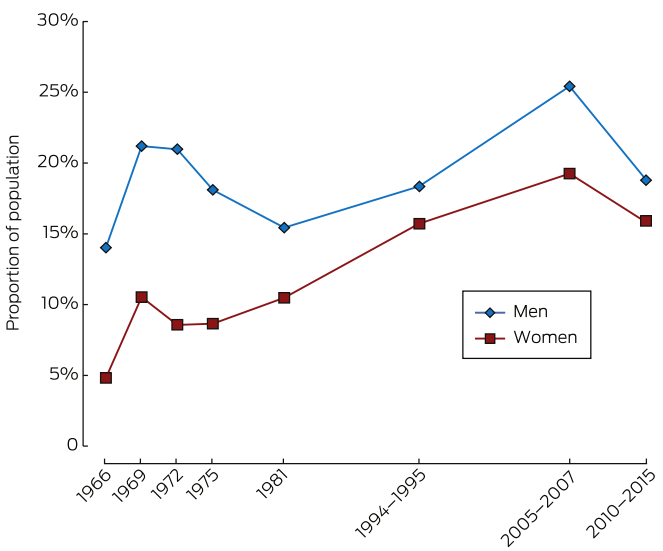
aerosol bronchodilator medications (LABAs, LAMAs) for doctor-diagnosed asthma and COPD has increased over the same period (Box 7).

Discussion

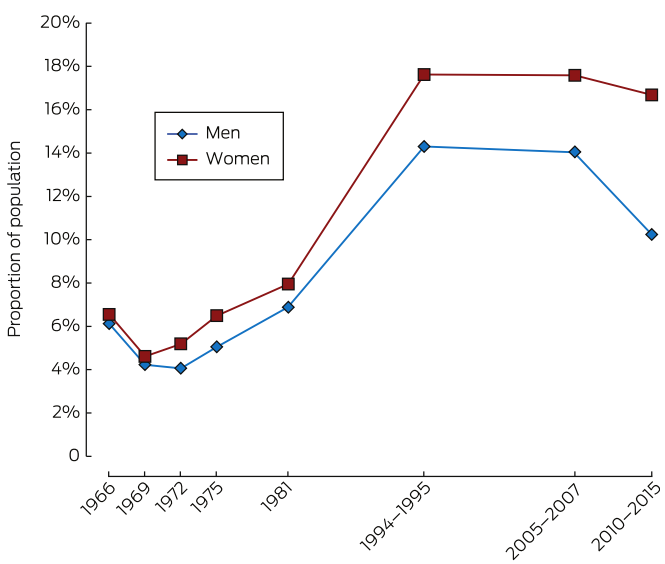
Smoking rates in the Busselton community have decreased over the past 50 years, although the decline appears to have slowed after the 1994–1995 survey. The decline in smoking rates has been attributed to efforts by health professionals, to statewide changes in pricing and prohibitions of smoking in certain areas, as well as to feedback of individual and overall survey results to the Busselton study participants and the local community. The reduction in smoking prevalence has not been associated with consistent reductions in rates of respiratory symptoms, but there have been significant improvements in objective indices of lung function.

Other explanations for our findings include the effects of improved and new medical treatments for established asthma and COPD. Bronchodilator regimens have improved and become more accessible over the past 50 years; other advances include treatment with high dose inhaled corticosteroids, metered dose inhalers and simple delivery devices for long-acting β-agonists and anticholinergic agents (since 1994–1995), education of patients about therapy in the community (including pharmacies), and increased compliance with recommended treatments. These factors are likely to have contributed to the changes we observed, together with the reduced smoking rates.

4 Age-standardised prevalence of cough and phlegm among 46–65-year-old participants in the Busselton Health Study surveys, 1966–2015



6 Age-standardised prevalence of dyspnoea among 46–65-year-old participants in the Busselton Health Study surveys, 1966–2015



7 Numbers of 46–65-year-old participants in the Busselton Health Study surveys, 1994–2015, with a history of doctor-diagnosed asthma or bronchial asthma or of chronic obstructive pulmonary disease (COPD), and the respiratory drug therapies employed by these patients

	People with asthma or bronchial asthma		People with COPD		People without asthma or COPD	
	Men	Women	Men	Women	Men	Women
Total numbers and proportions of survey participants, by survey period*						
1994–1995	105 (14%)	149 (18%)	62 (8%)	49 (6%)	539 (81%)	590 (80%)
2005–2007	60 (16%)	74 (17%)	18 (5%)	18 (5%)	303 (82%)	314 (79%)
2010–2015	219 (10%)	428 (17%)	118 (7%)	121 (5%)	1426 (84%)	1781 (80%)
Medication types employed (proportions of illness group)						
Short-acting β-agonists						
1994/95	46 (44%)	65 (44%)	18 (29%)	23 (47%)	3 (1%)	3 (1%)
2005/07	16 (27%)	24 (32%)	6 (33%)	4 (22%)	1 (0.3%)	0
2010/15	54 (25%)	114 (27%)	26 (22%)	36 (30%)	5 (0.4%)	5 (0.3%)
Long-acting β-agonists						
1994/95	0	0	0	0	0	0
2005/07	13 (22%)	17 (23%)	3 (17%)	2 (11%)	1 (0.3%)	1 (0.3%)
2010/15	54 (25%)	117 (27%)	23 (19%)	35 (29%)	5 (0.4%)	5 (0.3%)
Short-acting anti-muscarinic agents						
1994/95	1 (1%)	3 (2%)	1 (2%)	2 (4%)	0	0
2005/07	0	0	0	0	0	0
2010/15	0	1 (0.2%)	0	0	0	0
Long-acting anti-muscarinic agents						
1994/95	0	0	0	0	0	0
2005/07	2 (3%)	0	2 (11%)	0	1 (0.3%)	0
2010/15	4 (2%)	7 (2%)	4 (3%)	5 (4%)	0	1 (0.1%)
Inhaled corticosteroids						
1994/95	34 (32%)	45 (30%)	12 (19%)	18 (37%)	4 (1%)	1 (0.2%)
2005/07	17 (28%)	24 (32%)	5 (28%)	4 (22%)	1 (0.3%)	1 (0.3%)
2010/15	61 (28%)	131 (31%)	26 (22%)	37 (31%)	5 (0.4%)	7 (0.4%)
Oral bronchodilators						
1994/95	3 (3%)	9 (6%)	2 (3%)	4 (8%)	0	0
2005/07	0	1 (1%)	0	1 (6%)	0	0
2010/15	1 (0.5%)	3 (1%)	0	1 (1%)	0	0
Oral corticosteroids						
1994/95	2 (2%)	2 (1%)	1 (2%)	0	1 (0.2%)	1 (0.2%)
2005/07	1 (2%)	1 (1%)	0	0	4 (1%)	5 (2%)
2010/15	3 (1%)	6 (1%)	1 (1%)	1 (1%)	5 (0.4%)	6 (0.3%)

* Percentages are based on numbers of men and women without missing data, and therefore based on different denominators. ◆

We previously reported that adult-onset asthma in Busselton in 1994–1995 was more prevalent among cigarette smokers.[10] As many participants in the 1994–95 study would also have participated in the 2010–2015 survey, the observed improvements in lung function might have been expected because of the decline in smoking rates found by the earlier study.

We reported in a previous article that the prevalence of doctor-diagnosed asthma in the Busselton population increased between 1966 and 2005[11] (also seen in Box 5). This might be explained by diagnostic transfer resulting from the increased availability of more convenient and effective bronchodilator regimens, making the diagnosis of asthma more attractive to doctors, although a genuine increase in the prevalence of asthma in the population is also possible. Our 2010–2015 study and the findings in this report underline the difficulties of defining common airway diseases, and highlight the importance of objectively assessing chronic lung disease syndromes. The observed trends may reflect a combination of period and cohort effects, but disentangling the two would be difficult, particularly as our analysis was restricted to people aged 46–65 years during each survey.

The Busselton studies have been recognised as landmark population investigations[12,13] because they have provided

important epidemiological, clinical, and physiological information, as well as physical material for genetic studies. However, it is unlikely that changes in genetic characteristics could account for the changes we observed in this relatively stable and Australian population, predominantly of European background.

It might be anticipated that the prevalence of other smoking-related diseases in the Busselton population also declined over the 50-year period of the surveys. Consistent with the results of our study, it has indeed been reported that heart disease mortality in Busselton has improved.[14]

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Competing interests: No relevant disclosures.

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