Supplementary Material

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What are the health and socioeconomic impacts of allergic respiratory disease in Tasmania?

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1 Detailed methods and tables

1.1. Population and Prevalence

Table S1. Tasmanian population by year and sex (all ages) and by age group and sex (2018) (1)

Population	Females	Males	**Total**
By year			
2010	255,894	252,953	**508,847**
2011	256,693	254,790	**511,483**
2012	257,157	254,691	**511,848**
2013	257,891	254,629	**512,520**
2014	259,092	254,747	**513,839**
2015	260,385	255,011	**515,396**
2016	261,860	255,728	**517,588**
2017	263,689	258,463	**522,152**
2018	266,767	261,434	**528,201**
By age groups (2018)			
0-14 years	45,339	48,372	**93,711**
15-24 years	30,314	33,091	**63,405**
25-34 years	31,937	31,731	**63,668**
35-44 years	30,928	29,399	**60,327**
45-54 years	35,860	33,627	**69,487**
55-64 years	37,578	35,997	**73,575**
65-74 years	30,883	29,928	**60,811**
75+	23,928	19,289	**43,217**
All	**266,767**	**261,434**	**528,201**

Table S2. Prevalence estimate (thousands) of asthma and allergic rhinitis in Tasmania (2)

Prevalence	Asthma		Allergic rhinitis	
	n	*%*	n	*%*
By year				
2001	53.7	*11.6*	73.2	*15.8*
2004-05	62.5	*13.2*	69.8	*14.7*
2007-08	57.0	*11.8*	80.2	*16.5*
2011-12	58.1	*11.6*	94.7	*18.9*
2014-15	63.3	*12.6*	109.3	*21.7*
2017-18	66.0	*12.9*	109.4	*21.3*
By sex (2017-18)				
Females	39.0	*15.1*	53.9	*20.9*
Males	27.5	*10.9*	54.4	*21.5*
By age group (2017-18)				
0-24	20.3	*13.1*	31.5	*20.4*
25-44	16.4	*13.6*	32.8	*27.1*
45-64	19.4	*13.7*	30.6	*21.6*
65+	11.3	*11.7*	13.3	*13.8*

1.2. Direct Costs

1.2.1. ED visits, hospitalisations and GP visits

In the case of ED visits and hospitalisations, and when the incidence rate was not available, the incidence rate was calculated using the following standard equation:

$$IR_{o,d} = \frac{\#\ cases_{o,d,y} \times 100{,}000}{Pop_y}\ (cases\ per\ 100{,}000\ persons)$$

Where # $cases_{o,d,y}$ was the number of cases for outcome 'o', disease 'd', and year 'y', Pop_y was the population for year 'y', and $IR_{o,d}$ was the estimated incidence rate for outcome 'o' and disease 'd'. Where more than one year of data was available, an average was obtained, and assumed that the rate was constant in time.

The number of GP visits was estimated using rates per GP encounters from the Bettering the Evaluation and Care of Health (BEACH) program (3,4), and the annual number of GP visits was obtained from the Annual Medicare Statistics (5), considering the GP/VR GP Non-Referred Attendances.

1.2.2. Medication use

For asthma, the average yearly prescriptions incidence rate per 1,000 persons with asthma was estimated, and the yearly medication use was estimated using the following equation:

$$MedUse_{asthma_{2018_d}} = \frac{IR_{MU_d} \times Prev_{asthma_{2018}}}{1{,}000} \ (prescriptions\ per\ year)$$

Where $MedUse_{asthma_{2018_d}}$ was the total medication use of drug 'd' for asthma in 2018, IR_{MU_d} was the incidence rate for medication use for each drug 'd', and $Prev_{asthma_{2018}}$ was the prevalence of asthma for 2018.

For allergic rhinitis, Smith et al. (6) estimated that between 2013 and 2014 there was an average of 74,339 rhinitis therapy pharmacy transactions per year (96% single therapy and 4% multiple therapy types). We extrapolated the number of transactions per pharmacy to account for the 148 pharmacies operating in Tasmania during those years (PBS Expenditure and Prescriptions twelve months to 30 June 2017), and estimated a total of 440,087 AR pharmacy transactions for 24 months during 2013 and 2014. The incidence rate of transactions per 1,000 persons with AR was then estimated by dividing the yearly number of pharmacy transactions by the prevalence of people with AR.The number of transactions for AR medication use for 2018 was then estimated using the following equation:

$$MedUse_{AR_{2018_t}} = \frac{IR_{AR_t} \times Prev_{AR_{2018}}}{1{,}000}$$

Where $MedUse_{AR_{2018_t}}$ was the total number of pharmacy transactions for each type of transaction 't' associated with the treatment of AR in 2018, IR_{AR_t} was the incidence rate for medication use for each transaction type 't' (single or multiple therapy transaction) and $Prev_{AR_{2018}}$ was the prevalence of AR for 2018.

1.2.3. Other standard medical services and investigations

For asthma, Australia-wide costs for asthma as a burden of disease group condition was used and a per person cost using national asthma prevalence was estimated using the following equation:

$$UnitExp_{asthma_a} = \frac{Exp_{asthma_{2015-2016,a}}}{\left(\frac{Prev_{asthma,2014/2015} + Prev_{asthma,2017/2018}}{2}\right)}$$

Where $UnitExp_{asthma_a}$ was the estimated unitary expenditure cost for area of expenditure 'a' in AU$ per person-year, $Exp_{asthma_{2015-2016,a}}$ was the total expenditure for asthma for area of expenditure 'a' for the period 2015-16, $Prev_{asthma,2014/2015}$ was the asthma prevalence in Australia for the period 2014-15 (7) and $Prev_{asthma,2017/2018}$ was the asthma prevalence in Australia for the period 2017-18 (2). Then, total costs for Tasmania were estimated using the following equation:

$$OSMSICost_{asthma_{2018}} = \sum_{a} \left(UnitExp_{asthma_a} \times Prev_{asthma,TAS_{2018}} \right)$$

Where $OSMSICost_{asthma_{2018}}$ was the total cost for other standard medical services and investigations for asthma in 2018, and $Prev_{asthma,TAS_{2018}}$ was the prevalence of asthma for 2018 in Tasmania, and 'a' was the area of expenditure.

For AR, total costs for other standard medical services and investigations in Tasmania was estimated using the following equation:

$$OSMSICost_{AR_{2018}} = UnitExp_{AR_{ahos}} \times Prev_{AR,TAS_{2018}} + \sum_{a} \left(AvgFee_a \times GP_{enc,AR,TAS_{2018}} \times \%GPV_a \right)$$

Where $OSMSICost_{AR_{2018}}$ was the total cost for other standard medical services and investigations for AR in 2018, $UnitExp_{AR_{ahos}}$ was the estimated unitary expenditure cost for allied health and other services in AU$ per person-year, $Prev_{AR,TAS_{2018}}$ was the prevalence of AR for 2018 in Tasmania, $AvgFee_a$ was the average fee for AR per area of expenditure 'a' (allied health and other services; medical imaging; pathology; specialist services), $GP_{enc,AR,TAS_{2018}}$ was the number of GP encounters for AR in 2018 in Tasmania and $\%GPV_a$ was the percentage of GP encounters in which pathology tests were ordered, patients were referred to specialists or imaging tests were ordered.

1.3. Indirect Costs

1.3.1. Mortality

Based on the number of deaths with asthma as a primary cause (Table S3), the following equation was used to estimate an average asthma mortality incidence rate by sex across the Tasmanian population:

$$IR_{mort,asthma,s} = \frac{\sum_y \frac{\#\ cases_{mort,asthma,y,s} \times 100{,}000}{Pop_{y,s}}}{\#\ years} \ (cases\ per\ 100{,}000\ persons)$$

where $\#\ cases_{mort,asthma,y,s}$ was the number of cases for asthma mortality for sex 's' and year 'y', $Pop_{y,s}$ was the population for year 'y' and sex 's', and $IR_{mort,asthma,s}$ was the estimated incidence rate for asthma mortality (average between 2010 and 2017). Then, the total number of cases was estimated using the following equation:

$$\#\ cases_{mort,asthma,2018,s} = \frac{IR_{mort,asthma,s} \times Pop_{2018}}{100{,}000} \ (cases\ per\ year)$$

where $\#\ cases_{mort,asthma,2018,s}$ was the number of estimated asthma mortality cases for sex 's' during 2018.

Table S3. Total deaths by underlying cause, Asthma (ICD-10 code J45), Tasmania, 2010 – 2017 (8)

Year	Females	Males	Total
2010	10	4	**14**
2011	9	4	**13**
2012	7	5	**12**
2013	6	2	**8**
2014	10	5	**15**
2015	7	5	**12**
2016	8	7	**15**
2017	8	4	**12**

1.4. Lost productivity

Lost productivity is a component of indirect costs that includes Absenteeism, Presenteeism and Caregiver absenteeism. Absenteeism refers to the loss of working days as a result of experiencing a particular health condition, while presenteeism relates to working at suboptimal capacity due to this condition (9,10). Caregiver absenteeism refers to when parents or caregivers are impacted by the loss of working days to take care for asthma (or AR) affected children (11). Usually, lost productivity is measured in terms of days per year or percentage of time off work or working at low levels of productivity. There is large variation of estimated average lost days of work (absenteeism), lost productivity (presenteeism), and caregiver absenteeism per year amongst different studies (12–18).

For asthma, estimates for absenteeism range between 2.6 days of work per year as estimated from results of the 2011-12 Australian Health Survey (AHS) (12), to 23.25 days per year (9.3% of hours missed on sick days and time missed from being late or leaving early due to asthma) as estimated by Gruffydd-Jones (13). For the US, Nurmagambetov (14) estimated an additional 1.8 days missed from work due to illness/injury for people with asthma compared to people with no asthma. Higher values were found in Spain, with 1.54 days not working in a period of one month (~ 18.5 days per year) (15). Likewise, for presenteeism, estimates range between 3.67 days per year as estimated by McGregor et al. (16), to 11% of average daily productivity loss (~ 27.5 days per year) as estimated by Goetzel et al. (19). For Australia, Ampon et al (17) estimated that people with asthma have an additional 6.1 reduced activity days/year compared with people with no asthma. For caregiver absenteeism, estimates for the US range between 2.2 days/year to 7.87 days/year as estimated by Nurmagambetov (14) and Sullivan et al. (20) respectively.

Similarly, estimates on lost productivity due to AR show high variability, but are lower to those related to asthma. Absenteeism estimates range from 2.3 days/year in Sweden (21) to 8.5 days/year in the US (19). In relation to presenteeism, Lamb et al. (22) found that US employees with AR experienced symptoms during 52.5 days, and while they were symptomatic they were very unproductive for 2.3 hours (28.8% of the time). Considering 250 days working year, this would equate to an equivalent of 10.3 working days/year lost to reduced productivity. Hellgren et al. (21) estimated that the average productivity loss due to AR presenteeism is of 2 days/year. McGregor et al. (16) found that allergies/hay fever contribute to 6.12 days per year of presenteeism-related productivity loss. A systematic review done by Vandenplas et al. (18) obtained pooled estimates for absenteeism (3.6% [95% CI, 2.6% - 4.8%] missed work time) and presenteeism (35.9% [95% CI, 29.7% – 42.1%] impairment in work productivity). Estimates for caregiver absenteeism are lower to those obtained for asthma, and range between 0.8 days/year (21) and 3.68 days/year (22).

The total lost productivity was estimated using the following equation:

$$LostProductivity_{d,o,s} = \#Persons_d \times DaysLost\ Productivity_{d,o,s}$$

Where $LostProductivity_{d,o,s}$ was the total number of days of lost productivity for disease 'd' (asthma or AR), outcome 'o' (absenteeism, presenteeism, caregiver absenteeism) and scenario 's' (low, high); $\#Persons_d$ was the number of persons that have the disease 'd' and are potentially affected by lost productivity, and $DaysLost\ Productivity_{d,o,s}$ was the unit value in days/year of lost productivity for disease 'd', outcome 'o' and scenario 's'. In the case of absenteeism and presenteeism, $\#Persons_d$ was represented by the number of employed persons with disease 'd', and this was obtained by multiplying the percentage of employed population (23,24) by the prevalence of disease 'd'. In the case of caregiver absenteeism $\#Persons_d$ was represented by the number of school aged children between 5 and 14 years of age that had the disease 'd'. It was assumed that when one child missed school, one adult assumed the job of carer.

To estimate the average daily cost for care-giver absenteeism, the proportion of employed people was first estimated and used as the probability that the carer was employed. Then, the cost per day of care was calculated as the expected value of the salary loss, using the following equation:

$$Daily_{carer_{cost}}\left(\frac{AU\$}{day}\right) = \frac{\#EmployedPeople}{Population\_\ over15} \times Daily_{salary}(\frac{AU\$}{day})$$

Where $Daily_{carer_{cost}}$ was the estimated daily carer cost (or lost salary), $\#EmployedPeople$ was the total number of employed people over 15 years of age in Tasmania, $Population\_\ over15$ was the total population over 15 years of age (candidates to caring for a child), and $Daily_{salary}$ was the average daily salary for the Tasmanian population. We estimated an average daily care cost of AU$130 for 2018.

2 References

1. Australian Bureau of Statistics. ERP by SA2 (ASGS 2016), Age and Sex, 2001 Onwards. (2018) Available at: http://stat.data.abs.gov.au/Index.aspx?DataSetCode=ABS_ERP_ASGS2016 [Accessed November 15, 2018]

2. Australian Bureau of Statistics. National Health Survey, 2017-18. (2018) Available at: https://www.abs.gov.au/statistics/health/health-conditions-and-risks/national-health-survey-first-results/2017-18

3. Britt H, Miller GC, Henderson J, Bayram C, Harrison C, Valenti L, Wong C, Gordon J, Pollack AJ, Pan Y, et al. General practice activity in Australia. (2015). doi:GEP 27

4. Fahridin S, Britt H. Allergic rhinitis. Aust Fam Physician (2008) 37:

5. Department of Health. Annual Medicare Statistics. (2019) Available at: https://www1.health.gov.au/internet/main/publishing.nsf/Content/Medicare Statistics-1 [Accessed September 12, 2019]

6. Smith P, Price D, Harvey R, Carney AS, Kritikos V, Bosnic-Anticevich SZ, Christian L, Skinner D, Carter V, Durieux AMS. Medication-related costs of rhinitis in Australia: a NostraData cross-sectional study of pharmacy purchases. J Asthma Allergy (2017) 10:153–161. doi:10.2147/JAA.S128431

7. Australian Bureau of Statistics. National Health Survey, 2014-15. (2015) Available at: https://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/255E8365AB10F879CA258360000D24DB?opendocument

8. Australian Bureau of Statistics. 3303.0 Causes of Death, Tasmania, 2017. (2018) Available at: https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/3303.02017?OpenDocument

9. Baptista MC, Burton WN, Nahas AK, Wang Y-P, Viana MC, Andrade LH. Absenteeism and Presenteeism Associated With Common Health Conditions in Brazilian Workers. J Occup Environ Med (2019) 61:303–313. doi:10.1097/JOM.0000000000001538

10. Nurmagambetov T, Khavjou O, Murphy L, Orenstein D. State-level medical and absenteeism cost of asthma in the United States. J Asthma (2017) 54:357–370. doi:10.1080/02770903.2016.1218013

11. Nunes C, Pereira AM, Morais-Almeida M. Asthma costs and social impact. Asthma Res Pract (2017) 3:1. doi:10.1186/s40733-016-0029-3

12. Deloitte Access Economics. The hidden cost of asthma. (2015).

13. Gruffydd-Jones K, Thomas M, Roman-Rodríguez M, Infantino A, FitzGerald JM, Pavord I, Haddon JM, Elsasser U, Vogelberg C. Asthma impacts on workplace productivity in employed patients who are symptomatic despite background therapy: a multinational survey. J Asthma Allergy (2019) Volume 12:183–194. doi:10.2147/JAA.S204278

14. Nurmagambetov T, Kuwahara R, Garbe P. The Economic Burden of Asthma in the United States, 2008–2013. Ann Am Thorac Soc (2018) 15:348–356. doi:10.1513/AnnalsATS.201703-259OC

15. Ojeda P, de Burgoa VS. Costs associated with workdays lost and utilization of health care resources because of asthma in daily clinical practice in Spain. J Investig Allergol Clin Immunol (2013) 23:234–241.

16. McGregor A, Ashbury F, Caputi P, Iverson D. A Preliminary Investigation of Health and Work-

Environment Factors on Presenteeism in the Workplace. J Occup Environ Med (2018) 60:e671–e678. doi:10.1097/JOM.0000000000001480

17. Ampon RD, Williamson M, Correll PK, Marks GB. Impact of asthma on self-reported health status and quality of life: a population based study of Australians aged 18-64. Thorax (2005) 60:735–739. doi:10.1136/thx.2005.040311

18. Vandenplas O, Vinnikov D, Blanc PD, Agache I, Bachert C, Bewick M, Cardell L-O, Cullinan P, Demoly P, Descatha A, et al. Impact of Rhinitis on Work Productivity: A Systematic Review. J Allergy Clin Immunol Pract (2018) 6:1274-1286.e9. doi:10.1016/J.JAIP.2017.09.002

19. Goetzel RZ, Long SR, Ozminkowski RJ, Hawkins K, Wang S, Lynch W. Health, absence, disability, and presenteeism cost estimates of certain physical and mental health conditions affecting U.S. employers. J Occup Environ Med (2004) 46:398–412. doi:10.1097/01.jom.0000121151.40413.bd

20. Sullivan PW, Ghushchyan V, Navaratnam P, Friedman HS, Kavati A, Ortiz B, Lanier B. The national burden of poorly controlled asthma, school absence and parental work loss among school-aged children in the United States. J Asthma (2018) 55:659–667. doi:10.1080/02770903.2017.1350972

21. Hellgren J, Cervin A, Nordling S, Bergman A, Cardell LO. Allergic rhinitis and the common cold - high cost to society. Allergy (2009) 65:776–783. doi:10.1111/j.1398-9995.2009.02269.x

22. Lamb CE, Ratner PH, Johnson CE, Ambegaonkar AJ, Joshi A V., Day D, Sampson N, Eng B. Economic impact of workplace productivity losses due to allergic rhinitis compared with select medical conditions in the United States from an employer perspective. Curr Med Res Opin (2006) 22:1203–1210. doi:10.1185/030079906X112552

23. Australian Bureau of Statistics. 6202.0 - Labour Force, Australia, Nov 2019. (2019) Available at: https://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/6050C537617B613BCA25836800102753?opendocument [Accessed December 15, 2019]

24. Australian Bureau of Statistics. Labour Force, Australia, October 2018. (2018) Available at: http://www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/8A84F3F8AE60BF39CA2583690004C6D1?opendocument [Accessed December 12, 2018]