Considerations and Challenges for Planning a Public Health Approach to Asthma

Adam Davis and Elizabeth Herman

ABSTRACT *Addressing asthma from a public health perspective is a relatively new concept for which the literature provides little guidance. A public health approach seeks to decrease the burden of asthma and improve health outcomes at the population level, such as communities, cities, or states, by reaching large numbers of individuals with effective interventions and at reasonable cost. Projects designed to achieve a measureable impact at the population level are fundamentally different from projects or interventions designed to improve outcomes among individuals. This paper uses the experience of the Controlling Asthma in American Cities Project and a review of the relevant literature to explore some of the unique questions and considerations that are implicit when planning large-scale asthma projects intended to improve population outcomes. The paper is intended to inform decision making by local and state government agencies, managed care organizations, health systems, community coalitions, and funders. Analysis of asthma and other chronic disease projects aiming to achieve population-level impact is an area for continued public health research.*

KEYWORDS *Morbidity, Community, Public health, Population, Population-level, Intervention, Large scale*

INTRODUCTION

There is a compelling need for population-based approaches to addressing the burden of asthma, particularly in urban communities. Despite progress over the last 3 decades in medications for asthma treatment, improved air quality, the development of clinical guidelines for asthma management, and the increasing coverage by managed care, asthma prevalence, morbidity, and related costs have not decreased.¹ Many well-designed interventions (focused programs or actions designed to improve health outcomes) and projects (collections of complementary interventions) in clinical and community settings have demonstrated a short-term reduction in asthma morbidity.^{2,3} Most publications, however, describe small-scale pilots or research studies that assess efficacy among participants rather than impact upon a defined population, such as a county, city, neighborhood, or health plan membership. Interventions that affect populations rather than individuals are important because they have the potential for promoting the health of a larger number of individuals.⁴

The population perspective is the hallmark of public health.⁵ Although the preliminary steps that commonly constitute public health program planning—such

Davis is with the American Lung Association in California, Oakland, CA, USA; Herman is with the Centers for Disease Control and Prevention, National Center for Environmental Health, Atlanta, GA, USA.

Correspondence: Adam Davis, American Lung Association in California, Oakland, CA, USA. (E-mail: adavis@alacbay.org)

as conducting a needs assessment, constructing a logic model, and building a coalition—are well documented,^{6–8} guidance for directing resources to affect population-level measures of asthma morbidity is extremely limited. To achieve sustainable population-level impacts, projects must not only demonstrate effectiveness among participants but also have high reach, wide adoption, and long-term changes among patients and institutions.⁵ Public health's challenge is to have an impact on large numbers of individuals with asthma with effective interventions, which are implemented in complementary ways at reasonable cost.

The 7 sites of the Controlling Asthma in American Cities Project (CAACP), funded through a cooperative agreement with the Centers for Disease Control and Prevention, sought to reduce the burden of asthma among populations of inner-city children. Community-based asthma coalitions at each site were charged with developing and implementing a comprehensive set of asthma interventions based on local needs. Details of the project's purpose, design, strategic plan, and evaluation are described elsewhere.⁹ This paper draws on the CAACP experiences and the literature to (1) articulate the implicit questions and decisions of planning a public health approach to asthma and (2) discuss possible strategies and issues for consideration in addressing those questions and decisions. The paper is organized into topic areas corresponding to the following 8 questions:

- What population-level outcome measures are available and appropriate for asthma projects using a public health approach?
- How many individuals need to be reached and with what effectiveness to achieve desired outcomes for various population sizes?
- What external contextual factors are likely to influence the effectiveness of the intervention(s)?
- What are the criteria for choosing interventions to achieve population-level outcomes?
- How should resources be allocated across multiple asthma interventions within a project?
- What factors should be considered when deciding which individuals or groups of individuals to target within a given community or project area?
- How can projects effectively recruit large numbers of individuals to participate in interventions?
- How can health disparities be addressed in planning a public health approach to asthma?

Measuring Population-Level Outcomes

The evaluation of public health projects is fundamentally different from the evaluation of a stand-alone research study or a small-scale intervention; the former seeks to show improved health across a population, the latter only among those participating in interventions. Showing improved health across a population requires data representative of the entire population at multiple points in time. As the development of population-level databases is usually prohibitively expensive and time consuming, most disease-specific public health efforts use existing data sources. These might include the following: (a) publicly available databases, such as disease registries, hospitalization discharge records, or emergency department data; (b) proprietary medical records or claims data; or (c) surveys from a representative sample of the population. The data available for a given population might be quite limited. To ensure that a project's targeted outcomes are measurable, realistic, and

consistent with the level of funding, available databases and the information needed from them should be identified concurrent with the planning process and in coordination with the project's stakeholders.

Types of population-level asthma-related measures can be conceptualized in a pyramid, with the least common events at the top, ranging from mortality to asthma symptoms (Figure 1).¹⁰ Asthma mortality is seldom used as an outcome measure because it is a rare event. Hospitalization data are collected at the state level, and availability varies by state.¹¹ The CAACP sites were required to follow trends in hospitalizations for asthma as a primary outcome measure; those findings will be reported in a future publication. Emergency department (ED) visits for asthma are 3 to 4 times as common as hospitalizations.¹ Although ED data are theoretically a reasonable measure of a project's reach and effectiveness, only 2 CAACP sites were able to obtain those data for people residing in their project area from a central source. Others had to collect and collate information from individual hospitals serving their populations to estimate ED utilizations. No CAACP site chose to measure the frequency of outpatient medical services at a population level, mainly because distinguishing between urgent, unscheduled visits, which the project was intended to reduce, and routine visits, which the project was intended to increase, is difficult. One site, Chicago, analyzed patterns in asthma medication use at the population level, using a pharmacy chain's administrative database.¹² Measures of adherence to recommendations, symptom frequency, and missed days at school or work are available from national- and state-level surveys, but do not usually apply to geographic areas as small as the CAACP site catchment areas.¹³ Several sites were able to monitor asthma-related school absences at the school-district level. Measures of asthma prevalence such as "lifetime prevalence" or "current asthma" would not be expected to change with current interventions. Current interventions focus on controlling existing asthma because there is no known cure. Primary prevention is limited to reducing certain occupational exposures affecting relatively few individuals.

Scaling Interventions to Improve Population-Based Outcomes

To produce change at the population level, the number of individuals reached and the effectiveness of the intervention(s) must be commensurate with population size. Even the most effective interventions will not result in population-level change unless

FIGURE 1. Types of population-level outcomes.

enough people are affected. Estimating the number of individuals who must be reached, and with what effectiveness so that the expected change in a particular population-level outcome will be substantial (about 2 standard deviations), is an important step in planning a community-based intervention.

This task differs from power calculations used to determine the minimal sample size or experimental group necessary to achieve statistical significance in a study. That calculation requires estimates of the population parameters. The intent here is to achieve an actual change in the population parameter itself. Estimating the number of individuals who must be reached to achieve that change requires the following 3 pieces of data: the prevalence of asthma in the population, the frequency of the event to be measured among those with asthma (e.g., the rate of hospitalizations, ED visits, or office visits), and the random variation associated with that event. The change in the number of events that must be achieved in a given population (in order to exceed random variation) can be calculated. The intended direction of change can be either positive or negative. The number of people who must be reached to achieve that change can be calculated from the change in the number of events needed, the frequency of that event, and the effectiveness of the intervention or project.

For example, recent national data indicate that the prevalence of asthma is 7.3% and approximately 66 office visits, 8.8 ED visits, and 2.5 hospitalizations occur per 100 persons with current asthma.¹ As shown in Table 1, in a hypothetical population of 500,000 (the approximate size of CAACP target populations), one would expect 36,500 people with current asthma ($500,000 \times 0.073$), 24,090 office visits ($36,500 \times 0.66$), 3,212 ED visits ($36,500 \times 0.088$), and 913 hospitalizations ($36,500 \times 0.025$) for asthma annually. Estimating the change in the number of events needed to achieve substantial change requires multiplying the standard error of that event by 1.96 (1.96 is the critical value of the z distribution for a two-tailed test at the 0.05 level of significance). In Table 1, the standard error is approximated by taking the square root of the number of events in the population. This approximation, based on the Poisson distribution, is derived from the formula for relative standard error used for mortality data.¹⁴ Thus, in a population of 500,000, the number of ED visits that must be eliminated to reach significance ($p < .05$) is the square root of 3,212 multiplied by 1.96, or 111 events.

The number of individuals who must be reached to achieve the necessary change in number of events can be estimated by dividing the expected change in number of events by the rate for the event. Table 2 illustrates this calculation for a population of 500,000. As stated above, to substantially reduce the population-based ED visit rate for asthma, at least 111 visits must be eliminated by the intervention(s). If the intervention is 100% effective in eliminating ED visits among those with asthma and there are 8.8 ED visits for every 100 with current asthma, then approximately $111:0.088$ or 1,261 participants with current asthma must be enrolled. If <100% effective, that number is divided by the estimated effectiveness. An intervention that is 50% effective will need twice as many participants. Continuing with the above example, if the intervention eliminates half the ED visits among those enrolled, then 2,522 must be enrolled ($1,261:0.50 = 2,522$) to substantially decrease the ED visit rate for asthma. Further adjustments may be needed to allow for dropouts and incomplete participation, for population mobility (people who received the intervention moving out of the area, people who did not receive it moving in), as well as the uneven distribution of events in the population (some people having frequent events, others having none).

TABLE 1 Expected number and associated change in the number of events required to reach significance in populations of various sizes

Population size	Number with asthma ^a	Office visits for asthma ^b		ED visits for asthma ^c		Hospitalizations for asthma ^d	
		Number	Change ^e	Number	Change	Number	Change
5,000,000	365,000	240,900	962	32,120	351	9,125	187
2,500,000	182,500	120,450	680	16,060	248	4,563	132
1,000,000	73,000	48,180	430	6,424	157	1,825	84
500,000	36,500	24,090	304	3,212	111	913	59
250,000	18,250	12,045	215	1,606	79	456	42
100,000	7,300	4,818	136	642	50	183	26
50,000	3,650	2,409	96	321	35	91	19

Refers to count of events such as a hospitalization, ED visit, or office visit

^aBased on a prevalence of 7.3%

^bBased on a rate of 66 per 100 with asthma

^cBased on a rate of 8.8 per 100 with asthma

^dBased on a rate of 2.5 per 100 with asthma

^eChange = $1.96 \times$ standard error; standard error $\sim$ square root (number of expected events)

TABLE 2 Number of participants with asthma needed for a population of 500,000 by effectiveness of the intervention (assuming 7.3% prevalence of asthma)

Effectiveness of the intervention	Number of participants with asthma needed to demonstrate significant change in the event of interest*		
	Office visits for asthma	ER visits for asthma	Hospitalizations for asthma
100%	461 (304/0.66)	1,262 (111/0.088)	2,360 (59/0.025)
50%	921 (461/0.50)	2,522 (1261/0.50)	4,720 (2360/0.50)
25%	1,842 (461/0.25)	5,044 (1262/0.25)	9,440 (2360/0.25)

*Number needed=(number needed to change/rate of event)/effectiveness, e.g., for an intervention 50% effective in reducing emergency department (ED) visits for asthma, number needed=(111/0.088)/0.50=2522

These calculations, although rough estimates, permit planners to determine whether the fit between target population size, available resources, and the outcome to be measured is realistic. They also argue for directing interventions to individuals for whom a successful intervention would most likely contribute to a measureable change at the population level. Instead of estimating the number needing to be reached at the beginning of the project, the CAACP sites selected targets based on what planners considered feasible. A comparison of numbers reached at the midpoint of the project indicated that several sites lagged behind the others, requiring some redirection of activities at those sites.

External Factors That Influence Asthma Outcomes

A variety of external factors, including demographic changes in the project area, revision of reimbursement or coding policies, changes in Medicaid eligibility requirements, closing of safety-net health service providers, changes in the economy, concurrent interventions, changes in environmental exposures, and fluctuation in the cold/flu seasons, can theoretically influence asthma-related outcomes.¹⁵ Community changes that improve access to quality medical care or reduce environmental asthma triggers may make it difficult to attribute improved outcomes to a project. Changes that reduce access to care or medications, or increase environmental triggers, may mask the accomplishments of an asthma intervention.

Population movement out of a project area, a common occurrence, can theoretically affect outcome measures in a variety of ways. Each year, 14% of people in the United States change their address with the rate tending to be higher in lower socioeconomic neighborhoods.¹⁶ Although individuals and families participating in asthma interventions may continue to benefit after leaving a project area, their improved outcomes would not be reflected in a population-based measure. Because asthma prevalence varies among ethnic groups,¹⁷ a change in racial or ethnic distribution may result in different rates of healthcare utilization that mirror a demographic shift rather than project impact. While the direction of change in asthma outcomes due to demographic changes is difficult to predict, increasing the estimated “number needed to reach” to accommodate the potential loss to follow-up of individuals and families would be a conservative approach.

Over the 7-year project period, a number of external factors that had the potential to affect hospitalization rates and other outcome measures occurred in the CAACP sites. For example, in one site, new management at the local pediatric hospital relaxed standards for hospitalizing a child due to asthma. The sites

addressed the complexity of external factors in a variety of ways. Davis et al. analyzed pharmacy-fill data using multiple complementary techniques (time trends, comparison of the project area with similar areas in the city, and analysis by age group) to provide different perspectives and strengthen the attribution of improved patterns to the project.¹² In the final analysis of hospitalization data, all sites will superimpose a contextual analysis of important changes over the timeline of the projects’ interventions and trends in hospitalization data. Although no analytic techniques can completely control for contextual factors, documenting and acknowledging them can facilitate a realistic interpretation of outcome data.

Considerations When Selecting Interventions

Selecting interventions that are most likely to be effective in a project’s local context is a critical part of the local planning process. Reaching large numbers of people, in a variety of settings, in complementary and synergistic ways, and at reasonable cost, requires interventions at multiple levels.² The Spectrum of Prevention (Table 3)¹⁸ is one framework for categorizing the levels and types of interventions for asthma. The effectiveness, cost, and appropriateness to the local context should be considered when choosing specific interventions.

Asthma clinical guidelines, review papers, and meta-analyses provide an overview of the evidence base behind different types of interventions, and are usually based on a systematic review of multiple studies. These typically give greater weight to randomized, controlled trials and to studies with large sample sizes. If reviews or meta-analyses are not available, project planners may need to base their

TABLE 3 Types of asthma interventions categorized, using the Spectrum of Prevention as a framework

Influencing policy and legislation
Clean outdoor air policies and legislation
Clean indoor air policies and legislation
Occupational regulations
Healthcare delivery and financing
Strengthening social/organizational practices
Quality improvement initiatives
Information systems
Local school policies
Educating/training health care providers
Educating primary care providers
Specialized training for medical residents
Educating pharmacists
In-services for school and childcare center staff
Promoting community education
Group asthma education in community settings
Group asthma education in schools
Social marketing, public service announcements
Strengthening individual skills and knowledge
Case management (home, school, clinic)
Specialty asthma or allergy clinics, mobile clinics
Phone follow up or nurse monitoring
Patient education in hospitals and emergency rooms

Source: Adapted from the table in Cohen and Swift¹⁸

assessment of effectiveness on individual papers or their own reviews. When doing so, assessing the methodology of published studies is important, including the data source and the collection method. For example, many evaluations of asthma interventions rely on changes in self-reported behaviors or symptoms. The accuracy and precision of self-report is likely to vary by the type of question, the person collecting the information, time transpired since the reported event, and provider of the information (e.g., a patient or guardian).¹⁹ Evaluations that do not have a control or comparison group might show a positive change based on a phenomenon called “regression to the mean,” meaning that, when a series of events is tracked, the events will tend to return to a predictable mean on their own.²⁰ Regression to the mean can lead to an incorrect conclusion that attributes an asthma outcome to an intervention when it was actually due to chance. This effect might be especially pronounced in asthma interventions that focus on individuals with high utilization at baseline.²⁰

The effectiveness of interventions is dependent upon context.²¹ Interventions conducted under rigorous study design with carefully screened participants, by the most skillful professionals, may prove ineffective in other settings.^{5,22,23} The CAACP sites selected their interventions during a planning process that involved reviewing the literature on asthma interventions, conducting a needs assessment, soliciting stakeholder interests, and performing small pilots of proposed interventions. Some coalitions reached agreement on the mix of interventions through consensus; others followed structured procedures. As documented in annual reports, the Minneapolis/St Paul site actively engaged 115 people in intervention selection. Six workgroups met monthly for 7 months to move through a formal process that resulted in a prioritized list of interventions, an evaluation plan, and a proposed budget. A leadership team then identified areas of overlap and synergy from the six plans to compose a strategic project plan. All sites had a coalition-based process that balanced local needs and resources, stakeholder preferences, and evidence supporting intervention effectiveness.

While most interventions were evidence-based, CAACP sites implemented some interventions for which an evidence base was not yet available. They justified these interventions with logic models that linked the interventions and desired outcomes.²⁴ For example, the St. Louis site’s need assessment identified health care system fragmentation as one of the target area’s major challenges. The site implemented the Asthma Friendly Pharmacy intervention, although not supported by pre-existing evidence, because it appeared to be a critical link in a communications network among patients and their families, health care providers, and schools. Evaluation of that intervention focused on its success in establishing and maintaining those lines of communication²⁵ and now contributes to the evidence base for pharmacy interventions.

Allocating Resources across Multiple Interventions

Little practical guidance exists for allocating public health resources for asthma across the range of interventions listed in Table 3, and no studies have tested the effectiveness of different combinations of interventions. Given the number of possible combinations of interventions, differences in communities, timing of interventions, and variations in external factors affecting outcomes, an empirical answer to the question of the most effective mix of interventions is unlikely.

The CAACP projects chose interventions that addressed different levels of the Spectrum of Prevention. All sites provided individualized family and home asthma

services that focused on asthma self-management training and indoor-trigger reduction. The Philadelphia, Richmond, and Minneapolis/St. Paul sites reached out to parents and community members by providing asthma classes in community settings; Philadelphia site staff made extensive use of local communication networks (radio, newsletters, and newspapers) to increase community awareness of asthma and the CAACP. Training for primary health care providers on NAEPP guideline implementation was also included in all strategic plans. The Oakland and Minneapolis/St. Paul sites implemented interventions to institutionalize the reinforcement of key asthma messages into routine care for hospitalized and ED patients, respectively, and the Northern Manhattan, Minneapolis/St. Paul, and Oakland sites succeeded in institutionalizing asthma-friendly policies and procedures in their respective school systems. The Chicago site worked at the policy level to support smoking bans and the regulation of power plants and demolition sites.

CAACP sites noted an implicit tradeoff between designating comprehensive resources to a smaller number of people (i.e., high intensity) or fewer resources per person to a greater number of people (i.e., high reach). High-intensity interventions included, for example, individualized home-based medical and social support for families, and practice-based system-change interventions for health care providers. High-reach interventions included group trainings and classes, policy-based interventions, and mass media.

There were also decisions about reach and intensity within the context of one type of intervention. For example, among CAACP sites, the number of hours dedicated to group training of medical providers ranged from 1 to 8 hours and length of home-based support for families ranged from 1 to 18 visits. Intensive interventions, although generally effective for participating individuals or families, cost more per person and may have had a limited effect on population measures when the number of people or clinics reached is a small proportion of the population.⁵ Low-intensity interventions may not be effective in changing behaviors or achieving outcomes, or may take many years to demonstrate an effect.²⁶

Targeting Individuals

Project planners with limited resources must decide which individuals to target. When conducted on a large scale, even small differences in characteristics between participants and non-participants can have an impact on an intervention's effectiveness.²⁷ Identifying and targeting individuals who are most at-risk for adverse outcomes is essential for maximizing the intervention's impact.

Most publications on asthma interventions evaluate the impact on an intervention's participants without considering the implications for a larger population. Scaling up an intervention often introduces a new set of dynamics. For example, assume a hypothetical intervention targeting individuals with a recent asthma hospitalization is 100% effective at preventing a subsequent hospitalization for 1 year. Even if this intervention was given to every patient hospitalized in an entire year, it would reduce hospitalizations the following year by only a small amount²⁸ because only a fraction of hospital admissions for asthma in a population in a given year are readmissions.²⁹

Selection criteria for CAACP interventions were inconsistent across sites. For example, criteria used by various sites to enroll a family in an asthma case management focused on 1 or more of the following measures: asthma control, utilization history, severity, socioeconomic factors, school absences, and physician referral. The more resource-intensive interventions were generally more selective

(personal communication with CAACP site directors or investigators, February–September 2008), in keeping with evidence that most asthma morbidity and cost can be attributed to relatively few individuals.³⁰ The asthma guidelines frequently refer to “high risk” individuals, but both the guidelines and the CAACP sites used the term inconsistently.²

One challenge that planners face is the lack of correlation among different measures of asthma. Underlying severity and measures of current impairment, such as symptoms, functional limitations, or quality of life, are not reliable predictors of future risk of asthma exacerbation or adverse events.² Furthermore, different adverse events may not necessarily correlate with one another; someone who frequently misses school because of asthma may not necessarily be at risk for a hospitalization.

Risk assessment models have used empirical data to successfully predict, in the short term, who is most at risk for various outcomes and thus most likely to affect those outcomes in the future.^{31–34} These models include many variables, such as demographic data, various indicators of current asthma control, prescription patterns, and health care utilization history. Such models are limited because they differ for each population and require more data that are unlikely to be available outside of a managed care plan.

Recruitment of Individuals

The efficient identification, recruitment, and retention of a large number of individuals who drive adverse outcomes are particularly important when the goal is to impact population outcomes. Although the challenges of participant recruitment and retention are not unique to public health projects, they can dramatically limit a project’s ability to achieve a population-level impact. Individuals and groups who are high priority from a public health perspective may be the least able to participate in interventions.

Schools and daycare centers were logical partners for CAACP sites because they offered access to a large proportion of a community’s children and had an interest in reducing absences caused by poorly controlled asthma. Three sites—Oakland, Northern Manhattan, and Chicago—used questionnaire-based case identification of students with asthma in the schools as the primary method of identifying and recruiting students for interventions. Those sites also used the frequency of self-reported symptoms as a means of prioritizing students for interventions of high intensity and cost. Oakland was successful at engaging 76% of all students identified with asthma. In the Northern Manhattan site, 35% of parents of children identified with asthma participated in at least 1 asthma education activity offered by the daycare center.

Hospitals are potential venues for identifying and educating large numbers of patients with uncontrolled asthma,² as patients can be easily enrolled in an intervention while in the hospital without the traditional barriers of time and transportation.^{35,36} While the Oakland CAACP site found this to be an effective way to reach children with asthma, other sites with smaller hospital inpatient services found staffing such activities difficult.

Many health plans, which enroll large numbers of individuals in a community, have an interest in reducing costs and improving performance measures. Health plans generally have data that can be used to identify high-risk members or evaluate interventions.^{37–39} Some health plans referred children to CAACP services. Other CAACP site recruitment methods included referrals by medical providers (Chicago),

distribution of flyers advertising classes (Philadelphia), partnerships with social service agencies (Richmond and St Louis), outreach to parents of children in daycare (Northern Manhattan and Richmond), and door-to-door solicitation (Minneapolis/St. Paul).

Targeting Communities to Address Population Disparities

The reduction in disparities in disease burden among racial, ethnic, or other minority groups is an important public health goal, and one that requires focusing resources on certain populations and communities. Although all CAACP sites were selected because their populations suffered a high, disparate burden of asthma, they received no direction about addressing disparities within the sites. Many of the children with asthma in those communities were considered to have a disparate burden of asthma because of low socioeconomic status, unstable living situations, disorganized families, limited access to care, poor housing conditions, or some combination of these social determinants of health.

Social, economic, and psychological factors are important determinants of whether an individual will benefit from an intervention.⁴⁰ Individuals in challenging circumstances may have unique incentives or disincentives that affect behavior. For example, families enrolled in Medicaid may have a low threshold for ED use, which requires no appointment and whose cost is negligible to families. These phenomena may be a reason that so many patients present to the ED with mild symptoms.⁴¹

All CAACP sites offered referrals to address substance abuse, psychiatric, housing, and financial problems to the extent that those services were available locally, but varied in their efforts to actively address these social determinants of health. The Richmond site was most proactive in partnering with a local agency to provide a range of social services as well as asthma education and case coordination for children “who had failed every other intervention.” Similarly, the St. Louis site contracted with a social service agency to address families’ socioeconomic priorities to enable the families to also focus on controlling their children’s asthma.

Reaching people and groups who experience health disparities primarily for social and economic reasons often requires labor-intensive, time-consuming, and costly interventions. For this reason, it is important at the beginning of the planning process to reach agreement with funders and other stakeholders that the reduction of health disparities is a priority. Intensive interventions focused on a small group of people may not improve population-level indicators such as hospitalization and ED rates. However, if the priorities are reducing disparities and reaching individuals who could benefit most, interventions that address recidivism and include social services are indicated.

CONCLUSION

Although public health projects aiming to improve population-level outcomes are fundamentally different from projects seeking to improve participant outcomes, little guidance exists for choices necessary for planning and implementing them. Consideration of appropriate population-based outcome measures; the numbers needing to be reached to improve outcome measures; the choice and mix of interventions; and priorities in targeting and methods of recruiting participants, as well as decreasing disparities, all need to be addressed explicitly during the planning phase. The CAACP sites did not uniformly address these issues at the outset but would probably have benefited if they had. The authors hope that future research

will provide additional guidance on implementing projects attempting to reduce the burden of asthma at a population level.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge Jeanne Moorman, survey statistician with the Centers for Disease Control and Prevention, for her assistance with the calculations in the section on scaling intervention, and for providing Tables 1 and 2. This project was supported through a cooperative agreement with the Centers for Disease Control and Prevention, US Department of Health and Human Services, under program announcement 03030.

DISCLAIMER

The findings and conclusions in this manuscript are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

REFERENCES

1. Moorman JE, Rudd RA, Johnson CA, et al. National surveillance for asthma—United States, 1980–2004. *MMWR Surveill Summ.* 2007; 56: 1–54.
2. National Heart Lung and Blood Institute. *Expert Panel Report 3 (EPR 3): guidelines for the diagnosis and management of asthma.* Bethesda: National Institutes of Health; 2007.
3. Coffman JM, Cabana MD, Halpin HA, Yelin EH. Effects of asthma education on children's use of acute care services: meta-analysis. *Pediatrics.* 2008;121:575–86. <http://www.pediatrics.org/cgi/content/full/121/3/575>. Accessed March 4, 2008.
4. McNairn J, Ramos C, Portnoy J. Outcome measures for asthma disease management. *Curr Opin Allergy Clin Immunol.* 2007; 7: 231–5.
5. Glasgow R, Vogt T, Boles S. Evaluating the public health impact of health promotion interventions: the RE-AIM Framework. *Am J Public Health.* 1999; 89(9): 1322–7.
6. Institute of Medicine. *The future of public health.* Washington: National Academy Press; 1988.
7. Centers for Disease Control and Prevention. Logic model. <http://www.cdc.gov/eval/resources.htm>. Accessed February 25, 2010.
8. Centers for Disease Control and Prevention. Guide for state health agencies in the development of asthma programs. http://www.cdc.gov/asthma/pdfs/asthma_guide.pdf. Accessed February 25, 2010.
9. Herman E. Conceptual framework of the Controlling Asthma in American Cities Project. *J Urban Health.* 2010; 88 (suppl 1):
10. Centers for Disease Control and Prevention. Adapted from “A Public Health Response to Asthma,” PHTN Satellite Broadcast, Course Materials; 2001 *J Urban Health.* 2010; 88 (suppl 1):
11. Love D, Rudolph B, Shah G. Lessons learned in using hospital discharge data for state and national public health surveillance: implications for Centers for Disease Control and Prevention Tracking Program. *J Pub Health Management Practice.* 2008; 14(6): 533–42.
12. Davis S, Krishnan J, Lee K, et al. Effect of a community-wide asthma intervention on appropriate use of inhaled corticosteroids.
13. Centers for Disease Control and Prevention. Behavioral risk factor surveillance system. <http://www.cdc.gov/asthma/survey/brfss.html>. Accessed January 30, 2010.
14. Arias E, Anderson RN, Kung H, Murphy SL, Kochanek KD. Deaths: final data 2001. *Natl Vital Stat Rep.* 2003; 52(3): 111.

15. Johnston SL, Pattemore PK, Sanderson G, et al. The relationship between upper respiratory infections and hospital admissions for asthma: a time-trend analysis. *Am J Respir Crit Care Med*. 1996; 154: 654–60.
16. US Census Bureau. Population profile of the United States: dynamic version. Geographic mobility between 2004 and 2005. <http://www.census.gov/population/www/pop-profile/files/dynamic/Mobility.pdf>. Accessed February 25, 2010
17. Davis A, Kreutzer R, Lipsett M, et al. Asthma prevalence in Hispanic and Asian American ethnic subgroups: results from the California Healthy Kids Survey. *Pediatrics*. 2006; 118: 363–70.
18. Cohen L, Swift S. The spectrum of prevention: developing a comprehensive approach to injury prevention. *Inj Prev*. 1999; 5: 203–7.
19. Mathiowetz NA, Dipko SM. A comparison of response error by adolescents and adults: findings from a health care study. *Med Care*. 2000; 38: 374–82.
20. Tinkelman D, Wilson S. Asthma disease management: regression to the mean or better? *Am J Manag Care*. 2004; 10(12): 948–54.
21. Wang S, Moss JR, Hiller JE. Applicability and transferability of interventions in evidence-based public health. *Health Promot Int*. 2006; 21: 76–83.
22. Sorensen G, Emmons KM, Dobson AJ. The implications of the results of community intervention trials. *Annu Rev Public Health*. 1998; 19: 379–416.
23. Starfield B. Quality of care research: internal elegance and external relevance [commentary]. *JAMA*. 1998; 208: 1006–8.
24. Cheadle A, Beery W, Greenwald H, et al. Evaluating the California Wellness Foundation's Health Improvement Initiative: a logic model approach. *Health Promot Pract*. 2003; 4(2): 146–56.
25. Berry T, Prosser T, Wilson K, Castro M. Asthma friendly pharmacies: a model to improve communication and collaboration among pharmacists, patients, and health care providers. APHA Scientific Session and Event Listing
26. Glasgow RE, Hollis JF, McRae SG, Lando HA, LaChance P. Providing an integrated program of low intensity tobacco cessation services in a health maintenance organization. *Health Educ Res*. 1991; 6(1): 87–99.
27. Vogt TM, Hollis JF, Lichtenstein E, et al. The medical care system and prevention: the need for a new paradigm. *HMO Pract*. 1998; 12: 6–14.
28. Holgate S. *Difficult asthma: the unanswered questions*. London: Martin Dunitz Ltd; 1999.
29. Centers for Disease Control and Prevention. Asthma hospitalizations and readmissions among children and young adults—Wisconsin 1991–1995. *MMWR*. 1997; 46(31): 726–9.
30. Smith DH, Malone DC, Lawson KA, et al. A national estimate of the economic costs of asthma. *Am J Respir Crit Care Med*. 1997; 156: 787–93.
31. Li D, German D, Lulla S, et al. Prospective study of hospitalization for asthma: a preliminary risk factor model. *Am J Respir Crit Care Med*. 1995; 151: 647–55.
32. Vollmer WM, Markson LE, O'Connor E, Frazier EA, Berger M, Buist AS. Association of asthma control with health care utilization: a prospective evaluation. *Am J Respir Crit Care Med*. 2002; 165: 195–9.
33. Magid DJ, Houry D, Ellis J, Lyons E, Rumsfeld JS. Health-related quality of life predicts emergency department utilization for patients with asthma. *Ann Emerg Med*. 2004; 43: 551–7.
34. Eisner MD, Ackerson LM, Chi F, et al. Health-related quality of life and future health care utilization for asthma. *Ann Allergy Asthma Immunol*. 2002; 89: 46–55.
35. Teach SJ, Crain EF, Quint DM, Hylan MI, Joseph JG. Improved asthma outcomes in a high-morbidity pediatric population: results of an emergency department-based randomized clinical trial. *Arch Pediatr Adolesc Med*. 2006; 160: 535–41.

36. Castro M, Zimmerman NA, Crocker S, Bradley J, Leven C, Schechtman KB. Asthma intervention program prevents readmissions in high healthcare utilizers. *Am J Respir Crit Care Med*. 2003; 168: 1095–9.
37. Kantor A. Breathing easier. *AHIP Cover*. 2007; 48: 50–2. 54,56.
38. US Environmental Protection Agency. *2008 National Asthma Forum Change Package: the system for delivering high quality asthma care*. Washington: US Environmental Protection Agency; 2008.
39. Hoppin P, Jacobs M, Stillman L. *Investing in best practices for asthma: a business case for education and environmental interventions*. Dorchester: New England Asthma Regional Council; 2007.
40. Weil CM, Wade SL, Bauman LJ, Lynn H, Mitchell H, Lavigne J. The relationship between psychosocial factors and asthma morbidity in inner-city children with asthma. *Pediatrics*. 1999; 104(6): 1274–80.
41. Macias CG, Caviness AC, Sockrider M, et al. The effect of acute and chronic asthma severity on pediatric emergency department utilization. *Pediatrics*. 2006; 117(4 Pt 2): S86–95.