Economic Evaluation of the Maine Asthma Self-Management Education Program

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ECONOMIC EVALUATION OF THE MAINE AS-ME PROGRAM

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EXECUTIVE SUMMARY

Maine has among the highest rates of asthma nationally, especially among adults (National: 7.7% vs. Maine: 11.2%) (Maine CDC, 2022). Among the estimated 120,000 adults living in asthma, half (50.4%) report having experienced an asthma attack in the previous 12 months (Maine Center for Disease Control and Prevention, 2017). Uncontrolled asthma has an adverse impact on society, both through loss of life and productivity years and through the financial burden borne by individuals with asthma, their family, health systems, taxpayers, and employers (Yaghoubi, Adibi, Safari, FitzGerald, & Sadatsafavi, 2019). Asthma self-management education is an effective, evidence-based strategy for increasing medication adherence, improved asthma systems, attaining asthma control, and improving health outcomes (Gibson, et al., 2002; Janson, et al., 2003).

With funding from the U.S. Centers for Disease Control and Prevention, the Asthma Prevention and Control Program led the development of an evidence-based and locally informed asthma self-management education program called the Maine In-Home Asthma Education Program (Maine HAEP). The Program included both an educational component and a home environmental assessment. It was implemented by eight different agencies between 2016 and 2019. Program evaluation results showed a high level of efficacy in decreasing acute healthcare services and absenteeism, both at work and at school (Mitchell M, 2019).

Measuring the costs and economic benefits of the Program enables its impacts to be translated into objective monetary terms and help make the case for investments that support such programs. In addition, new programs such as the Maine HAEP can use economic evaluations as an intuitive step forward in looking at ways to expand the Program statewide.

Accordingly, the Asthma Prevention Control Program, within Maine Center for Disease Control and Prevention, contracted with Partnerships For Health to undertake a retrospective economic analysis of the Maine HAEP implemented between September 2015 and August 2019. The analysis was conducted from both a societal and payer perspective and yielded the following findings:

- 201 adults and children in Maine enrolled in the Maine HAEP provided by 8 agencies between 2015 and 2019.
- Of the 169 participants who completed the Program, 78 were followed up at 7 months. The economic analysis is based on this cohort's health outcomes.
- Return-on-Investment is time dependent. For every dollar invested in the Maine HAEP, between $1.80 (7 months) and $3.09 (12 months) is saved in averted health costs and loss of productivity.
- For every dollar invested in the Program, $1.86 per Quality-Adjusted Life Year is saved.

Introduction

Asthma Burden in Maine

The prevalence of asthma in Maine are some of the highest rates nationally, and the Maine adult asthma prevalence (11.2%) is higher than the United States (U.S.) average (7.7%) (Maine CDC, 2022). Among children, current asthma prevalence is 9.4% compared to 7.4% nationally (U.S. Centers for Disease Control and Prevention, 2021).

Maine has among the highest rates of asthma nationally, with 1 in 9 Mainers with current asthma (compared to 1 in 12 individuals nationally) (Maine Tracking Network, n.d.). It is unclear why Maine has higher than average asthma rates, but the reason is likely multifactorial. Maine is geographically located in what is commonly called the "tail-pipe" of the U.S., meaning that environmental pollutants from other states are carried by air patterns to Maine, resulting in high levels of airborne particulates, smog, smoke, and soot (Maine Indoor Air Quality Council, n.d.). Maine is also subject to high levels of summertime ozone (ibid). Additionally, high pollen levels caused by dense forestation, older housing stock, and reliance on woodburning to heat homes may be factors contributing to high asthma rates in Maine (ibid).

According to the Asthma Callback Survey [Adult: 2018; Child: 2015-2017], about half (50.4%) of adults and over a third (39.7%) of children with current asthma in Maine reported experiencing an asthma attack in the prior 12-month period (U.S. Centers for Disease Control and Prevention, 2018; U.S. Centers for Disease Control and Prevention, 2017). The most common treatment for asthma is the use of asthma controller medications (i.e., inhaled corticosteroids) which are typically inhalers used daily. Rescue medications (i.e., inhaled short-acting beta agonists) are used during asthma flare ups or attacks. Among Maine adults with current asthma, less than a third (28.7%) had used a controller medication (inhaled corticosteroid) in the prior three months, while over half (58.2%) had used a rescue medication (U.S. Centers for Disease Control and Prevention, 2018). Maine children with current asthma had similarly low adherence to controller medications, with only 1 in 5 (20.5%) reporting using a controller medication in the prior three months, while nearly half (48.0%) had used a rescue medication in that same time frame (U.S. Centers for Disease Control and Prevention, 2017).

A lack of routine health care visits may be one reason why adults and children with asthma are not accessing and using needed control medication. Nearly half of Maine adults with asthma (48.4%) and more than a third of children (34.0%) did not report a routine doctor visit in the prior year (U.S. Centers for Disease Control and Prevention, 2018; U.S. Centers for Disease Control and Prevention, 2017).

Asthma was the cause of over 4,100 deaths in the U.S. in 2020, with 12.6 deaths per one million individuals (National Center for Health Statistics, 2021). Fifteen Maine deaths in 2020 were attributable to asthma (ibid). Between 2011 and 2020, asthma caused 138 deaths in Maine: an average death rate of 10.3 deaths per one million Maine residents. (U.S. Centers for Disease Control and Prevention, 2021).

Asthma-Related Health Disparities

Asthma-related health disparities in Maine are similar to those seen nationally. However, adults in Maine have a much higher prevalence of asthma than the overall U.S., while Maine children have a relatively similar prevalence to U.S. children (8.0% in Maine compared to 7.9% in the U.S. in 2017) (Maine Center for Disease Control and Prevention, 2017).

Among the estimated 120,000 Maine adults (1 in 10 Maine adults) living with asthma in 2017, there are several health disparities (Maine Center for Disease Control and Prevention, 2017). Maine adults with asthma tend to live in more rural areas and areas of lower socioeconomic status across the state (ME Asthma Comm Plan). Those with the highest rates of asthma include individuals with less than a high school education (16.6%) or a household income of less than $15,000 (18.6%), adults of more than one race (19.1%) or American Indian or Alaskan native (17.3%), and adults with MaineCare as their primary health insurance (21.6%) (Maine Center for Disease Control and Prevention, 2017). Adult females in Maine also report a higher prevalence of asthma compared to Maine adult males (13.9% and 8.3%, respectfully) (ibid). Of those adults in Maine with asthma, 62.0% have poorly or not well controlled asthma (Maine Asthma Prevention and Control Program, 2021).

The characteristics of Maine children with asthma are similar to those of adults in Maine. The populations of children with the highest rates of asthma in Maine include, children living in a household with an income less than $15,000 (16.2%), children ages 12-17 (10.3%), and children of more than one race (15.2%) or black and African American children (11.8%) (Maine Center for Disease Control and Prevention, 2017). It is also found that Maine boys have a higher prevalence of asthma compared to Maine girls (9.3% and 6.7% respectively) (ibid). Of the children in Maine that have asthma 56.1% have poorly or not well controlled asthma (Maine Asthma Prevention and Control Program, 2021).

COVID-19 and Asthma

At the start of the COVID-19 pandemic there was a heightened concern regarding the risk of mortality if someone with asthma was to contract COVID-19 (Willems S, 2022). While this was an initial concern the literature has shown that this perceived risk has not been observed (ibid). However, black individuals with asthma have significantly higher rates of COVID-19 compared to black individuals without asthma (35.5% compared to 21.4%) (ibid). Additionally, asthma patients with COVID-19 that required hospitalization were more likely to be black (ibid). Similarly, other minority populations (both adults and children) with asthma were also at a higher risk of COVID-19 and those with asthma were more likely to have other comorbidities compared to their white counterparts. These additional comorbidities can worsen the effect of asthma-related health problems.

Overall, when exploring the impact of COVID-19 on individuals with asthma it is apparent that there was a greater impact felt by minority populations. Minority individuals with asthma had a more difficult time affording and obtaining their asthma medications during COVID, were at a greater risk of losing their health insurance and lived in areas that have a higher prevalence of COVID (Willems S, 2022).

Cost Burden of Uncontrolled Asthma

Individuals with poorly controlled asthma experience significantly higher healthcare usage and costs than those with well managed asthma (Ivanova et al., 2012). The national costs associated with uncontrolled asthma in the U.S. are projected to total $300.6 billion in direct healthcare costs over the next 20 years (Yaghoubi, Adibi, Safari, FitzGerald, & Sadatsafavi, 2019). When indirect costs such as productivity loss are added to the model, the projected total costs of asthma increase to $963.5 billion (ibid). In 2010, asthma's estimated total cost in Maine was $179 million (Yob, Huston, Teach, Braddick, & Severson, 2018). This amount included $160 million in direct costs and $19 million in indirect (productivity loss) costs (ibid). It was estimated that these costs would see a 60% increase by the year 2020, with an estimated total cost of asthma of just over $286 million (ibid).

Mitigating Asthma

While there is no cure for asthma, the goal of treatment is to achieve good asthma control through medication, avoidance of triggers, and self-management. Avoiding common asthma triggers within the home, school, and work environments is a proven method of asthma control. Exposure to pets, carpeting, mold, and dusts within the home can contribute to asthma symptoms for adults and children. From 2006 to 2010, 50.3% of ever-employed adults in Maine believed their asthma was caused or worsened by chemicals, smoke, fumes, or dust at their workplace (Yob, Huston, Teach, Braddick, & Severson, 2018). For children, having an asthma action plan on file at their school can also help lessen the opportunity for asthmatic attacks. An asthma action plan is a written plan that provides information and instructions on how a person can manage their asthma, including medication use, recognizing symptoms, and what to do in an emergency. From 2006-2010, approximately half of children with asthma reported that their asthma action plan was on file at their school (ibid).

Asthma self-management education. A substantial body of literature supports the effectiveness of asthma self-management education for adults and children. A Cochrane Review of 36 medical trials involving adults with asthma compared the efficacy of self-management education to that of usual care (Gibson, et al., 2002). Findings showed decreases in high-level healthcare utilization and school and work absenteeism, as well as improved quality of life (ibid). Individual studies have found similar benefits of asthma self-management education, including increased medication adherence and self-reported asthma control (Janson, et al., 2003); improved asthma symptoms (Barbanel, Eldridge, & Griffiths, 2003); and improved health outcomes during pregnancy and after, including higher birth weights for babies born to women who had asthma action plans during pregnancy (Murphy, Gibson, Talbot, Kessell, & Clifton, 2005).

Asthma self-management education is also effective for asthma control with children. A meta-analysis of 32 students on pediatric asthma self-management found that an educational component improved activity restriction, lung function, school absenteeism, and number of emergency room visits (Guevara, Wolf, Grum, & Clark, 2003). The greatest improvement was seen in children with the most severe symptoms (ibid). Other students have found that self-management education improves monitoring of peak expiratory flow (Burkhart, Rayens, Oakley, Abshire, & Zhang, 2007); improved quality of life and parental self-management knowledge (Shames et al., 2004); and parental intention to treat cough, a symptom of airway inflammation that is a prevalent early asthma symptom (Butz et al., 2005).

Asthma Self-Management Reimbursement

The National Asthma Control Program (NACP) funds 25 asthma programs across the United States (National Center for Environmental Health, 2020). This funding is provided through cooperative agreements and many programs are staffed by community health workers (CHWs) (ibid). Integrating CHWs into the program has helped several states expand the home-visiting options they offer while maintaining high quality services. States that used CHWs noted that obtaining reimbursement for services provided is critically important (ibid). Rhode Island, for example, developed a partnership with United HealthCare to pay for eligible members to receive Home Asthma Response Program home-visiting services (ibid). Seven other states reported that they are working with Medicare to make a case for payment and reimbursement of asthma services given to individuals who have frequent emergency department visits/hospitalizations (ibid). Developing and cultivating a collaboration with their Medicaid offices is an underlying goal for these states, as it would help them achieve sustainable funding for

community asthma services moving forward (ibid). For example, Utah has been able to secure Medicare funding in fee-for-service areas, which has allowed them to help expand their program (ibid).

Economic Analysis of Asthma Self-Management Programs

Economic evaluations are unique in their ability to assess the cost-effectiveness of a program by weighing costs and benefits (National Center for Environmental Health, Division of Environmental Hazards and Health Effects, Air Pollution and Respiratory Health Branch, 2015). These costs and benefits include not only direct program outcomes, but also indirect impacts on families, communities, funders, and society as a whole. Benefits can represent both monetary profits as well as quantified value of health benefits (ibid).

Cost-of-illness studies. Studies have reported return on investments (ROIs) for asthma disease case management of $1.00 : $2.40-$4.00 and $2.40-$4.00 per $1.00 spent for guidelines-based medical management of asthma (Rossiter, 2000; Cloutier, 2009) . These studies also suggested that the higher costs per intervention may be offset by savings from fewer asthma-related emergency room visits or hospitalizations (ibid).

Cost-effective comparison studies. ROI and cost-benefit ratio (CBR) are two forms of economic evaluation that compare the financial returns against the total costs of an intervention (Masters, 2017). A systematic review of 52 studies on the cost effectiveness of public health interventions identified a median ROI of $1.00: $14.30 and CBR of $8.30 (ibid). It is interesting to note that while the review included a broad range of public health programs, no asthma-specific intervention was included.

Nurmagambetov et al. (2011) synthesized the economic values of home-based, multi-trigger, multi-component asthma interventions and found a cost per participant between $231 -$14,858, depending on the type of remediation completed, education delivered, professional occupation of the educator/home visitor, and frequency of home visits. The CBR ranged between $12 - $57 (in 2007 U.S. dollars) per asthma symptom-free days (ibid).

Sustainable financing models. In 2016, the University of Massachusetts Medical School's Center for Health Law and Economics identified four models for sustainable financing of CHW programs in Maine (Center for Health Law and Economics, 2016). One model, using data from Kennebec County projected that the cost of a CHW project that served 112 children with poorly controlled asthma would cost approximately $220,000 over 3 years and would only yield a positive ROI ($1.00: $1.03) if they received additional (bonus) payments for meeting quality targets (ibid).

Economic evidence to support asthma self-management education (AS-ME). Evidence indicates that outpatient and/or home-based AS-ME programs are associated with positive ROIs (Hsu, Wilhelm, Lewis, & Herman, 2017). In a few instances, a positive return was only observed among patients who utilize urgent health care at high levels (ibid). Many factors can influence the ROI of an AS-ME program, including the intensity of home remediation services offered and utilized, education components, the professional status of the asthma educator, and number of visits conducted (Nurmagambetov, et al., 2011).

Maine In-Home Asthma Education Program

In 2015, with funding from U.S. CDC, the Maine Center for Disease Control and Prevention's Asthma Prevention and Control Program identified a gap in evidence-based, self-management education strategies in Maine for adults living with asthma, and coordinated the development, implementation, and evaluation of the Maine In-Home Asthma Education Program (Maine HAEP). Developed in collaboration with local content experts, Maine HAEP is an innovative, home-based asthma program that focuses on Maine adults and children with poorly controlled asthma with the overall goal of teaching self-management skills, reducing triggers in the home, and providing education to families and caregivers.

The Maine CDC Asthma Prevention and Control Program (MAPC) partnered with local CHW and community paramedicine agencies to implement Maine HAEP. The Program was intended to increase patients' knowledge, skills, and abilities relating to asthma self-management; improve medication adherence among patients; and reduce patient exposure to asthma triggers. In the long term, the Program aims to reduce asthma-related emergency room and urgent care visits, as well as work and school absenteeism with the overall intended outcome of improving the quality of life for adults and children living with asthma in Maine.

The Maine HAEP consists of six modules that can be delivered by educators working in various professional settings and delivered either in the educator's office or the client's home or workplace. Trained CHWs, paramedics, and certified asthma educators implemented Maine HAEP in the homes of individuals with asthma. For each module, educators engaged in facilitated conversation with clients to ensure a safe space for interactive learning, including questions, self-evaluation activities (e.g., asthma control scores, quality of life assessments, etc.), feedback, and demonstrations. The number of modules completed at each visit and the order in which the modules were completed were at the discretion of the educator and reflected the client's needs and situation. Maine HAEP was provided free to any person with asthma and/or their caregiver. The Program was delivered in multiple languages, including English, Arabic, Somali, and French. As such, written educational materials/handouts were limited.

Implementation agencies. The Program was implemented by eight different agencies between 2016 and 2019. Both the type of organization and its staff varied and included public health nurses, community paramedics, and Community Health Workers. All agencies received funding from MAPCP to implement the Program.

- *Bangor Public Health and Community Service* is an agency within the City of Bangor that provides social and public health services to people living in the greater Bangor area. In 2015, a Public Health Nurse and Certified Asthma Educator piloted the Program. Between 2015 and 2016, a total of 60 patients enrolled in the Program and 36 patients completed it.
- *Maine Access Immigrant Network (MAIN)* is an ethnic-based community organization serving African and Middle Eastern immigrants and asylees in the greater Portland area. Between 2017 and 2019, six Community Health Workers enrolled 51 patients. Forty-nine completed the Program. In 2019, MAIN mentored the Portland Community Health Center during their HAEP implementation.
- *United Ambulance Community Paramedicine Program* is a non-profit agency is funded through St. Mary's Hospital and Central Maine Medical Center in Lewiston, Maine. Paramedic and Community Paramedic services are provided to community members living in the greater Lewiston and Bridgton area. Since 2017, one Community Paramedic has worked with 48 patients

to complete the HAEP. All clients enrolled completed the Program. In addition, staff at United Ambulance provided mentoring to other ambulance services implementing HAEP.

- *Portland Community Health Center* is a Federally Qualified Health Center provides primary care to residents in the greater Portland area. In 2019, a Community Health Worker engaged 16 patients in HAEP.
- *St. George Volunteer Firefighters and Ambulance Association* provides emergency medical and ambulance services to residents of the town of St. George. In 2019, a Community Paramedic engaged 9 patients in HAEP.
- *NorthStar Ambulance* is a MaineHealth associate and provides ambulance and community paramedicine services to residents in Franklin county. In 2019, 3 patients were engaged in HAEP.
- *Northern Light Health Community Paramedicine Program* is a division of the Charles A. Dean Memorial Hospital provides ambulance and community paramedicine service to the greater Greenville area. In 2019, Community Paramedics engaged 12 patients in HAEP.
- *Mayo Regional Hospital Emergency Medical Services* provides ambulance and community paramedicine services to the greater Dover-Foxcroft area. In 2019, a Community Paramedic engaged 2 patients in HAEP.

An independent evaluation of the Program used a mixed methods design with quantitative priority to assess the efficacy of the Program (Mitchell M, 2019)[1]. The findings (see Figure 1) suggest that participation in the Program resulted in an increased number of adults and children with well-controlled asthma at Program completion (ibid). In addition, completion of the Program demonstrated reduction in adult and caregiver tobacco use, improved medication adherence, and decreased emergency health care utilization (e.g., urgent care, emergency department care, ambulance rides, overnight hospitalizations (ibid). The Program was redesigned in 2019 and implemented by different public and private health systems.

Need for Evaluation

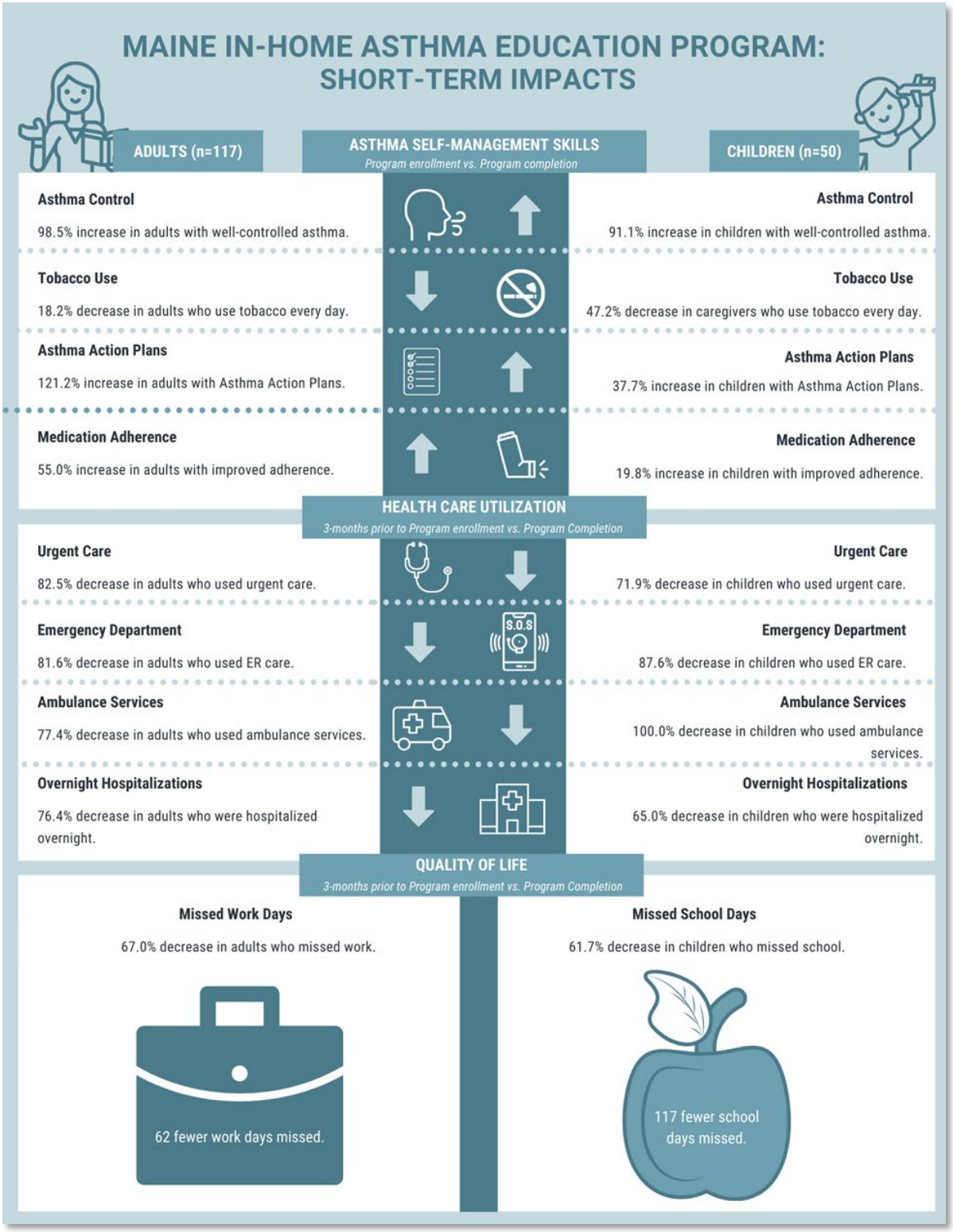
> *"One cannot begin with the notion that resources are plentiful so that one need only make some emotional plea in order to be able to mount a major health program. More attention to defining goals and evaluating efficacy should be combined with benefit-cost analysis if we are to improve the health of the nation."* – Lester Lave, Carnegie Mellon University

Measuring the costs and economic benefits of asthma self-management programs helps to translate their impact into objective monetary terms and help make the case for investments that decrease the asthma burden and improve quality of life. Cost analysis can also be used to inform public policy, advise resource allocation, and refine strategy implementation.

It is important that evaluations of public health programs, such as the Maine HAEP, consider the economic impact of the program over time and identify efficient means to achieve population-level asthma control. Economic evaluations are important way for new programs to assess operational costs and implications for expanding reach while maintaining effectiveness.

[1] A copy of the evaluation findings is available from the Maine CDC website: https://www.maine.gov/dhhs/mecdc/population-health/mat/information-and-publications/burden-report.htm

Figure 1. Short-Term Impacts of Maine HAEP



Methodology

Study Design

This study is a retrospective economic analysis of the Maine HAEP implemented between 2016 and 2019. It was conducted from both societal (e.g. economic) and payer perspectives (e.g., MaineCare) and aims to answer the following questions:

1. What is the average cost per Program participant?
2. What, if any, are the cost savings/benefits accrued to the Program?
3. What is the return-on-investment of the Program?

Data Sources

Client outcomes database. Short-term and intermediate health outcome data were provided to Partnerships For Health (PFH) in the form of a deidentified database. This included information on implementing agency, dates of engagement in the Program, demographic characteristics, asthma control, use of healthcare services, and work/school absenteeism.

Implementing agencies' contracts with Maine CDC. The total amount contractually obligated to each implementer was extracted from the encumbered contracts. These amounts were adjusted to 2019 U.S. dollars using the Consumer Price Index (U.S Bureau of Labor Statistics, 2022). In addition, based on the deliverables, each annual amount was proportionately allocated to infrastructure; education and outreach; training and professional development; and implementing the Program (i.e., treatment).

Costs. Various public data sources were used to estimate the cost of each type of healthcare service and wages. Table 1 summarizes these sources. All amounts were adjusted to 2019 U.S. dollars using the Medical Cost Hospital Calculator (Official Data Foundation, 2022) and Consumer Price Index (U.S Bureau of Labor Statistics, 2022).

Table 1. Costs Data Sources

COST	SOURCE
Urgent care visits (CPT Code: 99204)	CompareMaine health costs & quality (Maine Health Data Organization, 2022)
Emergency Room visits (CPT Code: 99284)	CompareMaine health costs & quality (Maine Health Data Organization, 2022)
In-patient hospitalization (Maine)	Kieser Family Foundation (2022)
Ambulance transportation (Codes: BLS 367.22, 439.63 to 442 with an average mileage of 20)	Office of MaineCare Services (State of Maine Department of Health and Human Services, 2022)
Average daily wage (Maine)	Center for Workforce Research and Information (Maine.gov, 2022)
Minimum wage (Maine)	State of Maine Department of Labor (State of Maine Department of Labor, 2022)

Analysis

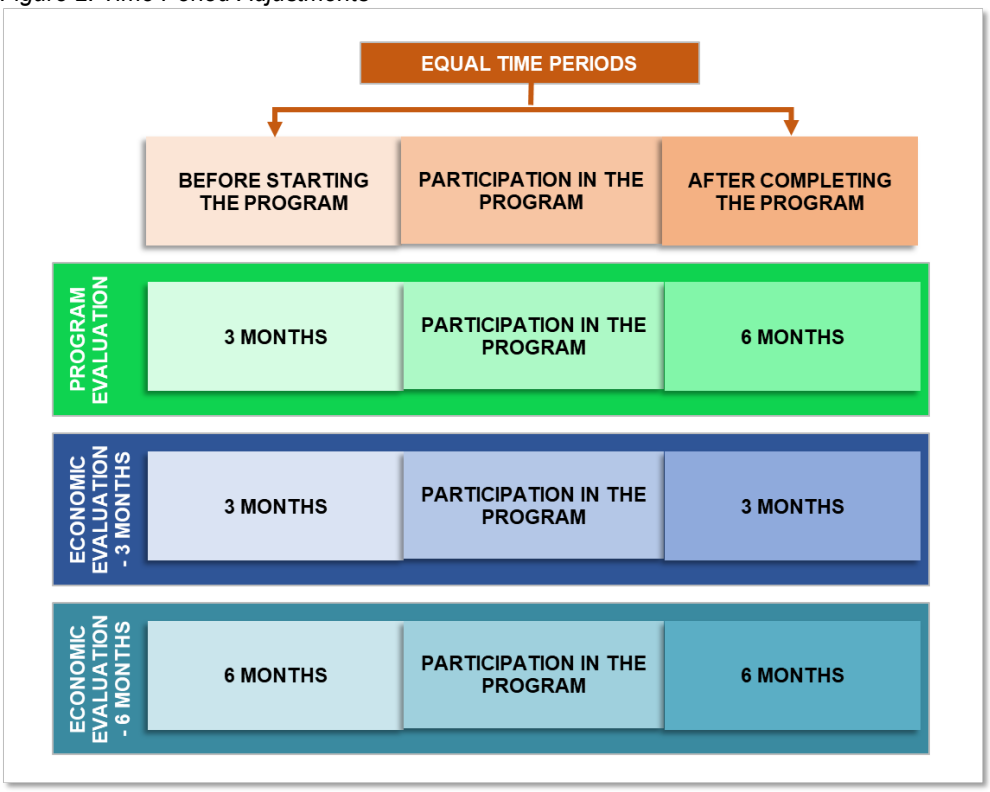
Program utilization. Utilization over the three-year period was measured in terms of clients who completed 60% and 100% of the AS-ME modules[2].Results were disaggregated by implementing agency. For this analysis, all participants were included (n= 230).

Resource allocation. To determine the cost per HAEP participant, both total costs and treatment-only costs were used. Total costs included: infrastructure; education and outreach; training and professional development; and implementing the Program (i.e., treatment). Treatment-only costs included the amount dedicated to providing education and support to participants. For this analysis, all participants were included (n= 230).

Outcomes cohort. A sub-set of participants (n=80) were followed for at least 6 months after completing the Program. This provided the opportunity to engage participants to assess intermediary outcomes and calculate realistic ROI ratios looking at the difference in healthcare, productivity, and quality of life years prior to the start of the Program (Time 1) and 6 months following completion (Time 2).

Time periods. To ensure accurate analysis of change, both time periods should be of equal lengths. As shown in Figure 2, Time 1 in the HAEP program evaluation was 3 months resulting in different time periods. To ensure homogeneity across time periods, the pre- and post- indicators were adjusted to be of equal lengths for ROI calculations.

Figure 2. Time Period Adjustments



[2] This aligns with the CDC guidelines for completion rates.

Determining benefits. The benefit of participating in the Program is defined using two different approaches: cost savings and quality of life years. For both analyses, only the Outcomes Cohort were included in the analysis (n=78)[3] as national guidelines on best practices recommend (Sanders G, 2016).

Cost savings. Cost savings were calculated as the difference in healthcare utilization and work/school absenteeism reported prior to and after participation. For adult participants, the average wage rate in Maine in 2019 was used to determine a monetary value for absenteeism. For child participants, it was assumed that the caregiver with the lower income would stay home to care for the child; accordingly, the minimum wage in 2019 was used.

Quality-Adjusted Life Years (QALYs). QALYs are measured from 0 (dead) to 1 (100% healthy) and multiplied by the remaining years of a person's lifespan to determine how many quality life years will be saved by treatment. In the absence of specific measurements, change in QALYs was determined by the number of people whose asthma was uncontrolled prior to Program participation and then well-controlled after Program participation. Based on Yaghoubi's probabilistic model, an estimated 0.07 QALYs are gained when a person's asthma goes from being uncontrolled to controlled (Yaghoubi, Adibi, Safari, FitzGerald, & Sadatsafavi, 2019). A monetary value was calculated using the standard amount of $50,000 per QALY (Neumann P, 2014).

[3] Two participants were excluded due to their extremely high use of healthcare services.

Results

Program Participation

Between December 2015 and May 2019, a total of 230 adults and children were referred to the Program. Overall, almost half of all patients were referred by primary care providers. Children with asthma and/or their caregivers were more likely to be referred by friends/family when compared to adults. Implementing agencies with strong relationships with health systems were more likely to receive referrals from primary care providers, emergency departments, or specialty care. This contrasted with community-based organizations (such as MAIN) which received most of their referrals informally through word-of-mouth in the community (Partnerships For Health, 2019).

The majority (87.4%)of people referred were enrolled and most (84.1%) completed the Program.

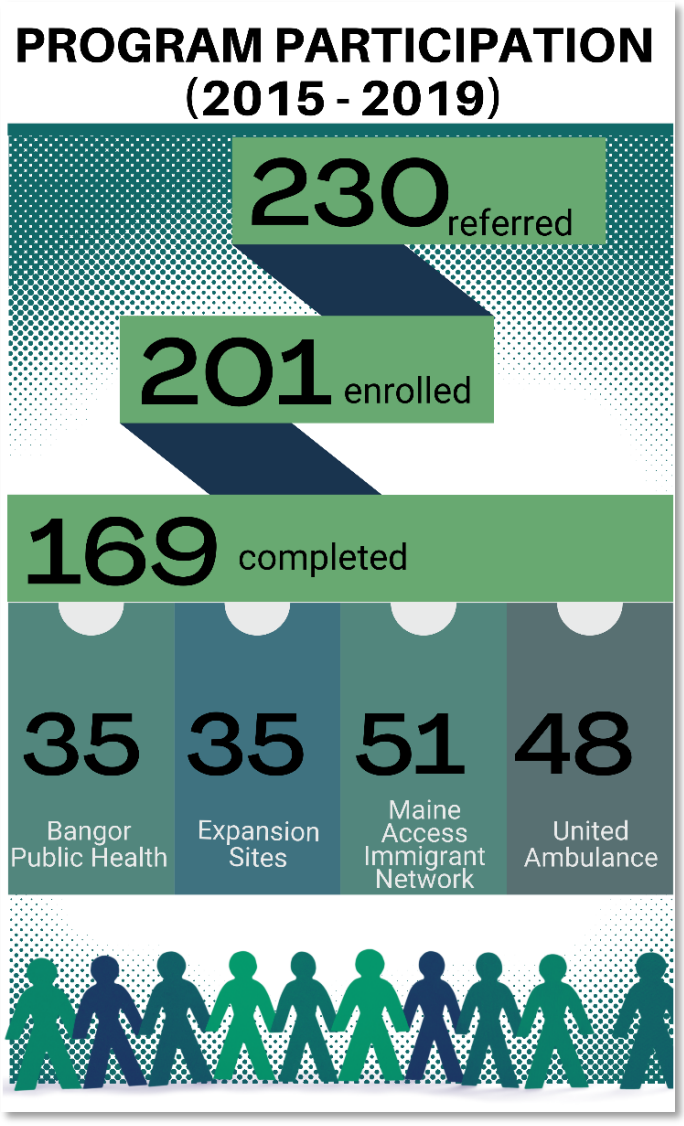
Of the 169 participants who completed all the modules, health outcomes 6 months after program completion are available for 78 individuals (66 adults and 12 children). This sub-population is referred to as the Outcomes Cohort and used to calculate the cost-benefit analysis.

Program Implementation Costs

Types of costs. There were various types of costs associated with the Program:

1. *Infrastructure costs.* These included contract management, staff supervision, meetings, etc. These costs were typically detailed in contracts as additional (non-educator) staff time, fiscal agent fee, etc. Depending on the agency and its stage of implementing the Program, this ranged from 10% - 55% of an annual contract.

2. *Education and outreach costs.* Given the newness of the Program, resources were spent raising awareness of the Program amongst health care providers and community members. This including meeting with health care system leadership, distributing promotional materials, and facilitating presentations. Education and outreach costs includes the development of materials, printing, and staff (educator and non-educator) time. Depending on the agency's service area, this ranged from 5% - 10% of an annual contract.



3. *Professional development costs.* While all educators were trained within their professional framework, resources were spent providing specialized training and attending professional development activities. All educators received content and case-based learning through established trainings and a monthly Project ECHO. Professional development costs were aligned with contract deliverables and included activities such as the development of materials, facilitation of trainings and Project ECHO sessions. Depending on the agency, this ranged from 5% - 20% of an annual contract.

4. *Program implementation costs.* These costs refer to those incurred completing the modules with individual clients and/or their parents. Examples of implementation costs include educators' cell phones, transportation, laptops, supplies, etc. These costs were dependent on the number of educators and the number of patients served and ranged from 15% - 85% of an annual contract.

Total and treatment-only program costs. Cost analysis estimates the cost of each unique participant by dividing total costs by the number of participants. Two different costs were used: the total costs (Table 2) and the treatment-only costs (Table 3). Both costs were adjusted for inflation and reflect the adjusted 2019 USD value. Total adjusted costs between FY16 and FY19 were $496,711.87. Removing the infrastructure, outreach, and professional development costs, resulted in a treatment-only cost of $242,267.00.

Table 2. Cost Elements for the Total Cost of Program Implementation (FY16 – FY19)

COST	FY16	FY17	FY18	FY19
Infrastructure	$15,560.85	$23,447.80	$5,845.70	$7,735.45
Outreach	$20,747.80	$10,823.90	$14,891.50	$10,235.45
Professional Development	$51,869.50	$11,573.90	$32,983.10	$40,119.05
Program Implementation	$15,560.85	$66,893.40	$63,193.70	$96,619.05
annual sub-total	$103,739.00	$112,739.00	$116,914.00	$154,709.00
Inflation adjustment	1.05	1.02	1.01	1.0
Annual Total Costs	$108,925.95	$114,993.78	$118,083.14	$154,709.00
Data source: Implementors contracts with DHHS (2015 – 2019)				

Table 3. Cost Elements for the Total Treatment-Only Costs of Program Implementation (FY16 – FY19)

COST	FY16	FY17	FY18	FY19
Program Implementation	$15,560.85	$66,893.40	$63,193.70	$96,619.05
Inflation adjustment	1.05	1.02	1.01	1.0
Annual Treatment Costs	$16, 338.89	$68,231.27	$63,825.64	$96,619.05
Data source: Implementors contracts with DHHS (2015 – 2019)				

Total and treatment-only costs for the Outcome Cohort only include two implementing agencies and accordingly is less, as shown in Table 4. FY16 is excluded from the table as the agencies were not active in the first year of program implementation.

Table 4. Cost Elements for Total and Treatment-Only Costs of Outcomes Cohort (FY17 – FY19)

COST	FY17	FY18	FY19
Total costs (including inflation adjustment)	$9,180.00	$118,083.00	$112,209.00
Treatment costs (including inflation adjustment)	$4,743.00	$63,826.00	$60,494.00
Data source: Implementors contracts with DHHS (2016 – 2019)			

Cost Per Participant

The cost per participant is dependent on the type of participant being considered. As summarized in Table 5, the cost per person enrolled in the Program was estimated at $2,471.20. This increases to $1,475.99 - $2,992.24 when calculating the cost per person who completed the Program. When considering cost per person with well-controlled asthma, the cost increases to $2,247.84 - $4,556.99.

Costs for the Outcomes Cohort are substantially less with costs per participants estimated at $2,428.00 - $1,303.67.

Table 5. Costs per Program Participant (2015 – 2019)

METRICS	TOTAL COSTS (FY16 – FY19)	TREATMENT-ONLY COSTS
Cost per person enrolled	$2,471.20	NA
Cost per person completed Program	$2,992.24	$1,475.99
Cost per person well-controlled asthma after Program completion	$4,556.99	$2,247.84
Cost per person with 6-month outcomes	$2,428.00	$1,303.67

Cost Savings

Table 6 and 7 detail the cost savings for both children and adult participants based on utilization and absenteeism reported 3 months prior to and an average of 3 months post Program completion[4]. Combined, a total of $78,570 is estimated to have been saved in adverted health care utilization and absenteeism.

Table 6. Three Month Cost Savings for Adult Participants (n=66) in the Outcomes Cohort

COST DRIVERS	PRE-POST PROGRAM CHANGE	MONETARY VALUE	TOTAL COST SAVINGS
Emergency Room Visits	39 fewer visits	$935 per visit	$36, 349
Urgent Care	26 fewer visits	$250 per visit	$6,464
Ambulance Runs	16 fewer runs	$545 per run	$8,567
Hospitalization	2 fewer nights	$2,638 per night	$5,653
Workforce absenteeism	62 fewer days absent	$195 per day	$11,988
		Total Savings	$69,021

[4] Follow-up survey was completed 7 months after Program participation. Self-reported outcomes were adjusted to 3 months to align with pre-survey.

Table 7. Three Month Cost Savings for Child Participants (n=12) in the Outcomes Cohort

COST DRIVERS	PRE-POST PROGRAM CHANGE	MONETARY VALUE	TOTAL COST SAVINGS
Emergency Room Visits	3 fewer visits	$935 per visit	$2,806
Urgent Care	15 fewer visits	$250 per visit	$3,750
Ambulance Runs	0 fewer runs	$545 per run	$0
Hospitalization	0 fewer nights	$2,638 per night	$0
Workforce absenteeism	34 fewer days absent	$88 per day	$2,992
		Total Savings	$9,548

When the time periods are adjusted for 7 and 12 months, total costs savings are $183,329.80 and $314,279.21 respectively.

Quality of Life

Within the Outcomes Cohort, 54 participants reported uncontrolled asthma prior to the Program and well-controlled asthma after Program completion. Using the literature-based rate of 0.07 QALY gained per person (Yaghoubi, Adibi, Safari, FitzGerald, & Sadatsafavi, 2019), an estimated 3.78 QALYs were saved, equivalent to $189,000 in benefits.

Return on Investment

Table 8 distinguishes the range of ROI. Return was calculated as net benefits (i.e., benefits less costs) and costs were considered as the investment. In the short-term (3 months) a negative ROI is evident ($1: $0.77). However, the ROI increases with a longer time period; within 7 months, a positive ROI was achieved ($1:$1.80). This doubles at 12 months where a $1 investment yielded a savings of $3.09. When viewed in terms of quality of life, the ROI yields a benefit of $1.86 for every dollar invested.

Table 8. Return-on-Investment Over Time

	3 MONTHS	7 MONTHS	12 MONTHS	QALYs
Total Treatment Costs[1]	$101,685.75	$101,685.75	$101,685.75	$101,685.75
Cost Savings for equivalent period	$78,569.80	$183,329.54	$314,279.21	$189,000.00
Return-on-Investment (costs: benefits)	$1 : $0.77	$1 : $1.80	$1 : $3.09	$1 : $1.86
Return-on-Investment[2] (%)	-22.7%	80.3%	209.1%	85.9%

Note:
[1] Treatment costs only include participants who had completed the Program and excludes outliers (n=78)
[2] Return on investment = (cost savings - costs) / costs

Discussion

Answering the Evaluation Questions

Maine has among the highest rates of asthma nationally, especially among adults (National: 7.7% vs. Maine: 11.2%) (Maine CDC, 2022). Among the estimated 131,000 adults living in asthma, half (50.4%) report having experienced an asthma attack in the previous 12 months (ME Burden Report). Uncontrolled asthma has an adverse impact on society, both through loss of life and productivity years and through the financial burden borne by individuals with asthma, their family, health systems, taxpayers, and employers (Yaghoubi, Adibi, Safari, FitzGerald, & Sadatsafavi, 2019). The national costs associated with uncontrolled asthma in the U.S are projected to total $300.6 billion in direct healthcare costs over the next 20 years (ibid).

The Maine In-Home Asthma Education Program has previously been shown to be effective in achieving asthma control and reducing utilization of acute healthcare services and absenteeism (Mitchell M, 2019). Approximately 169 adults and children completed the Program between 2015 and 2019, of which 68 were followed up with at 7 months. The latter were referred to in this evaluation as the Outcomes Cohort.

To determine the cost-effectiveness of the Program, a retrospective economic analysis from both societal and payer perspectives was undertaken. The majority of the analysis was based on the Outcomes Cohort.

What is the average cost per Program participant?

The analysis explored three different ways of defining costs: total costs, treatment-only costs, and Outcomes Cohort costs.

Total costs. This included all resources needed to implement the Program (e.g., education, outreach, infrastructure, professional development). Total costs ranged between $108,925.95 and $154,709.00 per annum. Many of these costs are fixed costs and typically decrease as the Program becomes established in the community and implementers are sufficiently trained. None of the agencies implemented the Program for more than 2 years, suggesting that the total costs reflect many of the initial start-up expenses. Total costs per person completing the Program was estimated to be $2,992.24.

Treatment-only costs. This only includes the expenses incurred when implementing the Program (i.e., providing direct services to the individual with asthma and/or their parent). These costs are variable and will fluctuate according to the number of participants. Accordingly, the annual treatment costs expanded as the number of educators and participants increased: from $16,338.89 in FY16 to $96,619.05 in FY19. As a proportion of the total costs, treatment-only costs increased from 15.0% (FY16) to 62.5% (FY19), which may be indicative of the Program moving from pilot to implementation status. The average treatment-only cost per person completing the Program was estimated to be $2,247.84.

Outcomes Cohort. While the total costs per person with 6-month outcomes ($2,428.00) was comparable with the average cost of a graduated participant ($2,992.24), the treatment-only costs were substantially less ($1,303.67).

The Outcomes Cohort costs are within range of other similar programs, where the cost per participant ranges between $231 - $14,858 depending on the education delivered, professional occupation of the educator, frequency of home visits, and types of remediation complete (Nurmagambetov, et al., 2011).

What, if any, are the cost savings/benefits accrued to the Program?

Cost savings. Cost savings were calculated as the difference between self-reported acute healthcare utilization and school/work absenteeism prior to and after participation in the Program. At follow-up, it was estimated that a total $78,570 had been saved in adverted healthcare utilization and absenteeism avoidance among 78 participants, for an equivalent 3-month period. These cost savings would be equivalent to $314,279.21 for a 12-month period.

Benefits. The benefits were calculated in terms of QALYs gained due to participants moving from uncontrolled to controlled asthma. Using Yaghoubi's (2019) rate, it was estimated that a value of $189,000.00 was accrued by the 54 participants who gained asthma control after completing the Program.

What is the return-on-investment of the Program?

The time period appears to play an important role when determining ROI. Often, a timeframe of 3 months prior to and following a program is used because of practical challenges in engaging participants for an extended period after completing a program and because studies suggest that participants' recall becomes compromised with longer follow-up periods (McCall MacBain Foundation, 2022). However, this analysis has demonstrated the importance of considering a longer time period for ROIs based on cost savings.

For the Maine HAEP, a 3-month time period resulted in a negative ROI ($1:$0.77). Extending the period to 7 months resulted in a 79.5% return with a ratio of $1:$1.80. This doubles at 12 months, where a $1 investment yields a saving of $3.09.

Economic analysis using QALYs may not be affected to the same extent. It is interesting to note that the ROI using QALYs resulted in an equivalent ROI to the 7-month period ($1:$1.86).

Conclusion and Recommendations

Attrition. The findings highlight the low attrition rate among participants. Due to the different time periods and funding levels, it is not feasible to look at attrition rates by type of agency or professional implementing the Program. Future evaluations may benefit from these considerations.

Quality of life. Quality of life is an important indicator of success of an intervention. Findings suggest that most participants (79.4%) achieved asthma control following participation in the Maine HAEP Program. Future evaluations may benefit from utilizing an instrument that would enable QALYs to be directly calculated.

Time. Each agency implemented the Program for a maximum of 2 years. During this time, resources were spent building infrastructure, training staff, and increasing awareness of the Program among healthcare providers and community members. This may have inflated the total costs as start-up costs are often substantial. It is recommended that, if possible, agencies are engaged for an extended period of time to achieve the benefits of diminishing fixed costs.

The findings highlighted the implications of during an economic evaluation over different periods of time and the dangers of using a too short a period. It is recommended that future program evaluation and economic evaluations use a minimum of 7-month pre- and post- program participation to determine health outcomes and the associated ROIs.

Financing the Program. MaineCare is currently transitioning its reimbursement system from fee-for-service to value-based payments. The results from the program effectiveness evaluation (Mitchell, 2019) suggested that the Program is effective in reaching two of the three healthcare improvement aims: improved health and quality (Institute for Healthcare Improvements, 2022). This evaluation provides evidence that the Program can also fulfill the third aim of reducing costs.

Limitations

Perspective. While perspective is important to assess costs from a certain vantage point, using payer or societal perspectives, will yield different utility and benefits than if using a programmatic, or participant perspective. Findings should be interpreted accordingly.

Implementation inconsistency between implementers. Implementers differed in the length of time in which they implemented the Program, their referral pathways, organizational structures, and community characteristics. This may impact the utility and benefit yielded from the Program when measuring QALYs and other costs.

Study design. The economic analysis is based on a pre-post program evaluation which has potential limitations such as regression-to-the-mean effects on the outcomes. In addition, the sample size is small, especially for children (n=12).

Confounders. No demographic confounders, such as participants' education, socio-economic status, length of time in the U.S. were adjusted for in the analysis as their influence on averted healthcare costs and productivity are not known. The Program was implemented in discrete geographic regions. Accordingly, there may be some local specificity that may impact the implementation costs and participant outcomes.

Cost data granularity. Cost data is based on contracts between the implementing agencies and the Maine CDC. No detailed information was available on actual expenditure. In addition, the proportion of resources allocated to treatment was estimated using contract deliverables.

Absence of cost utility. Cost utility quantifies decreases in mortality and morbidity attributed to an intervention using QALYs. The absence of this data in the program evaluation precluded a direct analysis of this.

Time periods. The program evaluation asked participants to reflect on different time periods prior to and after program completion. Results suggest that a 6-month time period be used in future evaluation

efforts. However, the benefits of having longer time periods will be balanced by a decrease in accuracy of memory.

Long term impact. It was beyond the scope of the previous program evaluation and this economic evaluation to determine how long the benefits of the Program last. This information would be invaluable to the Program and allow for a more comprehensive economic evaluation. It is recommended that future evaluations, if feasible, follow participants after 6, 12, and 18 months.

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