

Cost-Related Underuse of Medicines for Asthma—Opportunities for Improving Adherence



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What is already known about this topic? Nonadherence with asthma medicines is a global, avoidable problem exacerbated in the presence of financial barriers. In the United States, evidence has shown cost-related underuse of asthma medicines to be common amongst older patients.

What does this article add to our knowledge? Despite universal medicine access, cost-related underuse behavior rates (eg, reducing doses, skipping medicines, not [re]-filling prescriptions) were high across all age groups, impervious to concession beneficiary status and household income, but influenced by doctor-patient relationships.

How does this study impact current management guidelines? Targeting of interventions by physicians involved in respiratory care to promote the discussion of medicine costs with patients is urgently needed to address the unmet needs of nonadherence in asthma.

BACKGROUND: In asthma, underuse of cost-effective preventive treatments increases morbidity and mortality. The cost of medicines contributes to underuse (“nonadherence”), but the extent to which people with asthma skip or reduce doses or let prescriptions go unfilled when faced with cost pressures is unknown.

OBJECTIVE: To estimate the extent of cost-related underuse behaviors and associated factors.

METHODS: Using previously validated summary indicators, we conducted an online cross-sectional survey of adults and parents of children 5 to 17 years with asthma in Australia (a high-income country) and developed logistic regression models for adults and children with asthma, controlling for key clinical and demographic factors.

RESULTS: The survey was completed by $n = 792$ adults (mean age, 47 [standard deviation, 17] years, male 47%, concession

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Abbreviations used

COPD- Chronic obstructive pulmonary disease

CPI- Consumer price index

ICS- Inhaled corticosteroid

LABA- Long-acting β -agonist

60%) and $n = 609$ parents of children (5-10 years 51%, male 60%, concession 59%) with asthma. Cost-related underuse was reported by 52.9% adults and 34.3% parents, predominantly decreasing or skipping doses to make medicines last longer. Higher odds of cost-related underuse were observed with younger adults (adults: odds ratio [OR]: 1.19; 95% confidence interval [CI]: 1.12, 1.27), males (adults: OR: 1.49; 95% CI: 1.06, 2.08), having concerns about medicines (adults: OR: 3.12; 95% CI: 2.17, 4.35; parents: OR: 2.63; 95% CI: 1.56, 4.55), less comfortable talking to prescribers about cost (parents: OR: 1.22; 95% CI: 1.12, 1.33) or changing medicines (adults: OR: 1.12; 95% CI: 1.03, 1.22), feeling less engaged with prescribers about medicine decisions (parents: OR: 1.11; 95% CI: 1.01, 1.23), and with poorer asthma control (adults, poor control: OR: 1.87; 95% CI: 1.13, 3.09; parents, poor control: OR: 3.87; 95% CI: 1.99, 7.54), and requiring specialist (parents: OR: 1.83; 95% CI: 1.16, 2.87) or urgent health care visits (adults: OR: 1.54; 95% CI: 1.06, 2.23). Income and concession card status were not associated with cost-related underuse.

CONCLUSIONS: Adults and parents of children with asthma indicate high rates of cost-related underuse of asthma medicines, even in the context of national medicines subsidies.

Urgent targeting of interventions to promote discussion of medicines and costs between doctor and patients, particularly young adult males, is needed. © 2019 American Academy of Allergy, Asthma & Immunology (J Allergy Clin Immunol Pract 2019;7:2298-306)

Key words: Medication adherence; Asthma; Drug therapy

Asthma, a common chronic disease in children and adults, is one of the world's leading causes of death and disability and a substantial economic strain on health systems.¹ Inhaled corticosteroids (ICS) are cost-effective controller treatments that, if taken regularly, reduce the risk of serious exacerbations^{2,3} and asthma-related death.⁴ However, underuse of ICS limits clinical effectiveness and thus likely reduces the potential health-related and economic benefits on offer from such therapies.⁵

Adherence with ICS-containing medications is poor, averaging as little as 25% of the prescribed dose.⁶ Many factors, including lack of belief about the necessity of treatment and concerns about risks, are known to contribute.^{5,7} Out-of-pocket costs to patients also impact on the use of medicines for asthma among both adults and children.⁸⁻¹⁰ Higher out-of-pocket costs not only lead to significant lower supply of long-term medicines⁹ but also to more asthma-related hospitalizations and outpatient and emergency department visits.^{8,10} Evidence from the United States shows asthma to be associated with the some of the highest rates of cost-related underuse behaviors (ie, reducing doses, skipping medicines, or not [re]-filling prescriptions because of

cost). This behavior is not related to income¹¹ and occurs to a greater extent for asthma than for medications prescribed for other conditions such as cardiovascular diseases and diabetes.¹² In one of the only studies that has specifically compared cost-related underuse of medicines among those with and without asthma, people with asthma (and other chronic pulmonary diseases) who were prescribed inhalers had 43% higher odds of reporting cost-related underuse behaviors compared with those without such diseases.¹³

In Australia, although residents benefit from federally funded universal health coverage,¹⁴ and all inhaled asthma controller medications are government subsidized, individuals pay a copayment for each medicine dispensed. For concessional patients (those receiving government benefits [aged, unemployed, single parents, and long-term disability]), this is currently USD4.75 per prescription, whereas general (nonconcessional) patients pay up to USD29.23 per prescription. A "safety net" caps total annual copayments at the family level at USD284.16 (concession) and USD1126.13 (general). Copayments and safety nets increase annually with the consumer price index (CPI).

When the value of copayments for medicines rose in real terms (ie, more than the CPI increase) in 2005, dispensing data showed marked decreases in medicine use particularly for asthma and chronic obstructive pulmonary disease (COPD), especially among vulnerable groups.¹⁵ This reinforced earlier evidence suggesting cost as a barrier to the purchase of ICS inhalers,¹⁶ but efforts to address cost as a barrier to the use of asthma medicines have yet to emerge. Recent qualitative evidence shows that although such costs are acknowledged as a major issue by people with asthma, awareness of this by general practitioners is low.^{17,18}

Despite such evidence, the extent to which people with asthma skip or reduce doses or let prescriptions go unfilled when faced with cost pressures is unknown. This study sought to determine the extent of underuse of asthma medicines due to cost and identify factors that may be associated with such behavior, across a broad range of people with asthma. Some of the results of this study have been previously reported in the form of an abstract.^{19,20}

METHODS

Population

This study included a cross-section of Australian adults and parents of children aged 5 to 17 years with asthma. A nationally representative sample, based on Australian Bureau of Statistics for people with asthma stratified by age, gender, and location, was recruited through an online panel provider (Survey Sampling International, Melbourne, Australia), using a methodology that has been previously reported in detail.²¹ Panel members were selected via a 3-stage random selection process. First, a random sample of panel members was asked to participate in a survey (topic unspecified). Those who responded were asked one of several randomly selected profiling questions, including "Which of the following ailments have you ever suffered from?"; those who selected "asthma" were then filtered to identify those with current asthma and parents of children with current asthma aged 5 to 17 years, using standardized screening questions (see Table E1 in this article's Online Repository at www.jaci-inpractice.org).

Study recruitment was stratified by age, gender, and state of residence according to Australian Bureau of Statistics data for people with asthma.²² For completing the survey, participants received

TABLE I. Characteristics of 1401 respondents with asthma (792 adults and 609 children), overall and by self-reported cost-related medication underuse (see [Figure 1](#))

	Adult, n (%)		Children, n(%)	
	Overall (n = 792)	Any cost-related underuse (n = 419, 52.9%)	Overall (n = 609)	Any cost-related underuse (n = 209, 34.3%)
Age (mean, SD)*	47.0 (17.0)	42.3 (16.2)	40 (10.3)	36.9 (9.8)
Age, child with asthma				
5-10 y	—	—	309 (50.7)	130 (62.2)
11-17 y	—	—	300 (49.3)	79 (37.8)
Male gender (of person with asthma)	375 (47.3)	203 (48.4)	364 (59.8)	135 (64.6)
Annual household income, pretax (USD)				
Less than 38,480	298 (37.6)	141 (33.7)	149 (24.5)	47 (22.5)
38,480-53,871	137 (17.3)	85 (20.3)	102 (16.7)	44 (21.1)
>53,871	269 (34.0)	163 (38.9)	301 (49.4)	100 (47.8)
Concession beneficiary				
Yes	478 (60.4)	252 (60.1)	322 (52.9)	132 (63.2)
Self- or parent-rated health of person with asthma				
Excellent	34 (4.3)	19 (4.5)	86 (14.1)	35 (16.7)
Very good	209 (26.4)	103 (24.6)	312 (51.2)	103 (49.3)
Good	314 (39.6)	173 (41.3)	174 (28.6)	53 (25.4)
Fair	182 (23.0)	96 (22.9)	33 (5.4)	15 (7.2)
Poor	53 (6.7)	28 (6.7)	4 (0.7)	3 (1.4)
GINA symptom control, previous 4 wk				
Well controlled	178 (22.5)	57 (13.6)	149 (24.5)	18 (8.6)
Partly controlled	362 (45.7)	197 (47)	244 (40.1)	79 (37.8)
Poorly controlled	252 (31.8)	165 (39.4)	216 (35.5)	112 (53.6)
Urgent health service utilization for asthma, previous 12 mo				
One or more ED or hospital visits for worsening asthma	170 (21.5)	125 (29.8)	251 (41.2)	131 (62.7)
One or more urgent GP visits for asthma	337 (42.6)	228 (54.4)	366 (60.1)	165 (78.9)
Any urgent health service utilization for asthma	353 (44.6)	236 (56.3)	390 (64.0)	170 (81.3)
ICS-containing medications in last 12 mo				
No ICS	326 (41.2)	165 (39.4)	322 (52.9)	96 (45.9)
ICS-alone only	92 (11.6)	59 (14.1)	141 (23.2)	54 (25.8)
ICS/LABA ± ICS-alone	374 (47.2)	195 (46.5)	146 (24.0)	59 (28.2)
Concerns with asthma medications [†]				
Possible side effects of medications	241 (30.4)	154 (36.8)	214 (35.1)	84 (40.2)
Overuse of medication	148 (18.7)	103 (24.6)	180 (29.6)	89 (42.6)
The cost of medication	231 (29.2)	181 (43.2)	176 (28.9)	104 (49.8)
Forgetting the medication	144 (18.2)	100 (23.9)	183 (30.0)	71 (34.0)
There are no issues that concern me	325 (41.0)	105 (25.1)	190 (31.2)	26 (12.4)
Shared decision making [‡]				
Mean (SD)	4.3 (2.7)	4.6 (2.5)	4.4 (2.2)	4.9 (2.2)
Comfort discussing with doctor [§]				
Changing medications (mean, SD)	7.0 (2.4)	6.6 (2.4)	6.7 (2.2)	6.1 (2.0)
Cost of medications (mean, SD)	6.6 (2.7)	6.1 (2.7)	6.4 (2.5)	5.5 (2.4)

ED, Emergency department; GINA, Global Initiative for Asthma; GP, general practitioner; ICS, inhaled corticosteroid; LABA, long-acting β -agonist; SD, standard deviation.

*For children, of parent responding to survey.

[†]"In your use of asthma medication, do any of the following issues concern you?" This was a multiple-item response.[‡]Respondents were asked to indicate on a scale of 0 to 10, "Who usually makes the decision about what your asthma treatment will be?" with 0 = me only, 10 = doctor only.[§]Respondents were asked to indicate on a scale of 0 to 10, "How comfortable do you feel talking to your doctor about (a) asking to change your medications and (b) the cost of your medications?" with 0 = not comfortable at all, 10 = very.

"points" to a value of approximately USD1.11 from the panel provider.

The study was approved by University of New South Wales Australia Human Research Ethics Advisory Panel Committee (approval number # HREAP 2014-7-34), and all participants provided informed consent.

The survey was conducted between December 2015 and March 2016. Details about the survey, including the Checklist for Reporting Results of Internet E-Surveys, can be found in the [Methods](#) section (available in this article's Online Repository at www.jaci-inpractice.org) and the full survey is available from the corresponding author on request.

TABLE II. Reasons for not filling asthma prescriptions reported by adults and parents of children with asthma (n, %)

	Overall (n = 1401)	Adult (n = 792)	Children (n = 609)
During the last 12 mo, were any asthma medicines prescribed that you did not get?*			
Yes	355 (25.3)	198 (25.0)	157 (25.8)
If yes: which of these reasons explains why you did not get your asthma medicine?†			
Thought it would cost too much	105 (29.6)	56 (28.3)	49 (31.2)
Felt better, didn't need medicine	101 (28.5)	55 (27.8)	46 (29.3)
Didn't think it was necessary for my asthma	69 (19.4)	47 (23.7)	22 (14.0)
Didn't have time	67 (18.9)	27 (13.6)	40 (25.5)
Couldn't get the medicine soon enough	48 (13.5)	27 (13.6)	21 (13.4)
Was afraid of/was experiencing side effects	46 (13.0)	29 (14.7)	17 (10.8)
No pharmacy convenient	38 (10.7)	13 (6.6)	25 (15.9)
Didn't have a way to get the medicine	27 (7.6)	9 (4.6)	18 (11.5)
Didn't think the medicine would help my asthma	25 (7.0)	12 (6.1)	13 (8.3)
Don't like taking medicine	22 (6.2)	19 (9.6)	3 (1.9)

*During the last 12 mo, were any asthma controller medications prescribed for you that you did not get filled (dispensed from a pharmacy)? Please think about refills as well as new prescriptions.

†Respondents could select more than 1 reason.

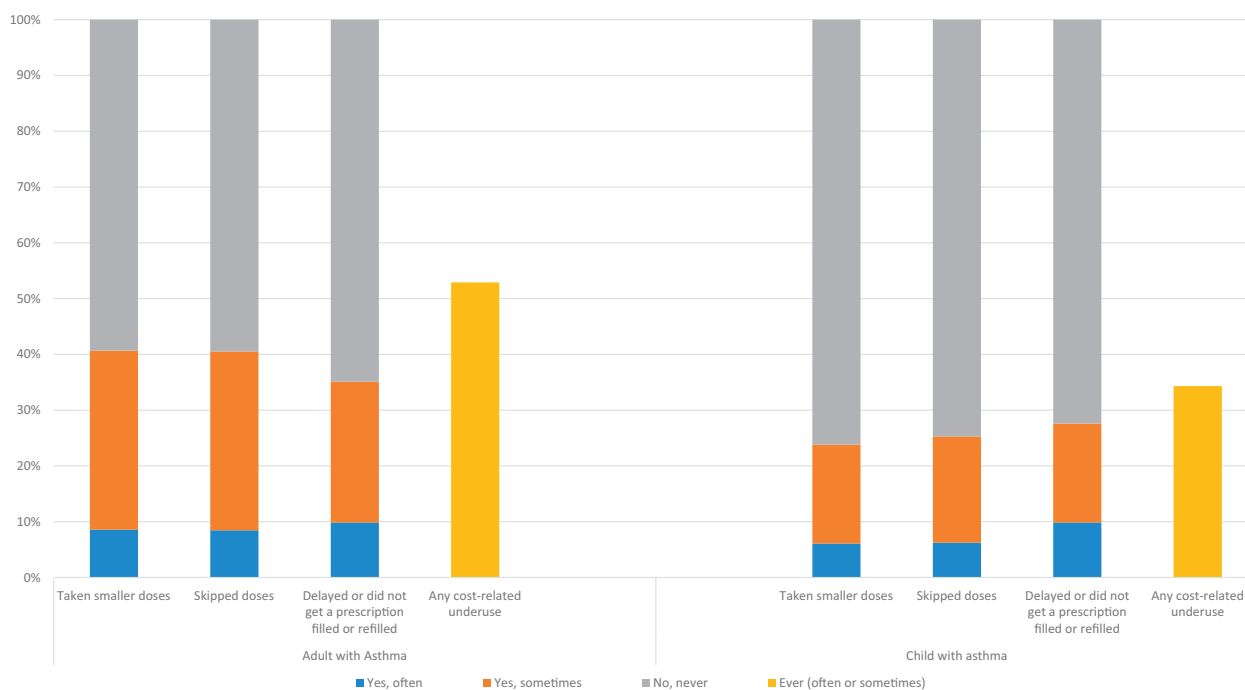


FIGURE 1. Proportion of cost-related underuse behaviors reported by adults (n = 792) and parents of children with asthma (n = 609) in the last 12 months.

Outcome

A previously validated and extensively used summary indicator for medication underuse behaviors due to cost was used.^{23,24} It was based on participants responding “yes, sometimes” or “yes, often” on any of the following questions specific to asthma medicines during the previous 12 months: “skipped doses to make the medicine last longer”; “taken smaller doses of a medicine to make the medicine last longer”; or “decide not to fill or refill a prescription because it was

too costly.” These questions have shown high test-retest reliability and construct validity.^{23,24}

Statistical analysis

Survey questions were used to determine the extent of cost-related underuse, and 2 logistic regression models were developed to determine the factors associated with cost-related underuse separately in (1) adults and (2) children with asthma. Given the large numbers

TABLE III. Relation between respondent demographic, treatment and health variables, and cost-related underuse of asthma medicines, as measured by odds ratio (OR, 95% confidence interval) derived from multivariable logistic regression (for unadjusted OR, see [Tables E4](#) and [E5](#) in this article's Online Repository at www.jaci-inpractice.org)*

Variable	Adults (n = 792)		Children (n = 609)	
	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age respondent, per 5-y increase	0.84 (0.79-0.89)	<.001	0.86 (0.77-0.97)	.012
Age of child with asthma				
5-10 y	Not applicable		1.37 (0.89-2.11)	.155
11-17 y	Not applicable			
Gender (of person with asthma)				
Male	1.00		1.00	
Female	0.67 (0.48-0.94)	.021	0.75 (0.49-1.16)	.195
Gender (parent respondent)				
Male	Not applicable		1.00	
Female			0.61 (0.39-0.96)	.031
Annual household income, pretax (USD)				
53,872 or more	1.00		1.00	
38,480-53,871	0.89 (0.54-1.48)	.659	1.83 (1.03-3.26)	.039
38,479 or less	0.70 (0.42-1.14)	.148	1.31 (0.72-2.40)	.376
Prefer not to say	0.35 (0.19-0.64)	.001	0.95 (0.46-1.98)	.895
Concession beneficiary				
No	1.00		1.00	
Yes	1.22 (0.81-1.85)	.347	1.27 (0.80-2.03)	.309
Private health insurance				
No	1.00			
Yes	0.70 (0.49-1.00)	.052		
Household composition				
Single living without dependents	1.00		1.65 (0.73-3.69) [†]	.226
Couple living without dependents	1.09 (0.71-1.68)	.870		
Single living with dependents	0.97 (0.63-1.47) [‡]	.705	1.00	
Couple living with dependents			1.17 (0.62- 2.21)	.634
No. of other chronic medications				
None	1.00		1.00	
1-4	1.33 (0.91-1.95)	.145	2.39 (1.48-3.87) [§]	<.001
5 or more	1.03 (0.61-1.75)	.913		
GINA symptom control, previous 4 wk				
Well controlled	1.00		1.00	
Partly controlled	1.59 (1.03-2.45)	.038	2.65 (1.39-5.05)	.003
Poorly controlled	1.87 (1.13-3.09)	.015	3.87 (1.99-7.54)	<.001
Any urgent health service utilization for asthma				
No	1.00			
Yes	1.54 (1.06-2.23)	.024		
Specialist visit for asthma, previous 12 mo				
No			1.00	
Yes			1.83 (1.16-2.87)	.009
Inhaled corticosteroid (ICS)-containing medications				
No ICS	1.00		1.00	
ICS experienced	1.59 (1.11-2.28)	.011	1.07 (0.70-1.63)	.756
Concerns with asthma medications				
There are no issues that concern me				
No	1.00		1.00	
Yes	0.32 (0.23-0.46)	<.001	0.38 (0.22-0.64)	<.001
Shared decision making			1.11 (1.01-1.23)	.036
Comfort discussing changing medications with doctor				
0-2 [¶]	1.10 (0.73-1.65)	.659		
3-10 [¶]	0.89 (0.82-0.97)	.007		

(continued)

TABLE III. (Continued)

Variable	Adults (n = 792)		Children (n = 609)	
	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Comfort discussing medication costs with doctor				
Mean			0.82 (0.75-0.89)	<.001
Model fit statistics				
Hosmer-Lemeshow goodness of fit (Prob > χ^2)	0.5182		0.3579	
AIC	892.6		606.9	
McFadden R^2 , adj.	0.166		0.216	
Observations	773 [#]		603 [#]	

AIC, Akaike Information Criterion; CI, confidence interval; GINA, Global Initiative for Asthma; ICS, inhaled corticosteroid; OR, odds ratio; Prob, probability.

*Both multivariable models adjusted for age, gender, income, concession status, household composition, number of medicines, ICS inhaler experience.

†Single or couple living without dependents.

‡Single or couple living with dependents.

§One or more other chronic medications.

¶Linear spline with knot at score = 3 as determined from Lowess smoothing plot of probability of cost-related underuse against variable.

#Household composition = other omitted from analysis (n = 19 adults and n = 6 children).

of potential factors, a purposeful selection procedure was used²⁵ controlling for key clinical and demographic factors (age, gender, income, concession status, household composition, number of medicines, ICS inhaler experience) (see the [Methods](#) section in this article's Online Repository at www.jaci-inpractice.org). Factors that approached significance at the univariable level ($P < .25$) were retained and the model was sequentially reduced to a preliminary main effects model by eliminating factors at the $P > .05$ level and comparing model fit and changes with coefficient sizes ($>20\%$ indicating potential confounding and retention of the candidate factor). Factors initially excluded based on the univariable analysis were sequentially added back into the preliminary main effects model and retained if significant at the $P < .05$ level. Prespecified interaction terms (ie, income and concession card status, ICS inhaler experience, and concerns about medications) were then added sequentially and, if significant, retained in the model. Statistical analyses were performed using Stata v14 (StataCorp LP, College Station, Texas, 2015).

RESULTS

The flowchart of study participation is shown in [Figure E1](#) (available in this article's Online Repository at www.jaci-inpractice.org). Of the 1944 participants eligible to complete the survey, 395 were excluded because their stratification quota was full; 1401 of the remaining 1549 participants completed the survey (90.4% completion rate).

The descriptive characteristics of the participants overall and for those reporting cost-related underuse behaviors are shown for adults and children in [Table I](#) and [Table E2](#) (available in this article's Online Repository at www.jaci-inpractice.org). Participants were similar in terms of age and gender compared with the broader asthma population; however, there was an over-representation of participants from inner regional Australia and an under-representation from outer regional/remote areas (see [Table E3](#), available in this article's Online Repository at www.jaci-inpractice.org). Of the adults with asthma (n = 792, 47.3% male; mean age, 47.0 years [standard deviation, 17.0]), the majority (77.5%) had partly or poorly controlled asthma symptoms. Overall, 58.8% had used any ICS-containing medication in the previous year (80.2% of

these as ICS/long-acting β -agonist [LABA]). Of the children with asthma (n = 609, 59.8% male), 50.7% were aged 5 to 10 years and 49.3% 11 to 17 years; 75.6% had partly or poorly controlled asthma symptoms. Overall, 47.1% of children had used any ICS-containing medication in the previous year (50.9% as ICS/LABA). A high proportion of both adults (44.6%) and children (64.0%) reported urgent health care for asthma in the previous 12 months.

Overall, one quarter of adults and parents reported not filling 1 or more asthma prescriptions (either new or refill) in the previous 12 months ([Table II](#)), with the most common reasons given being due to cost.

[Figure 1](#) shows that cost-related underuse of asthma medications was reported by 52.9% of adults and 34.3% parents of children with asthma. This primarily comprised modifying or skipping the dose of asthma medicines to make them last longer (as opposed to delaying or not filling prescriptions because of cost). The multivariable models presented in [Table III](#) and [Figure 2](#) demonstrate a number of factors associated with higher odds of cost-related underuse (see [Tables E4](#) and [E5](#) in this article's Online Repository at www.jaci-inpractice.org for univariable associations). For adults, significant demographic factors were younger age and being male. Adults who reported any concerns about medicines or lower comfort talking to the prescriber about changing their medicines had higher odds of cost-related underuse. Having less well-controlled asthma symptoms, any urgent utilization of health services for asthma and use of an ICS-containing medication in the previous 12 months were also significantly associated with cost-related underuse.

For children with asthma, after controlling for the age and gender of the parent responding to the survey, higher odds of cost-related underuse were associated with having more than 1 medication for a chronic disease (in addition to asthma), and visiting a specialist for asthma in the previous 12 months. In addition, parents having concerns about asthma medications, reporting less comfort discussing the cost of medicines with the prescriber, and less involved in making decisions about medicines had higher odds of cost-related underuse. For children, as for adults, having poorer asthma symptom control was significantly associated with cost-related underuse.

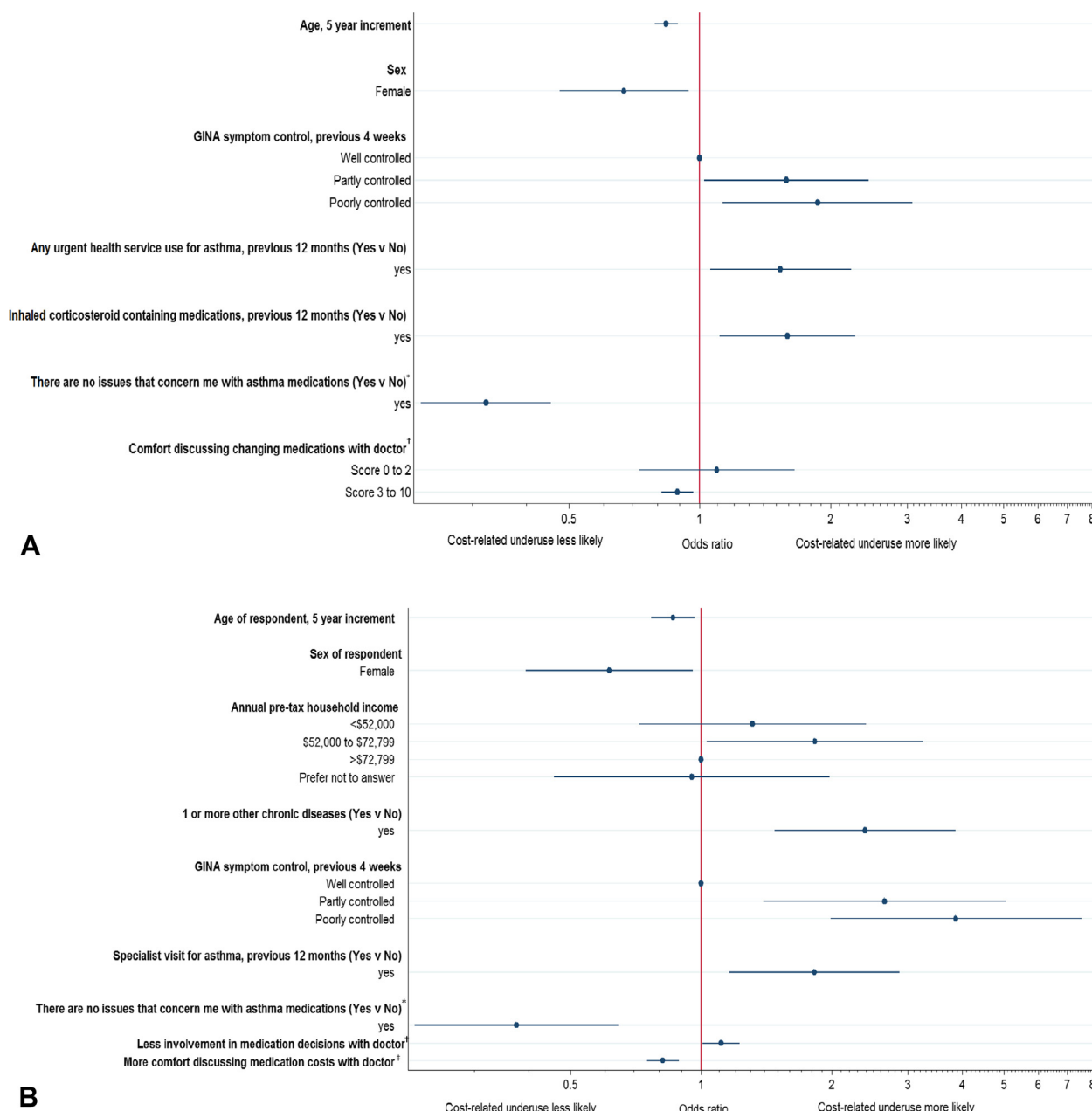


FIGURE 2. Multivariable logistic regression of cost-related underuse of asthma medications. **A**, Adults with asthma. Variables controlled for in this model were annual household income, concession beneficiary status, private health insurance, household composition, and the number of other chronic medications. **B**, Children with asthma. Variables controlled for in this model were age and sex of child with asthma, concession card status, household composition, and inhaled corticosteroid use in the previous 12 months. * "In your use of asthma medication, do any of the following issues concern you?" This was a multiple response item. Response options were: There are no issues that concern me; possible side effects; overuse; cost; or forgetting medications. † Respondents were asked to indicate on a scale of 0 to 10, "How comfortable do you feel talking to your doctor about asking to change your medications?" with 0 = not comfortable at all and 10 = very. ‡ Respondents were asked to indicate on a scale of 0 to 10, "How comfortable do you feel talking to your doctor about the cost of your medications?" with 0 = not comfortable at all and 10 = very.

For both adults and children, neither concession card status (reflecting the copayment faced by respondents for each medicine), income (reflecting the potential ability to pay), nor their interaction was statistically significantly associated with cost-related underuse. The exception was that parents of children in a mid-range income household (USD38,480-53,871) were at a

higher odds of indicating cost-related underuse than those in the highest income bands (odds ratio: 1.83, 95% confidence interval: 1.03-3.26, $P < .05$).

Table E6 (available in this article's Online Repository at www.jaci-inpractice.org) includes the model for cost-related underuse amongst adults and children with asthma who had

used an ICS-containing medication in the previous 12 months.

DISCUSSION

In spite of Australia's universal health care system, with government subsidy of all asthma controller inhalers, cost-related underuse of asthma medicines was reported by over half of adults and almost a third of parents of children 5 to 17 years with asthma in this study. In this cross-sectional survey of a nationally representative asthma population, younger male adults, people who had any concerns about asthma medicines or were less comfortable talking to prescribers about cost or changing their medicines, those with poorer asthma control, and people requiring either specialist or urgent health care visits for their asthma were more likely to report underuse of medicines because of cost. Parents who felt less engaged with prescribers about decisions regarding their child's asthma medications were also at higher odds of reporting cost-related underuse. Cost-related underuse of asthma medicines was not associated with concession card status and only associated with income when comparing children with asthma in a mid-range income band household with those in the highest income band.

The rates of cost-related underuse of medicines reported in this study appear substantially higher than US studies that found 20% to 31% of adults with asthma indicating these behaviors. For example, amongst 450 people aged ≥ 50 years using prescription medication for asthma, Piette et al¹² reported that 20% had underused asthma medication in the previous year, 12% at least monthly; asthma was one of the chronic conditions with the highest rates of cost-related underuse. In another study of 1726 patients aged ≥ 65 years using inhaled medication for asthma or COPD, Castaldi et al¹³ found that 31% reported cost-related underuse in the previous year. In our study, the rate of cost-related underuse among people ≥ 65 years was 32% and similar to the US study. But for people ≥ 50 years, the rate of cost-related underuse was 39.2%, almost double that reported (ie, 20%) in the US study by Piette et al.¹² Although both studies used a similar summary indicator, the older age group in the 2 US studies accounts for some of the observed differences. In our study, older age was associated with significantly lower cost-related underuse. Nevertheless, the figures indicating cost-related underuse are high when comparing features of the US and Australian health systems. These findings reinforce the hidden problem of costs in the access to health care in Australia.²⁶ The findings also highlight a potentially perverse structural problem in pricing medicines for asthma. For example, regular use of ICS-containing medications is associated with a substantial reduction in the risk of asthma-related hospitalization or death, but out-of-pocket costs in Australia for commonly prescribed ICS/LABA inhalers are 5 times that for reliever inhalers (eg, USD29.08 for fluticasone/salmeterol compared with USD5.55 for albuterol) that provide only short-term symptom relief.

Of particular importance, therefore, was our finding of a high level of uncontrolled symptoms (three quarters of adults and children) and need for urgent asthma health care (45% adults, 64% children). Significant associations were found between cost-related underuse of asthma medications and worse asthma symptom control, and, in adults, with a greater need for urgent health care for asthma in the previous 12 months. Children with poor asthma symptom control, which in other studies has been associated with obesity, learning disabilities, and poor mental

health, were nearly 4 times as likely to have cost-related underuse, and adults needing urgent asthma care in the previous 12 months were 50% more likely to have cost-related underuse. Cause and effect cannot be disentangled in a cross-sectional study, but prospective studies have shown a clear relationship between poor adherence and risk of uncontrolled asthma and exacerbations.²⁷

From a clinical standpoint, the study findings highlight the importance of out-of-pocket cost to adherence behavior by patients with asthma in Australia and the need for practitioners involved in their care to be open to and initiate discussions about medicine costs and concerns. Multifaceted interventions to improve medication use primarily address factors such as the role of the patient, their beliefs and self-management proficiency, and treatment-related factors such as dosing, inhaler technique, and adverse consequences. In more recent studies, the interaction between patients and their health care providers has been addressed.²⁸ However, in a recent qualitative study, we found that few general practitioners were aware of cost as a potential contributor to medication underuse, none were aware of the levels of out-of-pocket costs for asthma medications, and few asked their patients if cost was an issue.¹⁷ This lack of communication about medication costs was confirmed in qualitative interviews with patients and parents of children with asthma.¹⁸ The present findings should prompt an enquiry about cost as a potential problem rather than dose escalation, which would simply worsen cost pressures. Furthermore, educating clinicians and patients about the availability of lower cost and effective treatment options is needed. This is especially important in Australia where most adults and half of children are prescribed ICS as ICS/LABA, despite substantial, but little known, cost savings for both general and concessional patients through prescribing of low-dose ICS-alone.²⁹ In addition, better involvement of parents of children with asthma in medication decisions appears important, and there is some evidence that shared decision making leads to better adherence.^{30,31}

The lack of association with concession card status and income on cost-related underuse may be due to the substantial discounts (of up to 84%) on copayments available to low-income concession card holders. The increased odds of cost-related underuse for children in middle-income households compared with higher income households potentially reflects the inclusion of a subgroup that could be classified as the working poor, that is, people who are just above the income thresholds to qualify for concession card status. This idea has been raised previously,³² and our results suggest that further work is needed in this area to ensure necessary access to medicines.

Limitations

Although a validated indicator for cost-related underuse has been used, and robust methodology was used to avoid selection bias and response bias, this study has limitations. First, this was a cross-sectional study involving members of a large online panel and self-reporting medication-taking behavior over a 12-month look-back period. Although representative of the broader Australian asthma population in terms of gender, age, and location, it may not be representative for other factors that are important to cost-related underuse. Furthermore, self-reporting bias and recall bias cannot be excluded, though in this case we would expect our results to understate estimates. In addition, the

indicator for cost-related underuse has not been validated in the Australian context, including against more objective measures of medicine use such as prescription claims data or pill count. Second, nonvalidated measures of shared decision making and comfort talking to doctors were used. Third, we have not adjusted our models for annual household out-of-pocket costs; although this question was asked, participant responses were incomplete or not answered for 38% of participants (38% adults, 34% parents of children with asthma). In addition, whether a lower out-of-pocket cost reflects fewer treatments because of better health or cost-related underuse could not be disentangled. Finally, causative associations with clinical outcomes cannot be ascertained. Further prospective investigations are needed to better understand the clinical impact of cost-related underuse.

CONCLUSIONS

Adults and parents of children with asthma indicate high rates of cost-related underuse of asthma medicines in this Australian cohort. These behaviors were unrelated to concession card status and household income but were particularly prominent amongst males and younger participants and in high-need patients. Interventions that promote the discussion of medicines and costs between doctor and patients or parents, including the initiation of discussion around the availability of lower cost options, appear warranted.

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ONLINE REPOSITORY

METHODS

Population

This study included a cross-section of Australian adults and parents of children aged 5 to 17 years with asthma. A nationally representative sample, based on Australian Bureau of Statistics for people with asthma stratified by age, gender, and location, was recruited through an online panel provider (Survey Sampling International, Melbourne, Australia), using a methodology that has been previously reported in detail.^{E1} Panel members were selected via a 3-stage random selection process. First, a random sample of panel members was asked to participate in a survey (topic unspecified). Those who responded were asked one of several randomly selected profiling questions, including “Which of the following ailments have you ever suffered from?”; those who selected “asthma” were then filtered to identify those with current asthma and parents of children with current asthma aged 5 to 17 years, using standardized screening questions. Standardized screening questions to identify those with current asthma:

- (1) “Have you/your child ever been told by a health professional (such as a nurse, doctor, or pharmacist) that you have asthma?”
- (2) “Have you/your child had symptoms of asthma or taken medication for asthma in the last 12 months?”

Survey details

Survey questions were based on previous surveys administered among people with asthma in Australia^{E1} and New Zealand,^{E2} and included validated questions about medication underuse behaviors related to cost.^{E3,E4} The survey also collected information about the participants’ sociodemographic characteristics (eg, age, gender,

income, location), general health status and health care utilization (eg, comorbidities), asthma management and control (eg, asthma symptom control in past month based on the Global Initiative for Asthma,^{E5} urgent health care for asthma, previous medications, and asthma medication nonadherence), asthma medicine concerns, and health care decision making. Responses to the questions about asthma and medications for children with asthma were provided by the parent participant. The survey was piloted among the first 10% of the sample before full roll-out. Feedback from the pilot survey about the ease of completion as well as open-ended responses indicated that the survey was well understood and easy to complete; thus changes to improve the face validity of the survey were not required.

Statistical analysis

A purposeful selection procedure was used^{E6} controlling for key clinical and demographic factors (age, gender, income, concession status, household composition, number of medicines, inhaled corticosteroid [ICS] inhaler experience). Factors that approached significance at the univariable level ($P < .25$) were retained in the initial multivariable model. This model was sequentially reduced to a preliminary main effects model by eliminating factors at the $P > .05$ level and comparing model fit and changes with coefficient sizes ($>20\%$ indicating potential confounding and retention of the candidate factor). Factors in the univariable analysis with a P value $>.25$ were sequentially added back into the preliminary main effects model to determine significance in the multivariable setting and retained if significant at the $P < .05$ level. Prespecified interaction terms (ie, income and concession card status; ICS inhaler experience, and concerns about medications) were then added sequentially and if significant retained in the model.

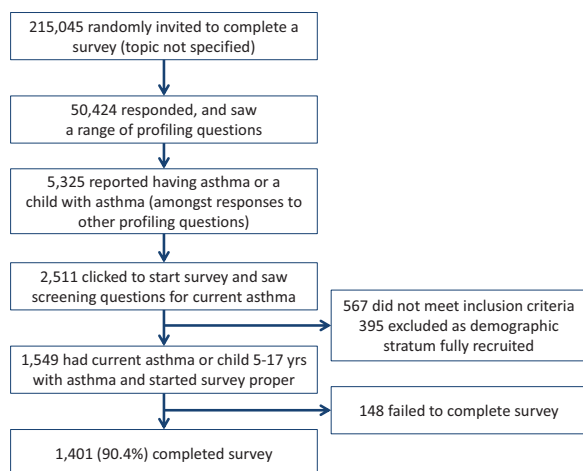
**FIGURE E1.** Flowchart for study participation.

TABLE E1. CHEcklist for Reporting Results of Internet E-Surveys (CHERRIES)^{E7}

Item category	Checklist item	Description
Design		The target population was people aged over 17 years with current asthma, and parents of children aged 5-17 years with current asthma, selected randomly from amongst members of a very large Australian web-based panel held by Survey Sampling International
Ethics	Ethics approval	Ethics approval was obtained from the University of New South Wales Human Research UNSW Human Research Advisory Panel Ethics Committee (Approval number # HREAP 2014-7-34)
	Informed consent	All participants, as members of a web-based panel, had already provided informed consent to participate in online surveys. Informed consent for the present survey was obtained from all those agreeing to complete a survey, with participants informed on the welcome page that all responses were confidential and anonymous and that reporting would be on an aggregate level only. Consent was indicated when respondents clicking the “Go to Survey” button from this page
	Data protection	Proprietary survey software and local servers were used to ensure data protection. No personal information was linked to survey results in any way. The fully deidentified data set is kept on password-protected computers
Development and pretesting		The survey instrument was designed using items from other published asthma surveys, input from qualitative research with health care professionals and people with asthma, validated questions relating to cost-related medication underuse behaviors, and stakeholder review. The survey was pilot tested with 121 respondents for any issues with question/response design, and with quantitative and qualitative data collected about ease of survey
Recruitment process	Open vs closed survey	This was an open survey. An online panel provider, Survey Sampling International (SSI), was engaged to use proportionate stratification sampling to recruit a cohort of people with asthma, representative of Australian populations with asthma based on age, gender, and state of residence, from their panel of potential survey participants Recruitment to SSI’s online panel is achieved in multiple ways, predominately through banner advertisements, invitations and messaging via relationships with other websites, online communities, and social media groups. SSI undertakes active strategies with communities of interest of all types to incorporate rare populations into the online sample blend. Potential participants go through rigorous quality screening before being accepted onto a panel
	Contact mode	To minimize bias, participants underwent a 3-stage randomization process. First, potential participants were selected at random from SSI’s panel to be invited to “take a survey”; no information about the survey topic was provided at this stage. A set of profiling questions was randomly selected for respondents to answer, one of which was the question “Which of the following ailments do you [your child] suffer from?” of which “asthma” was 1 of 6 randomly selected options. Those choosing “asthma” were directed to the screener page of the present survey. Responses to the questions about asthma and medications for children with asthma were provided by the parent participant
Recruitment process (cont’d)	Advertising the survey	The survey was not advertised; as above, randomly selected members of the online panel were invited to participate
Survey administration	Web/e-mail	This was a web-based survey, based on SSI’s participant interface. Responses were collected through the online survey platform and stored on secure local servers. Responses were multiple choice categoric and numeric
	Context	The panel provider, SSI, is a research services company that maintains a pool of potential respondents for research projects
	Mandatory/voluntary	Voluntary. Prospective respondents were screened to ensure that they had current asthma and were the appropriate age. Proportionate sampling was used to match the population of people in Australia with current asthma
	Incentives	Respondents were incentivized for their participation by the panel provider, SSI, with points that could be redeemed for money. The points obtained for participation in the present survey were estimated to have a value of \$1.11

(continued)

TABLE E1. (Continued)

Item category	Checklist item	Description
	Time/date	Responses were collected between December 2015 and March 2016
	Item randomization	No randomization of items was used
	Adaptive questioning	Adaptive questioning (branched) was used. Relevant survey items were displayed based on previous responses (eg, only those who had skipped a refill in the previous 12 mo were shown follow-up questions about reasons for this). Certain items were also populated based on previous responses
	No. of items	A maximum of 3 items were displayed on any one survey page. The full quantitative survey comprised a total of 23 items
	No. of screens	Not known
	Completeness check	All survey items were deemed to be mandatory, and respondents prompted to complete outstanding items before leaving the survey page on which the item was contained. Drop-off was low at 9.55%
	Review step	Respondents were unable to change their responses once submitted. The “save answers and continue” button on each page of the survey was preceded by the sentence “Please note that when you click the [Save answers and continue] button below, your responses will be saved to the database and you will no longer be able to change them”
Response rates	Unique site visitor	Determination of unique visitors was handled by the panel provider SSI. SSI utilizes digital fingerprinting and traps for geo-IP violations to ensure that respondents only complete the survey once
	View rate	Not applicable; respondents were invited through an external panel
	Participation rate	215,045 panel members were randomly invited to complete a survey (topic not specified); 50,424 responded giving a panel participation rate of 23.45%. When presented with a range of filtering questions including 6 randomly selected health condition, 5325 potential respondents said they had asthma (or a child with asthma), and 2511 (47.15%) of these proceeded to the survey screening questions about current asthma. Of these, 567 (22.58%) did not meet the inclusion criteria in the screening questions, and a further 395 (15.73%) were excluded as their demographic stratum was fully recruited
	Completion rate	Of the 1549 respondents who commenced the survey, 1401 completed it, giving a completion rate of 90.45%
Preventing multiple entries from the same individual	Cookies used	No
	IP check	SSI utilizes digital fingerprinting and traps for geo-IP violations to ensure only unique respondents completed the survey
	Log file analysis	Not used
	Registration	Entry to the survey was via a unique login provided to each invitee to the survey
Analysis	Handling of incomplete questionnaires	Only completed questionnaires were included in the final data set
	Questionnaires with atypical timestamp	No respondents were removed from the survey for completing the items too quickly. No “straight-liners” were identified in <i>post hoc</i> tests
	Statistical correction	Satisfactory numbers were achieved for all demographic subgroups, although some quotas were applied midway through the data collection process to more accurately match the sample frame of people with asthma in Australia

TABLE E2. Additional demographic characteristics

	Adult, n (%)		Children, n (%)	
	Overall (n = 792)	Any cost-related underuse (n = 419, 52.9%)	Overall (n = 609)	Any cost-related underuse (n = 209, 34.3%)
Education*				
Secondary school year 9 or 10 equivalent or below	133 (16.8)	69 (16.5)	66 (10.8)	33 (15.8)
Secondary school year 11 or 12 equivalent	151 (19.1)	83 (19.8)	119 (19.5)	33 (15.8)
Certificate or diploma (eg, TAFE)	275 (34.7)	134 (32.0)	205 (33.7)	60 (28.7)
University degree	233 (29.4)	133 (31.7)	219 (36.0)	83 (39.7)
Aboriginal and/or Torres Strait Islander identification	28 (3.5)	21 (5.0)	34 (5.6)	19 (9.1)
Language other than English, Yes	105 (13.3)	72 (17.2)	96 (15.8)	52 (24.9)
Residence†				
Major city	492 (62.2)	262 (62.7)	375 (61.7)	145 (69.7)
Inner regional	199 (25.2)	104 (24.9)	165 (27.1)	48 (23.1)
Outer regional/remote/very remote	100 (12.6)	52 (12.4)	68 (11.2)	15 (7.2)
Annual household income, pretax (USD)				
Less than 19,240	127 (16.0)	72 (17.2)	46 (7.6)	15 (7.2)
19,240-38,479	171 (21.6)	69 (16.5)	103 (16.9)	32 (15.3)
38,480-53,871	137 (17.3)	85 (20.3)	102 (16.8)	44 (21.1)
53,872-76,959	129 (16.3)	82 (19.6)	135 (22.2)	55 (26.3)
76,960 or more	140 (17.7)	81 (19.3)	166 (27.3)	45 (21.5)
Prefer not to say	88 (11.1)	30 (7.2)	57 (9.4)	18 (8.6)
Household composition, respondent				
Single occupant, living alone, sharing, or with parents	257 (32.4)	136 (32.5)	53 (8.7)	33 (15.8)
Couple without dependents	268 (33.8)	120 (28.6)	24 (3.9)	11 (5.3)
Couple with dependents	201 (25.4)	123 (29.4)	426 (70.0)	132 (63.2)
Single parent with dependent	47 (5.9)	26 (6.2)	100 (16.4)	30 (14.4)
Other	19 (2.4)	14 (3.3)	6 (1.0)	3 (1.4)
Other chronic conditions				
At least one additional chronic disease	471 (59.5)	243 (58.0)	183 (30.0)	94 (45.0)
Mean (SD)	2.1 (1.4)	2.1 (1.3)	1.3 (0.9)	1.5 (1.1)
No. of other chronic medications‡				
Median, IQR	3.0 (4)	3 (4)	2 (1)	2 (2)
Annual out-of-pocket costs, medication§				
Median, IQR, USD	222 (362)	222 (370)	222 (148)	185 (296)
Specialist visit for asthma, previous 12 mo	165 (20.8)	112 (26.7)	213 (35)	118 (56.5)
Short-acting β -agonist	717 (90.5)	370 (88.3)	559 (91.8)	178 (85.2)

IQR, interquartile range; SD, standard deviation; TAFE, technical and further education.

*For children, of parent responding to survey.

†Missing: adult (n = 1), children (n = 1).

‡If at least 1 other chronic disease reported.

§For respondents reporting an out-of-pocket cost: adults (n = 330), children (n = 183).

TABLE E3. Frequency (%) of sociodemographic characteristics for study population compared with population estimates from the Australian Health Survey 2011-2012

Characteristic	Study population (%)	Australian Health Survey 2011-2012 (%)
Age, y		
15-24	12	17
25-34	18	19
35-44	15	17
45-54	16	16
55-64	19	14
65-74	17	10
75 and older	3	7
Gender		
Male	47	46
Female	53	54
Location		
Major cities of Australia	62	66
Inner Regional Australia	36	24
Outer Regional and Remote Australia	2	9

TABLE E4. Unadjusted odds ratios (OR) and 95% confidence intervals for associations with cost-related underuse of asthma medications for adults with asthma (the multivariable associations shown in Table III are also repeated here for convenience)

Variable	Adults (n = 792)			
	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age, respondent, per 5-y increase	0.83 (0.80-0.87)	<.001	0.84 (0.79-0.89)	<.001
Gender (of person with asthma)				
Male	1.00		1.00	
Female	0.91 (0.69-1.20)	.511	0.67 (0.48-0.94)	.021
Education				
Secondary school or below	1.00		—	
Certificate or diploma (eg, TAFE)	0.83 (0.59-1.15)	.257	—	
University degree	1.16 (0.82-1.64)	.418	—	
Aboriginal and/or Torres Strait Islander identification				
No	1.00		—	
Yes	2.76 (1.16-6.57)	.022	—	
Language other than English			—	
No	1.00			
Yes	2.14 (1.38-3.31)	.001	—	
Residence				
Major city	1.00		—	
Inner regional	0.96 (0.69-1.34)	.813	—	
Outer regional/remote/very remote	0.95 (0.62-1.46)	.819	—	
Annual household income, pretax (USD)				
53,872 or more	1.00			
38,480-53,871	1.06 (0.70-1.62)	.777	0.89 (0.54-1.48)	.659
38,479 or less	0.58 (0.42-0.82)	.002	0.70 (0.42-1.14)	.148
Prefer not to say	0.34 (1.20-1.96)	<.001	0.35 (0.19-0.64)	.001
Concession beneficiary				
No	1.00		1.00	
Yes	0.98 (0.74-1.31)	.898	1.22 (0.81-1.85)	.347
Private health insurance				
No	1.00		1.00	
Yes	0.83 (0.62-1.09)	.182	0.70 (0.49-1.00)	.052
Household composition				
Single living without dependents	1.00		1.00	
Couple living without dependents	0.72 (0.51-1.02)	.062	1.09 (0.71-1.68)	.870
Single or couple living with dependents	1.34 (0.94-1.91)	.105	0.97 (0.63-1.47)	.705
General health and morbidity				
Self-rated health				
Excellent to very good	1.00		—	
Good	1.22 (0.87-1.70)	.252	—	
Fair to poor	1.11 (0.77-1.59)	.576	—	
No. of other chronic medications				
None	1.00		1.00	
1-4	1.02 (0.75-1.38)	.921	1.33 (0.91-1.95)	.145
5 or more	0.63 (0.43-0.94)	.023	1.03 (0.61-1.75)	.913
GINA symptom control, previous 4 wk				
Well controlled	1.00		1.00	
Partly controlled	2.53 (1.74-3.69)	<.001	1.59 (1.03-2.45)	.038
Poorly controlled	4.03 (2.68-6.06)	<.001	1.87 (1.13-3.09)	.015
Any urgent health service utilization for asthma				
No	1.00		1.00	
Yes	2.82 (2.11-3.78)	<.001	1.54 (1.06-2.23)	.024
Specialist visit for asthma, previous 12 mo				
No	1.00		—	
Yes	2.20 (1.53-3.16)	<.001	—	

(continued)

TABLE E4. (Continued)

Variable	Adults (n = 792)			
	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Short-acting β -agonist				
No	1.00		Not included*	
Yes	0.57 (0.34-0.93)	.025		
Inhaled corticosteroid (ICS)-containing medications				
No ICS	1.00		1.00	
ICS experienced	1.17 (0.88-1.55)	.280	1.59 (1.11-2.28)	.011
Concerns with asthma medications				
Possible side effects of medications				
No	1.00		—	
Yes	1.91 (1.40-2.61)	<.001	—	
Overuse of medication				
No	1.00		—	
Yes	2.38 (1.62-3.48)	<.001	—	
The cost of medication				
No	1.00		Not included*	
Yes	4.91 (3.44-7.00)	<.001	Not included*	
Forgetting the medication				
No	1.00		—	
Yes	2.34 (1.59-3.45)	<.001	—	
There are no issues that concern me				
No	1.00		1.00	
Yes	0.23 (0.17-0.31)	<.001	0.32 (0.23-0.46)	<.001
Shared decision making	1.07 (1.02-1.13)	.009	—	
Comfort discussing changing medications with doctor				
0-2 [†]	1.21 (0.87-1.70)	.259	1.10 (0.73-1.65)	.659
3-10 [†]	0.83 (0.77-0.89)	<.001	0.89 (0.82-0.97)	.007
Comfort discussing medication costs with doctor				
Mean	0.86 (0.81-0.91)	<.001		
Model fit statistics				
Hosmer-Lemeshow goodness of fit (Prob > χ^2)			0.5182	
AIC				
McFadden R^2 , adj.			0.166	
Observations			773 [‡]	

AIC, Akaike Information Criterion; CI, confidence interval; GINA, Global Initiative for Asthma; ICS, inhaled corticosteroid; Prob, probability; TAFE, technical and further education.

*Not included in multivariable regression modeling due to endogeneity between predictor and outcome or lack of variation in covariate (short-acting β agonist use).

[†]Linear spline with knot at score = 3 as determined from the Lowess smoothing plot of probability of cost-related underuse against variable.

[‡]19 household composition = other omitted from analysis.

TABLE E5. Unadjusted odds ratios (OR) and 95% confidence intervals for associations with cost-related underuse of asthma medications for children with asthma (the multivariable associations shown in Table III are also repeated here for convenience)

Variable	Children (n = 609)			
	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age, respondent, per 5-y increase	0.77 (0.70-0.84)	<.001	0.86 (0.77-0.97)	.012
Age, child with asthma				
5-10 y	2.03 (1.44-2.86)	<.001	1.37 (0.89-2.11)	.155
11-17 y	1.00			
Gender (of person with asthma)				
Male	1.00		1.00	
Female	0.73 (0.52-1.04)	.08	0.75 (0.49-1.16)	.195
Gender (parent)				
Male	1.00		1.00	
Female	0.55 (0.39-0.77)	.001	0.61 (0.39-0.96)	.031
Education				
Secondary school or below	1.00		—	
Certificate or diploma (eg, TAFE)	0.75 (0.48-1.14)	.177	—	
University degree	1.10 (0.73-1.65)	.644	—	
Aboriginal and/or Torres Strait Islander identification				
No	1.00		—	
Yes	2.57 (1.28-5.16)	.008	—	
Language other than English				
No	1.00		—	
Yes	2.68 (1.72-4.17)	<.001	—	
Residence				
Major city	1.00		—	
Inner regional	0.65 (0.44-0.97)	.033	—	
Outer regional/remote/very remote	0.45 (0.24-0.83)	.01	—	
Annual household income, pretax (USD)				
53,872 or more	1.00		1.00	
38,480-53,871	1.52 (0.96-2.41)	.072	1.83 (1.03-3.26)	.039
38,479 or less	0.92 (0.61-1.41)	.721	1.31 (0.72-2.40)	.376
Prefer not to say	0.93 (0.51-1.70)	.809	0.95 (0.46-1.98)	.895
Concession beneficiary				
No	1.00		1.00	
Yes	1.89 (1.34-2.67)	<.001	1.27 (0.80-2.03)	.309
Private health insurance				
No	1.00		—	
Yes	1.11 (0.79-1.56)	.535	—	
Household composition				
Single or couple living without dependents	3.11 (1.67-5.79)	<.001	1.65 (0.73-3.69)	.226
Single living with dependents	1.00		1.00	
Couple living with dependents	1.05 (0.65-1.68)	.001	1.17 (0.62-2.21)	.634
General health and morbidity				
Parent-rated health				
Excellent to very good	1.00		—	
Good	0.83 (0.56-1.21)	.326	—	
Fair to poor	1.78 (0.91-3.51)	.093	—	
No. of other chronic medications				
None	1.00		1.00	
1 or more	2.86 (1.99-4.10)	<.001	2.39 (1.48-3.87)	<.001
GINA symptom control, previous 4 wk				
Well controlled	1.00		1.00	
Partly controlled	3.48 (1.99-6.11)	<.001	2.65 (1.39-5.05)	.003
Poorly controlled	7.84 (4.48-13.73)	<.001	3.87 (1.99-7.54)	<.001

(continued)

TABLE E5. (Continued)

Variable	Children (n = 609)			
	Unadjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Any urgent health service utilization for asthma				
No	1.00		—	
Yes	3.57 (2.39-5.32)	<.001	—	
Specialist visit for asthma, previous 12 mo				
No	1.00		1.00	
Yes	4.16 (2.91-5.95)	<.001	1.83 (1.16-2.87)	.009
Short-acting β -agonist				
No	1.00		—*	
Yes	0.27 (0.15-0.52)	<.001	—*	
Inhaled corticosteroid (ICS)-containing medications				
No ICS	1.00		1.00	
ICS experienced	1.53 (1.09-2.14)	.013	1.07 (0.70-1.63)	.756
Concerns with asthma medications				
Possible side effects of medications				
No	1.00		—	
Yes	1.40 (0.99-1.97)	.060	—	
Overuse of medication				
No	1.00		—	
Yes	2.52 (1.76-3.61)	<.001	—	
The cost of medication				
No	1.00		—*	
Yes	4.51 (3.11-6.55)	<.001	—*	
Forgetting the medication				
No	1.00		—	
Yes	1.32 (0.92-1.90)	.128	—	
There are no issues that concern me				
No	1.00		1.00	
Yes	0.20 (0.13-0.32)	<.001	0.38 (0.22-0.64)	<.001
Shared decision making	1.17 (1.08-1.26)	<.001	1.11 (1.01-1.23)	.036
Comfort discussing changing medications with doctor				
Mean	0.85 (0.78-0.91)	<.001	—	
Comfort discussing medication costs with doctor				
Mean	0.81 (0.75-0.87)	<.001	0.82 (0.75-0.89)	<.001
Model fit statistics				
Hosmer-Lemeshow goodness of fit (Prob > χ^2)			0.3579	
AIC			606.9	
McFadden R^2 , adj.			0.216	
Observations			603 [†]	

AIC, Akaike Information Criterion; CI, confidence interval; GINA, Global Initiative for Asthma; ICS, inhaled corticosteroid; Prob, probability; TAFE, technical and further education.

*Not included in multivariable regression due to endogeneity between predictor and outcome, or lack of variation in covariate (short-acting β -agonist use).

[†]6 household composition = other omitted from analysis.

TABLE E6. Relation between respondent demographic, treatment and health variables, and cost-related underuse of asthma medicines for those using ICS in the last 12 months, as measured by odds ratio (OR, 95% confidence interval) derived from multivariable logistic regression*

Variable	Adults (n = 466)		Children (n = 287)	
	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
Age, respondent, per 5-y increase	0.80 (0.74-0.87)	<.001	0.84 (0.70-1.01)	.069
Age of child with asthma				
5-10 y	Not applicable		1.29 (0.68-2.48)	.433
11-17 y	Not applicable		1.00	
Gender (of person with asthma)				
Male	1.00		1.00	
Female	0.73 (0.46-1.16)	.183	0.97 (0.49-1.93)	.513
Gender (parent respondent)				
Male	Not applicable		1.00	
Female			0.81 (0.42-1.54)	.938
Annual household income, pretax (USD)				
53,872 or more	1.00		1.00	
38,480-53,871	0.61 (0.30-1.25)	.178	1.21 (0.52-2.84)	.658
38,479 or less	0.49 (0.25-0.97)	.042	1.90 (0.72-5.06)	.196
Prefer not to say	0.16 (0.07-0.38)	<.001	0.84 (0.29-2.42)	.750
Concession beneficiary				
No	1.00		1.00	
Yes	1.14 (0.64-2.02)	.660	1.77 (0.88-3.57)	.109
Private health insurance				
No	1.00		Not in final model	
Yes	0.59 (0.36-0.96)	.033		
Household composition				
Single living without dependents	1.00		3.51 (0.91-13.54) [†]	.068
Couple living without dependents	1.09 (0.63-1.90)	.756		
Single living with dependents	1.09 (0.60-1.96) [‡]	.782	1.00	
Couple living with dependents			2.58 (0.91-7.32)	.076
No. of other chronic medications				
None	1.00		1.00	
1-4	1.37 (0.79-2.37)	.267	2.07 (1.04-4.11) [§]	.038
5 or more	1.35 (0.67-2.71)	.403		
GINA symptom control, previous 4 wk				
Well controlled	1.00		1.00	
Partly controlled	1.26 (0.71-2.25)	.425	4.06 (1.45-11.35)	.008
Poorly controlled	2.00 (1.06-3.77)	.031	4.94 (1.72-14.16)	.003
Any urgent health service utilization for asthma				
No	Not in final model		1.00	
Yes			1.92 (0.90-4.13)	.093
Specialist visit for asthma, previous 12 mo				
No	Not in final model		Not in final model	
Yes				
Concerns with asthma medications				
There are no issues that concern me				
No	1.00		1.00	
Yes	0.24 (0.15-0.38)	<.001	0.30 (0.12-0.76)	.010
Shared decision making	1.10 (1.01-1.21)	.031	1.20 (1.04-1.38)	.012
Comfort discussing medication costs with doctor				
Mean	Not in final model		0.82 (0.72-0.92)	.001
Model fit statistics				
Hosmer-Lemeshow goodness of fit (Prob > χ^2)	0.3317		0.5601	

(continued)

TABLE E6. (Continued)

Variable	Adults (n = 466)		Children (n = 287)	
	Adjusted OR (95% CI)	P value	Adjusted OR (95% CI)	P value
AIC	505.6		301.95	
McFadden R^2 , adj.	0.187		0.211	
Observations	451 [¶]		286 [¶]	

AIC, Akaike Information Criterion; CI, confidence interval; GINA, Global Initiative for Asthma; ICS, inhaled corticosteroid; Prob, probability.

*Both multivariable models adjusted for age, gender, income, concession status, household composition, number of medicines, ICS inhaler experience.

†Single or couple living without dependents.

‡Single or couple living with dependents.

§1 or more other chronic medications.

¶Household composition = other omitted from analysis: adults (n = 15), children (n = 1).

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