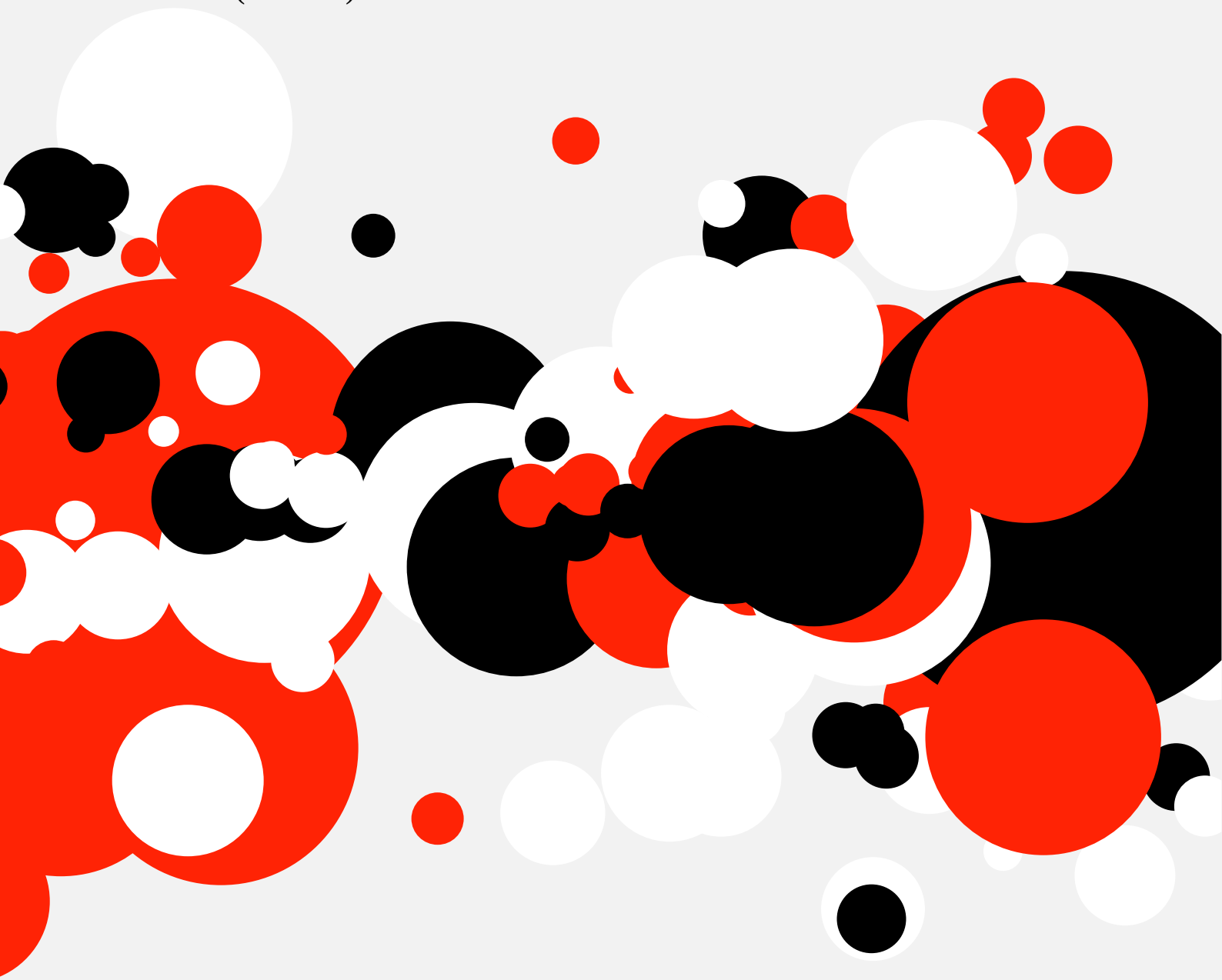
Economic Evaluation of The COACH Program® for Asthma Management.

CENTRE OF HEALTH ECONOMIC RESEARCH AND EVALUATION (CHERE)



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About CHERE

CHERE is an independent research unit affiliated with the University of Technology Sydney. It has been in operation since 1991 and in that time CHERE has developed a strong reputation for excellence in research in health economics and public health.

CHERE has extensive experience in evaluating health services and programs, and in assessing the effectiveness of policy initiatives. The Centre provides policy support to all levels of the health care system, through both formal and informal involvement in working parties, committees, and by undertaking commissioned projects. For further details about CHERE and our work refer to www.chere.uts.edu.au.

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Executive Summary

Background

Asthma Australia engaged the Centre for Health Economics Research and Evaluation (CHERE), based at the University of Technology Sydney, to undertake an economic analysis of The COACH Program®. The COACH Program® is a self-management education program which commenced in 2016 and is delivered by Asthma Australia within the federally funded Asthma Management Program. The Program provides education to people with asthma through the provision of regular scheduled calls with a trained Asthma Educator. The key objective of the Program is to improve individual's asthma control and overall general health.

Aims

This report assesses the cost and effectiveness of The COACH Program®. The primary aims were to investigate the effectiveness of The COACH Program® in terms of its impact on:

- Primary outcomes: asthma control (daytime, night-time, during exercise and needing a reliever): health service utilisation, to include health professional visits, hospitalisations, emergency department (ED) attendances;
- Program costs;
- Data quality follow-up.

Additionally, the evaluation provides an overview of:

- Patterns of The COACH Program® utilisation.
- Mediating factors of the primary outcomes of interest.

Methods

The evaluation utilises de-identified, individual-level participation and health data from the records of The COACH Program®, including self-reported health provider utilisation, hospital admission and ED presentations.

A before-and-after analysis is employed to examine whether program participation was associated with improvements in asthma management and health service outcomes. Several robustness checks are used to provide greater confidence that the key findings can be attributed to The COACH Program®.

Results

The COACH Program® was associated with the following key results:

- *Profile of The COACH Program® utilisation.*

  This analysis reports on the sample of individuals enrolled in The COACH Program® between January 1st, 2018 and July 2020. Approximately 69 percent of the individuals who were enrolled in the program were female, the average age was 45 years, with 16 percent being from a non-English speaking background and 6 percent who were of Aboriginal or Torres Strait Islander (ATSI) descent. Victoria was the most common state of residence of participants (19%), followed by South Australia (SA) (18%) and Queensland (QLD) (15%). The most

common referral sources were 1800-ASTHMA (43%), hospital (29%) and primary health care providers (20%). Over two-thirds of individuals had been unwell in the last 4 weeks. In terms of participation, individuals who utilised The COACH Program® do so for an average of 2.29 sessions over an average of 82 days. Approximately 53 percent of participants discontinued the program with the most common reason being disengagement. These participants attended on average 1.90 sessions over 56 days. The remaining 47 percent of participants graduated from COACH, attending on average 2.47 sessions over an average of 79 days. Strategies which target program engagement, would be beneficial in improving rates of discontinuation and subsequent asthma control for all participants.

- *Improved asthma control across all domains (daytime, night-time, during exercise and needing reliever)*

  There was a clinically and statistically significant improvement of 4.62 (p value<0.01) in asthma control (day-time night-time, during exercise and needing reliever) following enrolment in The COACH Program®, with the greatest benefit being between session 1 and session 2 (5.18 p value <0.01). For participants who 'graduated' (i.e. met most or all of the program targets), this gain increased to between 7.28 points and 8.36 points (p value <0.01). The key elements of the program which mediated asthma control were time (number of sessions), implementing planned reviews, encouraging written asthma plans and preventer adherence.

- *Enhanced asthma management through increased planned health provider visits and GP follow-up*

  There is evidence that COACH is associated with enhanced asthma management through a multi-disciplinary approach combining COACH strategies with planned primary care reviews. There was a statistically significant increase in both planned visits (0.28, p value <0.01) and overall health provider visits (0.64, p value <0.1) following completion of The COACH Program®. The key elements of the program which mediated the number of planned visits were time (number of sessions), planned review at enrolment, and having a current written asthma plan. For Aboriginal and Torres Strait Islander (ATSI) participants, the magnitude of the effect of COACH on planned visits was approximately twofold that of non-ATSI participants.

- *Reduced hospital visits and reduced ED attendances for individuals referred from hospital (ACT- Calvary hospital and other hospitals)*

  There is evidence in the literature that shows that improved asthma control is associated with reduced ED attendance and hospital visits[1]. However, the relationship is complex and has been found to be influenced by medication use, co-morbid conditions, minority status and the environment[2]. The results from this study are preliminary but show some promising trends. There was a statistically significant reduction in hospital inpatient visits across all participants on average, following completion in The COACH Program®. For referrals from hospital (ACT- Calvary hospital and other hospitals), this occurred in conjunction with a reduction in ED attendances, although not statistically significant.

- *Increased ED attendances for individuals referred from 1800-asthma, QUIT and primary health care.*

  In contrast, there was an increasing trend in ED presentations for individuals from non-hospital referrals (1800-asthma, QUIT and primary health care), although not statistically significant This sample are more likely to be smokers, or have recently quit and while their overall utilisation is lower than the hospital group, there is evidence that individuals who have recently quit smoking may experience an increase in acute respiratory episodes in the short-term, which leads to increased ED admission perhaps due to unobserved health conditions (comorbid conditions) or lower asthma control during the night and during activity. The inclusion of additional questions relating to co-morbidities at enrolment, would improve the robustness of the analysis and provide greater confidence that the key findings can be attributed to The COACH Program®.

- *Cost of The COACH Program®*

  The cost of running The COACH Program® for participants with asthma was $849,178 per year which equated to $1,918 per individual per year.

- *Cost savings associated with reduced health service utilisation*

  The net cost savings associated with reduced health service utilisation, was $319 per person per year, and this was due to reduced hospital inpatient visits ($371). The additional costs incurred for enhanced asthma management equated to $54 per person per year. For this cost, there was an observed improvement in asthma control (day-time night-time, during exercise and needing reliever) following enrolment in The COACH Program®. This analysis does not consider other possible economic and health benefits of the program such as reduced pharmaceutical costs, improved quality of life, increased productivity due to reduced absenteeism or potential longer-term cost-savings resulting from improved asthma control.

Conclusion

Overall, the results indicate that The COACH Program® has an important role to play in enhanced asthma management by mitigating the risk of hospitalisations and ED presentations through improved asthma control and through multidisciplinary care.

Recommendations

The results of the evaluation suggest that there could be data quality improvements relating to participant engagement and follow-up, missing and linked data, supplementation of existing quality life measures, and the identification of a control group.

The estimates from this study are based on a within intervention timeframe using self-reported data. The Program is subject to high rates of drop out (both due to early graduation and discontinuation) and as such would be strengthened with the inclusion of follow-up data (both post intervention for those who exit early and 12-month) focusing initially on the sub-group of participants who graduated from COACH, where the gains in asthma control are the greatest. In addition, the inclusion of individually linked data would be informative and could consider both acute inpatient care and Medicare funded or privately funded medical services or pharmaceuticals, which have been identified in the literature as important drivers of cost[2-5].

The COACH Program®. reports on two quality of life measures, the QOL-GAD for generalised anxiety disorder and the PHQ-9 for depression. The number of participants for whom these quality of life measures was available was approximately 4 percent of the overall sample. (not reported in the analysis). Including valid quality of life instruments in the economic assessment of health and medical services is well- established, as it is a fundamental component of cost utility analysis, which is considered the gold standard of economic evaluation methods. Improving the completion rate of these data or supplementing the existing instruments with a condition specific QOL such as the AQL-5D measure would be a simple way to improve the robustness of future evaluations.

Furthermore, to strengthen the causal interpretation of the results in this report, the identification of a comparison group would be beneficial. With an appropriate comparison group, it would have been possible to compare how a reference group's utilisation changed without The COACH Program®. With this limitation in mind the consistency in the results over a longer time period provides additional confidence in the robustness of the findings.

1 Introduction

Asthma is a chronic respiratory condition affecting up to one in nine Australians, resulting in 39,500 hospital admissions and more than 400 deaths each year, according to the latest information published by Asthma Australia [6]. The prevalence of asthma has increased considerably in the last two decades, with Australia having one of the highest prevalence rates internationally, currently 11 percent, with almost twice this rate for Indigenous Australians[7]. In response, asthma was identified as a national health priority in 2009, and since then there have been several government policies aimed at addressing the impact of one of Australia's most widespread chronic health conditions. The most recent policy is the National Asthma Strategy 2018 which outlines a targeted and comprehensive approach to optimise asthma diagnosis and management. One of its key areas of focus is on the quality of care afforded to disadvantaged groups who are more vulnerable to disease[8].

Asthma is associated with high economic and social costs. In 2015, the total costs for asthma in Australia were estimated to be close to A$28 billion per year (or, $11,740 per person), encompassing direct health care costs (A$1.2 billion) and the indirect costs of loss of productivity, time off work, premature death and other costs [9]. There is evidence in the literature that the burden of asthma can be reduced through effective disease management strategies (pharmacological treatment and GP follow-up) combined with self-management education programs[8,10,11]. Given the increasing burden associated with asthma in Australia, it is important to explore the most cost-effective ways to manage the condition.

1.1 The COACH Program® Model.

The COACH Program® model for asthma was established in 2016 as a component of the federally funded Asthma Management Program and in response to the increasing burden of asthma management on primary health care. The COACH Program® specifically addresses a gap in patient education and support. It is a confidential, free health service provided by trained Asthma Educators through the provision of regular scheduled phone calls to individuals with asthma. The objectives of the program are to:

- Improve individuals' ability to manage their own asthma and improve overall general health.
- Enable individuals to achieve their asthma management goals.
- Provide a multi-disciplinary approach to asthma health care delivery.

This report focuses on assessing the costs and effectiveness of The COACH Program® that is administered by Asthma Australia. This report will form the basis of the final output of this project.

1.2 Current asthma evaluations

While there is limited evidence on the effectiveness of the COACH Program® model on asthma management, a number of international studies have evaluated the impact of enhanced asthma management strategies, that are similar to COACH. A systematic review conducted by Yong & Shafie in 2014, found 49 studies, which measured the cost-effectiveness of asthma management using a range of strategies including education, environmental control, and self-management. The

authors found the most cost-effective enhanced management strategies (ICER range dominant to $27,000 per outcome reported) were a mixture of education and self-management by an integrated team of healthcare and allied healthcare professionals The authors concluded that whilst the availability and accessibility are equally important factors to consider, the sustainability of the cost-effective management must be further investigated using a longer time horizon, especially for chronic diseases such as asthma[11].

An initial pilot analysis of The COACH Program® model was conducted in 2018 and reported a significant improvement in asthma control scores (between 2 and 6 points) in the first 6 weeks of the program. This analysis expands on the current evaluation by utilising up to 2.5 years of data to evaluate the COACH Program® model. Robust econometric methods are employed, with consideration of a range of explanatory variables, including the background characteristics of the participants.

1.3 Evaluation aims and outline of this report

The evaluation focuses on three main areas of interest.

- The first is to analyse the patterns of The COACH Program® utilisation.
- The second is to analyse costs.
- The third is a statistical analysis of the effect of participation on asthma control and on the use of mainstream clinical services. Specifically, with respect to the number of health provider attendances, hospital inpatient and emergency department (ED) presentations. The impacts of mediating factors are also considered.

The structure of the report is as follows:

- Section 3 – Data and empirical approach
- Section 4 – Program expenditure
- Section 5 – Data Analysis of the characteristics of The COACH Program® individuals
- Section 6 – Estimated cost savings
- Section 7 –Summary of findings
- Section 8 – Discussion and conclusions
- Section 9 - References
- Appendix A Model summary

2 Data and empirical approach

2.1 Data

Data for the analysis were obtained from Asthma Australia, who provided detailed data on the individuals who enrolled in The COACH Program® between January 1st, 2018 and July 2020. There were 1.106 individuals who participated in the program during this timeframe. For the purposes of this report this group is defined as The COACH Program® sample.

2.2 Empirical approach

A cost-consequence analysis was conducted, which measures the costs and outcomes associated with the delivery of The COACH Program®. Using this method, the outcomes are reported separately from the costs because there are multiple outcomes that are relevant which cannot be combined in a cost-effectiveness analysis (for example; x, y, z). This type of analysis is best suited to retrospective cohort studies, where a comparison group cannot be established, and as such there is insufficient evidence to conclude causality. Section 3 presents a descriptive analysis of The COACH Program® sample.

Section 4 focuses on the costs of the program. A top down approach is used, whereby a calculation of total expenditure for a given program is presented by the total units of activity (e.g. participants) to derive a unit cost [12]. This approach uses aggregate, budgetary data provided by Asthma Australia to estimate a unit cost per participant. The advantage of this approach is that it provides a reliable, simple method of measuring the expenditure required to replicate the service as well as provide a straightforward per unit cost.

Section 5 focuses on whether changes in asthma control, and in the number of health provider attendances, inpatient separations and ED presentations occurred following enrolment in The COACH Program®. As a comparison group could not be established, a pre/post regression analysis using fixed periods of time to observe whether the patterns of health care changed over time is employed. Using the initial period of 12-months prior to enrolment (or 4 weeks for asthma control) and comparing these to four subsequent sessions after the date of active enrolment, the analysis tests whether there is a significant and persistent effect across all 5 observation periods (i.e. 5 phone calls). This approach provides more robust evidence that any short-term impacts that are observed, are sustained in the long-term. Mediating effects and subgroups are also considered.

3 Descriptive analysis of the characteristics of individuals in The COACH Program®.

In this section of the report, the analysis focuses on The COACH Program® data to assess the patterns of utilisation for participants. The data include variables related to the demographics and health of the individuals, enrolment patterns (number of sessions completed), and how they were referred to The COACH Program®.

3.1 Overview of The COACH Program® sample.

Table 1 summarises The COACH Program® sample of individuals who enrolled between January 1st 2018 and July, 2020[i]. Approximately 69 percent of the individuals who were enrolled in the program were female, the average age was 45 years, with 16 percent being from a non-English speaking background and 6 percent who were of Aboriginal or Torres Strait Islander (ATSI) descent. Victoria was the most common state of residence of participants (19%), followed by South Australia (SA) (18%) and Queensland (QLD) (15%). The most common referral sources were 1800-ASTHMA (43%), hospital (29%) and primary health care providers (20%). Fifty three percent of participants had never smoked and 26 percent were ex-smokers. Over two-thirds of individuals reported they had been unwell in the last 4 weeks (68%).

On average, individuals in The COACH Program® attended 2.24 sessions, with 31 days between each session. Attendance was over 50 percent in the first 3 sessions and dropped to 16 percent by session 5. Approximately 54 percent of participants discontinued the program. In terms of asthma management, the average asthma score of participants at the time of enrolment was 12 out of a possible 25 points. Participants' annual health utilisation for asthma included an average of 2.99 health provider visits, 0.39 planned visits, one ED presentation and 0.59 hospital inpatients stays, in the 12 months prior to enrolment. Approximately one third of participants had a current asthma plan and a 50 percent reported consistent preventer usage of more than 8 weeks.

[i] The demographic sample is subject to missing observations.

Table 1: Background characteristics of The COACH Program® sample (at enrolment)

			Sample (n=1106)			
Variable		Measurement	Observations	Mean	Min	Max
Section A. Outcome variables						
Asthma score		Range 5 to 25	860	12	5	25
Asthma symptoms						
	Day	Range 1 to 5 (More than 2 days per week, no more than 2 days per week)	911	1.60	1	5
	Need reliever	Range 1 to 2 (More than 2 days per week, no more than 2 days per week)	908	1.17	1	2
	Activity	Range 1 to 4 (Limitation on activity to no limitations)	909	1.40	1	4
	Night	Range 1 to 2 (Symptoms during night or on waking, No symptoms during night or on waking)	909	1.21	1	2
Planned visits to HP		1=Yes, 0=No	821	0.39	0	1
Visits to HP in last 12 months		Range 0 to 11	818	2.99	0	11
Visits to ED in last 12 months		Range 0 to 11	790	0.98	0	11
Visits to hospital in last 12 months		Range 0 to 11	774	0.59	0	11
Section B. Demographics						
COACH sessions		Number of sessions Range 1 to 5	3326	2.24	1	5
Time between sessions		Time between sessions Range 0 to 1144	3323	31	0	1144
COACH_1 attendance		Range 0 to 1	1106	1.00	0	1
COACH_2 attendance		Range 0 to 2	1034	0.93	0	1
COACH_3 attendance		Range 0 to 3	644	0.58	0	1
COACH_4 attendance		Range 0 to 4	360	0.33	0	1
COACH_5 attendance		Range 0 to 5	182	0.16	0	1
Dropout [b]						
	Discontinued	1=Yes, 0=No	1106	0.53	0	1
	Graduated	1=Yes, 0=No	1106	0.47	0	1
Age		Range 1 to 92	999	45	1	92
SEIFA		Range 0 to 10	1106	5.48	0	10
RA code		Range 0 to 5	1106	1.50	0	5
Gender		Male	1089	0.31	0	1
ATSI	Aboriginal, Torres Strait islander	1=Yes, 0=No	976	0.06	0	1
Non-English-speaking background		1=Yes, 0=No	847	0.16	0	1
State	ACT	1=Yes, 0=No	1106	0.08	0	1
	NSW	1=Yes, 0=No	1106	0.14	0	1
	NT	1=Yes, 0=No	1106	0.02	0	1
	QLD	1=Yes, 0=No	1106	0.15	0	1
	SA	1=Yes, 0=No	1106	0.19	0	1
	TAS	1=Yes, 0=No	1106	0.11	0	1
	VIC	1=Yes, 0=No	1106	0.18	0	1
	WA	1=Yes, 0=No	1106	0.12	0	1

RA= , ATSI= Aboriginal Torres Strait Islander a. captured across all sessions. b. cumulative at session 5.

Table 1 Background characteristics of The COACH Program® sample continued..

		Sample (n=1106)			
Variable	Measurement	Observations	Mean	Min	Max
Section C. Health status					
Smoking status					
Ex-smoker	1=Yes, 0=No	884	0.25	0	1
Never smoked	1=Yes, 0=No	884	0.52	0	1
Recently quit	1=Yes, 0=No	884	0.05	0	1
Unwell in last 4 weeks	1=Yes, 0=No	759	0.76	0	1
Section D. Asthma management					
Visit plan review (initial)					
0	1=Yes, 0=No/Don't know	857	0.59	0	1
1	1=Yes, 0=No/Don't know	857	0.39	0	1
Written asthma plan					
No	1=Yes, 0=No	1018	0.53	0	1
No-never heard of one	1=Yes, 0=No	1018	0.05	0	1
Yes- current (last 12 months)	1=Yes, 0=No	1018	0.28	0	1
Yes-interim plan	1=Yes, 0=No	1018	0.08	0	1
Yes- not current	1=Yes, 0=No	1018	0.07	0	1
Time consistent preventer use					
2-4 weeks	1=Yes, 0=No	781	0.13	0	0
4-8 weeks	1=Yes, 0=No	781	0.06	0	1
Less than 2 weeks	1=Yes, 0=No	781	0.31	0	1
More than 8 weeks	1=Yes, 0=No	781	0.50	0	1
Use spacer	1=Yes, 0=No	1106	0.41	0	1
Have spacer	1=Yes, 0=No	1106	0.46	0	1
Spirometry	1=Yes, 0=No	981	0.44	0	1
Section E: Referral source					
1800 Asthma	1=Yes, 0=No	1106	0.43	0	1
ACT Calvary	1=Yes, 0=No	1106	0.07	0	1
Hospital	1=Yes, 0=No	1106	0.22	0	1
Key partners	1=Yes, 0=No	1106	0.00	0	1
Org support	1=Yes, 0=No	1106	0.02	0	1
Pharmacy	1=Yes, 0=No	1106	0.02	0	1
Primary Health Care	1=Yes, 0=No	1106	0.20	0	1
QUIT	1=Yes, 0=No	1106	0.05	0	1

RA= , ATSI= Aboriginal Torres Strait Islander

4 Program expenditure

This section summarises The COACH Program® expenditure. These costs have been grouped into nine areas, consisting of: (i) staffing costs; (ii) software; and (iii) preceptorships; (iv) consultancy; (v) training and professional development; (vi) marketing; (vii) travel and incidentals; (viii) program evaluation and (ix) management fees.

Based on these budget summaries, it was possible to calculate an average cost per individual per year. The average cost per individual per year was calculated as the annualised cost (Table 2) divided by the annualised participation (Table 3). Participation is determined by the number of individuals enrolled per financial year in The COACH Program®. The average cost per participant with asthma per year was $1,918.

Table 2: Average expenditure (2016-2020) The COACH Program®

	Average annual (2016 to 2020)
Staffing costs	
CSS educators, administrator, and manager	$427,820
Other staff [a]	$28,871
Staffing on-costs [b]	$45,669
Software	
Licence	$57,336
Hosting fees	$6,078
Data tool fixing	$2,000
Software upgrade	$20,000
Preceptorship [c]	$18,994
Consultancy	
Asthma Foundation WA	$67,200
Interpretation fees	$3,000
Training and professional development [d]	
Letter writing	$7,000
Lifestyle risk factor training	$5,000
Train the trainer	$2,250
Marketing and program tools [e]	$32,200
Travel and incidentals [f]	$10,680
Program evaluation	$15,000
Management fees [g]	$224,730
Total costs	$973,828
Total costs for participants with asthma	**$849,178**
Cost per participant with asthma [h]	**$1,918**

CSS=COACH staff; a. Other staff =non-COACH staff completing COACH duties (assumed 60% of staff time);b. Staffing on-costs includes leave, superannuation and salary packaging; c Annual preceptorship = total preceptorships since inception (AA+ AFWA)/4 years since inception; d Training costs = total training costs since inception/4 years since inception. e. Marketing costs= Total promotional budget/ years since inception+ 60% of other promotional budget; f. Incidentals include postage and stationery; g. Management fees = 30% of total overhead costs. h. Cost per participant = Total annual cost*proportion of sample who is a person with asthma / 1,107 participants annualised.

Table 3: Total participation (2018-2020) sample.

	N
Total participants for costing	
Enrolments since 1 January 2018 (time period of evaluation) [a]	1,107
Annualised	443

a. assumes average utilisation is consistent for years before January 2018

5 Analysis of asthma control, health provider, hospital inpatient and ED presentations

The focus now turns to the wider impacts of the program, specifically what impact The COACH Program® had on asthma control, health provider utilisation (planned visits and total health provider visits), ED presentations and hospital inpatient stays.

As a comparison group could not be established, a pre/post analysis is conducted, using fixed periods of time to observe whether the patterns of asthma control, health provider visits, hospital visits and ED presentations changed over time.

The analysis of asthma control focuses on 4-week timeframes whereby participants were asked "In the last 4 weeks how has your asthma control been…".

The analysis of health utilisation focuses on rolling 12-monthly time periods, whereby participants were asked "In the last 12 months how many visits to health provider/ED presentations/hospital inpatient stays did you have….". The time periods were defined as: 12-months pre enrolment, and then subsequently each timeframe following enrolment, up to a maximum of 5 sessions (average 46 days between sessions). The differences between each time period are compared with consideration of whether these differences persist across all observation periods.

5.1 Modelling approach- Adjusted asthma control and health service utilisation

A regression analysis approach was used to estimate the expected outcomes for individuals who participate in The COACH Program®. Regression analysis is a form of predictive modelling which investigates the relationship between the explanatory variable of interest, in this case The COACH Program®, and the outcomes of interest: asthma control and health utilisation. For each outcome of interest two analyses were conducted. The first analysis was an unadjusted analysis, which uses a pooled Ordinary Least Squares (OLS) and controlled for time only. In the second analysis (referred to as the adjusted analyses), a panel data random effects model is used to control for explanatory variables of interest, time and missing observations (summarised in Appendix A).

The outcome variables were defined as:

- Asthma control (score 0 to 25) including the domains of asthma control: Day-time (score 1 to 5), night time (score 1 to 2), control during activity (score 1 to 4) and needing to see a doctor for asthma (score 1 to 2);
- Health professional visits (Yes/No) and the number of health professional visits, ED presentations and health inpatient stays in the last 12 months.
- In addition, an exploratory analysis of 'drop out' was conducted to consider the main factors which drive participants to drop out of The COACH Program® before the end of five sessions. Drop out was defined as those who are 'currently enrolled', those who discontinue (due to patient request, the patient being not contactable, the patient being deceased, or 'other') and those who graduate (as they have met key targets or they opt out).

The explanatory variables of interest included:

- The COACH Program® characteristics such as number of sessions, time between sessions and drop out; asthma management strategies such as encouraging implementation of a written asthma plan with a GP, preventer adherence, use and having a spacer and being shown inhaler technique.

- Health of individuals was also considered, including whether participants had been unwell in the last 4 weeks, the number of flares in the last 12 months and current smoking status.

- Background characteristics included: gender, age, state of residence, Socio-Economic Indexes for Areas (SEIFA), Remoteness Area (RA), and source of referral to The COACH Program®.

- Interactions effects were considered throughout the modelling, where there was evidence of differential effects of the above explanatory variables over time. For example, participants who have been unwell in the last 4 weeks may experience higher than average initial gains in asthma control. Similarly, participants with lower initial asthma control may have different patterns of health utilisation over time to participants with more controlled asthma control at enrolment. To explore these differences the following interactions are considered:

    - An interaction of the number of COACH sessions with statistically significant mediating factors were considered in the asthma control models (defined as the interaction model)

    - Asthma control and number of sessions were considered in the health service utilisation models.

    - An interaction of ATSI status and number of sessions was considered in the sub-group analysis.

Table 4 and Table 7 summarise the results of the unadjusted analysis and the adjusted analysis for asthma control and health service utilisation.

5.1.1 Asthma control

Main regression model (no interactions)

Table 4 presents the estimates for The COACH Program® enrolment on asthma control. Results are presented as an overall asthma control score and across the 4 key domains of asthma control, which include: daytime, night-time, during activity/exercise and needing to use a reliever. The results showed that on average, individuals' reported asthma control of 13.05 (out of a possible 25) in the 4-weeks leading up to The COACH Program® enrolment. Asthma control scores lower than 15 indicate 'Very poorly controlled' asthma. The unadjusted results indicated a statistically significant increase in asthma control (6.66**, p value <0.01) over the course of the program. The adjusted results are largely consistent with the unadjusted results. At the completion of 5 sessions, individuals reported a 4.62 improvement in asthma control (p value <0.01), when compared to the pre-enrolment 4-week period, up to 17.67. This represents a clinically significant improvement in asthma control (> 3 points) from 'Very poorly controlled' to score in the 'Not very well controlled' range (16 to 19 range). This improvement was observed consistently across all domains of asthma control (daytime, night-time, during activity and needing reliever less).

To further understand the mediating factors behind these effects we turn to the explanatory variables of interest which were a driver of asthma control and its domains. As illustrated in Figure 1 and Figure 2, the effect size of each variable is presented by a point estimate with a 95% confidence interval (CI)

(blue line). The red line (x=0) indicates a null effect, which means that any coefficient which crosses the red line does not reach statistical significance. Coefficients are displayed relative to the reference category. Negative coefficients (e.g. ACT Calvary hospital) indicate asthma control scores, which are lower than the reference category, which in this case is 1800-ASTHMA. Positive coefficients indicate asthma control scores, which are higher than the reference category. For example, the point estimates of COACH_2 to COACH-5 are large and positive, with the 95% CI remaining above the line of null effect, which indicates a statistically significant difference in asthma control at all COACH sessions, relative to the initial session.

The key elements of The COACH Program® which mediated asthma control were time (number of sessions), and 'graduating' from The COACH Program®. Notably, the largest increase in asthma control occurred between the initial COACH session and COACH_2, whereby asthma control scores improved by 5.16 points. Individuals with poor health (unwell in last 4 weeks) with a history of flare ups, those referred from ACT-Calvary (compared to 1800-asthma) and participants who did not have a current written asthma plan reported lower asthma control. Figure 2 presents the mediating factors of asthma control across the four domains: daytime, night-time, activity and needing a doctor. We find that the effects of day-time asthma control have the greatest impact (large and positive effect), followed by control during activity/exercise. Being a non-smoker (ex-smoker, non-smoker, recently quit) was positively associated with day-time asthma control. There was no significant difference between current smokers and those who had recently quit, in asthma control during night-time, activity/exercise or needing a reliever.

Table 4: Asthma control: daytime, night-time, during activity and needs doctor before and following The COACH Program® enrolment (main model with no interactions)

	Mean		Mean difference (95% CI)			
	Pre (Intervention)	Post (Intervention)	Unadjusted (OLS)[a]		Adjusted (RE) + explanatory variables b	
	1	2	3		4	
Asthma control (Total)	13.05	17.67	6.66**++	[5.82,7.50]	4.62**++	[3.17.6.06]
Day time	1.78	2.45	1.12**	[0.88,1.36]	0.67**	[0.23,1.11]
Night-time	1.25	1.49	0.39**	[0.31, 0.47]	0.23**	[0.08,0.38]
During activity	1.40	1.60	0.54**	[0.38, 0.70]	0.04**	[-0.26,0.34]
Need reliever less	1.25	1.46	0.39**	[0.31, 0.47]	0.21**	[0.06,0.36]

Asthma control scores, 95% confidence intervals (CI) in parentheses,+ p<0.10 * p<0.05 ** p<0.01, ++ = clinical significance. OLS= Ordinary Least Squares, RE=Fixed Effects

a. Logistic regression (OLS) includes explanatory variables for time (Session 1 to 5). Controls for missing observations
b. Random effects regression includes explanatory variables for: number of COACH sessions (1 to 5), drop out (discontinued and graduated) demographics (Age, gender, SEIFA, RA, Non-English speaking background, Aboriginal/ Torres Strait Islander, state of residence, referral source); health status of the patient (unwell in last 4 weeks, initial number of flares in last 12 months, planned review at enrolment); asthma management (time consistent preventer use, inhaler technique, written asthma plan, use spacer, have spacer, spirometry. Model considers missing observations.

Figure 1 Mediating factors of average asthma control (Main model, no interactions)

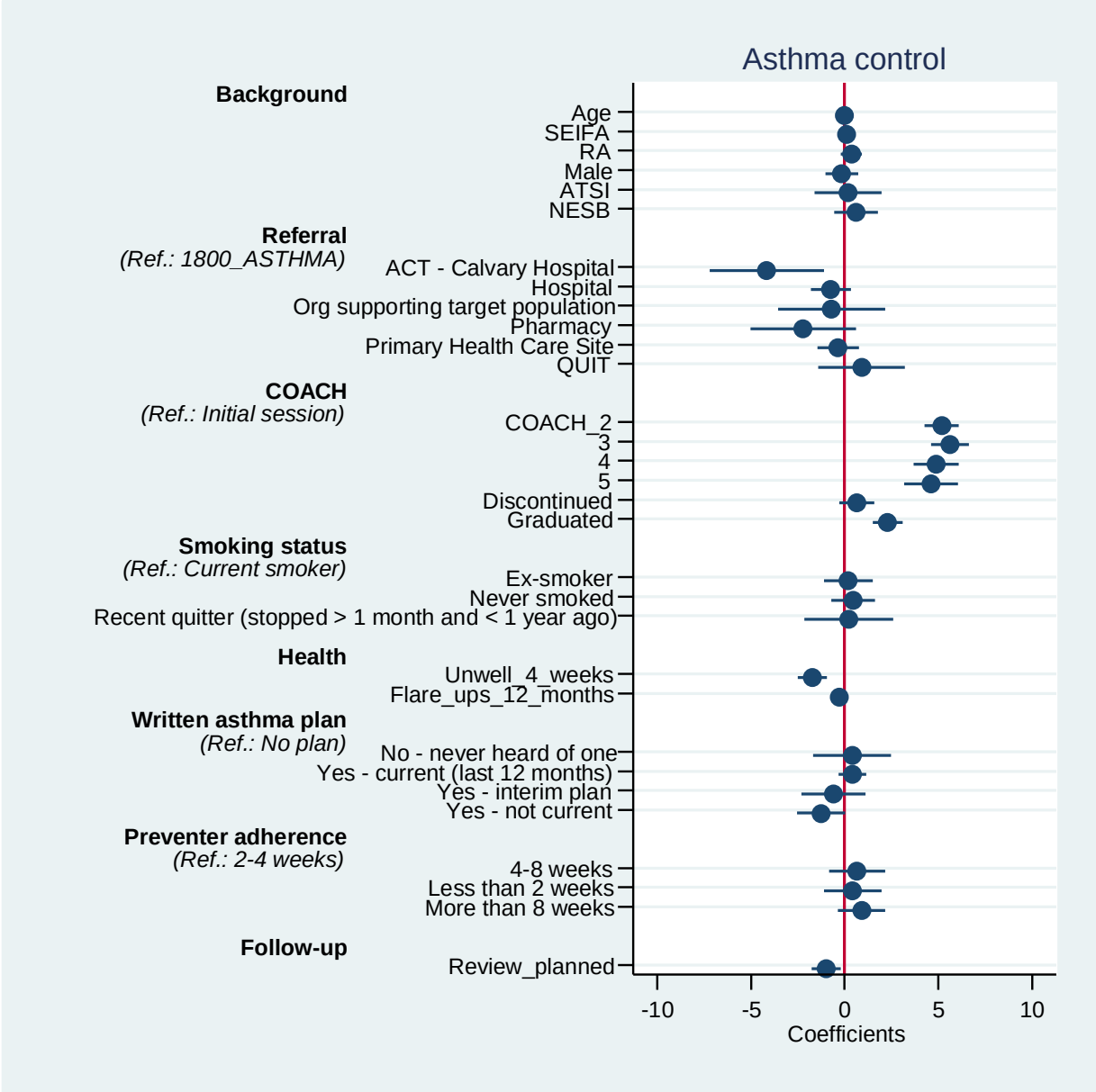
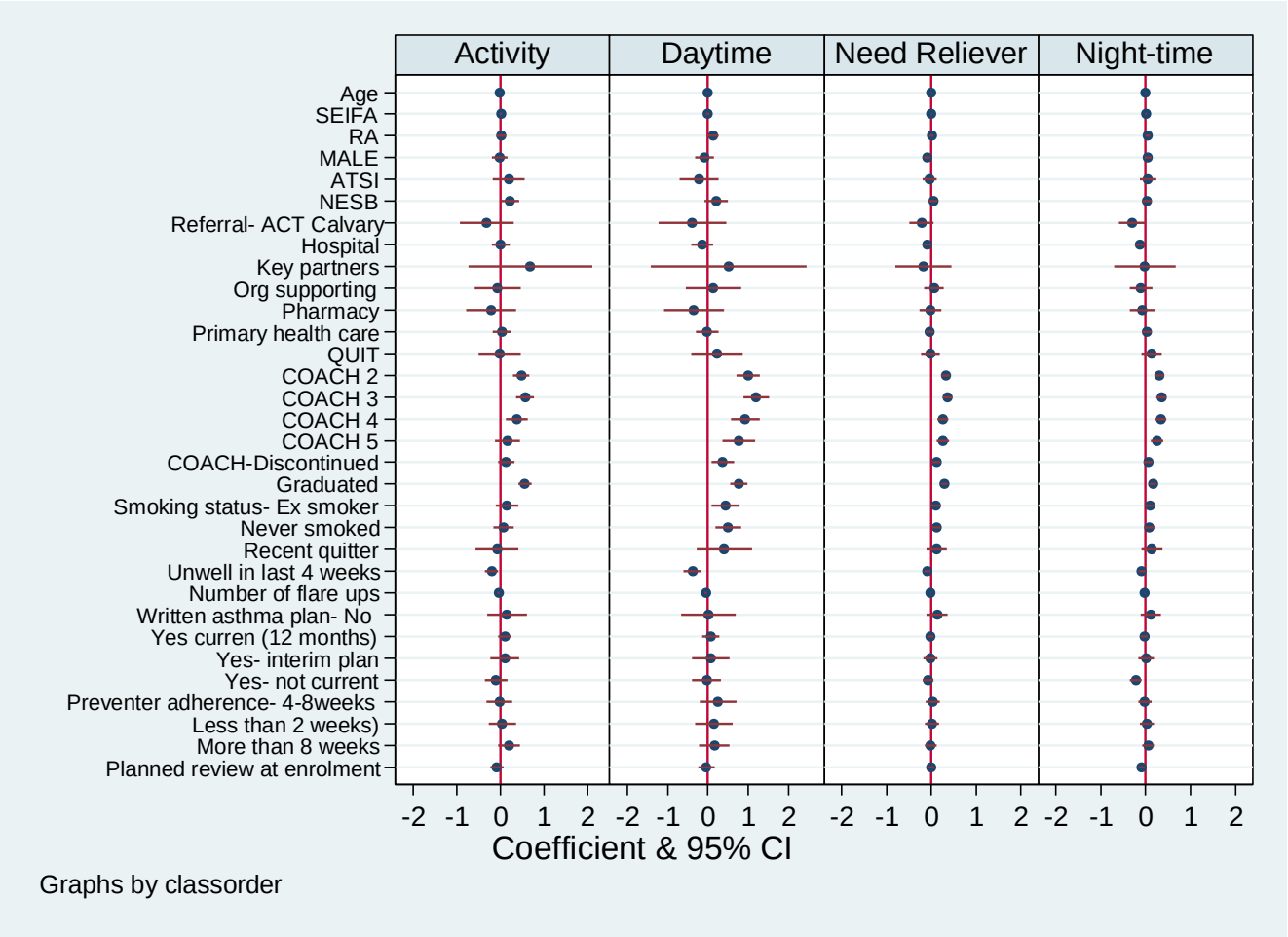


Figure 2 Mediating factors of average asthma control (by daytime, night-time, activity, Need reliever) (Main model- no interactions)



Regression model with interactions of key mediating variables and number of sessions (time).

The next stage of the analysis is to explore whether asthma control improvement (i.e. gains in asthma over time) differ by sub-groups and to do this we focus our analysis on interacting statistically significant mediating factors identified in Figure 1 and Figure 2, with the number of sessions. The basic premise of this interaction is that the impact of the number of COACH sessions may be different for different participants. For example, participants who have been unwell in the last 4 weeks may experience higher than average initial gains in asthma control, as they implement some of the key components of The COACH Program®. Similarly, participants who 'graduate' early from The COACH Program® may have different gains in asthma control over time than participants who 'discontinue'. To examine these trajectories further we re-specify the main regression model from Figure 1, with the inclusion of the following interactions: time*referral site; time*drop out; time*unwell in last 4 weeks; time*smoking status, time* written asthma plan, time*number of flare ups in last 12 months.

Table 5 presents the estimates for The COACH Program® enrolment on asthma control, once an interaction effect with time has been considered. Results are presented as a pre and post intervention asthma control score and a calculated mean difference (with 95%CI). The results suggest that there may be differences in asthma improvement by sub-groups. Notably participants who are referred from 1800-ASTHMA (5.47, p value <0.01) and pharmacy referral (6.05, p-value <0.01) showed greater

gains in asthma control than the average participant (4.62, p value <0.01). Similarly, participants who reported being unwell in the last 4 weeks (5.62, p value <0.01) and those participants who had a current asthma plan (5.82, p value <0.01) or had never heard of a written asthma plan (9.13, p value <0.1) demonstrated greater gains in asthma control. In contrast, participants who did not have a current asthma plan had the lowest asthma control gains (2.30, p value <0.1), which suggests that written asthma plans are a key component of successful asthma control.

Interestingly, there were notable differences in asthma control improvement by 'drop out' status. At the end of each COACH session participants were defined as being 'current' if they had completed the session, 'discontinued' if they were lost to follow-up, had requested to discontinue or were assessed as being disengaged in the process, or 'graduated', if they had reached most or all of the program targets or had completed the full program of five sessions[ii]. During the period from January 2018 to July 2020, 47 percent of participants had graduated from COACH and 53 percent had discontinued. Discontinuation occurred most commonly after 2 sessions (46 percent of all discontinuations). Graduated students reported the highest gains in asthma control over time, irrespective of when they graduated. Participants who graduated after session 2 (23 percent of all graduations) reported an 8.22** point improvement in asthma score, an 8,36** improvement in asthma score for graduation after session 3 (27.5 percent of all graduations) and 7.28** if they graduated after session 4 (24 percent of all graduations). In contrast, for the ~50 percent of the sample who discontinued COACH, whilst their pre-enrolment asthma control of 'Very poor control' was similar to those who graduated. these participants had lower than average gains in asthma control (Range 4.36** to 4.97**), perhaps due to program disengagement or other unobserved co-morbidities.

[ii] Participants can also 'graduate' if they become disengaged in the program but have participated in at least 3 sessions.

Table 5 Asthma control: before and following The COACH Program® enrolment (interaction with time)

	Mean			
	Pre (Intervention)	Post (Intervention)	Adjusted (RE) + explanatory variables [a]	Sample size (at enrolment) N=1106
	1	2	3	
Average asthma control	13.05	17.67	4.62**	
Key variables * number of sessions				
By referral site				
1800_ASTHMA	13.40	18.87	5.47**	0.43
ACT	9.01	11.75	2.74	0.07
Other hospital	13.28	17.35	4.07**	0.22
Org supporting	12.71	13.03	0.32	0.00
Pharmacy	12.06	18.12	6.05+	0.02
Primary health care	15.23	17.45	2.22+	0.02
QUIT	15.76	19.03	3.27	0.20
If unwell in last 4 weeks				
No	15.98	17.34	1.36*	0.24
Yes	12.07	17.69	5.62**	0.76
Smoking status				
Current smoker	13.65	17.86	4.21*	0.18
Ex-smoker	12.99	16.88	3.89**	0.25
Never smoked	13.80	17.95	4.15**	0.52
Recently quit [b]	12.64	13.93	1.29	0.05
Written asthma plan				
No	12.54	17.79	5.41**	0.53
No-never heard of one	11.45	19.72	9.13*	0.05
Yes- Current (12 months)	12.27	17.89	5.82**	0.28
Yes- Interim	11.87	17.29	5.46*	0.08
Yes - not current	12.81	15.61	2.30+	0.07
Drop out [b]				
After session 2 — No	12.69	17.14	4.45**	N/A
After session 2 — Discontinued	13.29	18.09	4.80**	0.25
After session 2 — Graduated	11.96	20.18	8.22**	0.11
After session 3 — No	12.62	17.38	4.69**	N/A
After session 3 — Discontinued	13.24	18.25	4.97**	0.13
After session 3 — Graduated	11.84	20.31	8.36**	0.13
After session 4 — No	12.62	16.83	4.14**	N/A
After session 4 — Discontinued	13.24	17.64	4.36**	0.05
After session 4 — Graduated	11.84	19.24	7.28**	0.11
Other SA				
ED on entry >=3	11.91	15.76	3.85	0.02

Asthma control scores 95% confidence intervals (CI) in parentheses,+ p<0.10 * p<0.05 ** p<0.01, ++ = clinical significance. a. Random effects regression includes explanatory variables for: number of COACH sessions (1 to 5), demographics (Age, gender, SEIFA, RA, Non-English speaking background, Aboriginal/ Torres Strait Islander, state of residence, referral source); health status of the patient (unwell in last 4 weeks, initial number of flares in last 12 months); asthma management (time consistent preventer use, inhaler technique, written asthma plan, use spacer, have spacer, spirometry, visit plan review. b. Dropout sample % of total sample at each time point (After session 5 not reported due to in sufficient sample size) Model

considers missing observations. Interactions time##smoking status, time# unwell in last 4 weeks, time#referral site, time#no.offlareups in last 12 months. Drop out and written asthma measured at time 4 (not estimable at time 5). Drop out sample based on denominator=1106

We know from Figure 1 and Figure 2, that the number of sessions is an important mediating factor of asthma control for participants of COACH. The results from Table 5 above revealed differences in asthma control gains for individuals who drop out of COACH before five sessions, which suggests that there are other key factors (other than time), which are important drivers of asthma control. While it is possible that the differential trends observed may be due to unobservable background characteristics of individuals, such as motivation or unreported co-morbidities, there may also be key components of The COACH Program® which drive success. Table 6 summarised the number of participants who dropout following each COACH session. As discussed above, it is evident that discontinuations are highest after session 2 and session 3. Graduations are highest after session 3 but are consistently observed following session 2.

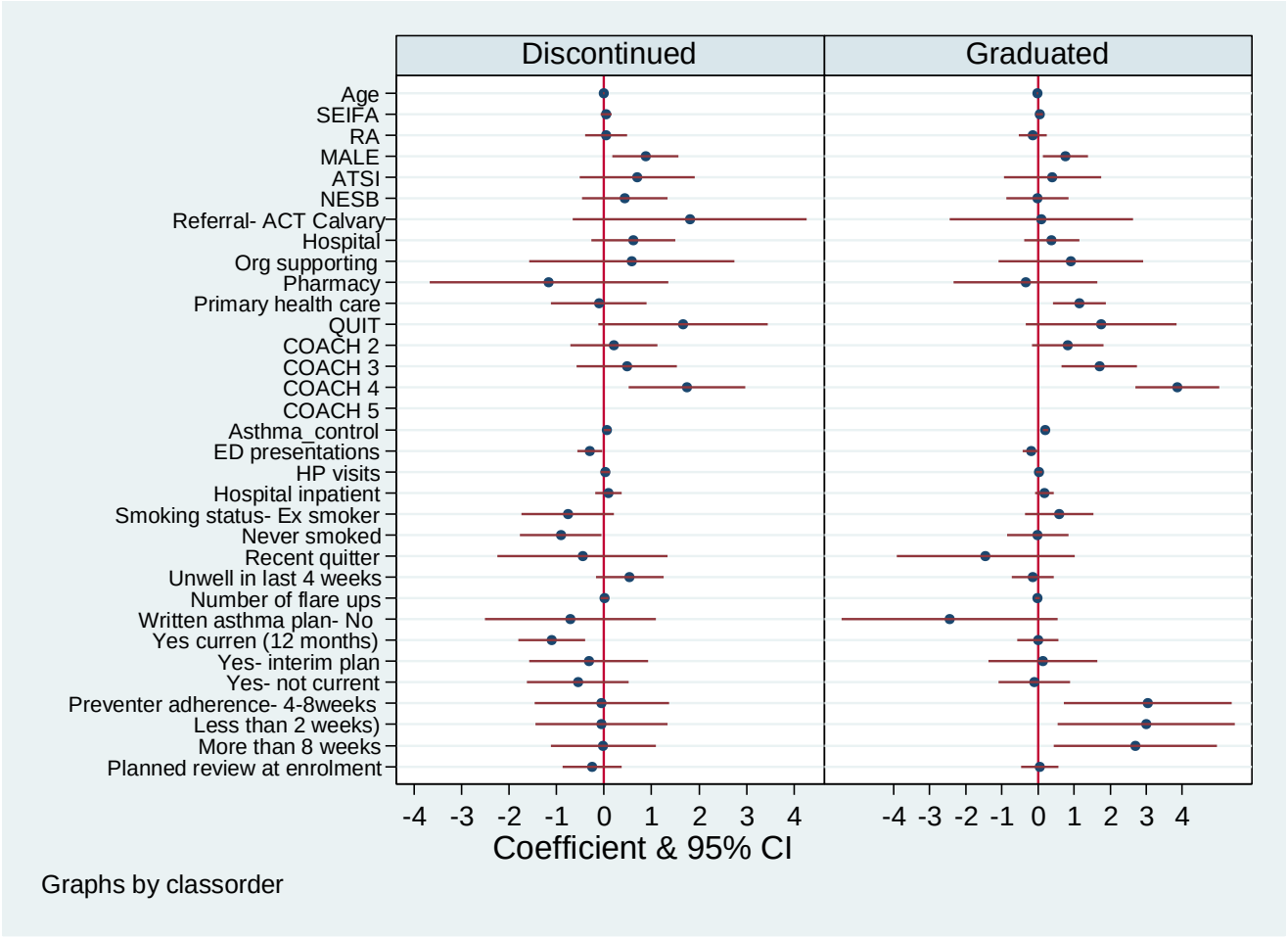
Table 6 COACH Program drop out over number of sessions

Drop out	1	2	3	4	5	Cumulative total
Current	1,034	644	360	182	0	0
Discontinued	62	273	142	55	59	591
Graduated	10	117	142	123	123	515

To explore these differential effects further we turn to the key factors which influence a participant's decision to drop out (Figure 3). We estimate a model[iii] in which the outcome variable is defined as drop out (No, discontinued, graduated). The explanatory variables of interest include the background characteristics and components of COACH defined in Section 5.1. In addition, the variables of asthma control score and health utilisation (ED presentations, HP visits) are included as explanatory variables. The results can be interpreted in a similar fashion to Figure 1 and 2, whereby coefficients on the right-hand side of the red line are positively associated with the outcome (more likely). Coefficients on the left-hand side of the red line are negatively associated with the outcome, or less likely. We find that in addition to time, preventer adherence appears to be an important indicator of graduation. For participants' who discontinued The COACH Program®, males were more likely to discontinue than females and those with current written asthma plans and those who had never smoked, were less likely to discontinue. Overall, the results suggest that strategies which target program engagement, through preventer adherence and by encouraging current written asthma plans, would be beneficial in improving asthma control for all participants. The high rates of drop out may also be a limitation in measuring effect sizes of subsequent health utilisation following COACH Program participation (discussed further below).

[iii] Multinominal logit regression model

Figure 3 Mediated factors associated with drop out (exploratory analysis)



5.1.2 Health providers/planned visits

The next section of the results focuses on planned and unplanned health utilisation of participants in COACH. The evidence from the literature shows that patients with partly and uncontrolled asthma were more likely to have had unscheduled healthcare visits, hospitalizations, visits to their healthcare providers for asthma compared to patients with well-controlled asthma (Gold et al., 2014b). Our hypothesis is that The COACH Program® may increase planned health utilisation, through additional visits to GPs for written asthma plans and subsequently reduce unplanned utilisation, as their asthma control improves. Table 7 shows the pre and post intervention health utilisation for individuals who participated in The COACH Program®. On average, individuals recorded 3.65 health provider visits with a rate of 0.52 planned visits in the 12-months leading up to The COACH Program® enrolment. There was a statistically significant increase in planned visits and health provider visits following enrolment in the program. At completion, individuals recorded 0.28 higher rate of planned visits (p value <0.01) and 0.64 higher health provider visits (p value <0.1), when compared to the pre-enrolment 12-month period.

The key elements of The COACH Program® which mediated planned visits were time (number of sessions), intention to have a review at enrolment, and having a current written asthma plan (Figure 4). Notably, ATSI individuals reported higher rates of planned visits, as well as participants who were ex-smokers or had never smoked. Similarly, the key factors which influenced health provider visits were preventer adherence and having a written asthma plan (Figure 4).

Table 7: Health service utilisation: health providers, ED presentations and hospital visits before and following The COACH Program® enrolment

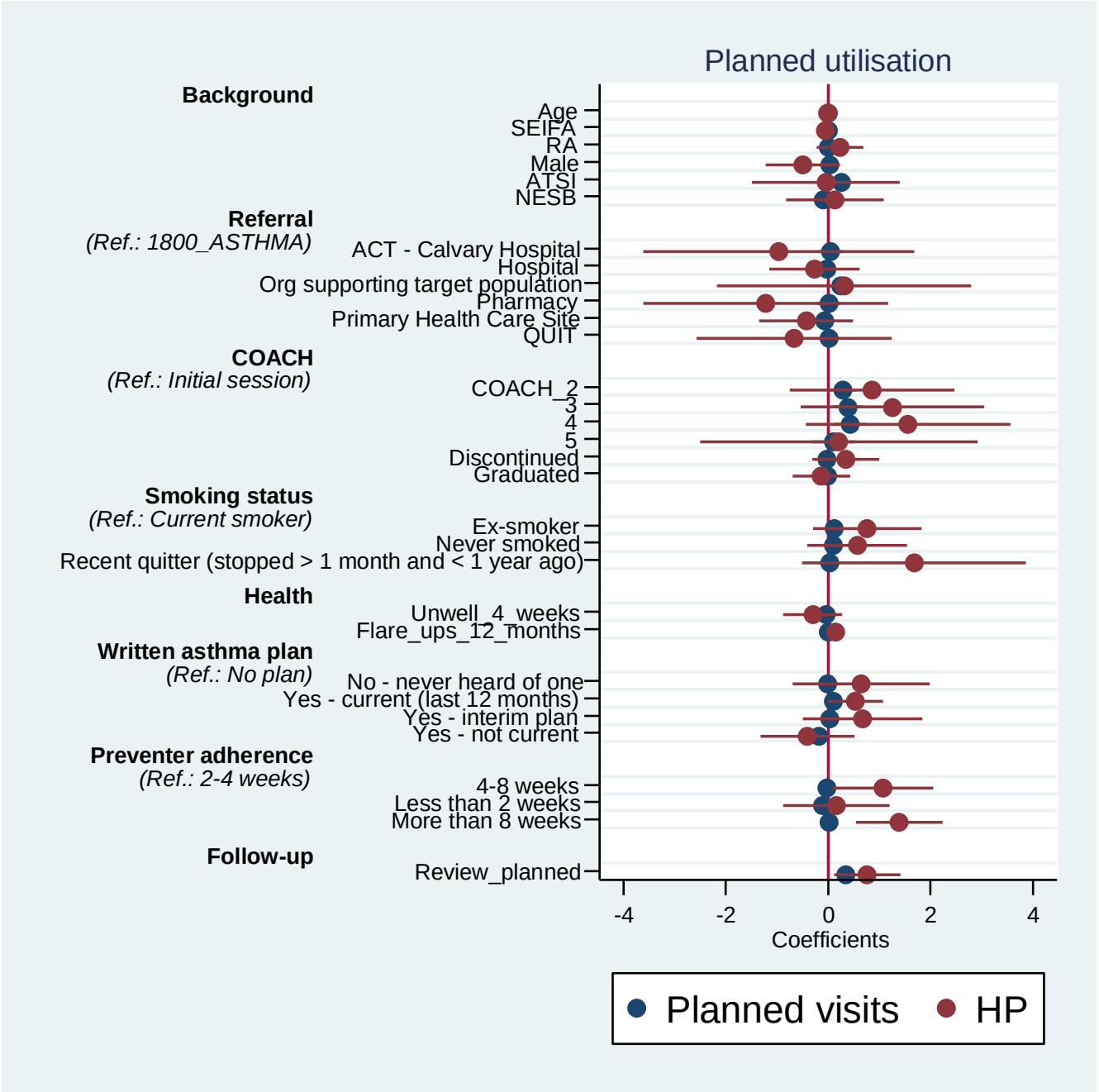
	Mean		Mean difference (95% CI)			
Health utilisation	Pre (COACH)	Post (COACH)	Unadjusted (OLS)[a]		Adjusted (RE) + explanatory variables [b]	
	1	2	3		4	
Health providers	3.65	4.16	1.74**	[1.11,2.37]	0.64+	[-0.49,1.77]
ED visit	1.00	1.12	0.28+	[-0.02,0.58]	0.21	[-0.04,,0.44]
Hospital inpatient	0.68	0.43	0.20	[-0.05,0.45]	-0.20+	[-0.52,0.12]
Planned visits	0.52	0.79	0.50**	[0.42,0.58]	0.28**	[0.12,0.42]

Pre- COACH is measured at session 1, post-COACH is measured at session 5.95% confidence intervals (CI) in parentheses, + p<0.10 * p<0.05 ** p<0.01, OLS= Ordinary Least Squares, RE=Random effects

a. Logistic regression (OLS) includes number of coach sessions (1 to 5)

b. Random effects regression includes explanatory variables for: number of COACH sessions (1 to 5), demographics (Age, gender, SEIFA, RA, Non-English speaking background, Aboriginal/ Torres Strait Islander, state of residence, referral source); health status of the patient (unwell in last 4 weeks, initial number of flares in last 12 months); asthma management (time consistent preventer use, inhaler technique, written asthma plan, use spacer, have spacer, spirometry, visit plan review. Interaction: asthma control# time. Model considers missing observations.

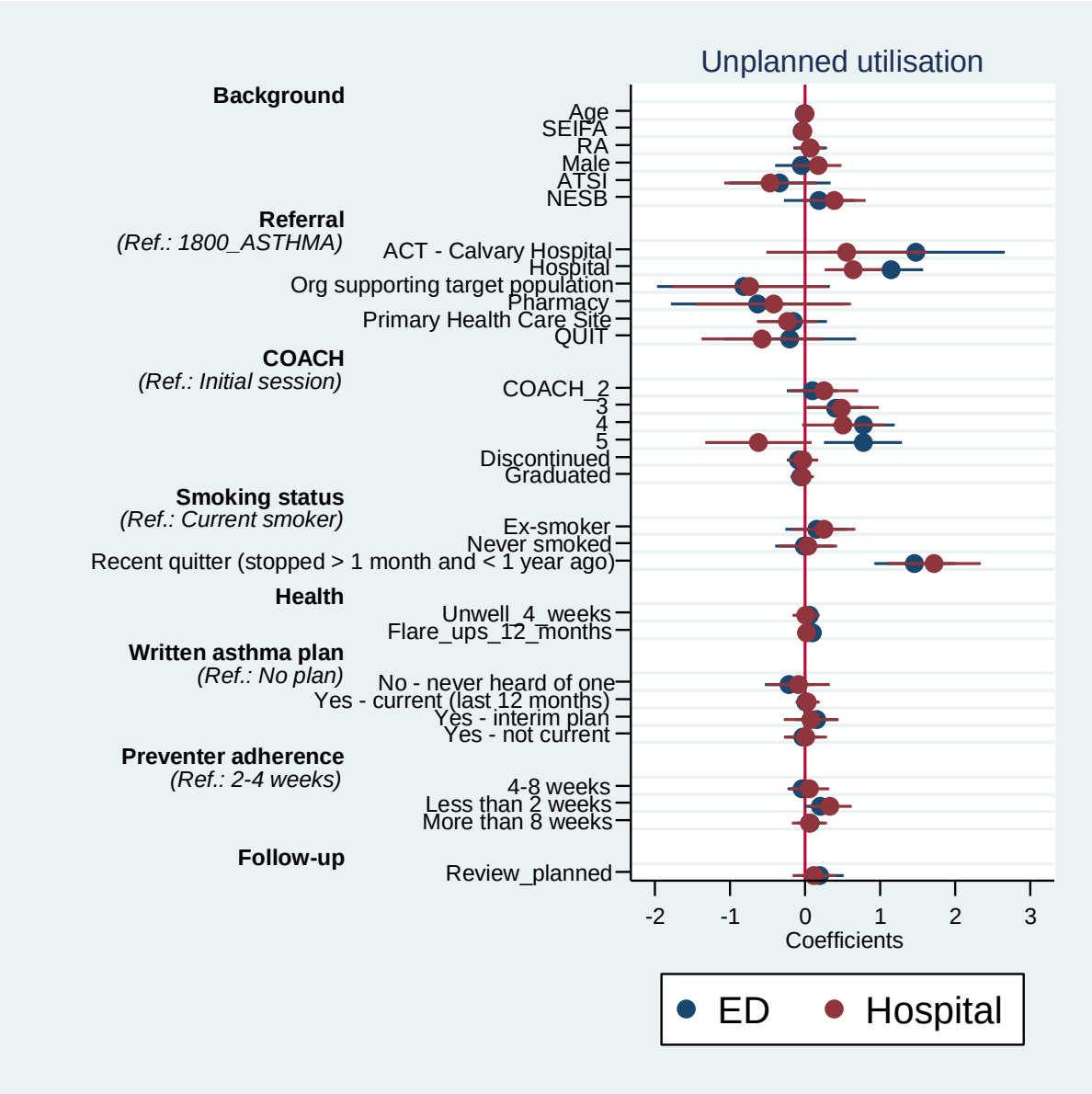
Figure 4 Mediating factors of planned utilisation (planned visits and number of visits to health professionals (HP)



5.1.3 ED presentations and hospital stays

ED presentations and hospital stays represent 'unplanned health utilisation' in the analysis. In the 12-months leading up to The COACH Program® enrolment, individuals on average attended the ED once and had 0.67 stays as a hospital inpatient, for asthma related issues (Table 7). There was a statistically significant decrease in hospital stays following completion of the program, with individuals reporting 0.20 fewer inpatients stays (p value <0.10), when compared to the pre-enrolment 12-months. Somewhat counterintuitively, there was an increasing trend in ED presentations following enrolment in the program. However, these results were not statistically significant (0.21). From Figure 5, it is evident that the key drivers of ED presentations were hospital referrals (ACT-Calvary and other hospital), no. of COACH sessions, low preventer adherence and smokers who had recently quit. Interestingly, there was some evidence that individuals from hospital and non-hospital referral sources had opposing trends in ED presentations, with non-hospital sites showing negative coefficients (less likely to present to hospital), although not statistically significant. This suggests that there is significant heterogeneity in the characteristics of individuals in these two groups.

Figure 5 Mediating factors of unplanned utilisation (ED and hospital)



To explore this heterogeneity further we conducted a sub-group analysis of ED presentations and inpatient stays by 'hospital'[iv] and 'non-hospital'[v] referral status (Table 8, Table 9, Figure 6 and Figure 7). Our hypothesis is that smoking status may be driving short-term acute health care presentations. Indeed, smoking status is a key risk factor in the development of asthma[13]. The results indicated in Table 8 show that hospital referral participants had higher pre-COACH ED and inpatient visits, than non-hospital referral participants, which is largely unsurprising given the referral source is hospital. In the 12-months leading up to The COACH Program® enrolment, individuals from hospital referrals attended the ED on average 2.04 times and had 1.42 stays as an inpatient, for asthma related issues. Individuals from non-hospital referrals reported 0.97 ED visit and 0.66 inpatient stays. Following completion of COACH, there was a statistically significant decrease in hospital stays in both groups, with individuals reporting 0.83 fewer inpatients stays (p value <0.10) for hospital referrals and 0.2 fewer inpatient visits for non-hospital referrals, although not statistically significant

In contrast, while there is evidence of slightly fewer ED visits in the hospital group (-0.01)(Table 8), there was an opposite trend in ED presentations in the non-hospital group, with evidence that ED visits increased over time (0.21)(Table 9), although not statistically significant. It appears that the non-hospital referral group is driving the trend of increasing ED visits observed in Table 7. It is evident from Figure 6 that the non-hospital sample are more likely to be smokers who have recently quit. From Figure 1, we know that smoking status was not a key mediating factor in overall asthma control. The results showed that while, there was a positive effect of smoking on one of the individual domains being day-time asthma control, for smokers who had recently quit, there was a null effect for other domains of asthma control (Figure 2). It is therefore reasonable to conclude that the observed trend of increasing ED presentations may be associated with night-time, activity/exercise or needing a reliever, for smokers who have recently quit.

Table 8: Health service utilisation: health providers, ED presentations and hospital visits before and following The COACH Program® enrolment- Hospital referral

Health care utilisation (12 months) (Hospital referrals) (Obs=150, N=62)

	Mean		Mean difference		
Health utilisation	Pre-COACH	Post – COACH	Adjusted (RE) + explanatory variables a		
	1	2	3		
Health providers	3.65	3.80	0.15	[-2.45,2.15]	Mediating trend of improved asthma score (not statistically significant)
ED visit	2.04	2.03	-0.01	[-0.59,0.32]	
Hospital inpatient visits	1.42	0.59	-0.83+	[-1.63,-0.11]	
Planned visits	0.59	0.66	0.10	[-0.20,0.41]	

95% confidence intervals (CI) in parentheses, + p<0.10 * p<0.05 ** p<0.01, RE=Random effects
a. Random effects regression includes explanatory variables for: number of COACH sessions (1 to 5), demographics (Age, gender, SEIFA, RA, Non-English speaking background, Aboriginal/ Torres Strait Islander, state of residence, referral source); health status of the patient (unwell in last 4 weeks, initial number of flares in last 12 months); asthma management (aim preventer well, haler technique, written asthma plan, use spacer, have spacer, spirometry, visit plan review. Interaction: asthma control# time. Model considers missing observations.

[iv] Non-hospital referrals include 1800-ASTHMA, QUIT, Primary care, Pharmacy and Org supporting.
[v] Hospital referrals include ACT -Calvary and other hospital.

Table 9: Health service utilisation: health providers, ED presentations and hospital visits before and following The COACH Program® enrolment- Non-hospital referral

Health care utilisation (12 months) Non-hospital referrals (Obs 501, N=212)

	Mean		Mean difference		
Health utilisation	Pre COACH	Post COACH	Adjusted (RE) + explanatory variables a		
	1	2	3		
Health providers	3.61	4.26	0.64+	[-0.44,1.46]	Mediated by smoking status (recently QUIT or smokers)
ED visit	0.97	1.18	0.21	[-0.08,0.32]	
Hospital inpatient visits	0.66	0.46	-0.2*	[-0.52,0.01]	
Planned visits	0.52	0.82	0.30**	[0.15,0.43]	

Pre COACH is measured at session 1, post COACH is measured at session 5.95% confidence intervals (CI) in parentheses,+ p<0.10 * p<0.05 ** p<0.01, OLS= Ordinary Least Squares, RE=Random effects

b. Random effects regression includes explanatory variables for: number of COACH sessions (1 to 5), demographics (Age, gender, SEIFA, RA, Non-English speaking background, Aboriginal/ Torres Strait Islander, state of residence, referral source); health status of the patient (unwell in last 4 weeks, initial number of flares in last 12 months); asthma management (aim preventer well, inhaler technique, written asthma plan, use spacer, have spacer, spirometry, visit plan review. Interaction: asthma control# time Model considers missing observations.

Figure 6 Mediating factors of ED presentations, by hospital /non-hospital referral.

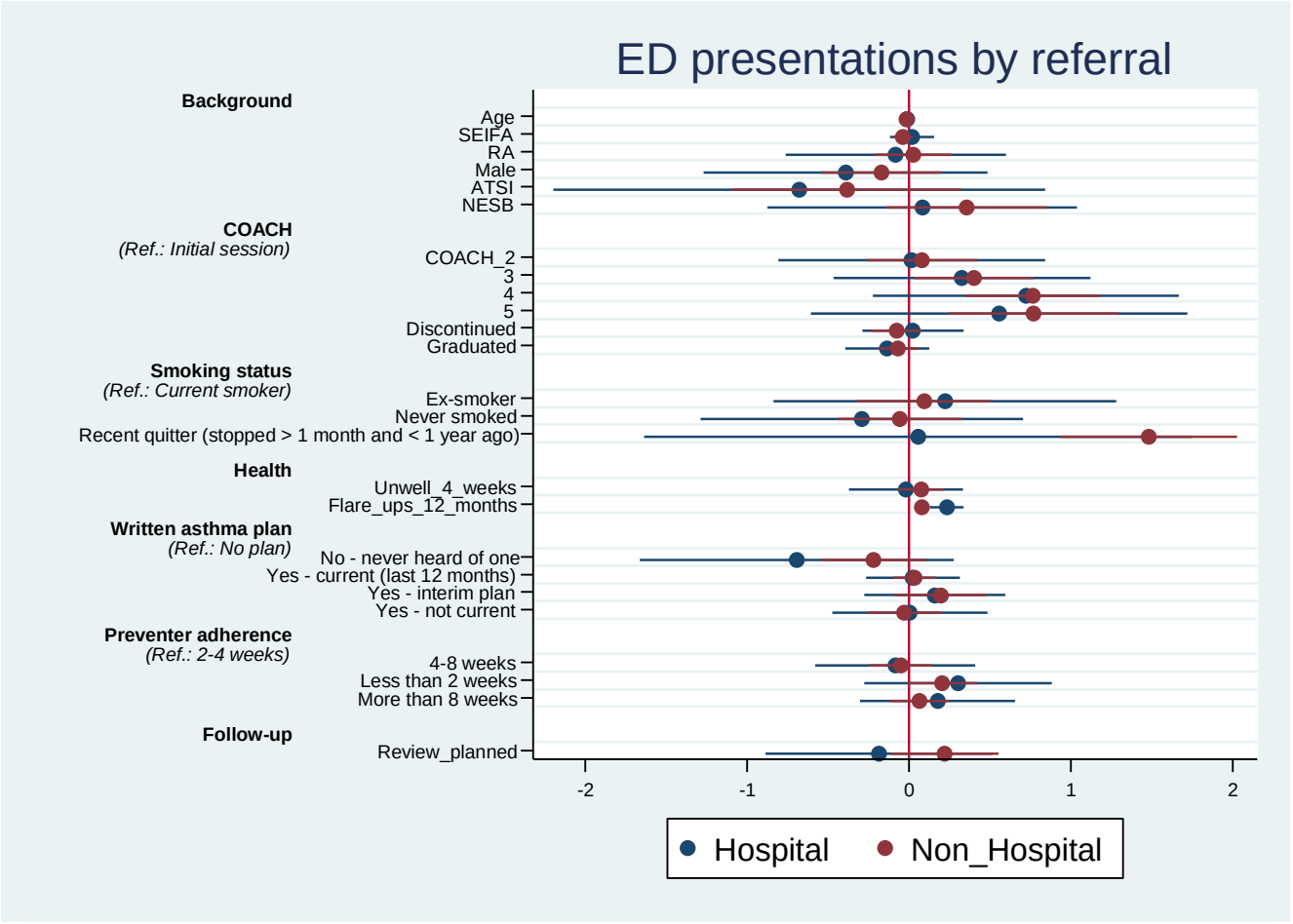
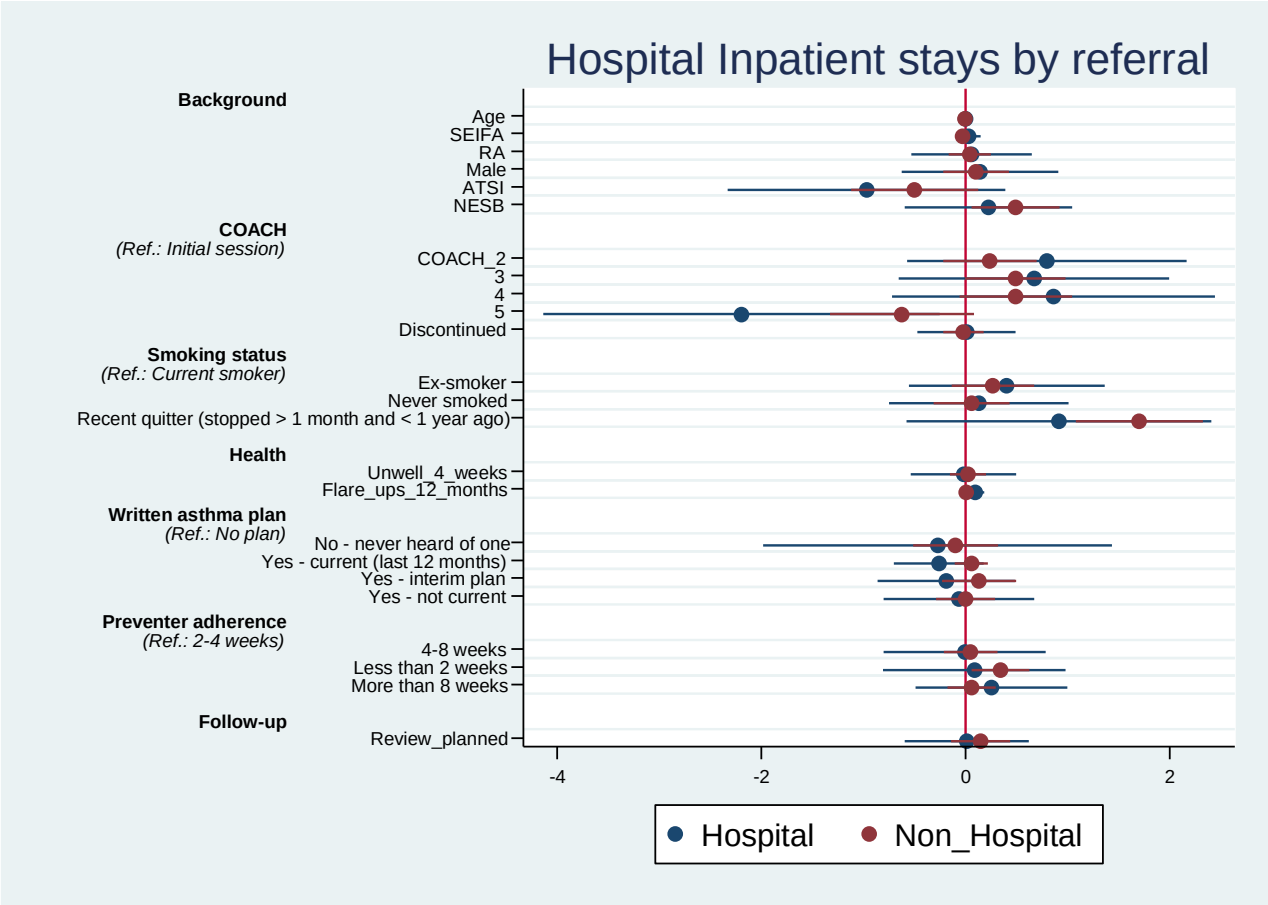


Figure 7 Mediating factors of hospital inpatient stays, by hospital referral



These findings contrast with our hypothesis is that The COACH Program® may reduce unplanned utilisation, as participants' asthma control improves. There are several possible reasons for this discrepancy. First, it is feasible that the levels of improvement observed in asthma control in this study do not yet reach the threshold to impact unplanned health utilisation. If you recall from Table 4, participants reported average asthma control following COACH of 17.67 and up to 20.31 for those who had graduated (Table 5). Whilst these represent both clinically and statistically significant changes in asthma control, these levels are characterised by asthma control guidelines as a change from 'Very poorly controlled' to 'Not well controlled' asthma for the average participant, and a change from 'Very poorly controlled' asthma to 'Well controlled' for a portion of participants who graduate. Indeed, the literature suggests that participants with both poorly and partly controlled asthma had higher rates of unscheduled health care visits and hospitalizations (Gold et al 2014b).

Second, there is likely to be a time-lag between asthma control improvement and changes in unplanned health utilisation, which may not be adequately captured in these data. Notably, for participants who graduate from COACH before the end of session 5 (76 percent of the sample who graduate), their health utilisation data is captured for one additional session (up to 40 days after graduation) and as such this may be insufficient time for the benefits the program to be observed.

Third, the estimation of effect sizes appears to be limited by the high rates of drop out. As indicated in Table 6, 591 (53%) of the total 1,106 participants discontinued COACH, with 532 doing so before session 5. The remaining 47% graduated from COACH, but in a similar trend to discontinuing participants, most graduated prior to session 5. The implication of this early drop out is two-fold. First, the sample size is reduced to such a level, which limits the estimation of significant effects.

Second, the sample for which the program is most successful (i.e. those who graduate) are no longer captured in the data.

Lastly, it is recognised in the literature that this relationship is complex and has been found to be influenced by many factors including medication use, co-morbid conditions, minority status and the environment[2]. Future analysis would be strengthened with the inclusion of post intervention (for those who exit early) and 12-month follow-up data and individually linked data, to consider both medical services and pharmaceuticals. It is recommended that the focus should be on the sub-group of participants who graduated from COACH, where the gains in asthma control are the greatest.

5.1.4 Other Subgroup analysis

The analysis so far has estimated average asthma control and health utilisation for participants who participated in COACH. The mediating effects of asthma control and health utilisation were then explored, focusing on time, referral site and the impact of 'drop out'. The results in Figure 5, Figure 6 and Figure 7 also revealed differences in health utilisation for individuals of ATSI descent. We hypothesise that the differential trends observed may be an indicator of community health strategies which have been implemented as part of this policy response.

To explore this further we replicate the regression analysis of health utilisation (reported in Table 7) with the addition of an interaction between ATSI status with time (number of sessions). The basis for this interaction is to examine the specific impact of time (number of COACH sessions) on health utilisation for ATSI individuals. While the sample size is small (approximately 60 people or 5% of the COACH population), it is largely representative of the national ATSI population (3.3%). The results from Table 10 show that individuals from ATSI descent are almost twice as likely to attend planned health visits for their asthma (0,49 p value <0.01), compared to non-ATSI participants (0.27, p value<0.01) at completion of COACH. In addition, there was a decreasing trend in ED presentations and hospital visits and these trends are of a larger magnitude for ATSI participants, when compared to non-ATSI participants, although not statistically significant. Interestingly, ATSI participants also reported decreasing health provider visits following completion of the COACH program, which is in contrast with the results observed in Table 6, which showed that planned visits and health provider visits were a sign of improved asthma management . Perhaps, what we are observing is a differential service model for remote or disadvantaged communities, whereby community health providers are co-located on hospital sites. If this is the case, a decreasing trend in health provider visits would be consistent with a reduced need for acute health care.

Table 10: Health service utilisation: health providers, ED presentations and hospital visits before and following The COACH Program® enrolment- ATSI participants

Health care utilisation (12 months) (ATSI) (Obs=787, N=317)

Health utilisation	Mean		Mean difference	
	Pre COACH	Post COACH	Adjusted (RE) + explanatory variables a	
	1	2	3	
Health providers				
Non-ATSI	3.64	4.25	0.61	[-0.37,1.59]
ATSI	3.85	3.30	-0.55	[-3.17,2.07]
ED visit				
Non-ATSI	1.03	1.16	0.14	[-0.06,0.34]
ATSI	0.80	0.34	-0.46	[-1.02,0.10]
Hospital inpatient visits				
Non-ATSI	0.70	0.46	-0.25+	[-0.52,0.02]
ATSI	0.29	0.00	-0.39	[-1.18,0.37]
Planned visits				
Non-ATSI	0.51	0.61	0.27**	[0.12,0.42]
ATSI	0.78	1.00	0.49*	[0.06,0.92]

95% confidence intervals (CI) in parentheses ,+ p<0.10 * p<0.05 ** p<0.01, RE=Random effects

a. Random effects regression includes explanatory variables for: number of COACH sessions (1 to 5), demographics (Age, gender, SEIFA, RA, Non-English speaking background, Aboriginal/ Torres Strait Islander, state of residence, referral source); health status of the patient (unwell in last 4 weeks, initial number of flares in last 12 months); asthma management (aim preventer well, inhaler technique, written asthma plan, use spacer, have spacer, spirometry, visit plan review. Interactions with asthma control # time, ATSI#time. Model considers missing observations.

Table 11 presents asthma control scores and health utilisation for the sub-group of ACT Calvary. These results are based on the regression model for the outcome variables with interaction with time. The results show increasing trends in all of the outcomes of interest, albeit not statistically significant. At commencement of the program, this sample have lower than average (hospital) asthma control and health utilisation (Table 11 compared to Table 8). Improvements in asthma control are evident, but the gains are lower than average. In addition, there appears to be an increase unplanned hospital visits (ED and inpatient), which is in contrast with the trend observed for all hospital participants (decreasing trend) (Table 8).

Table 11 Health service utilisation: health providers, ED presentations and hospital visits before and following The COACH Program® enrolment- ACT Calvary participants

Asthma Control and Health care utilisation (12 months) (ACT Calvary)

	Mean		Mean difference	
Health utilisation	Pre-COACH	Post COACH	Adjusted (RE) + explanatory variables a	
	1	2		3
Asthma Control	9.01	11.75	2.74	[-1.54,7.02]
Health providers	2.04	3.88	1.84	[-1.16, 4.85]
ED visit	1.95	2.16	0.21	[-0.37, 0.79]
Hospital inpatient visits	0.85	1.15	0.29	[-0.46,1.05]
Planned visits	0.53	0.57	0.03	[-0.45,0.51]

95% confidence intervals (CI) in parentheses ,+ p<0.10 * p<0.05 ** p<0.01, OLS= Ordinary Least Squares, RE=Random effects

a. Random effects regression includes explanatory variables for: number of COACH sessions (1 to 5), demographics (Age, gender, SEIFA, RA, Non-English speaking background, Aboriginal/ Torres Strait Islander, state of residence, referral source); health status of the patient (unwell in last 4 weeks, initial number of flares in last 12 months); asthma management (aim preventer well, haler technique, written asthma plan, use spacer, have spacer, spirometry, visit plan review. Interactions with asthma control # time, ATSI#time. Model considers missing observations.

Overall, the results showed that participation in The COACH Program® is positively associated with improved asthma control for all participants, with notably greater gains for participants who graduate. These effects are driven by the number of COACH sessions, preventer adherence and planned follow-up reviews. Asthma control has 4 main components: daytime, night-time, activity/exercise and needing a reliever and all of these contributed to overall asthma control scores.

The association between The COACH Program® and health utilisation is more heterogeneous, and the estimation of effect sizes appears to be limited by the high rates of drop out.

The results highlight, firstly, that not all measures of reduced health utilisation are related to better outcomes. Notably, there is some evidence that COACH is associated with improved self-management combining COACH strategies such as encouraging written asthma plans with GPs and preventer adherence with planned primary care reviews and ongoing follow-up. As a result, successful asthma management is associated with increased planned health utilisation for all participants, with notably larger effects for ATSI participants.

Additionally, there is evidence that COACH is associated with reduced acute respiratory episodes, for certain groups, namely those referred from hospital sources, through reduced ED presentations and hospital inpatient visits, These individuals typically present with higher overall utilisation and as such appear to benefit from The COACH Program®, through improved asthma control. There was limited evidence of differential effects of COACH for participants with higher initial unplanned visits (i.e. the frequent flyers to ED).

For individuals referred from non-hospital sites, the evidence is less clear. This sample are more likely to be smokers, or have recently quit (referred from QUIT or Primary health care) and while their overall utilisation is lower than the hospital group, there is evidence that individuals who have recently quit smoking may experience an increase in acute respiratory episodes in the short-term, which leads to increased ED admission perhaps due to lower asthma control during the night and

during activity. Improved long-term data follow-up (notably for participants who exit the program early) will further inform these results.

6 Cost consequence analysis

Based on the estimates on health service utilisation in Table 7, it was possible to calculate the costs and consequences of The COACH Program®. Cost savings to Government for individuals involved in The COACH Program® were calculated using the unit costs from the National Hospital Cost Data Collection Report and Medicare the average cost per ED presentation, GP management plan and inpatient stay are outlined in Table 11. Cost savings were then calculated as the difference between the pre-The COACH Program® utilisation (in the 12-months leading up to enrolment) and the post The COACH Program® utilisation (in the 12-months leading up to the last COACH session) , multiplied by these unit costs[vi]. The cost savings associated with reduced health service utilisation was $371 per person per year for inpatient visits.

Table 11: Unit costs

	Unit cost	Source
Cost of ED presentation	$884	Ref a.
Cost of health provider	$85	Ref a.
Cost of inpatient stay for asthma	$2,543	Ref b.
	N (% or total sample)	
Health provider hours	1053 (95%)	Sample Jan 1,2018- July 2020
ED	866 (78.3%)	
Inpatient	806 (72.8%)	

a.[14]https://www.ihpa.gov.au/publications/national-hospital-cost-data-collection-report-public-sector-round-22-financial-year. b. GP management plan (Average MBS item 721, 723, 732 = ($$112+$88 +$56)/3 = $85. includes MBS rebate .http://www9.health.gov.au/mbs/search.cfm

[vi] To calculate average cost savings per person, a weighted average approach was used based on the sample size for each of the outcomes.

Table 12 Costs and consequences of COACH program participation (time horizon = intervention period)

	Mean		Mean difference (95% CI)	
	Pre	Post	Incremental Difference	Weighted by sample
Costs	1	2	3	
COACH Intervention	$1,918	$1,918	$0	$0
Health providers [a]	$308	$363	$54	$52
ED visit			NS	
Hospital inpatient [b]	$1,694	$1,178	-$516	-$371
Planned visits		Captured in HP visits		
Total cost (including cost of intervention)	***$3,920***	***$3,458***	***-$461***	***-$319***
Asthma control	13.05	17.67	4.62**	4.62**
Day time	1.78	2.45	0.67**	0.67**
Night-time	1.25	1.49	0.23**	0.23**
During activity	1.40	1.60	0.04**	0.04**
Need reliever less	1.25	1.46	0.21**	0.21**
Health utilisation				
Health providers	3.62	4.25	0.64+	0.64+
ED visit	0.97	1.18	0.21	0.21
Hospital inpatient	0.67	0.46	-0.20+	-0.20+
Planned visits	0.52	0.80	0.28**	0.28**

NS= not statistically significant. ED= emergency department, a. GP management plan (Average MBS item 721, 723, 732 = ($$112+$88 +$56)/3 = $85. includes MBS rebate .http://www9.health.gov.au/mbs/search.cfm.
b.https://www.ihpa.gov.au/publications/national-hospital-cost-data-collection-report-public-sector-round-22-financial-year. ED= $884, Inpatient = $2,543 per episode. Health utilisation sample weighted average

7 Summary of findings

The aim of this evaluation was to investigate the effectiveness of The COACH Program® in terms of its impact on: asthma control, community health service utilisation (planned and health provider), hospital visits and emergency department attendances; program costs; and provide an overview of patterns of The COACH Program® course utilisation. This section reports the key findings of the evaluation.

7.1 Profile of The COACH Program® utilisation.

A large proportion of the participants were referred to The COACH Program® from 1800-ASTHMA. This method of referral accounted for 43 percent of the 1,106 individuals followed by hospital sites (28%) and primary health care (20%). There was a greater proportion of females who used COACH with Victoria being the largest catchment area followed by SA and QLD. The average age of individuals was 45 years. Over 50 percent of participants had never smoked, and one quarter were ex-smokers. Over two-thirds of individuals had been unwell in the last 4 weeks. In terms of participation, individuals who utilised The COACH Program® do so for an average of 2.29 sessions over an average of 82 days. Approximately 53 percent of participants discontinued the program with the most common reason being disengagement. These participants attended on average 1.90 sessions over 56 days. The remaining 47 percent of participants graduated from COACH, attending on average 2.47 sessions over an average of 79 days.

7.2 Program Costs

The cost of running The COACH Program® for participants with asthma was $849,178 per year which equated to $1,918 per individual per year.

7.3 Asthma control, health provider visits, hospital visits and ED attendances

There was a clinically and statistically significant improvement in average asthma control (daytime night-time, during exercise and needing reliever) following enrolment in The COACH Program® (4.62, p value <0.01), notably for those participants who graduate from The COACH Program (up to 8.36 p value <0.01). According to asthma control guidelines, this represents a shift from 'Very poorly controlled' (5 to 15) asthma to 'Not well controlled' (15 to 25) for the average participant, and a change from 'Very poorly controlled' asthma to 'Well controlled' (20 to 25) for a portion of participants who graduate. This improvement coincided with a statistically significant increase in both planned visits (0.50, p value <0.01) and overall health provider visits (0.64, p value <0.1). There is evidence that COACH is providing a multi-disciplinary approach to asthma health care delivery, which combines strategies such as recommending participants visit their GP for written asthma plans and preventer adherence with planned primary care reviews and ongoing follow-up[8]. Additional strategies which target program engagement would be beneficial in reducing discontinuation and thereby improving asthma control for all participants.

There was a statistically significant reduction in inpatient health utilisation outcomes (-0.20, p value <0.1) (for both hospital and non-hospital referrals) and a decreasing trend in ED presentations (for hospital referrals) following enrolment in The COACH Program®, with the

greatest benefit occurring after at least 4 sessions. Whether the full extent of the decreased utilisation is directly attributable to the program is difficult to gauge without a valid comparison group, however, it should be noted that the reduced reliance on acute health care services in conjunction with increased planned health visits, suggests that individuals are improving their ability to manage their own asthma and this is one of the key objectives of the program.

There was an increasing trend in ED presentations for individuals form non-hospital referrals (1800-asthma, QUIT and primary health care). This sample are more likely to be smokers, or have recently quit and while their overall utilisation is lower than the hospital group, there is evidence that individuals who have recently quit smoking may experience an increase in acute respiratory episodes in the short-term, which leads to increased ED admission perhaps due to lower asthma control during the night and during activity. This is in contrast with reduced hospital inpatient visits, which suggests that while individuals are presenting at ED for acute respiratory episodes, they may not be severe enough to not warrant admission. In addition, the estimation of effect sizes appears to be limited by the high rates of drop out. As such, the inclusion of data on co-morbidities and the addition of post intervention (for those who exit early) and 12-month follow-up data will improve the robustness of the study and assist in determining the long-term trends for the sub-sample of COACH participants.

Additionally, there is evidence that individuals with ATSI status benefit from COACH, through improved planned asthma management and follow-up.

7.4 Cost savings

The cost savings associated with reduced health service utilisation, was $371 per person per year, and this was due to reduced hospital inpatient visits. The additional costs incurred for enhanced asthma management equated to $54 per person per year. This analysis does not consider other possible economic and health benefits of the program such as reduced pharmaceutical costs, improved quality of life or increased productivity due to reduced absenteeism. Indeed, the literature reports that those with uncontrolled asthma incur greater indirect costs due to lost productivity [15-18] largely due to missed days of work or school[1]. Furthermore, this analysis does not consider any potential long-term cost savings that may be accrued following improved asthma control.

8 Conclusions and recommendations

In this study, we present new evidence that enrolment in The COACH Program® can lead to significant improvement in asthma control and subsequent health utilisation. Using robust panel random-effects models, the results demonstrate that there are clear and consistent effects of improving asthma control for all participants and across all of the domains. The greatest gains in asthma control were observed in participants who graduated, when compared to those who discontinued. Therefore, strategies which target program engagement, through preventer adherence and by encouraging current written asthma plans, would be beneficial in improving asthma control for all participants.

The effects of COACH on health utilisation is more heterogeneous and highlights the importance of considering other mediating factors such as service delivery model, ATSI and smoking status, as well as other comorbidities. Notably, the results highlight that there may be unobserved health conditions (comorbid conditions) in people with asthma can complicate the management of the disease and compromise quality of life. Comorbidities are a common occurrence in asthma patients [2] and this was evidenced in the sub-group analysis in Section 5.1.4, whereby unobserved characteristics of smokers who had recently quit appeared to be driving the overall ED presentations. Common co-morbidities include acute respiratory infections, chronic obstructive pulmonary disease (COPD), nutritional or metabolic disease and circulatory diseases. The inclusion of additional questions relating to co-morbidities at enrolment, would improve the robustness of the analysis and provide greater confidence that the key findings can be attributed to The COACH Program®.

The results of the evaluation suggest that there could be data quality improvements relating to participant long term follow-up, missing and linked data, and the identification of a control group. The estimates from this study are based on a within intervention timeframe using self-reported data. In addition, The Program is subject to high rates of drop out (both due to early graduation and discontinuation) and as such would be strengthened with the inclusion of follow-up (both post intervention for those who exit early and 12 month data) and individually linked data, focusing initially on the sub-group of participants who graduated from COACH, where the gains in asthma control are the greatest. This approach would consider both acute inpatient care and Medicare funded or privately funded medical services or pharmaceuticals.

Evidence from the literature suggests that improved asthma control is associated with reduced direct healthcare costs. In an observational study of 3,630 asthma patients aged 12 years or older from nine Asia-Pacific countries (including Australia), greater proportions of patients with partly and uncontrolled asthma used oral steroid, quick relief or rescue medications, long-term maintenance medications than patients whose asthma was well controlled[1]. These findings are supported by evidence in the international context which report that those with uncontrolled asthma use more medications [1,15,19] and have greater healthcare utilisation [1,2,15-19] than those with controlled asthma. The results presented in these studies are suggestive of an association between asthma control and health care utilisation. However, the methodology applied in these analyses are not able to determine causality or consider the potentially more complex relationship between asthma control and direct and indirect costs. Our study provides new evidence from which to inform the relationship between asthma control and health utilisation in the Australian context.

The COACH Program®. reports on two quality of life measures, the QOL-GAD for generalised anxiety disorder and the PHQ-9 for depression. The number of participants for whom these quality

of life measures was available was approximately 4 percent of the overall sample (not reported in the analysis). Including valid quality of life instruments in the economic assessment of health and medical services is well- established, as it is a fundamental component of cost utility analysis, which is considered the gold standard of economic evaluation methods 10. The inclusion of a condition-specific preference-based measures (CSPBM), the AQL-5D would be a valid alternative to the GAD and the PHQ-9 as it is measured in terms of a 5-dimension 5-level preference-based measure for asthma 11. The health state classification system was derived from the Asthma Quality of Life Questionnaire (AQLQ) 12 and includes specific questions around concern about asthma, shortness of breath, weather and pollution stimuli, sleep impact and activity limitations. Each dimension has 5 levels of severity with level 1 denoting no problems and level 5 indicating extreme problems and has been found to have good validity and reliability for use in economic evaluation[20,21]. Improving the completion rate of these data or supplementing the existing instruments with a generic QOL such as the AQL-5D measure would be a simple way to improve the robustness of future evaluations.

Furthermore, to strengthen the causal interpretation of the results in this report, the identification of a comparison group would be beneficial. With an appropriate comparison group, it would have been possible to compare how a reference group's utilisation changed without The COACH Program®. With this limitation in mind the consistency in the results over a longer time period provides additional confidence in the robustness of the findings.

Overall, the results from this evaluation indicate that The COACH Program® has an important role to play in asthma management, by mitigating the risk of hospital admissions and ED presentations, and by enabling individuals to manage their own asthma control.

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Appendix 3: Model summary

Equation Specification									
Primary Outcomes									
	Asthma control	Planned visits	Health provider visits	ED	Inpatient visits	Subgroup (hospital, non-hospital)	Asthma control with interactions	Dropout	Sub-group (ATSI)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Background characteristics									
COACH sessions	X	X	X	X	X	X	X	X	X
Time between sessions	X	X	X	X	X	X	X	X	X
Age	X	X	X	X	X	X	X	X	X
Drop out	X	X	X	X	X	X	X	X	X
SEIFA	X	X	X	X	X	X	X	X	X
RA code	X	X	X	X	X	X	X	X	X
Gender	X	X	X	X	X	X	X	X	X
ATSI	X	X	X	X	X	X	X	X	X
NESB	X	X	X	X	X	X	X	X	X
State	X	X	X	X	X	X	X	X	X
Health									
Smoking status	X	X	X	X	X	X	X	X	X
Unwell in last 4 weeks	X	X	X	X	X	X	X	X	X
Asthma management									
Visit plan review	X	X	X	X	X	X	X	X	X
Written asthma plan	X	X	X	X	X	X	X	X	X
Time consistent preventer use	X	X	X	X	X	X	X	X	X
Use spacer	X	X	X	X	X	X	X	X	X
Have spacer	X	X	X	X	X	X	X	X	X
Spirometry	X	X	X	X	X	X	X	X	X
Referral source	X	X	X	X	X		X	X	X
Interactions with time									
Asthma##		X	X	X	X	X			X
ATSI##							X		X
Smoking #							X		
Drop out#							X		
WAP #]							X		
Referral source#							X		
Unwell #							X		

Equation Specification continued..									
Primary Outcomes									
	Asthma control	Planned visits	Health provider visits	ED	Inpatient visits	Subgroup (hospital, non-hospital)	Asthma control with interactions	Dropout	Sub-group (ATSI)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Missing observations							X		
m_asthmascore	X	X	X	X	X	X	X	X	X
m_time between appt	X	X	X	X	X	X	X	X	X
m_NESB	X	X	X	X	X	X	X	X	X
m_days preventer well	X	X	X	X	X	X	X	X	X
m_preventer adherance	X	X	X	X	X	X	X	X	X
m_visit planned review	X	X	X	X	X	X	X	X	X
Analysis employed	XTREG, RE	Linear probability model (panel)	XTREG, RE	XTREG, RE	XTREG, RE	XTREG, RE	XTREG,RE	MNL	XTREG, RE

Model assessed were OLS, ZINB, XTNBREG. Model fit were assessed based on exploratory analysis of explanatory variables and model goodness of fit statistics (AIC, BIC, rho, log likelihood). All analysis was conducted in STATA 14. Missing observations were included if not Missing completely at random (MCAR),. Eq (6) was run as separate models for hospital and non-hospital sites