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# **Guide to Analyzing the Cost-Effectiveness of Community Public Health Prevention Approaches**

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# 1. INTRODUCTION

This guide provides practical advice to help program managers and evaluators understand, design, and perform cost-effectiveness (CE) evaluations of community public health prevention programs. Each chapter of the guide provides advice for addressing specific components of a CE analysis. For example, Chapter 2 describes the planning process for CE analysis and decisions about study design that must be made up front—prior to collecting or analyzing cost or effectiveness data. Chapter 3 discusses issues that need to be considered when selecting from among possible outcome measures for the prevention program. Chapter 4 contains advice and tools for measuring program costs. Chapter 5 contains instructions for performing a CE analysis and provides examples, and Chapter 6 answers the question of how results from CE studies can be used by decision makers.

Throughout the guide, we have attempted to provide easy-to-follow instructions, advice, and relevant examples to lead community program managers and evaluators through the design and implementation of CE analysis. In the interest of brevity, the guide focuses on common concerns about how best to design and perform CE analysis in a community prevention setting that focuses on health promotion. For a more complete treatment of issues surrounding CE analysis and related economic studies (e.g., cost-benefit, business case analysis) in both clinical and community settings, we encourage readers to consult one of the many texts available on economic evaluation as applied to public health or health care. A list of such texts is provided in Appendix A. These texts are geared primarily toward researchers and provide additional methodological details for conducting economic evaluations of clinical or community prevention efforts. Examples of CE studies from the literature are summarized in Appendix B.

## 1.1 Background

Disease prevention and health promotion have been increasingly emphasized as two of the most important goals of public health. In 2002, President Bush announced the HealthierUS Initiative, which identifies four key objectives for Americans: increase physical activity, promote responsible diet, increase use of preventive health screenings, and make healthy choices concerning smoking and alcohol. The U.S. Department of Health and Human Services' Steps to a HealthierUS Initiative (Steps) provides additional support for disease prevention and health promotion activities by working with community programs to reduce the burden of chronic disease. The community-level prevention approaches that have been implemented vary, but most are based on the socioecological framework of behavior change. They attempt to encourage healthy lifestyle choices by intervening directly with individuals or indirectly through multilevel social and environmental factors (e.g., interpersonal, organizational, community, and public policy) that influence individuals' ability to make healthy lifestyle choices (McLeroy et al., 1988).

Careful evaluations of the different programs are needed to aid decision making about which prevention interventions to promote in a particular community. Decision makers need answers to questions such as the following: (1) Does the program work? Does it have the desired impact on risk behaviors or health? (2) Is the program the best use of scarce resources? The main contribution of CE analysis is in addressing the second of these questions. However, it can also shed light on the real-world impact of interventions and programs.

CE analysis quantifies program costs in dollars. Program outcomes are quantified in nonmonetary units, such as increased minutes of exercise, reduced number of cigarettes smoked, life years gained, or even quality-adjusted life years (QALYs) gained. CE analysis can be used to estimate the cost-effectiveness of a single program as compared with the alternative of “no program” or to compare the cost-effectiveness of several different possible prevention programs—those designed to achieve both similar and disparate outcomes. For example, a CE study of a single prevention program as compared with the alternative of no program might tell us that the program costs \$1,000 for each additional 30 minutes of physical activity achieved. Similarly, a CE study of two alternative approaches for increasing physical activity might indicate that Program A costs \$50 for each 30 minutes of physical activity achieved, while the mutually exclusive Program B costs \$1,000 to achieve the same outcome. Such information is useful to decision makers when trying to decide whether to fund a specific community prevention approach and how much of several alternative prevention approaches to support. Results from CE analysis are also useful to community program managers for deciding whether to use additional resources to expand an existing program or to change intervention approaches and implement an alternative prevention strategy.

## **1.2 How Should This Guide Be Used?**

This guide is intended for use by the managers and evaluators of community prevention programs to assist with assessing program costs and cost-effectiveness. It focuses on the questions and issues that need to be addressed to evaluate a program’s cost-effectiveness.

We strongly recommend that CE analysis be planned as a single component in a much broader strategy for program evaluation. The overall evaluation strategy for a program should first involve assessing whether the program meets specific process goals, such as determining whether the program is providing the services it was intended to provide at the appropriate level and intensity. This is sometimes referred to as “implementation fidelity” (see, e.g., Rychetnik et al., 2002). The overall evaluation should also involve a strategy for evaluating the broader public health impact (see Chapter 3). For example, it is important to evaluate program inputs, such as participation, as well as program outcomes, to understand the likely public health impact of a program. Other evaluation techniques, such as RE-AIM (Reach, Efficacy/Effectiveness, Adoption, Implementation, and Maintenance) and the

Centers for Disease Control and Prevention's (CDC's) "Framework for Program Evaluation in Public Health" (CDC, 1999; see Appendix A for a list of resources), that take into account the program's reach into the community and other factors may be more appropriate for a broader evaluation. CE analysis is best for summarizing the value of a program (cost per unit of benefit) so that a decision maker can assess whether the program's benefits are worthwhile in light of its costs. This guide was written to provide instructions, advice, and examples to help community public health prevention program managers and evaluators conduct CE studies. Instructions and advice for performing other types of economic evaluations are available in Haddix, Teutsch, and Corso (2003) and Drummond et al. (1997).

We recommend using the guide early in the planning process for CE analysis to help identify the specific questions you would like to answer about the value of your program and determine what information is needed to answer those questions. In particular, we recommend that you review Chapter 2 and related resources on study design as you are beginning to plan a CE study. Similarly, Chapter 6 answers questions about how results from CE analysis are used in decision making that may be useful to consider during the planning phase of a CE study. You may choose to read the guide in its entirety before getting started on CE analysis or consult relevant chapters as needed to guide cost and cost-effectiveness data collection, analysis, and interpretation.

CE studies can provide information that is useful for decision making by program managers and policy makers at local, state, and national levels. However, results from CE studies should be considered in combination with other factors, such as the feasibility and desirability of intervening within a specific population, to help inform policy decisions about which prevention strategies to adopt. It is our hope that this guide will serve as a starting point for community program managers or evaluators who are interested in incorporating CE analysis into an overall strategy for health prevention program evaluation.



## 2. PLANNING FOR A COST-EFFECTIVENESS STUDY

The first and possibly the most important step in performing a cost-effectiveness (CE) study is to ask and answer a few questions that will help to identify data needs—both amount and type—and the most appropriate methods for analysis. Clearly defining the questions to be addressed and the expected outcomes of economic studies during the planning process can help minimize problems with data collection or analysis during study implementation.<sup>1</sup>

The following key questions should be asked and answered prior to implementing a CE study:

1. What question(s) do you want to answer?
2. What study perspective is of interest to you and your stakeholders?
3. What is the intervention of interest? What is it intended to do?
4. What is the relevant time frame for the intervention approach? What is the relevant period for analyzing intervention outcomes?
5. Which type of economic study should be performed (e.g., cost-effectiveness, cost-benefit, business case)?

In the subsections that follow, we discuss issues that should be considered when answering these questions and provide examples, and in some cases suggestions, of how the questions may be answered. A checklist is provided at the end of the chapter to help guide decision making in the planning stages of a CE study.

### 2.1 Defining the Study Question(s)

An important first step in preparing to conduct any study—economic or noneconomic—is to clearly define the question(s) that the study is intended to answer. Doing so requires careful consideration of who will be using the study results and what kinds of decisions will be made based on those results. Defining the study question is a critical first step because subsequent decisions about which intervention approaches to consider, the costs and outcomes to include, and the analysis methods to apply will differ depending on which question(s) you wish to answer. Possible study questions and examples that may be of interest to managers and evaluators of community prevention programs and their stakeholders are shown in Table 2-1.

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<sup>1</sup>This section draws heavily from the chapter on study design in Haddix, Teutsch, and Corso (2003). We recommend that readers consult their more comprehensive treatment to answer additional questions about how to design an economic evaluation of a prevention program.

**Table 2-1. Possible Cost-Effectiveness Study Questions**

Question	Examples	Stakeholders
What is the cost-effectiveness of a newly implemented prevention strategy as compared with doing nothing new?	<ul style="list-style-type: none"> <li>▪ What is the cost-effectiveness of a media campaign to prevent smoking?</li> <li>▪ What is the cost-effectiveness of a school-based intervention to improve asthma management in children?</li> </ul>	Program managers/ evaluators
Would a more intense prevention approach be cost-effective compared with the current approach?	<ul style="list-style-type: none"> <li>▪ What is the cost-effectiveness of adding one-on-one counseling and intervention sessions to a screening program that identifies women at high risk for cardiovascular health problems (i.e., compared with the baseline screening program)?</li> <li>▪ What is the cost-effectiveness of increasing the frequency of cooking classes from once a month to bi-monthly?</li> </ul>	Program managers/ evaluators
What is the cost-effectiveness of prevention strategy A as compared to one or more alternative approaches for achieving the same outcome?	<ul style="list-style-type: none"> <li>▪ What is the cost-effectiveness of a community-wide media campaign to reduce youth smoking as compared with a school-based classroom intervention designed to reduce youth smoking?</li> <li>▪ What is the cost-effectiveness of a weekly weight loss program as compared to a worksite financial incentive for weight loss?</li> </ul>	Program managers/ evaluators Policy makers
What is the cost-effectiveness of prevention strategy A as compared to alternative strategies for achieving different behavioral or health outcomes?	<ul style="list-style-type: none"> <li>▪ What is the cost-effectiveness of a school-based asthma management intervention as compared with a school-based smoking prevention intervention?</li> <li>▪ What is the cost-effectiveness of a school-based smoking prevention intervention as compared with a cardiovascular health screening program for low-income women?</li> </ul>	Policy makers

Although the questions in Table 2-1 are merely examples of the types that could be addressed through economic analysis, they help to illustrate the notion that different audiences may be interested in answers to different questions. The first two questions, which focus on a single program’s value—both compared with doing nothing new and compared with a specified program expansion—provide answers that are likely to be of interest primarily to managers or prospective managers of the evaluated programs. The answers to those questions can help managers decide whether they believe a particular program or program expansion is worth the investment. Policy makers may also be

interested in the value of implementing a specific intervention, but their primary focus is on selecting from among possible prevention strategies to support.

Consequently, the last two questions in Table 2-1, which involve comparisons across different types of programs, are likely to be of interest to decision makers in determining how to allocate scarce public health resources across possible prevention strategies. Information from these studies could be used to help guide decisions at the community, state, or national level about which programs or combinations of programs might achieve public health objectives for a given level of investment (Partnership for Prevention, 2001).

When defining the two or three key study questions for economic evaluation, it is important to consider how you expect the results to be used—both by whom and for what purpose. It is also important to have a clear understanding of the intervention, its target population, and its intended effects. By addressing these issues early in the process, decisions can easily be made about what types of data need to be collected and analyzed to provide the desired information to program stakeholders.

## 2.2 Identifying the Study Perspective(s)

The study perspective refers to the viewpoint the study will take to quantify costs and outcomes. In other words, will the study take the point of view of

- the health care system,
- the school or community service provider,
- the program participant,
- society as a whole, or
- some other stakeholder?

Identifying the study perspective is an important early step because it dictates the types of costs and outcomes that must be quantified and included in the CE study. Once the study perspective is chosen, it is helpful to list the intervention program costs that should be considered in the analysis. For example, if the community service provider perspective is chosen, then only those program costs paid for by the community provider, such as salaries and building space costs, will be included in the analysis. Other costs, such as the value of participants' time spent traveling to and attending counseling sessions, will not be captured.

The societal perspective captures the value of all resources used for an intervention, even if no actual payment is made for some of those resources. Economists describe this as an approach based on opportunity costs, where opportunity costs represent the value of a good or service in its next best use. For example, the opportunity cost of an hour of volunteer work is the wage payment that could be earned if the hour were spent working for paid wages. Similarly, the opportunity cost of participating in a prevention program is the value of a participant's time spent in leisure (what the participant would be doing if not

participating in the prevention program), which is typically valued using hourly wage rates. By valuing volunteered goods and services at their opportunity cost, decision makers get a more complete understanding of the level of resources needed to replicate the prevention program. If these costs are ignored, a program may appear to be relatively inexpensive simply because it relies heavily on volunteers.

Because it captures the full value of all opportunity costs associated with a prevention program, which makes it easier to compare results across studies, the societal perspective is the recommended standard for CE analysis (Gold et al., 1996). However, the societal perspective may be difficult to implement because of its comprehensiveness and because it may require assigning costs to resources that are not bought or sold.

When deciding on the perspective(s) of a CE analysis, it is important to consider the interests of program stakeholders. For example, if you are evaluating a worksite weight management program, the employer's perspective is likely to be important. If the evaluation focuses on a school-based asthma management program, then it may be important to consider the perspective of a particular school or school district or even the parents of students. In general, all stakeholders who sponsor or use a prevention program will be interested in the costs and outcomes that are unique to their perspectives. Further, stakeholder decisions about continued or additional funding for the prevention activity are likely to be influenced at least in part by results from CE analysis.

Both the narrow stakeholder and the broader societal perspectives are useful. If results are intended for use in policy decisions (e.g., determining which prevention programs to support), the analysis should be done from a societal perspective to allow for comparisons of cost-effectiveness across alternative programs. If you use the societal perspective but are unable to include all opportunity costs related to the prevention program, be sure to state clearly which costs are included and which costs are not. For example, when evaluating a prevention program, it may not be possible to capture and value participants' time spent in the targeted prevention activities. Regardless, a list of which costs were included and which were excluded should be provided in the study report.

## **2.3 Determining the Time Frame and Analytic Time Period**

### ***2.3.1 Understand the Intervention***

Before choosing the intervention time frame and analytic time period, it is important to have a clear understanding of the intervention and what it is intended to do. Chapter 3 provides detailed guidance on developing a logic model to depict the inputs and expected outcomes of the interventions being evaluated.



### 2.3.2 Intervention Time Frame

The next step in developing a plan for performing a CE study is to determine the relevant time frame for the intervention strategies of interest. In other words, a decision needs to be made about the length of time over which intervention costs and outcomes (generally short-term) need to be collected. Although selecting the intervention time frame is straightforward for programs that involve one-on-one contact with participants over the course of 6 months or a year, determining the time frame for a media campaign or policy change (e.g., adding walking trails) is more difficult. The following are examples of interventions with easily defined time frames:

- A one-on-one nutrition counseling program with women at high risk for cardiovascular disease that lasts for 12 sessions (i.e., one year)
- A worksite financial incentives program that tracks and rewards employees' weight loss over 1 year
- A school-based physical activity program that enrolls students for a period of 3 months

For many other types of prevention approaches, it may be challenging to define the beginning or end of the program. The following are examples of these types of intervention strategies:

- A policy change to eliminate soda vending machines from high schools
- An ongoing educational campaign to increase physical activity among adults aged 65 and older

Evaluations of these types of programs must decide on a time frame for the intervention that is long enough to cover program start-up and full program implementation (i.e., beyond the initial surge in behavioral changes in response to a new program). The intervention time frame is wholly dependent on the nature of the prevention strategy to be evaluated and must be determined using the best judgment of the program managers, working together with program evaluators. Haddix, Teutsch, and Corso (2003) recommend that program evaluations use a time frame that is long enough to account for

- seasonal variations in costs or outcomes,
- program start-up and ongoing costs, and
- achievement of a relatively stable outcome.

For example, in considering the policy change to eliminate soda vending machines from high schools, one semester may be long enough to account for seasonal variations in soda consumption and for full implementation of the policy. But program evaluators may decide that the intervention needs to be in place for one or more school years before a relatively stable new level of soda consumption and overall caloric intake is realized among high school students. In other words, it is possible that the removal of soda machines will have a

large initial impact on reducing soda consumption but that, over time, soda consumption may increase again as students respond to the loss of soda access by, for example, consuming sodas brought from home. Defining the intervention's time period as one semester might cause the evaluator to overestimate the impact of the policy on students' soda consumption or caloric intake.

### ***2.3.3 Analysis Time Period***

Another question that must be addressed when preparing to conduct a CE study is the time period for analysis of program costs and benefits, or the analytic horizon. The analytic horizon often differs from the time period for the intervention because many of the benefits of prevention activities are expected to be realized in the future, long after data on prevention program costs and outcomes are collected and valued. These future benefits are typically estimated by modeling expected changes in health outcomes, given the actual changes in behaviors resulting from the prevention effort. For example, although a worksite program that offers financial incentives for weight loss might last for only 1 year, the expected benefits of weight loss, especially sustained weight loss, in terms of reduced cardiovascular risks, may not be realized until decades into the future. In general, the analytic horizon should be extended as far into the future as necessary to capture all important costs, harms, and benefits of the prevention strategy (Haddix, Teutsch, and Corso, 2003).

From a practical standpoint, however, the analytic horizon may be limited by the amount and quality of data available to model future benefits. If data are lacking on the relationship between current weight loss and the future risk of coronary heart disease, for example, then it may not be possible to extend the analytic horizon to capture all possible future benefits and costs. In this case, the analytic horizon should be extended as far into the future as data will allow.

### ***2.3.4 Discounting***

The notion of discounting takes into account the fact that money available for spending today is worth more than the same amount of money available for spending years into the future. For example, few people would save \$100 today to yield a return of only \$100 in 10 years. However, most people would be willing to save some smaller amount (say \$80) to yield a \$100 return at a future date.

Discounting is another element of a CE study that should be addressed up front. When discounting is applied in an economic analysis, it addresses the concern that benefits or costs that will be realized 10 or 20 years from now have less current value than the same level of benefits realized today. Because some prevention approaches may yield benefits in the near future (e.g., asthma management programs), whereas others are more likely to produce benefits over a long-term horizon (e.g., physical activity programs), discounting

should be used in economic studies to convert all future benefits and costs to their present value.

Most health economists agree that a discount rate of 3% should be used to calculate the present value of costs and benefits (Gold et al., 1996). To illustrate the impact of discounting future costs and benefits, consider the following example:

- A prevention program to reduce smoking produces medical benefits of \$5,000 in 30 years. Assuming a 3% annual discount rate, the present value of program benefits is \$2,005.

Discounting future costs and benefits works in the same way as calculating compound interest on a savings account. Just as small differences in interest rates can have a large impact on compounded savings over time (or on monthly mortgage payments), so too can changes in discount rates. This is especially true for programs where the majority of costs are realized in early years and are discounted only slightly, while the majority of benefits are realized in later years and are discounted heavily. In the example above, a 0% discount rate would generate present value benefits of \$5,000; a 3% discount rate would generate present value benefits of \$2,005; and a 5% discount rate would generate present value benefits of \$1,073. Because of these differences, it is important to use the same discount rate when comparing the present value of costs and benefits across prevention programs. Following current conventions, a discount rate of 3% should be applied to future costs and benefits, but other discount rates may also be used to enable comparisons with older studies that may have used discount rates of 5% or higher (Corso and Haddix, 2003).

## **2.4 Selecting the Type of Economic Study to Conduct**

Once the key study questions have been defined, a decision about the type(s) of economic study that can best answer the questions must be made. The most common approaches for evaluating health-related prevention programs are cost analysis, cost-effectiveness analysis (CEA), and cost-benefit analysis (CBA).<sup>2</sup>

### **2.4.1 Cost Analysis**

Cost analysis studies identify the personnel and other resources used to deliver prevention services and calculate the monetary value of those resources to various stakeholders, such as society as a whole, community providers, or government funding agencies. These studies provide information about the start-up and implementation costs of a prevention program—useful information to program managers who may be considering whether to implement a specific prevention approach. Cost studies also allow program managers to address questions about the program resources (usually personnel) that contribute the most to

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<sup>2</sup>A careful discussion of these alternative approaches as applied to alcohol treatment services is available in Bray and Zarkin (2005). Partnership for Prevention (2001) also provides a clear general overview that is intended for a policy audience.

overall costs. Answers to these questions can be useful for considering alternative resource mixtures to limit program costs.

### **2.4.2 Cost-Effectiveness Analysis**

CEA goes a step beyond cost analysis by comparing both the costs and effectiveness of two or more prevention strategies (one of which may be a “no program” baseline). Results from CEA allow program managers to answer questions about whether a particular program produces outcomes that are worth the program investment (i.e., is cost-effective) or which of several related programs is the most cost-effective. In CEA, the effectiveness of a program is measured in terms of health or behavioral outcomes. For example, a worksite-based influenza immunization program might measure program effectiveness in terms of “cases of influenza averted” or “number of employees vaccinated.” To facilitate comparisons of cost-effectiveness across prevention programs, even those designed to achieve different health outcomes, some CE studies convert health outcomes to a common measure. Life-years saved and quality-adjusted life years (QALYs) gained are two examples. QALYs are a useful measure for programs that primarily reduce morbidity rather than extend life. Some reference materials refer to CEAs that use QALYs as a cost-utility analysis.

### **2.4.3 Cost-Benefit Analysis**

CBA values the outcomes of prevention programs in dollar terms, allowing costs to be weighed against benefits for programs with many different types of outcomes. CBA may be the most appropriate form of analysis if a program has significant nonhealth or intangible benefits. For example, the construction of a bike path may have measurable long-term impacts on health, but it may also affect housing values along the path. A specific type of CBA is cost offset analysis, which compares the cost of prevention to reductions in health care and related costs resulting from the prevention program.<sup>3</sup> The idea is that the cost of prevention is offset by savings in future disease costs.

When deciding from among alternative methods for comparing costs and benefits, you should also be aware that CBA is somewhat controversial because it assigns a dollar value to all health outcomes, including life. Placing a dollar value on a healthier or longer life is difficult, and the different methods for doing so all have certain limitations.<sup>4</sup>

### **2.4.4 Cost-Effectiveness Analysis and Using This Guide**

This guide focuses on CEA. If you have decided that CEA is the appropriate tool for answering your study questions, you may consult this guide to address questions about how

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<sup>3</sup>Note that some references categorize cost offset studies as a cost analysis (see, e.g., Partnership for Prevention, 2001). However, because they involve a comparison of prevention program costs to benefits valued in dollar terms (or cost savings), they can be categorized as a CBA.

<sup>4</sup>For additional information on CBA as applied to health preventions and treatments, see Haddix, Teutsch, and Corso (2003) and Drummond et al. (1997). A detailed theoretical and practical treatment of how to value longevity and health can be found in Freeman (1993).

to select appropriate outcome measures that can be used in CEA (Chapter 3), how to measure program costs (Chapter 4), and how to combine information on program costs and outcomes to answer questions about cost-effectiveness (Chapter 5).

## 2.5 Checklist for Cost-Effectiveness Analysis

The checklist in Table 2-2 summarizes several of the issues discussed in this chapter that should be addressed before proceeding with data collection and analysis. This checklist may help guide your CE study planning.

**Table 2-2. Checklist for Planning a Cost-Effectiveness Study<sup>a</sup>**

Decision	Check When Complete
1. Define the study question(s)	<input type="checkbox"/>
2. Decide who will use study results and how	<input type="checkbox"/>
3. Determine which prevention approaches to evaluate and model the inputs and intended outcomes of each	<input type="checkbox"/>
4. Identify the perspectives (societal is recommended, <sup>b</sup> but other stakeholder perspectives may also be useful)	<input type="checkbox"/>
5. Prepare initial list of program costs to be collected	<input type="checkbox"/>
6. Select possible health and risk behavioral outcome(s)	<input type="checkbox"/>
7. Determine intervention time frame	<input type="checkbox"/>
8. Decide on analysis time period	<input type="checkbox"/>
9. Select discount rate (3% is recommended)	<input type="checkbox"/>
10. Choose type of economic study	<input type="checkbox"/>

<sup>a</sup>Modified from Haddix, Teutsch, and Corso (2003), page 26.

<sup>b</sup>Gold et al., 1996.



### **3. MEASURING THE OUTCOMES OF COMMUNITY PUBLIC HEALTH PREVENTION APPROACHES**

This chapter focuses on issues that need to be considered when selecting outcome measures for use in evaluations of community public health prevention programs.<sup>5</sup> Although we offer guidance for selecting from among several possible measures of program effectiveness, additional resources should be consulted when preparing to implement a full-scale outcome evaluation (see Appendix C for examples). Advice for selecting outcome measures specifically for use in cost-effectiveness analysis (CEA) is given in Chapter 5.

In Section 3.1, we briefly describe several recent and ongoing community prevention programs that seek to (1) prevent or manage chronic disease or (2) change the behavioral risk factors that contribute to chronic disease. The programs we describe focus on asthma, diabetes, or overweight and obesity, or they target risk factors, such as poor nutrition, physical inactivity, and tobacco use. For each program described, we provide examples of the outcome measures used in program evaluation.

In Section 3.2, we provide guidance for selecting outcome measures for use in evaluations of the effectiveness of health promotion and disease prevention programs. In Section 3.3, we demonstrate the process of selecting outcome measures by working through an example that focuses on the American Legacy Foundation's truth<sup>®</sup> campaign.

#### **3.1. Overview of Major Disease Prevention and Health Promotion Programs**

In this section, we summarize several programs that have been implemented at local, state, or national levels to prevent disease or eliminate the risk factors leading to disease. We also provide examples of the outcome measures being used to evaluate whether these programs are working. Because the programs target a variety of diseases or risk factors and several different population subgroups (e.g., school-aged children, 40- to 64-year-old low-income women), the outcome measures used to evaluate these programs also vary a great deal. Some evaluations focus on changes in program participants' attitudes and beliefs that can be observed in the short-term, whereas others focus on intermediate changes in laws/policies or in individual behavior. Still others may focus on long-term changes in health. The programs are also evaluated using data from a variety of sources, such as surveys of program participants or national and local surveillance data.

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<sup>5</sup>The approaches described in this chapter are meant to apply equally to community-based and community-placed programs. Community-based programs are identified, developed, and evaluated in partnership with community members and key stakeholders; community-placed programs are typically initiated by an external agent who defines community needs and often evaluates program performance.

### **3.1.1 Steps to a HealthierUS (Steps)**

Steps aims to reduce the incidence of chronic disease and related risk factors by promoting healthy behaviors, such as nutrition and physical activity, while attempting to reduce unhealthy behaviors, such as tobacco use. The primary initiative is to encourage Americans to engage in small behavior changes. The cumulative impact of such small changes, or steps, is expected to ease the burden of chronic disease. For example, it has been estimated that reducing net caloric intake by about 100 calories per day could significantly reduce the burden associated with the obesity epidemic (Hill et al., 2004). Below, we provide examples of specific objectives of the Steps program as they relate to each disease or risk behavior targeted by the program. We also provide examples of outcome measures being used by local programs to evaluate the effectiveness of Steps toward achieving program objectives.

#### *Asthma*

- Program objective: Reduce asthma-related hospital emergency department visits among children and adults.
  - Outcome measure: Number of visits to an emergency department with first listed diagnosis of asthma among children and adults aged 5 to 64 years

#### *Diabetes*

- Program objective: Increase the proportion of adults with diabetes who have at least one annual foot examination.
  - Outcome measure: Number of foot exams among people with diabetes in the past year

#### *Overweight and Obesity*

- Program objectives: Increase the proportion of children, adolescents, and adults who are at a healthy weight and reduce the proportion of children, adolescents, and adults who are obese.
  - Outcome measures: Body mass index (BMI) using height and weight measurements and accepted cutoffs for overweight and obesity in children and adults

#### *Nutrition*

- Program objective: Increase the proportion of persons aged 2 and older who consume at least two daily servings of fruit, at least three daily servings of vegetables, and at least six daily servings of grain products.
  - Outcome measure: Amount of these foods eaten during the previous day in grams

#### *Physical Activity*

- Program objective: Increase the proportion of the nation's public and private schools that require daily physical education for all students.



- Outcome measure: Number of minutes of physical education per week required for students attending this school

#### *Tobacco Use*

- Program objective: Increase insurance coverage of evidence-based treatment for nicotine dependency.
- Outcome measures: Numbers and types of cessation interventions covered by health insurance plans (e.g., nicotine replacement therapy, telephone counseling, face-to-face counseling, classes or group meeting, and self-help materials)

### **3.1.2 American Legacy Foundation's truth<sup>®</sup> Campaign**

The truth<sup>®</sup> campaign is a large-scale youth smoking prevention campaign. With its edgy and hard-hitting message delivered through print, radio, the Internet, and television, the campaign aims to inform youth about the tobacco industry and its marketing tactics so that youth are better able to make informed choices about their own tobacco use. The campaign also aims to provide youth with images that convey the message that smoking is not “cool,” in an effort to change attitudes, beliefs, and ultimately behavior toward tobacco use. The following are some outcome measures used to evaluate the effectiveness of the campaign among youth:

- Changes in attitudes about cigarette companies
- Changes in attitudes about smoking
- Number of cigarettes smoked during the past 30 days
- Self-reported expectations about whether the youth will quit smoking or will smoke during the coming year

### **3.1.3 National Cancer Institute's American Stop Smoking Intervention Study (ASSIST)**

ASSIST was designed to aid states in developing effective smoking reduction strategies. The program's goal was to influence policy decisions by altering the social, cultural, economic, and environmental factors that lead to the promotion of smoking. ASSIST was a large-scale intervention involving 17 states. Within those states, a network of state and local coalitions were charged with developing and implementing interventions. Outcome measures included the following:

- Smoking prevalence among adults 18 years and older, as measured by the NCI-sponsored Tobacco Use Supplement to the U.S. Census Bureau's Current Population Survey in 1992–1993 and 1998–1999
- Per capita cigarette consumption, which was assessed every 2 months by calculating the total number of cigarette packs moved from warehouses divided by the state's adult population for each state

- Initial Outcomes Index (IOI), which was used as an indicator of the intensity of each state's tobacco control policies and included the percentage of smokers covered by 100% smoke-free work sites, total cigarette price, and legislative ratings

### ***3.1.4 Well-Integrated Screening and Evaluation for Women Across the Nation (WISEWOMAN)***

WISEWOMAN is administered by the Centers for Disease Control and Prevention's (CDC's) Division of Nutrition and Physical Activity and aims to promote a healthy diet and physical activity for low-income, under- or uninsured women aged 40 to 64 to reduce their risk of cardiovascular and other chronic diseases. WISEWOMAN offers screenings for cardiovascular disease risk factors (i.e., cholesterol, diabetes, blood pressure) and tailored intervention sessions aimed at reducing risk factors. Outcome measures include the following:

- Total cholesterol
- High density lipoprotein (HDL) cholesterol
- Systolic blood pressure
- Diastolic blood pressure
- Diagnosis of diabetes
- Current smoking status
- 10-year risk of coronary heart disease (CHD) estimated via existing CHD risk calculators

### ***3.1.5 National Cancer Institute's Community Intervention Trial for Smoking Cessation (COMMIT)***

COMMIT was a randomized community-based intervention trial designed to increase smoking cessation among smokers, with an emphasis on heavy smokers. It involved 11 matched pairs of communities. It was recognized that, in order to influence heavy smokers to quit smoking, other community-level changes needed to occur. These changes included increasing the priority of smoking as a public health issue, increasing the community capacity to modify smoking behavior, increasing the influence of existing policy and economic factors that discourage smoking within a community, and increasing social norms and values supporting smoking cessation (NCI, 1995). Thus, experimental sites received a multifaceted public health intervention that involved working with physicians and worksites to increase cessation programs and services, as well as using mass media to educate the members of the community about available resources for smoking cessation. Outcome measures included the following:

- Percentage of health care facilities within the community that adopted and effectively implemented smoke-free environment policies
- Number of people reached by health promotion media messages
- Number of heavy smokers with at least one quit attempt

## 3.2 Guidance for Identifying Outcome Measures for Use in Evaluation of Disease Prevention and Health Promotion Programs

In the previous section, we described some of the major efforts at local, state, and national levels to prevent disease and promote health among Americans. Our discussion also provided examples of outcome measures to assess whether the programs are working. Although those examples are helpful for identifying possible outcome measures for evaluating the effectiveness of any community-based prevention program, program managers may also benefit from general guidelines on how to select appropriate measures relevant to their evaluation. This section outlines suggested approaches and discusses several important factors that should be considered and weighed when selecting among alternatives.

### 3.2.1 Modeling Program Goals and Expected Impacts

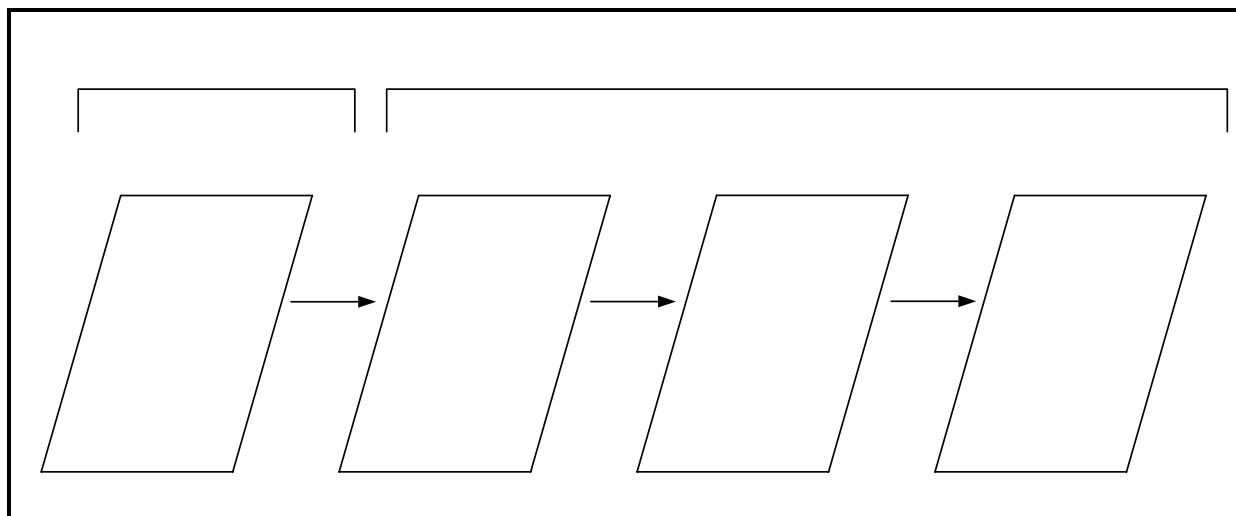
The first step in identifying potential outcome measures for evaluating an intervention program is to carefully think through how the program inputs and any external factors are likely to affect the health outcomes and behaviors that the program seeks to impact. Developing a logic model may be useful for clarifying how the program inputs and external factors are expected to affect the health outcomes of interest. A logic model is a visual representation of the relationship between the primary health outcome (e.g., disease), program inputs, external factors (e.g., risk factors that are not affected by the program), and program outcomes.<sup>6</sup> For further information on developing logic models, see resources from the Kellogg Foundation (2004). As an example, a logic model for the American Legacy Foundation's truth<sup>®</sup> anti-tobacco campaign is provided in Figure 3-1.

The truth<sup>®</sup> campaign, described previously, was a media-based, countermarketing intervention. The box in the far left of Figure 3-1 represents the program inputs, or determinants. It is assumed that the determinants are the active ingredient that will lead to the desired outcome. The desired outcome for truth was a reduction in smoking behavior, represented by the box to the far right. Although not shown in the diagram, the ultimate health outcome targeted by the program is a reduction in cardiovascular disease brought about by reductions in smoking. Notice also that there are two steps between the identified determinants and the ultimate program outcome. These intervening events—awareness of the campaign and changes in beliefs about tobacco use—are also program outcomes because they are assumed to be affected by the program inputs. These types of outcomes are often referred to as short-term and intermediate outcomes, respectively.

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<sup>6</sup>For additional information on logic modeling, see articles about the PRECEDE/PROCEED model (Gielen and McDonald, 1997) and intervention mapping (Bartholomew, Parcel, and Kok, 1998). Both are useful approaches for modeling health behavior change that incorporate the framework of a logic model and hence are excellent starting points for those not familiar with the logic model (Kok et al., 2004). Another highly accessible source on logic modeling is provided by Renger and Titcomb (2002).

**Figure 3-1. Logic Model for the truth<sup>®</sup> Anti-Tobacco Campaign**



One should also consider whether characteristics of the respondent **Inputs** influence the anticipated outcomes. These characteristics, referred to as effect modifiers, systematically influence the magnitude of the selected outcome. In the truth<sup>®</sup> anti-tobacco campaign, for example, age could be considered as a potential effect modifier because older adolescents are more likely to engage in a range of risky behaviors—including smoking—than younger adolescents. To fully appreciate the potential impact of effect modifiers, consider the hypothetical case in which a characteristic divides the population exactly in half (e.g., gender) and the intervention has positive effects of a given size on one group and negative but equal effects on the other group. Without accounting for the different impacts of the intervention across population subgroups, an evaluation would suggest that the intervention is not effective.

When specifying program outputs in a logic model, it is **Media-based anti-tobacco messages** important to consider the relevance of each possible outcome to the goals of the program, the scope of influence of the program, whether a potential outcome could realistically be affected by the program in the time allotted by the evaluation, and whether a possible outcome represents a meaningful change (CDC, 2001).

The logic model highlights a number of important factors that should be considered in identifying possible outcome measures for program evaluation. The logic model helps differentiate between short-term, intermediate-term, and long-term outcomes. Short-term outcomes typically reflect changes that are directly associated with program inputs, such as awareness of the media campaign, including television ads. **Internet Web site** Intermediate-term outcomes typically reflect changes in attitudes or beliefs that result from changes in short-term outcomes. It is reasonable to expect, for example, that a person exposed to information

regarding the benefits of physical activity may acquire improved attitudes and beliefs about physical activity and, thus, be more likely to exercise daily than someone who was not exposed to information regarding the benefits of physical activity. Long-term outcomes often refer to changes in behavior, such as smoking reduction. Long-term outcomes also often include changes in health status, such as changes in the future risk of lung cancer or coronary heart disease brought about by behavioral changes like smoking cessation.

CDC's *Introduction to Program Evaluation for Comprehensive Tobacco Control Programs* (2001) outlines suggested outcome measures to evaluate the effectiveness of programs aimed at reducing tobacco use. CDC stratifies outcomes in the following manner (CDC, 2001):

- Short-term outcomes
  - Increased knowledge and awareness about environmental tobacco smoke (ETS)
  - Increased public support for smoke-free public places, workplaces, and schools
  - Increased public exposure to information about ETS
  - Education of policy makers, legislators, workplace managers and owners, and school officials about the harmful effects of ETS exposure
- Intermediate outcomes
  - Increased percentage of smoke-free homes
  - Increased percentage of smoke-free private cars
  - New legislation restricting or prohibiting smoking in enclosed public places
  - Increased percentage of workplaces with voluntary bans restricting or prohibiting smoking
  - Increased percentage of public places with nonsmoking policies
  - Increased percentage of restaurants with nonsmoking policies
  - Increased adherence to and enforcement of nonsmoking policies
- Long-term outcomes
  - Reduced exposure to ETS and reductions in related health problems

Notice also that the intermediate outcomes can be subclassified into individual-level and policy-level outcomes. Outcomes such as “increased percentage of smoke-free private cars” reflect changes related to individual-level behavior. In contrast, outcomes such as “increased percentage of public places with nonsmoking policies” reflect policy-level changes that are designed to alter the social environment. Changes to the social environment may not be immediately observable in individual behavior but have the capacity for long-term behavior change because they alter exposure to risk and protective factors.

The logic model is also useful for specifying the program inputs, or determinants, and for illustrating the chain of association that links program inputs to anticipated outcomes. When

program determinants are closely related to an outcome (theoretically or temporally), we would expect to observe a larger program impact than when an outcome occurs further down the chain. The longer the chain, the more likely that confounding and third variable effects can influence the measured outcome (Mandelblatt et al., 1996). Confounding variables are those that may affect the outcome of interest but are not targeted for influence by the program. Also, a longer chain may require more assumptions about the linkages between possible program outcomes. For example, if a program provides information to high school students about the benefits of physical activity, we would expect to observe a larger impact of that program on attitudes toward physical activity and on students' activity levels than on health outcomes, which may not materialize until years later. Attitude and behavior changes are more likely to be direct results of the program, whereas changes in health status due to the program would be difficult to measure both because of the many other factors that may affect changes in health status (i.e., genetics, environment, nonactivity-related behaviors) and because of the time lag between the program and its expected impact on health status.

Consideration of the time lag between implementation of a program and its intended effects is particularly relevant when policy-level intermediate outcomes are planned. Often, there will be a lag between initiation of a new health policy and its adoption by targeted individuals who may be unaware of the new policy, may be reluctant to comply with the new policy, or may attempt to circumvent its effects. When this occurs, program effects may be suppressed if evaluation activities are carried out too soon following the implementation of the policy change. Evaluators, in consultation with substantive experts, should determine an appropriate timeline for evaluation based on the likely pattern of uptake among targeted individuals. In this context, an understanding of how diffusion of innovation affects health behavior may be useful (Hubard and Hayashi, 2003). Diffusion theory examines the theoretical and practical aspects of making a behavior change. When such changes require substantial investment of time or resources, diffusion may be slower than when change is simple and requires little of participants.

Finally, the logic model specifies the time frame of the intervention program. Understanding the time frame is useful for identifying possible outcome measures most likely to be affected within the span of intervention and data collection activities (see Section 2.3.1 for details). The observable consequences of some program effects may occur beyond the horizon of intervention activities (e.g., health status in the example provided above), suggesting that these consequences would be more difficult to measure than immediate impacts. Considering the logic model for the truth<sup>®</sup> campaign once again, the long-term outcome (reduced smoking onset) is only likely to occur following the short- and intermediate-term outcomes of message awareness and attitude change. The process of moving through the chain of outcomes will take time. Accordingly, if long-term outcomes are measured too soon

following the introduction of program determinants, important changes in long-term outcomes may be missed.

The logic model provides a clear, visual overview that can be helpful in determining where, when, and to what extent program outcomes can be expected. Additional information on program outcomes can be derived by assessing implementation fidelity. Not generally viewed as a part of the logic model, implementation fidelity, or accountability, can be seen as a potential modifier of program outcomes. One useful method, called “Getting to Outcomes” (Wandersman et al., 2000), provides a systematic approach for assessing the conditions under which a program has been conducted and can help to identify potential misalignments between the program’s logic model and the context in which the program is being implemented. Such misalignment can reduce the effectiveness of an otherwise efficacious program. This can occur, for example, when program developers misread community needs or when community members do not recognize the value of program inputs, leading to underutilization of the prevention program. When issues of program implementation adversely influence program effects, measures of program effectiveness may be reduced.

### ***3.2.2 Sources of Information on Outcome Measures***

In the previous subsection, we described a framework for identifying program outcomes and the extent to which they are likely to be affected by the prevention program. In this section, we discuss approaches for gathering information about possible program outcomes of interest. Although surveying program participants is a common way to collect data on a program’s impact, surveys are limited in terms of the types of outcome data that may reasonably be collected over the course of an intervention program. In fact, most programs have only limited resources for data collection and at best may be able to collect data on changes in attitudes or beliefs among the targeted population. In addition, self-reported information collected from participants about changes in their attitudes or behavior (e.g., smoking or physical activity) may not be reliable. For example, women typically understate weight, while men generally overstate height, both of which lead to underestimates of BMI. To supplement data from surveys of program participants or the targeted group for participation, several additional sources of information are available. These sources of information should be considered when identifying possible outcome measures for evaluating program effectiveness.

#### *Evidence-Based Review*

One way to identify potential outcome measures is to conduct a review of the literature and other available evidence on the effectiveness of a particular program in achieving similar behavioral or health outcome changes. For example, if a community program is geared toward increasing physical activity, a literature search on community intervention programs that target changes in physical activity can be conducted. Through this literature search,

relevant outcome measures that have been used successfully in evaluating the effectiveness of community-based physical activity programs can be identified. For example, a study by Kirtland et al. (2003) identified environmental measures of community support for physical activity, including the following:

- Use of trails, swimming pools, recreation centers, and/or parks;
- Perceived safety of public recreation facilities in the community; and
- Perceived importance of recreational/physical activity clubs, programs, or organized recreational events in the community.

Use of walking or bike trails, public recreation centers, and/or public swimming pools, for instance, could be used to evaluate the effectiveness of a community intervention aimed at increasing physical activity.

### *National Surveys and Surveillance Systems*

In addition to conducting an evidence-based review, there are a number of national surveillance sources that measure health and related outcomes on a regular basis. These data sources can be consulted to identify potential outcome measures for assessing program effectiveness. For example, the following data sources provide information on physical activity outcome measures at multiple levels (i.e., short-term, intermediate, and long-term):

- National Health and Nutrition Examination Survey (NHANES)
  - Includes questions regarding the following:
    - Physical activity limitations caused by any long-term physical, mental, or emotional problem or illness
    - Difficulty in performing certain activities (e.g., preparing meals, standing up from an armless chair, grasping small objects) due to a health problem
    - Transportation-related activities
    - Daily physical activities and leisure time physical activity in the last 30 days
    - Sedentary activities, such as television viewing time
- School Health Policies and Program Studies (SHPPS)
  - Includes questions on the following topics:
    - Elementary, middle, and high school recess and instruction
    - Adapted physical education
    - Interscholastic sports coaches
- Behavioral Risk Factor Surveillance System (BRFSS)
  - Includes questions on the following:
    - Number of days in the past month in which physical or mental health problems interfered with usual activities



- Participation in physical activities or exercise, such as running, golf, or gardening, in the past 30 days

### *Small Studies*

Another method for identifying potential outcome measures is to review measures used in small-scale studies that targeted the behavior or health outcome of interest. This approach can be especially helpful when the intervention is implemented at the community or individual level and the outcomes of interest are specific to a more focused intervention. For example, in assessing parents' involvement in their daughters' physical activity, Davison, Cutting, and Birch (2003) focused on the following outcome measures:

- How active are you in enrolling your daughter in sports?
- How often do you go to your daughter's sporting events with her?
- How important is it to you to be actively involved in your daughter's sporting events?
- How much do you enjoy sport/physical activity?
- How often does your family use sport/physical activity as a form of family recreation?
- How much do you use your own behavior to encourage your daughter to be physically active?

While such an intervention is most likely derived from the broader issue of obesity, its target groups (i.e., parents and daughters) and behavior of interest (i.e., physical activity) are more specific. Thus, using a BMI measure from a national surveillance system may not be specific enough to measure the effectiveness of the intervention.

### **3.2.3 Data Quality**

When attempting to identify sources of information on program outcomes, the quality of the data should also be considered. It is important to ensure that the data are reliable, valid, and informative. For example, using existing tobacco use data sources, such as the Youth Tobacco Survey (YTS), BRFSS, and the Youth Risk Behavior Survey (YRBS), helps to ensure that data have been reliably collected and compiled. However, data from those sources are also self-reported and may not be appropriate for some interventions. For instance, self-reported height and weight are often less reliable than estimates taken by health care providers. Men tend to overestimate height, while women tend to underestimate weight. Thus, it is important to keep such information in mind when selecting an outcome variable.

### **3.2.4 Criteria for Selecting Among Possible Outcome Measures for Program Evaluation**

Once possible outcome measures for evaluating a program's effectiveness and sources of information on these measures have been identified, it is often useful to narrow the focus of the evaluation by selecting a few outcome measures that best capture the program's impact and possess desirable features for use in the analysis of program success. In this section,

we discuss several factors to consider when choosing from among possible outcome measures for use in program evaluation. Additional considerations for selecting outcome measures that are appropriate for use in evaluating a program's cost-effectiveness are discussed in Chapter 5.

### *Reliability*

A natural starting point in the identification of a good outcome measure is the reliability of the measure. A measure is reliable when it is accurate and stable. For example, a person whose true total cholesterol level is 185 mg/dl may have a reported cholesterol score of 175 mg/dl on one day and of 195 mg/dl on another. In general, we expect some minor variations but expect that these variations will average to zero. We call these minor variations "random error." When a measure has little random error, it is said to have a high degree of reliability. We can extend this discussion of reliability to measures given to different subgroups or samples. Notice that an important requirement for assessing reliability is having more than one instance of the measure and some idea about the true value. This is often difficult to achieve in practical situations and so it may be helpful to examine the published literature for information on estimates of the true value.

### *Validity*

Validity indicates the degree to which a particular outcome measures what we think it is measuring. When the selected outcome is observable and easily recognizable, measurement validity is not much of an issue. Height and weight are examples of measures that have a high degree of validity, so long as a good measuring device is used. On the other hand, many health status outcomes represent a complex array of behavioral, physiological, and psychological features. An outcome such as cardiovascular risk is not observable or easily recognizable and different people could include different facets in its measure. For example, to ensure that a measure is valid, we need to be able to show that

- All the important characteristics of the outcome are included in the measure, and
- The outcome of interest can reasonably be inferred from the items in the measure.

It would not, for example, be valid to infer cardiovascular risk from observing a person engaged in moderate to vigorous exercise and simply taking their heart rate or blood pressure. There are a host of other factors to be considered. In the WISEWOMAN study, for example, a measure of 10-year risk of coronary heart disease (CHD) was calculated using an existing, previously validated algorithm (Wilson et al., 1998) that included age, total cholesterol, HDL cholesterol, blood pressure, diagnosis of diabetes, and smoking status as input risk factors (Finkelstein, Khavjou, and Will, forthcoming; and Finkelstein et al., 2002). Using only one or a subset of these measures would fail to capture important characteristics of the desired outcome. A complete evaluation of validity will require an understanding of the health outcome, the determinants of the program, and the nature of the anticipated

program effects. For outcomes that are observable and easily recognizable, a single item measure is likely to be sufficient. When an outcome is more complex, however, multiple item measures are likely to be needed.

### *Sensitivity*

The third criterion, sensitivity, addresses the degree to which the selected measure is capable of detecting the changes that are assumed to occur as a result of the prevention program. Although broad measures of health status may be attractive, they may lack appropriate discrimination. On the other hand, selecting a measure of health status that is too narrowly defined may limit comparability. Understanding the degree to which a measure is sensitive will require understanding the research question or program objectives, the relationship between program inputs (determinants) and program outputs, and consideration of the program timeline. For example, the ultimate goals of the Steps program included a reduction in the number of hospital emergency department visits for asthma. The outcome measure compares the number of visits to an emergency department with a first listed diagnosis of asthma among persons aged 5 to 64 to the U.S. population of persons aged 5 to 64. A more sensitive measure of the reduction in emergency department visits for asthma could be constructed by only including persons with a confirmed history of asthma aged 5 to 64 as the comparison group. In WISEWOMAN, where the goal is to reduce heart disease risk, the researchers conducted sensitivity analyses assessing the ability of currently available CHD risk algorithms to detect changes in risk as a result of changes in input risk factors (e.g., blood pressure, cholesterol). Another example is a smoke alarm installation program aimed at improving fire safety. Although the primary outcome of interest in this program is the number of fires averted, it may be difficult to assess the outcome if the program is implemented on a small scale (e.g., one community) because of the small number of house fires in a given community per year.

### *Summary*

Reliability, validity, and sensitivity are important because others will examine them when reviewing the results of program evaluations. Program outcomes are measured to evaluate whether anticipated effects have been achieved. These results are often used to obtain additional funding from policy makers or to convince a constituency (e.g., community group or coalition) to participate in future program activities. If outcomes are measured with instruments that are unreliable, lack validity, or are not sensitive to the program being evaluated, the results may be difficult to interpret. In addition, constituencies and policy makers who recognize these limitations will be unwilling to accept the results.

### **3.3 Example of an Approach for Selecting Outcome Measures for Program Evaluation: The American Legacy Foundation's truth<sup>®</sup> Campaign**

The previous subsections outlined an approach for identifying program outcomes and data sources and for selecting specific outcome measures to focus on in evaluating program effectiveness. In this section, we provide an example of how the approach may be applied to evaluate the success of an existing program—the American Legacy Foundation's truth campaign—in preventing the onset of smoking among youth.

As a brief review, the American Legacy Foundation's national youth tobacco countermarketing media campaign was targeted to 12- to 17-year-old adolescents who are open to smoking and 18- to 24-year-old young adults as an important secondary audience. The truth campaign delivers its messages primarily through national television broadcast of its tobacco countermarketing ads. One of the primary goals of the truth campaign was to reduce tobacco use and initiation among youth and adolescents aged 12 to 24. Outcomes measured by the campaign include

- exposure to antismoking media,
- smoking beliefs and expectations,
- attitudes toward tobacco,
- attitudes toward cigarette companies, and
- smoking behavior.

First, consider the logic model for the truth campaign presented in Figure 3-1. The media campaign messages (e.g., television ads, Internet Web sites) represent the program inputs. The outputs include exposure to media campaign messages, attitudes toward tobacco, and smoking onset. The primary outcome of interest is smoking onset among youth. It is anticipated that exposure to the media campaign messages will change youth attitudes toward tobacco and that these changes will reduce smoking onset among youth.

Next, consider the potential outcomes and how they may be classified as short-, intermediate-, or long-term. In the current example, exposure to antismoking media would be classified as a short-term outcome. Such outcomes can reasonably be anticipated within a short period of time and can be viewed as the direct result of the program inputs. If the effectiveness of the program were measured shortly after initiation of the media campaign, short-term outcomes may be the only effects that could be reasonably expected. Smoking beliefs and expectations represent intermediate outcomes. They are removed from the program inputs and require the achievement of short-term outcomes (i.e., exposure to antismoking media), but they are not the ultimate goal of the program. Smoking behavior represents a long-term outcome and is the primary outcome of interest. Although health outcomes could also be considered as long-term outcomes, measures of these would not be

very sensitive in a young population. Because of the well-established link between smoking and poor cardiovascular health and lung cancer, it is therefore acceptable to focus on changes in smoking behavior as the outcome of interest.

Once the outcomes of interest have been identified, available data sources capturing that information can be explored. YTS, for instance, includes the following items relevant to smoking onset:

- How old were you when you first tried a cigarette?
- Have you ever tried or experimented with cigarette smoking, even one or two puffs?
- At any time during the next 12 months do you think you will smoke a cigarette?

Changes in any of the three outcomes could be consistent with program success. A reduction in the percentage of youth reporting experimentation with cigarettes might be due to a successful antismoking ad campaign. Yet, applying the three criteria for selecting among possible outcome measures for program evaluation discussed in Section 3.3 can help in selecting the best measure(s) for evaluating program success. In terms of reliability, because the first item requires the respondent to think retrospectively about his or her behavior, it may be less reliable than the other two items. The criterion of validity seems to be most satisfied by the first two items, because they are clear indicators of smoking behavior. The second item may be less valid because it is aimed at experimentation, rather than smoking onset, typically a subtle but important distinction. Sensitivity, the third criterion, seems to be most satisfied by the third item, as differences in responses by the same participants over time are possible. The same would not be expected for the first two items (unless, of course, the reliability criterion is violated, as noted previously).

Based on the application of the three criteria, the third item is the best outcome measure for determining the effectiveness of the campaign. If this item were given to respondents before the start of the campaign and then 6 and 12 months after the start of the campaign, responses could be compared over time. If more respondents indicated that they do not think they will smoke a cigarette in the next 12 months at 6 months after the campaign than before the campaign, it could be concluded that the campaign was effective in changing expectations about smoking, which should ultimately reduce smoking onset among youth.

### **3.4 Checklist for Outcomes Measurement**

The checklist in Table 3-1 summarizes several issues discussed in this chapter that should be addressed when selecting outcomes for program evaluation. This checklist may help guide your decision making about which outcomes to use in evaluating your program.

**Table 3-1. Checklist for Outcomes Measurement**

Decision	Check When Complete
1. Specify logic model and expected program outcomes.	<input type="checkbox"/>
2. Identify potential sources of information on program outcomes.	<input type="checkbox"/>
3. Evaluate each possible outcome measure applying the three criteria: reliability, validity, and sensitivity.	<input type="checkbox"/>

## 4. IDENTIFYING AND QUANTIFYING PROGRAM COSTS

An important component of the evaluation of public health programs is to quantify their costs. Program costs provide an overview of the resources required to develop and implement a program and help to evaluate its financial performance. Cost estimates may be used to understand how budgets are allocated across programs or across activities within a program. Program costs can also be used as part of an economic evaluation. For example, if a program proves to be effective, additional evaluation of its cost-effectiveness will further inform decision makers on how it compares to other programs.

Quantifying costs will help answer the following questions:

1. How much does it cost to develop the program?
2. How much does it cost to field the program, and how are these costs allocated across activities?
3. If the program were to be implemented in a new community, what level of resources would be required?
4. If the program were to be expanded to reach more participants within the current community, what level of additional resources would be required to fund this expansion?

These questions will help guide which program costs to capture and how to quantify them.

The next section outlines how to identify the different types of costs that a public health program may incur and explains how to quantify these costs. Specific examples are drawn from the following public health programs:

- The Centers for Disease Control and Prevention's (CDC's) Well-Integrated Screening and Evaluation for Women Across the Nation (WISEWOMAN) Program, a screening and lifestyle intervention program aimed at reducing cardiovascular disease (CVD) risk factors among low-income women aged 40 to 64 in various U.S. states; and
- Canada on the Move, a program aimed at increasing physical activity levels in Canada, used a Web-based interface to collect data on Canadians' use of pedometers. The purpose of the program was to determine the effectiveness of pedometers as a means of increasing physical activity.

### 4.1 Identifying Types of Costs

This section briefly describes the aspects that should be considered when identifying costs:

- The perspective from which costs should be collected
- The costs to develop and implement a program
- The time frame required to collect costs

### **4.1.1 Evaluation Perspective**

Although a program can be evaluated from multiple perspectives, public health programs are generally analyzed from either a public health or a societal perspective. For an analysis from a public health perspective, it is only necessary to include costs associated with the actual development and delivery of the program to participants in the public health community. From a societal perspective, however, costs to participants and any other opportunity costs, such as donated building space, should also be included (Haddix, Corso, and Gorsky, 2003). However, quantifying all of these costs can be challenging and costly.

#### *Public Health Perspective*

To evaluate a program from a public health perspective, two types of costs must be collected: the actual expenditures to develop and implement the program and the value of donated resources or resources not funded by the program.

The value of donated resources and resources not funded by the program must be quantified for three main reasons:

1. If the program is to be implemented in a new community or expanded to more participants in the same community, donated resources may no longer be available or sufficient; therefore, to estimate the costs of implementing a program elsewhere or expanding a current program, it is necessary to include the value of these resources when costs are quantified for the current program.
2. If costs are being collected for similar programs in different communities, donated resources must be included to ensure that the costs between programs are comparable.
3. Because donated resources are likely to affect the effectiveness of the program, their value must be included in the costs to conduct economic evaluation.

The following examples illustrate instances in which donated resources and resources not funded by the program should be included when quantifying costs.

***Donated Resources.*** A nutritionist volunteers her time to teach in a WISEWOMAN intervention. Should she no longer choose to donate her time, WISEWOMAN will have to compensate another similarly qualified person to provide the service. Therefore, the value of her donated time should be included. Similarly, although Canada on the Move did not directly incur costs for the purchase of pedometers, because the pedometers used by program participants were donated, pedometer costs should be included in cost analysis.

***Resources Not Funded by the Program.*** As a result of program participation, some WISEWOMAN enrollees may be referred to existing smoking cessation classes in the community or may be prescribed medications for diabetes, hypertension, or high cholesterol. Although WISEWOMAN does not pay for these classes or prescription medications, WISEWOMAN participants are likely to experience improvements in CVD risk factors as a result of their exposure to them. If these improvements are captured in the



effectiveness results, their costs should be included in the cost analysis. Otherwise, not all of the costs required to yield the program outcomes are captured.

In Canada on the Move, pedometer distribution was coordinated by a major food company, which placed the pedometers in boxes of food sold in grocery stores. Although Canada on the Move did not incur costs to distribute pedometers to participants, these costs should nonetheless be included in analysis because a key goal of the program was to increase physical activity through pedometer use and self-monitoring.

### *Societal Perspective*

As mentioned previously, to collect the costs from a societal perspective, the opportunity costs to participants must be included. Opportunity costs are those costs associated with the value of resources in their next best use. For Canada on the Move, opportunity costs were the value of time that participants lost to other activities when they increased their physical activity levels through walking. In WISEWOMAN, opportunity costs are the value of time to attend lifestyle intervention sessions and time spent reading nutrition facts labels, exercising, or cooking healthier meals outside of the intervention sessions. Although these time costs and out-of-pocket expenses are important to recognize, they are often difficult and expensive to quantify. It may be most appropriate to show that a program is cost-effective from the public health perspective before expending the additional resources required to collect data on all costs to participants. (For more details on how to quantify opportunity costs to participants, see Appendix C.)

### **4.1.2 Costs to Develop and Implement a Program**

Development costs are the costs required to start up a program and are those costs incurred before a program is implemented. They include costs to develop specific components of the program and capital investments that can be used for the length of the program. Costs associated with the development of program components, such as educational materials or screening questionnaires, are referred to by economists as sunk costs because they are not expected to recur if the program were to be expanded or implemented in a different location. Capital investments, such as buying a car or a building, are referred to as fixed costs because they are not proportionately dependent on the size of the program.

Implementation costs are the ongoing costs required to field program activities. They can either be fixed or depend on the volume of the program activity. Economists define the latter costs as variable costs, because they increase as more participants are added to a program. Ongoing costs are incurred as long as the program is fielded. Examples of ongoing fixed costs are monthly rent or advertising costs. Examples of ongoing variable costs are medical examination costs or costs for incentives given to participants.

When conducting a cost analysis, the costs to develop and implement a program should be included in estimates of total program costs. It is necessary to distinguish development costs from ongoing costs when estimating resources required to implement the same program elsewhere or to expand an existing program. For example, doubling the size of an existing program would not likely double total program costs because many program resources, including start-up costs, will not need to be reproduced. Increasing the size of an existing program will primarily affect the variable costs of the program, not the fixed costs.

In the WISEWOMAN program, substantial resources were spent to develop nutrition and physical activity interventions, purchase computers, and train staff; these activities would not be repeated if the program were to be expanded to enroll more women in the same community. For example, total WISEWOMAN costs are estimated to be \$600 per participant (including start-up and ongoing costs). However, if development costs are excluded, it costs \$450 per participant to provide WISEWOMAN services on an ongoing basis. Therefore, if WISEWOMAN were to expand to more women within a currently fielded program, it would cost \$450 to provide WISEWOMAN services to each additional participant.

On the other hand, if a program were to be newly implemented in a different community, then a portion of the development costs, such as purchasing computers or training new staff, and the ongoing costs would be incurred to start up and field the program, but the sunk costs will not be incurred again. For example, if the WISEWOMAN program were implemented in a new state, new staff would have to be trained and new computers would have to be purchased. However, new nutrition and physical activity interventions would not need to be developed.

#### ***4.1.3 Evaluation Time Frame***

In general, four factors influence the time period for which relevant program costs should be collected. The chosen time period must be long enough to (1) observe program effectiveness, (2) avoid capturing only cycles or patterns in costs (e.g., costs affected by seasonal effects), (3) collect both start-up costs and ongoing costs, and (4) observe stable implementation costs (Haddix, Corso, and Gorsky, 2003).

In the WISEWOMAN program, participants are screened for CVD risk at baseline with a rescreening that occurs 1 year from baseline. Therefore, costs should be collected for at least 1 year to capture ongoing costs for the time frame necessary to measure program effectiveness. A longer period also better reflects ongoing costs because costs should stabilize as more participants are enrolled in the program and as staff are fully trained on program delivery. If a program funds a month-long advertising campaign every 6 months, then the costs must be collected for a long enough period so that the cost of the ad campaign is spread out over time. If costs were collected for only the month in which the campaign ran and assumed to repeat every month, implementation costs would be overestimated.

## 4.2 Quantifying Costs

This section describes how to quantify program costs from a public health perspective. The method presented is a two-step process:

1. Costs are broken down by each activity the program performs; and
2. Costs within each activity are subdivided into five resource components: labor, contracted services, materials and supplies, buildings and facilities, and donated or on-hand resources.

Costs should be quantified from actual expenditures or commitments (through bills, receipts, contracts, or wages paid) rather than projected expenditures, because budgets may not accurately reflect the value of resources used.

### ***4.2.1 Separating Costs by Program Activity***

The first step in quantifying program costs is to determine the main activities the program performs. Separating costs by activity, known as the activity-based approach, will help to answer questions about which activities drive overall costs and how program costs would change if specific activities were added or eliminated. In the WISEWOMAN program, primary activities include the following:

- Recruiting participants,
- Screening for cardiovascular risk factors,
- Providing lifestyle interventions, and
- Conducting program administration/oversight.

Program administration/oversight represents an activity for nearly every program and generally includes what does not fall directly into any of the other primary activities of the program.

Once primary program activities have been identified, they must be categorized as activities associated with program development, program implementation, or both, to be able to separately quantify start-up and ongoing costs. For example, in the Canada on the Move program, primary activities included (1) Web site development, (2) development of Web site materials, (3) survey tool development and testing, (4) program administration/oversight, (5) promotion and marketing/media campaigns, and (6) Web site implementation. For this program, administration/oversight and promotion and marketing fell into both categories: program start-up and ongoing program efforts. The other activities clearly fell into either development or implementation activities.

#### **4.2.2 Subdividing Activity Costs by Resource Component**

Once primary program activities are identified, costs for each activity should be collected for the following resource components: (1) noncontract labor, (2) contracted services, (3) materials and supplies, (4) buildings and facilities, and (5) donated labor and resources or those not funded by the program. For each component, as the costs are quantified, the costs for start-up activities and ongoing activities should be separately noted.

1. *Noncontract labor.* Noncontract labor costs consist of the total compensation of employees for their time spent performing program activities. Total compensation includes salaries or wages plus benefits. Noncontract labor costs should be calculated (for example, via timesheets) for all individuals whose time spent on the program is not captured through another mechanism (i.e., billed directly to the program). If an employee works on multiple activities within the program, a timesheet may help quantify the amount of time spent on each activity. A sample timesheet and accompanying instructions is presented in Table C-1.
2. *Contracted services.* Contracted service costs include costs for program activities provided by outside entities, such as physician services, consulting, or data collection. Documenting contracted service costs is straightforward but requires programs to keep track of the bills associated with contracted services and to map the bills to the appropriate activity. For example, the cost of physicians who perform screenings for the WISEWOMAN program is determined by the bill submitted for services rendered. In Canada on the Move, the development and set-up of the Web-based interface was provided through a contract with a Web site development firm. Table C-2 provides a sample worksheet and accompanying instructions to track these costs.
3. *Materials and supplies.* The costs of materials and supplies include costs for purchases to support program activities (e.g., cookbooks and pedometers for WISEWOMAN). Tracking and recording bills for materials and supplies throughout the duration of the program facilitates the cost estimation approach. Table C-2 provides a sample worksheet and accompanying instructions to track these costs.
4. *Buildings and facilities.* The costs of buildings and facilities include rent and/or mortgage payments, as well as their physical maintenance and operating costs (including utilities, taxes, and insurance). Table C-3 provides a sample worksheet and accompanying instructions to track these costs.
5. *Labor and resources donated or not funded by the program.* The value of donated labor and resources or resources not funded by the program (including contracted services, materials and supplies, and buildings and facilities) can be estimated as the costs that would have been incurred had these resources not been available for free use. For example, if a program is using a building free-of-charge, the value of this building could be estimated from current real estate values of monthly rents in the surrounding area. The value of the volunteer nutritionist from the WISEWOMAN program could be estimated by determining the market salary, or average wage, of a similarly qualified nutritionist. In Canada on the Move, the value of the donated pedometers should be estimated using the market price of pedometers bought in bulk, since the program required a large volume of pedometers. The costs of donated labor should be recorded in Table C-1, and the costs of donated materials and supplies or buildings and facilities should be appropriately recorded in Tables A-2 or A-3.

### 4.3 Conclusion

By classifying start-up and ongoing costs by activity and by resource component, two cost reports such as those in Table C-4 can easily be generated: one quantifying total program costs and another quantifying program costs per participant. This approach will demonstrate how costs vary across and within activities. Knowing the cost of each program activity will contribute to the economic evaluation of a program and help answer questions about how much the program costs, how much specific program activities cost, and how much it would cost to expand the program or implement a similar program in another location.

The checklist in Table 4-1 summarizes several issues discussed in this chapter that should be addressed when collecting and analyzing data on program costs. This checklist may help you organize and prioritize data needs for program cost analysis.

**Table 4-1. Checklist for Program Cost Analysis**

Decision	Check When Complete
1. List key program activities.	<input type="checkbox"/>
2. Determine perspective of the analysis and time frame for cost data collection.	<input type="checkbox"/>
3. List all resources used to support each program activity (e.g., labor, donated resources).	<input type="checkbox"/>
4. Create system and forms for collecting and analyzing cost data (see Appendix C for sample forms).	<input type="checkbox"/>



## 5. CONDUCTING A COST-EFFECTIVENESS STUDY

Cost-effectiveness analysis (CEA) combines information about the costs (Chapter 4) and outcomes (Chapter 3) of a community prevention program to produce information that can be used to answer questions about whether a program is cost-effective, whether program expansions would be cost-effective, and/or whether a program is more or less cost-effective than alternative prevention strategies.

CEA evaluates the costs required to yield a specific nonmonetary outcome, such as the cost per life-year gained, the cost per asthma-related emergency room (ER) visit averted, or the cost per inch lost from the waist. In this chapter, we begin by providing some advice for selecting program outcomes for use in CEA. We then describe how to calculate the necessary cost-effectiveness ratio(s) (CER) to answer your study questions and how those CERs can be used to allocate resources across prevention strategies.

### 5.1 Selecting Outcome Measures for Cost-Effectiveness Analysis

Although the selection of outcome measures for evaluating program success was discussed in Chapter 3, in this subsection we discuss some issues to consider when selecting outcome measures specifically for use in CEA. The effectiveness of a community prevention program can be assessed in terms of both immediate and longer-term outcomes (see Chapter 3 for additional discussion on measuring program effectiveness). For example, in the short-term, a program that encourages physical activity through financial rewards may lead to increases in the percentage of participants who achieve the recommended level of physical activity per week. In the long-term, if improvements in physical activity levels are sustained, the program may lead to reductions in chronic disease incidence, such as diabetes, stroke, heart disease, and cancer. Such improvements in health may eventually yield longer and better lives for program participants—outcomes that can be quantified as life-years gained or quality-adjusted life years (QALYs) gained. All of these outcomes—increases in physical activity, chronic disease cases averted, and improvements in life-years gained or QALYs gained—are legitimate outcomes for use in CEA. The decision about which of these program outcomes to use in CEA should be made by considering which outcome measure best answers the study question, what outcomes are most easily comprehended by the target audience for the cost-effectiveness (CE) study, and whether data are available to link short-term program outcomes to longer-term changes in health and mortality.

Although final health outcomes, such as the number of strokes averted or life years gained, are generally recommended for use in CEA (see Haddix, Teutsch, and Corso, 2003, and Drummond et al., 1997), intermediate outcomes may be appropriate when evaluating many types of community prevention efforts, especially if these outcomes are more easily understood by the target audience for CE studies. For example, because data are not readily available to link a physical activity intervention to health outcomes that would be realized

decades in the future, it may be appropriate to use an intermediate program outcome, such as changes in physical activity levels among participants. Drummond et al. (1997) recommend that when an intermediate outcome is selected, it should either be viewed as valuable in its own right (e.g., increased physical activity or vaccination against disease) or have a well-established link to a desirable health outcome (e.g., link between increased physical activity and reductions in chronic disease or link between vaccination and reduced incidence of vaccine-preventable disease).

To help you decide on the most appropriate outcome measure(s) in CEA of your prevention program, we provide hypothetical program examples and their corresponding outcome measures in Table 5-1. Information about the program or study factors that influenced the outcome measure decision is also provided.

**Table 5-1. Hypothetical Prevention Programs and Outcomes for CEA**

<b>Program Description</b>	<b>Outcome(s) for CEA</b>	<b>Issues in Outcome Selection</b>
Worksite program to increase physical activity	Increased number of employees meeting physical activity recommendations	Program comparison is to other worksite approaches to increase physical activity (vs. to prevention strategies with noncomparable outcomes)
School-based asthma management program	Asthma-related acute care visits averted and QALYs gained	Program impact on health and well-being can be estimated in the short-term (vs. many years in the future)
City policy to create additional sidewalk space	Increased number of walking trips per month	Program comparison is to other approaches to increase walking/ biking trips Difficulty of linking increased walking trips to future health improvements
Screening and intervention program to identify and reduce cardiovascular disease risks	Number of participants with reduced blood pressure Change in systolic or diastolic blood pressure Reduction in the average 10-year probability of cardiovascular disease	Multiple program outcomes needed to be summarized in a single CE measure for policy makers Program comparison is to other approaches to reduce cardiovascular disease risks

No single right answer exists to the question of which outcome measure to use in CEAs of prevention programs. In fact, you may choose to use multiple outcome measures to address the interests of diverse stakeholders. For example, although a company’s wellness committee chairperson may be interested in the cost per additional employee achieving weekly physical activity recommendations, the human resources vice president may be more interested in the cost per missed work day averted (or related measure of change in



employee productivity). To satisfy the interests of both stakeholders, CERs should be calculated using both types of program outcome measures, if possible. Results would then be reported as the program cost per additional employee achieving physical activity recommendations ( $= \text{total program costs} / \text{change in number of employees meeting physical activity recommendations among targeted employees}$ ) and as the program cost per missed work day averted ( $= \text{total program costs} / \text{change in number of work days missed among targeted employees}$ ).

### ***5.1.1 Quality-Adjusted Life Years and Their Measurement***

If program stakeholders are interested in being able to make cost-effectiveness comparisons across prevention programs with disparate outcomes, then a common outcome measure, such as life-years saved or quality adjusted life-years (QALYs) gained, will need to be used for each program under consideration. For example, when comparing a program that seeks to increase physical activity to a program that seeks to reduce asthma-related health care visits and costs, the measured program outcomes—increased minutes of weekly physical activity and number of asthma-related ER visits averted—will need to be converted to a common measure so that CERs can easily be understood and compared across the two programs. Both programs may be viewed as worth the investment if, for example, the first has a cost of \$500 per additional 30 minutes of weekly physical activity and the second has a cost of \$350 per asthma-related ER visit averted. However, without estimating a common outcome measure for both programs, questions about which program is more cost-effective cannot be answered.

QALYs have been recommended for use in CEA to improve the comparability of results across CE studies (Gold et al., 1996). QALY measures are generally preferred to measures of life-years gained because the QALY measure captures gains both from increased life and from reduced morbidity. To use QALYs as the outcome measure of interest, it is necessary to first collect data on short-term or intermediate program outcomes, such as changes in physical activity or ER use among asthma patients. These outcomes are then linked to information from the literature or other data sources to estimate the future health outcomes likely to result from participation in the prevention program, such as a reduced likelihood of diabetes, stroke, or death. Finally, health outcomes are then converted to QALYs using estimates of people's preferences for being in various health states ranging from excellent health (valued at 1) to death (valued at zero). Dasbach and Teutsch (2003) discuss the estimation of QALYs and possible sources in the literature for valuing the quality of life in various health states, such as having diabetes, asthma, hypertension, and/or other specific health conditions. Drummond et al. (1997) provide a detailed treatment.

## 5.2 Analyzing the Cost-Effectiveness of a Prevention Program

After program costs have been analyzed and decisions have been made about which outcomes to use as measures of program effectiveness, CERs can be calculated to answer the key study questions.

### 5.2.1 Average Cost-Effectiveness

Average CERs are useful for considering the cost per additional outcome achieved by a program as compared to a baseline of doing “nothing.” An average CER is calculated by dividing program costs by the change in outcomes generated by the program:

$$Ave\_CER = \frac{Cost}{\Delta Outcome} \quad (5.1)$$

In a recent study on the cost-effectiveness of different vaccination strategies in hospitals, average CERs were calculated for each hospital in the study (Honeycutt et al., 2006). CERs were calculated by dividing total vaccination program costs (estimated by the study authors) in each hospital by the number of patients vaccinated (data collected from each hospital). The cost-effectiveness of the study’s hospital vaccination programs ranged from \$22 to \$362 for each additional patient vaccinated.

If the outcomes under consideration are health outcomes (e.g., cases of diabetes averted), as opposed to short-term or intermediate program outcomes (e.g., increased minutes of physical activity), then the measure of cost used in the numerator of the CER should be net of disease costs and productivity losses averted by the program. Estimating the societal cost of each program in this manner helps to ensure the comparability of CERs across alternative programs. The societal cost of a program that produces measurable health benefits is the cost of the program less any cost savings that can be attributed to the program. Gift, Haddix, and Corso (2003) provide details on calculating CERs when health outcomes are used as measures of program effectiveness. For simplicity, our treatment simply uses the term “costs” to represent program costs. Those costs should be net of disease costs and productivity losses averted if health outcomes are used in the analysis.

A program is often considered to be cost-effective if its CER is below the commonly used threshold of \$50,000 per life-year gained (Hlatky, 2002). However, because CERs are measures of how a program’s costs compare to its outcomes, judgments about whether the outcomes achieved are worth the costs are for policymakers to decide, not researchers. If study results indicate that a program has a cost per stroke averted of \$2,500, policymakers must decide whether it is worthwhile to invest in the program.

### 5.2.2 Incremental or Marginal Cost-Effectiveness

In making decisions about whether to expand a prevention program or whether to fund one prevention program versus another, it is important to calculate CERs that compare a

program expansion to the existing program (marginal CERs) or that compare all alternatives (incremental CERs).

Incremental, or marginal, CERs calculate the extra cost required to get an additional unit of the outcome. In the vaccination program example, incremental CERs were calculated to compare three different vaccination program types. The incremental CER was the additional cost per additional patient vaccinated under Program B as compared to Program A. Incremental CERs are used to compare a program with its next best alternative (i.e., an intervention that provides the next highest effectiveness).

The incremental, or marginal, CER is calculated as follows:

$$Inc\_CER = \frac{Cost\_B - Cost\_A}{\Delta Outcome\_B - \Delta Outcome\_A} \quad (5.2)$$

The numerator represents the difference in program (or net program) costs between Programs A and B, and the denominator captures the difference in impact on outcomes between Programs A and B. Equation 5.2 assumes that Program B has higher effectiveness than Program A.

When several programs or program options are available, some evaluators will calculate the average CER according to Equation 5.1 and then choose to implement the program or program option with the lowest CER. However, this approach may not always be appropriate. In some cases, the program to implement will not be the one with the lowest CER (Bala and Zarkin, 2002). Selection among several alternative programs or program options depends on several factors, including overall program effectiveness and budget constraints.

The examples in each of the subsections that follow demonstrate how comparisons across programs should calculate and use measures of incremental cost-effectiveness when selecting the program or program option to fund or implement. Chapter 6 contains further discussion about how policy makers could use information about the incremental cost-effectiveness of alternative programs to select programs that best meet policy criteria for funding (e.g., achieve greatest total effectiveness or achieve greatest effectiveness per program participant).

### *Decision Making Using CERs*

Policy makers are often interested in CE study results to help inform decisions about which prevention programs to fund from among several alternatives. In some cases, interest is in selecting from among programs that target different behaviors or outcomes. In others, it is in selecting from among programs that target the same behavior or outcome. The next two subsections provide examples that use incremental CERs to inform decision making about which programs should be funded, given that the budget for prevention spending is limited.

**A. Programs Targeting Different Health Conditions.** An example of two programs targeting different health conditions are the National Breast and Cervical Cancer Early Detection Program (NBCCEDP) targeting cancer and the WISEWOMAN program aimed at reducing cardiovascular disease risk factors. Although these programs serve similar populations (middle-aged, low-income, uninsured women), they are aimed at improving different health conditions; as a result, they can be delivered to the same (or different) participant groups independent of each other.

To compare programs targeting different health conditions, the average CER presented in Equation 5.1 should be calculated for each program. To facilitate comparison across programs with disparate outcomes, a common measure of effectiveness must be used for each of the programs. For that reason, use of broad health outcome measures, such as life years gained or number of deaths averted, is generally recommended.

Once the average CER is calculated, programs should be rank ordered based on their CER. Programs with lower CERs represent more cost-effective strategies. For example, Table 5-2 presents cost-effectiveness results for three programs targeting different conditions. In this example we use the number of deaths averted by the program as our measure of effectiveness. This is a broad measure that is equally appropriate and relevant for programs targeting cancer, cardiovascular disease, and other health conditions.

**Table 5-2. Cost-Effectiveness of Three Programs Targeting Different Health Conditions**

Program	Net Program Costs	Number of Deaths Averted	Average CER
	A	B	C = A/B
1	\$500,000	100	\$5,000 (lowest)
2	\$100,000	10	\$10,000 (middle)
3	\$1,500,000	125	\$12,000 (highest)

When comparing programs that address different health outcomes, based on cost-effectiveness alone, programs with lower average CERs should be given priority over programs with higher cost-effectiveness ratios. In our example, Program 1 has the lowest CER (\$5,000/death averted) and is therefore the most cost-effective program.

However, in order to decide which program(s) should be implemented, the available prevention budget must be taken into consideration. Following the example in Table 5-2, if the available prevention budget is less than \$500,000, then you should implement as much of Program 1 as your budget allows. By doing so, you would have the greatest impact possible on reducing deaths for the given budget. For example, if \$250,000 was spent on

Program 1, the expected number of deaths averted would be 50. By comparison, if \$250,000 was spent on Program 2, the expected number of deaths averted would be 25.

If the available prevention budget is exactly \$500,000, then you should implement all of Program 1. If the budget is \$500,000 to \$600,000, then you should implement all of Program 1 and as much of Program 2 as you can. The logic here is the same as described above. If \$550,000 were available for prevention efforts and \$500,000 were spent on Program 1, with the remaining \$50,000 spent on Program 2, then the expected number of deaths averted is 105. If, instead, the \$550,000 were spent on Program 3, with a lower average CER, then the expected number of deaths averted would be almost 46 ( $[\$550,000/\$1,500,000] \times 125$ ). If the prevention budget is more than \$600,000, then you should implement all of Programs 1 and 2 and as much of Program 3 as possible to achieve the greatest possible impact on number of deaths averted through funded prevention programs.

**B. Programs Targeting the Same Health Conditions.** An example of programs targeting the same health condition are different smoking cessation strategies (e.g., self-help materials vs. physician counseling vs. pharmacotherapy vs. quit lines). When considering only programs that target the same behavior or condition, the effectiveness measure can be more narrowly focused (such as the number of quitters for smoking cessation programs) because the programs being compared have a common aim.

Perhaps counter to intuition, selection among programs targeting the same risk factor or health condition is often a more complicated process than selection among programs targeting disparate outcomes. Based on CE study results alone, in many cases, you will find that the optimal solution would be to offer a combination of two programs; that is, some participants from your target population should get one program and some participants should get another. However, for equity reasons, it might be unethical to provide interventions with different levels of effectiveness to individuals within the same target population (Ubel et al., 1996; Cantor, 1994). Thus, you should offer the same program to everyone even if it results in lower effectiveness than a mix of two programs.

***Equity Concerns: Offering the Same Program to Everyone in the Target Population.***

If you are limited to offering the same program to everyone in your target population, then you should pick the program that provides the highest effectiveness at a cost below your budget. To do so, you should calculate the average CER using Equation 5.1, rank order programs based on their effectiveness, and pick the program that results in the highest effectiveness but costs no more than the budget.

Table 5-3 presents cost-effectiveness results for four programs targeting the same health condition rank ordered based on their effectiveness. If the available budget is \$150,000 and equity concerns dictate that every participant in the target population must receive the same intervention, then Program B should be selected because it provides the greatest

**Table 5-3. Cost-Effectiveness of Four Programs Targeting the Same Risk Factor or Health Condition**

Program	Total Program Costs	Number of ER Visits Averted	Average CER
A	\$125,000	10	\$12,500
B	\$100,000	15	\$6,667
C	\$750,000	50	\$15,000
D	\$1,000,000	100	\$10,000

effectiveness (15 averted ER visits) without going over the available budget. Program A should not be selected because even though it costs less than the available budget, it is less effective than Program B (10 averted ER visits). Programs C or D cannot be implemented because they are not affordable and even if they could be partially implemented with the \$150,000, the expected number of ER visits averted would be lower than under Program B (10 for Program C and 15 for Program D versus approximately 22 if the full \$150,000 were spent on Program B).

**Efficiency Concerns: Offering a Mix of Programs Within the Target Population.** If it is acceptable to provide individuals within the target population with a combination of different programs, then your decision-making process will be different from the one outlined above and you may be able to achieve more of the desired program outcome (e.g., ER visits averted) for a given investment of prevention dollars. As in the example where equity concerns required that the same program be given to everyone in the target population, the first step of this process requires rank ordering interventions based on their effectiveness. Next, incremental CERs should be calculated for each intervention using Equation 5.2.

Identifying a program to implement based on CE results requires comparing the incremental CERs of each program. An example is shown in Table 5-4, where both average and incremental CERs are given for four programs that target the same health condition (asthma). The programs have already been rank ordered by effectiveness (measured by the number of ER visits averted). The least effective intervention (Program A) has the same incremental CER as its average CER because it is compared to the alternative of doing nothing (with zero costs and zero effectiveness). For Program B, however, the incremental CER is calculated by dividing the difference in program costs between Program B and Program A ( $\$100,000 - \$125,000 = -\$25,000$ ) by the difference in effectiveness between the two programs ( $15 - 10 = 5$ ). Note that because Program B is both less costly and more effective than Program A, its incremental CER is negative. The literature on cost-effectiveness will often state that such programs are “cost saving” because moving from the alternative program to a cost saving program can save society money while achieving the

**Table 5-4. Incremental Cost-Effectiveness of Four Programs Targeting the Same Risk Factor or Health Condition**

Program	Total Program Costs	Number of ER Visits Averted	Average CER	Incremental CER
A	\$125,000	10	\$12,500	\$12,500
B	\$100,000	15	\$6,667	(\$5,000)
C	\$750,000	50	\$15,000	\$18,571
D	\$1,000,000	100	\$10,000	\$5,000

Note: Values shown in parentheses represent negative numbers.

same level of effectiveness. In the language of CEA, Program B is said to “strongly dominate” Program A. In general, a program is strongly or weakly dominated if its incremental CER is higher than the incremental CER of the alternative with the next highest effectiveness (as Program A’s incremental CER is higher than that of Program B). Greater effectiveness could be achieved by implementing a mix of two alternative programs (Cantor, 1994).

Strongly dominated programs should be removed from the analysis. Once a strongly dominated program (e.g., Program A in the example in Table 5-4) is excluded from the analysis, the incremental CERs for the remaining programs must be recalculated to make comparisons across the remaining programs (Table 5-5). Program B’s incremental CER is now equal to its average CER because it is being compared to the “do nothing” alternative. Table 5-5 shows that the incremental CER of Program B (\$6,667) is less than the incremental CER of Program C (\$18,571), indicating that Program B should not be excluded from consideration. Now consider Programs C and D. The incremental CER of Program C (\$18,571) is greater than the incremental CER of Program D (\$5,000), which has the next highest effectiveness levels. Program C should therefore be excluded from further consideration because, for the same level of investment in asthma management, a mix of Programs B and D will be more effective than Program C alone. Program C is said to be weakly dominated by Programs B and D. For example, if \$750,000 were available to support asthma management efforts, investing all the money in Program C would be expected to avert 50 ER visits. By investing \$100,000 in Program B and the remaining \$650,000 in Program D, the expected number of ER visits averted is 15 from Program B and 65 from Program D ( $[\$650,000/\$1,000,000] \times 100$ ), for a total of 80 ER visits averted. Clearly, this strategy is preferred.

**Table 5-5. Incremental Cost-Effectiveness of Four Programs Targeting the Same Risk Factor or Health Condition after Eliminating Program A**

Program	Total Program Costs	Number of ER Visits Averted	Average CER	Incremental CER
B	\$100,000	15	\$6,667	6,667
C	\$750,000	50	\$15,000	18,571
D	\$1,000,000	100	\$10,000	5,000

Weakly dominated strategies (Program C in this example) should again be removed from the analysis and incremental CERs for the remaining programs should be recalculated (Table 5-6). Because the incremental CER of Program B (\$6,667) is less than the incremental CER of its next best alternative, Program D (\$10,588), neither should be eliminated. Further selection of the most appropriate program or combination of programs to be implemented will be determined by budget constraints and program characteristics. If \$1,000,000 were available to spend on asthma management and Program B could easily be expanded by tenfold, devoting the entire budget to Program B would yield the greatest benefits (= 150 ER visits averted). If Program B cannot easily be expanded, the best solution is to give all of Program B to some individuals in the target population and avert 15 ER visits, then give \$900,000 worth of Program D to the rest of the target population to avert 90 ER visits, for a total of 105 ER visits averted. Spending the full \$1,000,000 on Program D would yield 100 ER visits averted—less than the 105 ER visits averted in the solution that involves a mix of Programs B and D.

**Table 5-6. Incremental Cost-Effectiveness of Four Programs Targeting the Same Risk Factor or Health Condition after Eliminating Programs A and C**

Program	Total Program Costs	Number of ER Visits Averted	Average CER	Incremental CER
B	\$100,000	15	\$6,667	6,667
D	\$1,000,000	100	\$10,000	10,588

### 5.3 Sensitivity Analysis

Sensitivity analysis is an important additional step in conducting CE studies to examine the extent to which changes in the cost or effectiveness values used to calculate CERs affect conclusions. For example, if the cost of a particular service is uncertain, sensitivity analysis should recalculate CERs using high and low values for the service to examine the extent to which differences in costs affect study conclusions.



In the example shown in Table 5-6, if the cost of Program D were reestimated as \$500,000 in a sensitivity analysis, the average CER for Program D would be \$5,000 and the incremental CER, as compared to Program B, would be  $\$400,000/85 = \$4,706$ , which is lower than the incremental CER for Program B of \$6,667. In this case, Program D would dominate Program B, making it the best investment of prevention dollars, based solely on CE results.

#### 5.4 Checklist for Cost-Effectiveness Analysis

The checklist in Table 5-7 summarizes the key steps in performing CEA. This checklist may help guide your efforts to assess the cost-effectiveness of your program and make comparisons with alternative programs.

**Table 5-7. Checklist for Cost-Effectiveness Analysis**

Decision	Check When Complete
1. Select outcome(s) for CEA.	<input type="checkbox"/>
2. Calculate average CER for each program evaluated.	<input type="checkbox"/>
3. Rank possible programs by effectiveness (lowest to highest) and calculate incremental CERs.	<input type="checkbox"/>
4. Eliminate all dominated (strongly or weakly) programs, recalculating CERs each time a program is eliminated.	<input type="checkbox"/>
5. Perform sensitivity analyses.	<input type="checkbox"/>



## 6. USING RESULTS FROM COST-EFFECTIVENESS STUDIES

In this chapter, we build on the examples provided in Chapter 5 in describing how results from cost-effectiveness (CE) studies may be used to make decisions about the most efficient allocation of prevention resources. In Section 6.1, we provide three examples of resource allocation decisions that make use of CE study results. Section 6.2 contains some final remarks about the challenges and importance of evaluating the cost-effectiveness of community prevention approaches.

### 6.1 Using Cost-Effectiveness Study Results to Allocate Prevention Resources

We identified three possible resource allocation scenarios that a decision maker could face when selecting the best program(s) to implement given budget constraints:

1. A fixed total dollar amount is available for a given condition (e.g., \$1 million is available to prevent/reduce obesity).
2. A fixed per capita dollar amount is available for each person with a given condition (e.g., in a disease management program, \$500 is available to treat each patient with diabetes).
3. A fixed dollar amount is available for a unit gain in effectiveness (e.g., it is acceptable to spend \$10,000 per additional death averted).

The decision-making process for each of these three scenarios is described in the subsections that follow. For each, we focus on decisions that can maximize the total effectiveness achieved given available spending levels.

#### ***6.1.1 A Fixed Total Dollar Amount Available for a Given Condition***

Here, the goal is to choose a program or a combination of two programs that would provide the highest effectiveness given the budget constraint. Considering again the example in Table 5-6, replicated as Table 6-1, the decision rule should be as follows:

- For budgets less than \$100,000, implement as much of Program B as you possibly can.
- For budgets from \$100,000 to \$1,100,000, implement all of Program B and as much of Program D as you possibly can.
- For budgets greater than \$1,100,000, implement all of Programs B and D.

For example, if \$1 million is available to prevent or reduce obesity, you would spend \$100,000 on Program B (and avert 15 ER visits) and spend the remaining \$900,000 on Program D (and avert 90 additional deaths for a total of 105 averted ER visits). In contrast, if all of the \$1 million was spent on Program D, the maximum number of averted ER visits would be only 100.

**Table 6-1. Cost-Effectiveness of Four Programs Targeting the Same Risk Factor or Health Condition after Eliminating Programs A and C**

Program	Total Program Costs	Number of ER Visits Averted	Average CER	Incremental CER
B	\$100,000	15	\$6,667	6,667
D	\$1,000,000	100	\$10,000	10,588

However, if it is possible to offer more of Program B at the same cost and with the same effectiveness, then Program B should be expanded before implementing Program D. For example, suppose Program B has 1,000 participants. If that program can enroll an additional 1,000 participants for the same or lower total cost (\$100,000) achieving the same or higher effectiveness (15 ER visits averted), then Program B should be expanded before allocating resources to Program D. Given the assumption of identical costs and outcomes following a program expansion, a \$1 million investment in Program B would yield 150 ER visits averted.

**6.1.2 A Fixed Per Capita Dollar Amount Available for Each Person with a Given Condition**

In certain cases, a fixed dollar amount will be available for each person with a given health condition. For example, in a disease management program, you might have \$500 budgeted for each person with diabetes. Here, the per capita budget should be compared with the per capita program costs. In our examples in Chapter 5, we used total program costs and total number of deaths averted to calculate cost-effectiveness ratios (CERs) rather than per capita program costs and per capita number of deaths averted, because for some programs, such as community-wide campaigns (e.g., the truth anti-tobacco campaign), per capita costs cannot be calculated. The example presented in Table 6-2 uses the same programs that we described earlier, except now we assume that each of the programs enrolled 1,000 participants. All cost and effectiveness figures are shown at the participant level. (Note that, because the numerator and denominator of the CERs are both divided by 1,000, CERs remain unchanged.)

We have already established that Programs B and D should be considered for implementation. The final decision of which program or combination of programs to offer depends on the available budget. For example, if your budget allows for spending \$100 per person, then you should select Program B (from Table 6-2) because it is the most effective program available that does not exceed the budget. If your allowable budget is \$1,000 or more per person, then you should select Program D because implementation of this program results in the highest effectiveness without going over the budget of \$1,000 per participant. However, if Program D is not affordable, but the budget allows you to spend

**Table 6-2. Cost-Effectiveness Based on Per Participant Costs and Effectiveness**

Program (1)	Program Costs per Participant (2)	Number of ER Visits Averted per Participant (3)	Average CER (4)	Incremental CER (5)
B	\$100	0.015	\$6,667	6,667
D	\$1,000	0.100	\$10,000	10,588

more than the per person cost of Program B (i.e., the allowable budget per participant falls between \$101 and \$999), then you should offer a combination of Programs B and D. Some individuals in your target population would then get Program B, and some would get Program D (provided that you are allowed to offer interventions of different effectiveness to individuals within the same target population). The formula below can be used to calculate the percentage of individuals who should receive the more effective program—Program D in the example. The remaining individuals should receive the less effective program—Program B:

$$\% \text{ More Effective} = \frac{B - C_B}{C_D - C_B} \quad (6.1)$$

The B in the numerator is the budget amount allowed for each person with a risk factor or disease, and  $C_B$  and  $C_D$  are per capita costs of Programs B and D, respectively (with Program D being more effective than Program B). For example, if the allowable budget is \$800 per person, 78% of people from the target population should get Program D and the remaining 22% should receive Program B ( $[(800 - 100) / (1000 - 100)] = 0.78$ ).

### 6.1.3 A Fixed Dollar Amount for a Unit Gain in Effectiveness

In the third scenario, a decision maker is willing to pay up to a certain dollar amount for every additional unit gain in effectiveness (e.g., up to \$50,000 per death averted). This means that you need to choose the most effective intervention for which the incremental CER per unit of outcome compared to the alternative with the next highest effectiveness is less than your budget amount. In our example (Table 6-2, Column 5), Program B should be selected if the acceptable amount to be paid for an additional death averted is between \$6,667 and \$10,588. In contrast, Program D should be selected if the acceptable amount to be paid for an additional death averted is greater than \$10,588.

## 6.2 Conclusions

CEA is a helpful tool that can be used to inform and influence the decision-making process. However, many factors may affect decision making, and it is important to acknowledge that CEA is just one of them. In Chapter 1, we noted that broader evaluation approaches (such

as RE-AIM) provide additional information that may be relevant for determining the appropriate use of scarce resources. Ethical and political considerations, including issues of reach, equity, needs, and priorities, also play an important role (Haddix et al., 2003). In Chapter 5, we noted that a lower effectiveness program may be chosen over a mix of two programs if it is considered unethical to give individuals within the same target population interventions of different efficacy.

Another example of the equity-efficiency trade-off was discussed in Ubel et al. (1996), where decision makers chose a less cost-effective colon cancer screening program over a more cost-effective program because the latter was too expensive to be given to everyone. If decision makers place greater importance on equity than on efficiency, a program that reaches only a portion of the target population may not be selected even if it results in higher total effectiveness than a program that reaches everyone but with lower total effectiveness. In addition, decision makers may not always value equally the benefits gained by various members of society. For example, a benefit gained by one population subgroup (e.g., children) may be regarded differently than the same benefit to another subgroup (Haddix et al., 2003). In this case, even if CEA results indicate that one program is more cost-effective than another, it may not be implemented if the program with lower cost-effectiveness targets a highly valued subgroup.

One must also be cautious when comparing cost-effectiveness results obtained from different studies because they will most likely use different methods and include different outcomes, costs, and baselines. Different studies may rely on a variety of assumptions and focus on different populations (Haddix et al., 2003). To improve comparability across studies, you should, at a minimum, adjust for inflation (if program costs are reported from different years). The Community Preventive Services Task Force has developed a detailed guide for abstracting cost-effectiveness studies, which can be used to enhance comparability of economic evaluations across community health promotion and disease prevention interventions (Carande-Kulis et al., 2000).

Finally, although this guide has presented the steps involved in cost-effectiveness analysis as a straightforward process, performing CEA is often time-consuming and requires that community programs or health departments commit staff and other resources to data collection, analysis, and reporting of results. It may be difficult to commit resources to performing CEA given competing demands on the time of program and evaluation staff. Yet, as the federal government increasingly requires evidence on the cost, cost-effectiveness, or cost-benefit of prevention efforts, the need for performing CEA and related studies will only increase.

## REFERENCES

- Bala, M. V., & Zarkin, G. A. (2002). Application of cost-effectiveness analysis to multiple products: A practical guide. *Am J Manag Care, 8*(3), 211-218.
- Bartholomew, L. K., Parcel, G. S., & Kok, G. (1998). Intervention mapping: A process for developing theory- and evidence-based health education programs. *Health Education and Behavior, 25*(5), 545-563.
- Bray, J. W., and Zarkin, G. A. (2005). Economic evaluation of alcohol treatment. RTI International manuscript.
- Cantor, S. B. (1994). Cost-effectiveness analysis, extended dominance, and ethics: A quantitative assessment. *Med Decis Making, 14*(3), 259-265.
- Carande-Kulis, V. G., Maciosek, M. V., Briss, P. A., Teutsch, S. M., Zaza, S., Truman, B. I., Messonnier, M. L., Pappaioanou, M., Harris, J. R., & Fielding, J. (2000). Methods for systematic reviews of economic evaluations for the Guide to Community Preventive Services. Task Force on Community Preventive Services. *Am J Prev Med, 18*(1 Suppl), 75-91.
- Centers for Disease Control and Prevention (CDC). (2001). Introduction to program evaluation for comprehensive tobacco control programs. Atlanta, GA: CDC. <http://www.cdc.gov/tobacco>.
- Centers for Disease Control and Prevention (CDC). (1999). Framework for program evaluation in public health. *MMWR 48*(No. RR-11).
- Corso, P. S. & Haddix, A. C. (2003). Time effects. In A. C. Haddix, S. M. Teutsch, and P. A. Corso (Eds.), *Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation*, 2nd Edition. London: Oxford University Press.
- Dasbach, E. F. & Teutsch, S. M. (2003). Quality of life. In A. C. Haddix, S. M. Teutsch, and P. A. Corso (Eds.), *Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation*, 2nd Edition. London: Oxford University Press.
- Davison, K. K., Cutting, T. M., & Birch, L. L. (2003). Parents' activity-related parenting practices predict girls' physical activity. *Medicine and Science in Sports and Exercise, 35*(9), 1589-1595.
- Drummond, M. F., O'Brien, B., Stoddart, G. L., & Torrance, G. W. (Eds.) (1997). *Methods for the economic evaluation of health care programmes*. (2nd Edition). New York: Oxford University Press.
- Finkelstein, E. A., Troped, P. J., Will, J. C., & Palombo, R. (2002). Cost-effectiveness of a cardiovascular disease risk reduction program aimed at financially vulnerable women: The Massachusetts WISEWOMAN project. *Journal of Women's Health and Gender-Based Medicine, 11*(6), 519-526.
- Freeman, A. M. (1993) *The Measurement of Environmental and Resource Values*. Washington, DC: Resources for the Future.

- Gielen, A. C., & McDonald, E. M. (1997). The PRECEDE-PROCEED planning model. *Health Behavior and Health Education*, 2nd Edition (pp. 359-383). San Francisco, CA: Jossey-Bass.
- Gift, T. L., Haddix, A. C., & Corso, P. S. (2003). Cost-effectiveness analysis. In A. C. Haddix, S. M. Teutsch, and P. A. Corso (Eds.), *Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation*, 2nd Edition. London: Oxford University Press.
- Gold, M. R., Siegel, J. E., Russell, L. B., & Weinstein, M. C. (Eds.). (1996). *Cost Effectiveness in Health and Medicine*. New York: Oxford University Press.
- Haddix, A. C., Corso, P. S., & Gorsky, R. D. (2003). Costs. In A. C. Haddix, S. M. Teutsch, and P. A. Corso (Eds.), *Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation*, 2nd Edition. London: Oxford University Press.
- Haddix, A. C., Teutsch, S. M., & Corso, P. A. (Eds.). (2003). *Prevention effectiveness: A guide to decision analysis and economic evaluation*, 2nd Edition. London: Oxford University Press.
- Hill, J. O., Peters J. C., & Jortberg, B. T. (2004). The step diet: Count steps, not calories to lose weight and keep it off forever. New York, NY: Workman
- Hlatky, M. (2002). Economic endpoints in clinical trials. *Epidem Rev*, 24(1), 80-84.
- Honeycutt, A., Coleman, M., Wirth, K., & Anderson, W. (2006). Cost-effectiveness of standing orders for influenza and pneumococcal vaccinations in North Carolina hospitals. RTI working paper.
- Hubard, S. M., & Hayashi, S. W. (2003). Use of diffusion of innovations theory to drive a federal agency's program evaluation. *Evaluation and Program Planning*, 26, 49-56.
- W. K. Kellogg Foundation. (2004). Using logic models to bring together planning, evaluation, & action: Logic model development guide. Battle Creek, MI: W. K. Kellogg Foundation. Accessed January 27, 2006, from <http://www.wkcf.org/Pubs/Tools/Evaluation/Pub3669.pdf>.
- Kirtland, K. A., Porter, D. E., Addy, C. L., Neet, M. J., Williams, J. E., Sharpe, P. A., Neff, L. J., Kimsey, C. D. Jr, & Ainsworth, B. E. (2003). Environmental measures of physical activity supports: Perception versus reality. *American Journal of Preventive Medicine*, 24(4), 323-331.
- Kok, G., Schaalma, H., Rutter, R. A., & Van Empelen, P. (2004). Intervention mapping: A protocol for applying health psychology theory to prevention programmes. *Journal of Health Psychology*, 9(1), 85-98.
- Mandelblatt, J. S., Fryback, D. G., Weinstein, M. C., Russell, L. B., Gold, M. R., & Hadorn, D. C. (1996). Assessing the effectiveness of health interventions. *Cost-Effectiveness in Health and Medicine* (pp. 135-175). New York: Oxford University Press.
- McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, 15(4), 351-377.



- National Cancer Institute (NCI). (1995). *Community-based interventions for smokers: the COMMIT field experience*. Smoking and Tobacco Control Monograph No 6. Bethesda, Maryland: Public Health Service. Accessed January 27, 2006, from <http://dccps.nci.nih.gov/tcrb/monographs/6/>.
- Partnership for Prevention. (2001). What Policymakers need to know about cost effectiveness. Washington, DC: Partnership for Prevention.
- Renger, R., & Titcomb, A. (2002). A three-step approach to teaching logic models. *American Journal of Evaluation, 23*(4), 493-503.
- Rychetnik, L., Frommer, M., Hawe, P., & Shiell, A. (2002). Criteria for evaluating evidence on public health interventions. *Journal of Epidemiology and Community Health, 56*, 119-127.
- Ubel, P. A., DeKay, M. L., Baron, J., & Asch, D. A. (1996). Cost-effectiveness analysis in a setting of budget constraints—is it equitable? *N Engl J Med. 334*: 1174-1177.
- Wandersman, A., Imm, P., Chinman, M., & Kaftarian, S. (2000). Getting to outcomes: A results-based approach to accountability. *Evaluation and Program Planning, 23*, 389-395.
- Wilson, P. W., D'Agostino, R. B., Levy, D., Belanger, A. M., Silbershatz, H., & Kannel, W. B. (1998). Prediction of coronary heart disease using risk factor categories. *Circulation. 97*(18), 1837-1847.



## APPENDIX A

### ADDITIONAL RESOURCES ON PROGRAM AND ECONOMIC EVALUATION FOR PUBLIC HEALTH

**Table A-1. Resources for Economic Evaluation**

Authors/Editors	Title
Drummond MF, O'Brien B, Stoddart GL, Torrance GW	Methods for the economic evaluation of health care programmes (2nd Ed.). 1997. Oxford University Press.
Gold M, Siegel J, Russell L, Weinstein M	Cost-effectiveness in health and medicine. 1996. Oxford University Press.
Haddix AC, Teutsch SM, Corso PS	Prevention effectiveness: A guide to decision analysis and economic evaluation. 2003. Oxford University Press.
Drummond MF, McGuire A	Economic evaluation in health care: Merging theory with practice. 2002. Oxford University Press.
Johannesson, M	Theory and methods of economic evaluation of health care (Developments in Health Economics and Public Policy, v. 4). 1996. Kluwer Academic Publishers.
Muenning P, Kahn K	Designing and conducting cost-effectiveness analyses in medicine and health care (Jossey-Bass Health Care Series). 2002. Jossey-Bass.
Pettiti DB	Meta-analysis, decision analysis, and cost-effectiveness analysis: Methods for quantitative synthesis in medicine (2nd Ed.). 2000. Oxford University Press.
Siegel JE, Clancy CM	Community-based interventions: Taking on the cost and cost-effectiveness questions. 2000. Health Services Research. 35(5): 905-909.
Carande-Kulis VG, Maciosek MV, Briss PA, et al.	Methods for systematic reviews of economic evaluations for the Guide to Community Preventive Services. 2000. American Journal of Preventive Medicine. 18(Supplement 1): 75-91.
Bala MV, Zarkin GA	Application of cost-effectiveness analysis to multiple products: A practical guide. 2002. American Journal of Managed Care. 8(3): 211-218.
Finkelstein EA, Wittenborn JA, Farris RP	Evaluation of public health demonstration programs: The effectiveness and cost-effectiveness of WISEWOMAN. 2004. Journal of Women's Health. 13(5).
Birch S, Gafni A	Economics and the evaluation of health care programmes: Generalisability of methods and implications for generalisability of results. 2003. Health Policy. 64(2): 207-219.

**Table A-2. Resources for Program Evaluation**

<b>Authors/Editors</b>	<b>Title</b>
McKenzie JF, Smeltzer JL	Planning, implementing, and evaluating health promotion programs: A primer (3rd Ed.). 2001. Allyn and Bacon.
RE-AIM	A systematic way for researchers, practitioners, and policy makers to evaluate health behavior interventions. It can be used to estimate the potential impact of interventions on public health. More information at <a href="http://www.re-aim.org">www.re-aim.org</a> .
CDC	Framework for program evaluation in public health. 1999. MMWR. 48(RR-11).
W.K. Kellogg Foundation	Using logic models to bring together planning, evaluation, and action: Logic model development guide. More information at <a href="http://www.wkkf.org/Pubs/Tools/Evaluation/Pub3669.pdf">www.wkkf.org/Pubs/Tools/Evaluation/Pub3669.pdf</a> .
Kellam SG, Langevin DJ	A framework for understanding "evidence" in prevention research and programs. 2003. Prevention Science. 4(3): 137-153.
Boothroyd RA, Banks SM, Evans ME, Greenbaum PE, Brown E	Untangling the Web: an approach to analyzing the impacts of individually tailored, multicomponent treatment interventions. 2004. Mental Health Services Research. 6(3): 143-153.
Hawe P, Shiell A, Riley T, Gold L	Methods for exploring implementation variation and local context within a cluster randomised community intervention trial. 2004. Journal of Epidemiology and Community Health. 58(9): 788-793.
Hutchinson L	Evaluating and researching the effectiveness of educational interventions. 1999. British Medical Journal. 318: 1267-1269.

Note: This list represents some of the resources that were consulted in preparing this guide; it is not exhaustive.

## **APPENDIX B: EXAMPLES OF COST-EFFECTIVENESS ANALYSES OF COMMUNITY PREVENTION STRATEGIES IN THE LITERATURE**

1. **Chirikos TN, Herzog TA, Meade CD, Webb MS, Brandon TH. Cost-effectiveness analysis of a complementary health intervention: the case of smoking relapse prevention. *International Journal of Technology Assessment in Health Care*. 2004; 20(4):475-480.**

**Objectives:** We assessed the cost-effectiveness of smoking relapse prevention interventions designed to keep quitters from resuming the use of cigarettes. Because relapse prevention is complementary to smoking cessation efforts, the appropriate test of its cost-effectiveness is whether it reduces the incremental cost-effectiveness ratio (ICER) of smoking cessation. The major goal of the study is to carry out such a test.

**Methods:** Data from a randomized trial that ascertained the effectiveness of alternative modes of smoking relapse prevention were combined with ICER estimates of smoking cessation to assess whether relapse prevention is cost-effective.

**Results:** The trial produced convincing evidence that relapse prevention yields statistically significant reductions in the proportion of quitters who are smoking at 24 months post-quit. The intervention effects are substantial enough to raise the denominator terms of the smoking cessation ICER and, thereby, offset the amount relapse prevention adds to cost numerator terms. In this sense, smoking relapse prevention tends to pay for itself.

**Conclusions:** Smoking relapse prevention is a highly cost-effective addition to current efforts to curb cigarette consumption. Complementary health interventions of this type should be assessed by different methods than those commonly found in the cost-effectiveness literature.

2. **Curry SJ, Grothaus LC, McAfee T, Pabiniak C. Use and cost-effectiveness of smoking-cessation services under four insurance plans in a health maintenance organization. *NEJM*. 1998; 339(10):673-679.**

**Background:** Lack of information about the effect of insurance coverage on the demand for and use of smoking-cessation services has prevented wide-scale adoption of coverage for such services.

**Methods:** In a longitudinal, natural experiment, we compared the use and cost-effectiveness of three forms of coverage with those of a standard form of coverage for smoking-cessation services that included a behavioral program and nicotine replacement therapy (NRT). The study involved seven employers and a total of 90,005 adult enrollees. The standard plan offered 50% coverage of the behavioral program and full coverage of NRT. The other plans offered 50% coverage of both the behavioral program and NRT

(reduced coverage), full coverage of the behavioral program and 50% coverage of NRT (flipped coverage), or full coverage of both the behavioral program and NRT.

**Results:** Estimated annual rates of use of smoking cessation services ranged from 2.4% (among smokers with reduced coverage) to 10% (among those with full coverage). Smoking cessation rates ranged from 28% (among users with full coverage) to 38% (among those with standard coverage). The estimated percentage of all smokers who would quit smoking per year as a result of using the services ranged from 0.7% (with reduced coverage) to 2.8% (with full coverage). The average cost to the health plan per user who quit smoking ranged from \$797 (with standard coverage) to \$1,171 (with full coverage). The annual cost per smoker ranged from \$6 (with reduced coverage) to \$33 (with full coverage). The annual cost per enrollee ranged from \$0.89 (with reduced coverage) to \$4.92 (with full coverage).

**Conclusions:** Use of smoking cessation services varies according to the extent of coverage, with the highest rates of use among smokers with full coverage. Although the rate of smoking cessation among the benefit users with full coverage was lower than the rates among users with plans requiring co-payments, the effect on the overall prevalence of smoking was greater with full coverage than with the cost sharing plans.

**3. The Diabetes Prevention Program Research Group Within-trial cost-effectiveness of lifestyle intervention or metformin for the primary prevention of type 2 diabetes. *Diabetes Care*. 2003; 26(9):2518-2523.**

**Objective:** The Diabetes Prevention Program (DPP) demonstrated that intensive lifestyle and metformin interventions reduced the incidence of type 2 diabetes compared with a placebo intervention. The aim of this study was to assess the cost-effectiveness of the lifestyle and metformin interventions relative to the placebo intervention.

**Research Design and Methods:** Analyses were performed from a health system perspective that considered direct medical costs only and a societal perspective that considered direct medical costs, direct nonmedical costs, and indirect costs. Analyses were performed with the interventions as implemented in the DPP and as they might be implemented in clinical practice.

**Results:** The lifestyle and metformin interventions required more resources than the placebo intervention from a health system perspective, and over 3 years they cost approximately \$2,250 more per participant. As implemented in the DPP and from a societal perspective, the lifestyle and metformin interventions cost \$24,400 and \$34,500, respectively, per case of diabetes delayed or prevented and \$51,600 and \$99,200 per quality-adjusted life year (QALY) gained. As the interventions might be implemented in routine clinical practice and from a societal perspective, the lifestyle and metformin interventions cost \$13,200 and \$14,300, respectively, per case of diabetes delayed or prevented and \$27,100 and \$35,000 per QALY gained. From a health system perspective,

costs per case of diabetes delayed or prevented and costs per QALY gained tended to be lower.

**Conclusions:** Over 3 years, the lifestyle and metformin interventions were effective and were cost-effective from the perspective of a health system and society. Both interventions are likely to be affordable in routine clinical practice, especially if implemented in a group format and with generic medication pricing.

**4. Dueson RR, Brodovicz KG, Barker L, Zhou F, and Euler GL. Economic analysis of a child vaccination project among Asian Americans in Philadelphia, Pa. Arch Pediatr Adolesc Med. 2001 Aug; 155 (8):909-914.**

**Objective:** To ascertain the cost-effectiveness and the benefit-cost ratios of a community-based hepatitis B vaccination catch-up project for Asian American children conducted in Philadelphia, Pennsylvania, from October 1, 1994, to February 11, 1996.

**Design:** Program evaluation.

**Setting:** South and southwest districts of Philadelphia.

**Participants:** A total of 4384 Asian American children.

**Interventions:** Staff in the community-based organizations educated parents about the hepatitis B vaccination, enrolled physicians in the Vaccines for Children program, and visited homes of children due for a vaccine dose. Staff in the Philadelphia Department of Public Health developed a computerized database; sent reminder letters for children due for a vaccine dose; and offered vaccinations in public clinics, health fairs, and homes.

**Main Outcome Measures:** The numbers of children having received 1, 2, or 3 doses of vaccine before and after the interventions; costs incurred by the Philadelphia Department of Public Health and the community-based organizations for design, education, and outreach activities; the cost of the vaccination; cost-effectiveness ratios for intermediated outcomes (i.e., per child, per dose, per immunoequivalent patient, and per completed series); discounted cost per discounted year of life saved; and the benefit-cost ratio of the project.

**Results:** For the completed series of three doses, coverage increased by 12 percentage points at a total cost of \$268,600 for design, education, outreach, and vaccination. Costs per child, per dose, and per completed series were \$64, \$119, and \$537, respectively. The discounted cost per discounted year of life saved was \$11,525, and 106 years of life were saved through this intervention. The benefit-cost ratio was 4.44:1.

**Conclusion:** Although the increase in coverage was modest, the intervention proved cost-effective and cost-beneficial.

5. **Finkelstein EA, Troped PJ, Will JC, and Palombo R. Cost-Effectiveness of a cardiovascular disease risk reduction program aimed at financially vulnerable women: The Massachusetts WISEWOMAN project. *Journal of Women's Health and Gender-Based Medicine*. 2002; 11(6):519-526.**

**Objective:** The Massachusetts WISEWOMAN Project is a cardiovascular disease (CVD) risk reduction program targeting older uninsured and underinsured women. The cost-effectiveness of providing CVD screening and enhanced lifestyle interventions (EI), compared with providing CVD screening and a minimum intervention (MI), was assessed at five EI and six MI health care sites.

**Methods:** Cost calculations were based on data collected during screenings and intervention activities conducted with 1,586 women in 1996. Risk factor data, including cholesterol and blood pressure measures, were used to create a summary effectiveness outcome, the 10-year probability of developing coronary heart disease (CHD). The cost-effectiveness ratio of the EI, compared with the MI, was calculated by dividing the incremental cost of the EI by the incremental effectiveness of the EI.

**Results:** The incremental cost of the EI was \$191. During the 1-year study period, the 10-year probability of CHD decreased from 9.4% to 9.2% in the MI group and from 10.3% to 9.8% in the EI group. Based on these results, it would cost \$637 to achieve a 1 percentage point larger decrease in the 10-year probability of CHD for women enrolled in the EI. However, because differences between groups were not statistically significant, we cannot reject the hypothesis that the EI results in no greater reductions in CHD risk.

**Conclusions:** Although women enrolled in both the MI and EI showed decreases in CHD risk during the study period, future research is needed to assess the impact of lifestyle interventions targeting financially disadvantaged women.

6. **Hatziandreu EJ, Sacks JJ, Brown R, Taylor WR, Rosenberg ML, and Graham JD. The cost effectiveness of three programs to increase use of bicycle helmets among children. *Public Health Report*. 1995 May-June; 110(3):251-259.**

Each year in the United States, 280 children die from bicycle crashes and 144,000 are treated for head injuries from bicycling. Although bicycle helmets reduce the risk of head injury by 85%, few children wear them.

To help guide the choice of strategy to promote helmet use among children ages 5 to 16 years, the cost-effectiveness of legislative, communitywide, and school-based approaches was assessed. A societal perspective was used, only direct costs were included, and a 4-year period after program startup was examined. National age-specific injury rates and an attributable risk model were used to estimate the expected number of bicycle-related head injuries and deaths in localities with and without a program.



The percentage of children who wore helmets increased from 4 to 47 in the legislative program, from 5 to 33 in the community program, and from 2 to 8 in the school program. Two programs had similar cost-effectiveness ratios per head injury avoided. The legislative program had a cost of \$36,643; the community-based program had a cost of \$37,732; and the school-based program had a cost of \$144,498 per head injury avoided. The community program obtained its 33% usage gradually over the 4 years, while the legislative program resulted in an immediate increase in usage. Thus, considering program characteristics and overall results, the legislative program appears to be the most cost-effective. The cost of helmets was the most influential factor on the cost-effectiveness ratio.

The year 2000 health objectives call for use of helmets by 50% of bicyclists. Because helmet use in all these programs is less than 50%, new or combinations of approaches may be required to achieve the objective.

**7. Holtgrave DR, Kelly JA. Preventing HIV/AIDS among high-risk urban women: The cost-effectiveness of a behavioral group intervention. *Am J Public Health*. 1996; 86:1442-1445.**

**Objectives:** A human immunodeficiency virus (HIV) intervention trial for women at high risk for acquired immunodeficiency syndrome and attending an urban clinic was reported previously. The behavioral group intervention was shown to increase condom use behaviors significantly. This study retrospectively assessed the intervention's cost-effectiveness.

**Methods:** Standard methods of cost and cost-utility analysis were used.

**Results:** The intervention cost was just over \$2,000 for each QALY saved; this is favorable compared with other life-saving programs. However, the results are sensitive to changes in some model assumptions.

**Conclusions:** Under most scenarios, the HIV prevention intervention was cost-effective.

**8. Holtgrave DR, Kelly JA. Cost-effectiveness of an HIV/AIDS prevention intervention for gay men. *AIDS Behav*. 1997; 1(3):173-180.**

The present study sought to determine the cost per discounted QALY saved by a small group workshop-format, cognitive-behavioral HIV-prevention intervention for gay men. The methodology employed was a retrospective cost-utility analysis of the behavioral intervention. The ability of the intervention to effect HIV-related behavior change was previously assessed in a randomized controlled trial. In the original trial, clients were recruited from gay bars, health department clinics, and other community settings in metropolitan area of 400,000 residents; the intervention was delivered in a medical school outreach setting. The participants were 104 gay men; 87% of the clients identified their race/ethnicity as White and 13% as ethnic minority. The experimental intervention comprised 12 sessions and provided HIV-related risk behavior education, self-management and sexual assertion training, and development of reliable and positive social support

networks. The comparison condition was a wait-list control group. The main outcome measure in our retrospective cost-utility analysis was “cost per discounted QALY saved.” Under base-case assumptions, the cost of the intervention was \$24,000 (rounded to the nearest thousand). The discounted medical costs averted by preventing HIV infection were \$42,000. Approximately 5.5 discounted QALYs were saved. Hence the intervention is cost-saving under base-case assumptions (i.e., the cost per discounted QALY saved ratio is less than zero). The results are generally robust to changes in cost-utility analysis model parameters and assumptions. Because the intervention is cost-saving under base-case assumptions, it compares favorably with other health service interventions in which society currently invests. Behavioral interventions such as the one examined here should receive serious consideration for investment by public health decision makers allocating fiscal resources for health services.

**9. Johnson-Masotti AP, Pinkerton SD, Kelly JA, Stevenson LY. Cost-effectiveness of an HIV risk reduction intervention for adults with severe mental illness. *AIDS Care*. 2000; 12(3):321-332.**

Small-group HIV prevention interventions that focus on individual behavioral change have been shown to be especially effective in reducing HIV risk among persons with severe mental illness. Because economic resources to fund HIV prevention efforts are limited, health departments, community planning groups and other key decision makers need reliable information on the cost and cost-effectiveness (not solely on effectiveness) of different HIV prevention interventions. This study used an economic evaluation technique known as cost-utility analysis to assess the cost-effectiveness of three related cognitive-behavioral HIV risk reduction interventions: a single-session, one-on-one intervention; a multi-session small-group intervention; and a multi-session small-group intervention that taught participants to act as safer sex advocates to their peers. For men, all three interventions were cost-effective, but advocacy training was the most cost-effective of the three. For women, only the single-session intervention was cost-effective. The gender differences observed here highlight the importance of focusing on gender issues when delivering HIV prevention interventions to men and women who are severely mentally ill.

**10. Kahn JG, Kegeles SM, Hays R, Beltzer N. Cost-effectiveness of the Mpowerment Project, a community-level intervention for young gay men. *J Acquir Immune Defic Syndr*. 2001 Aug; 15; 27(5):482-491.**

**Objectives:** Previous evaluation demonstrated that the Mpowerment Project community-level intervention for young gay men reduces HIV risk behaviors. The current analysis was undertaken to estimate the intervention’s health and economic outcomes.

**Design/Methods:** We conducted a retrospective cost-effectiveness analysis. We estimated HIV infections averted, the gain in QALYs, cost per infection averted, and net cost. Using a population-level model, we portrayed two epidemic scenarios: the first with stable HIV prevalence and the other with rising HIV prevalence. Inputs included behavior change

resulting from the intervention and program cost data. Cost was calculated from three perspectives: societal, societal excluding volunteer time, and that of a community-based organization (CBO). Outcomes were calculated for 1, 5 (baseline), and 20 years.

**Results:** The Mpowerment Project averted an estimated 2.0 to 2.3 HIV infections in the first year (according to the epidemic scenario), 5.0 to 6.2 over 5 years, and 9.2 to 13.1 over 20 years. The societal cost per HIV infection averted was estimated at between \$14,600 and \$18,300 over 5 years. Costs per infection averted were 28% lower when excluding volunteer time and 35% lower from the CBO perspective. Net savings were \$700,000 to \$900,000 over 5 years from the societal perspective.

**Conclusions:** The Mpowerment Project is cost-effective compared with many other HIV prevention strategies. The cost per HIV infection prevented is far less than the lifetime medical costs of HIV disease.

**11. Meenan RT, Stevens VJ, Hornbrook MC, La Chance PA, Glasgow RE, Hollis JF, Lichtenstein E, Vogt T. Cost-effectiveness of a hospital-based smoking cessation intervention. *Medical Care*. 1998; 36(5):670-678.**

**Objectives:** This study evaluated the cost-effectiveness of a smoking cessation and relapse-prevention program for hospitalized adult smokers from the perspective of an implementing hospital. It is an economic analysis of a two-group, controlled clinical trial in two acute care hospitals owned by a large group-model health maintenance organization. The intervention included a 20-minute bedside counseling session with an experienced health counselor, a 12-minute video, self-help materials, and one or two follow-up calls.

**Methods:** Outcome measures were incremental cost (above usual care) per quit attributable to the intervention and incremental cost per discounted life-year saved attributable to the intervention.

**Results:** Cost of the research intervention was \$159 per smoker, and incremental cost per incremental quit was \$3,697. Incremental cost per incremental discounted life-year saved ranged between \$1,691 and \$7,444, much less than most other routine medical procedures. Replication scenarios suggest that, with realistic implementation assumptions, total intervention costs would decline significantly and incremental cost per incremental discounted life-year saved would be reduced by more than 90%, to approximately \$380.

**Conclusions:** Providing brief smoking cessation advice to hospitalized smokers is relatively inexpensive, cost-effective, and should become a part of the standard of inpatient care.

**12. Myers ML, Cole HP, Westneat SC. Cost-effectiveness of a ROPS retrofit education campaign. *J Agric Saf Health*. 2004 May; 10(2):77-90.**

A community educational campaign implemented in two Kentucky counties was effective in influencing farmers to retrofit their tractors with rollover protective structures (ROPS) to

protect tractor operators from injury in the event of an overturn. This article reports on the cost-effectiveness of this program in the two counties when compared with no program in a control county. A decision analysis indicated that it would be effective at averting 0.27 fatal and 1.53 nonfatal injuries over a 20-year period; extending this analysis statewide, 7.0 fatal and 40 nonfatal injuries would be averted in Kentucky. Over the 20-year period, the cost per injury averted was calculated to be \$172,657 at a 4% annual discount rate. This cost compared favorably with a national cost of \$489,373 per injury averted despite the additional program cost in Kentucky. The principle reason for the increased cost-effectiveness of the Kentucky program was the threefold higher propensity for tractors to overturn in Kentucky. The cost per injury averted in one of the two counties was \$112,535. This lower cost was attributed principally to incentive awards financed locally for farmers to retrofit their tractors with ROPS.

**13. Pinkerton SD, Holtgrave DR, DiFranceis WJ, Stevenson LY, Kelly JA. Cost-effectiveness of a community-level HIV risk reduction intervention. *Am J Public Health*. 1998 Aug; 88(8):1239-1242.**

**Objectives:** The authors evaluated the cost-effectiveness of a community-level HIV prevention intervention that used peer leaders to endorse risk reduction among gay men.

**Methods:** A mathematical model of HIV transmission was used to translate reported changes in sexual behavior into an estimate of the number of HIV infections averted.

**Results:** The intervention cost \$17,150, or about \$65 000 per infection averted, and was therefore cost saving, even under very conservative modeling assumptions.

**Conclusions:** For this intervention, the cost of HIV prevention was more than offset by savings in averted future medical care costs. Community-level interventions to prevent HIV transmission that use existing social networks can be highly cost-effective.

**14. Pinkerton SD, Holtgrave DR, Jemmott JB. Economic analysis of an HIV risk reduction intervention for male African American adolescents. *J Acquir Immune Defic Syndr*. 2000; 25:164-172.**

**Purpose:** To evaluate the cost-effectiveness of a cognitive-behavioral HIV risk reduction intervention for African-American male adolescents that has previously been shown to be effective at reducing sexual risk taking.

**Methods:** Standard techniques of cost-utility analysis were employed. A societal perspective and a 3% discount rate were used in the main analysis. Program costs were ascertained retrospectively. A mathematical model of HIV transmission was used to translate observed changes in sexual behavior into an estimate of the number of HIV infections the intervention averted. Intervention effects were assumed to last for 1 year. For each infection averted, the corresponding savings in future HIV-related medical care costs and QALYs were estimated. The overall net cost per QALY saved (cost-utility ratio) was then

calculated. Sensitivity analyses were performed to assess the robustness of the main results.

**Results:** The cost-utility ratio was approximately \$57,000 U.S. per QALY saved when training costs were included, and \$41,000 U.S. per QALY saved when they were excluded. The intervention appeared substantially more cost-effective when the analysis was restricted to the subgroup of participants who reported being sexually active at baseline. Assumptions about the prevalence of HIV infection and the duration of intervention effectiveness also greatly affected the cost-utility ratio.

**Conclusions:** The HIV prevention intervention was moderately cost-effective in comparison with other health care programs. Selectively implementing the intervention in high-HIV prevalence communities and with sexually active youth can enhance cost-effectiveness.

**15. Pinkerton SD, Holtgrave DR, Valdiserri RO. Cost-effectiveness of HIV-prevention skills training for men who have sex with men. AIDS. 1997; 11:347-357.**

**Objective:** A previous study empirically compared the effects of two HIV-prevention interventions for men who have sex with men: (1) a safer sex lecture and (2) the same lecture coupled with a 1.5-hour skills training group session. The skills-training intervention led to a significant increase in condom use at 12-month follow-up, compared with the lecture-only condition. The current study retrospectively assesses the incremental cost-effectiveness of skills training to determine whether it is worth the extra cost to add this component to an HIV-prevention intervention that would otherwise consist of a safer sex lecture only.

**Design:** Standard techniques of incremental cost-utility analysis were employed.

**Methods:** A societal perspective and a 5% discount rate were used. Cost categories assessed included staff salary, fringe benefits, quality assurance, session materials, client transportation, client time valuation, and costs shared with other programs. A Bernoulli-process model of HIV transmission was used to estimate the number of HIV infections averted by the skills-training intervention component. For each infection averted, the discounted medical costs and QALYs saved were estimated. One- and multi-way sensitivity analyses were performed to assess the robustness of base-case results to changes in modeling assumptions.

**Results:** Under base-case assumptions, the incremental cost of the skills training was less than \$13,000 (or about \$40 per person). The discounted medical costs averted by incrementally preventing HIV infections were over \$170,000; more than 21 discounted QALY were saved. The cost per QALY saved was negative, indicating cost-savings. These results are robust to changes in most modeling assumptions. However, the model is moderately sensitive to changes in the per-contact risk of HIV transmission.

**Conclusions:** Under most reasonable assumptions, the incremental costs of the skills training were outweighed by the medical costs saved. Thus, not only is skills training effective in reducing risky behavior, it is also cost-saving.

**16. Pinkerton SD, Johnson-Masotti AP, Otto-Salaj LL, Stevenson LY, Hoffmann RG. Cost-effectiveness of an HIV prevention intervention for mentally ill adults. *Mental Health Serv Res.* 2001; 3:45-55.**

Adults with severe mental illness are at high risk for HIV infection and transmission. Small-group interventions that focus on sexual communication, condom use skills, and motivation to practice safer sex have been shown to be effective at helping mentally ill persons reduce their risk for HIV. However, the cost-effectiveness of these interventions has not been established. We evaluated the cost-effectiveness of a 9-session small-group intervention for women with mental illness recruited from community mental health clinics in Milwaukee, Wisconsin. We used standard techniques of cost-utility analysis to determine the cost per QALY saved by the intervention. This analysis indicated that the intervention cost \$679 per person, and over \$136,000 per QALY saved. When the analysis was restricted to the subset of women who reported having engaged in vaginal or anal intercourse in the 3 months prior to the baseline assessment, the cost per QALY saved dropped to approximately \$71,000. These estimates suggest that this intervention is marginally cost-effective in comparison with other health promotion interventions, especially if high-risk, sexually active women are preferentially recruited.

**17. Roux L, Pratt M, Yanagawa T, Yore M, Tengs TO. 2004. Measurement of the value of exercise: a cost-effectiveness analysis of promoting physical activity among adults. Poster session, CEA Methods and Applications, Health Services Research.**

**Purpose:** Our objective was to assess the cost-effectiveness of population-wide strategies to promote physical activity in adults.

**Methods:** We developed a novel and comprehensive state-transition Markov model to estimate the costs, health gains (QALYs), and cost-effectiveness of four alternate public health strategies to promote physical activity. To identify strategies, we selected those that were "strongly recommended" by the U.S. Task Force for Preventive Services. Interventions exemplifying each of four strategies were evaluated. A community-wide campaign strategy was represented by a multifactorial and multimedia-dependent health education intervention. An intervention emphasizing the use of personal trainers and financial incentives exemplified an individually-adapted health behavior change strategy. A social support strategy was represented by an intervention that incorporated organized walking groups, social gatherings, phone calls, and home visits. Finally, a strategy of enhanced access was characterized by an intervention that exposed an entire community to an environment conducive to an active lifestyle (e.g., new bicycle paths, fitness facility hour extension). Each intervention was compared to a no intervention alternative. Efficacy

estimates were obtained from randomized controlled trials. A systematic review of disease burden by exercise status was used to assess the relative risk of five diseases (coronary heart disease, ischemic stroke, colorectal cancer, breast cancer, and type 2 diabetes) for each of the following physical activity levels: (1) inactive, (2) irregularly active, (3) sufficiently active to minimally meet public health recommendations, and (4) highly active. Quality of life data by disease state, exercise level, age, and gender were obtained using the Quality of Well Being Scale. Longitudinal medical costs for the disease states were gathered from a 400,000-member claims database and annualized using actuarial methods. Costs and QALYs were assessed from a societal perspective over 10-, 20-, 30-, and 40-year time horizons and discounted back to the present at 3%.

**Results:** While the most effective strategy focused on enhancing access to physical activity, social support was the most cost-effective strategy at \$6,400 per QALY, assuming a 40-year time horizon. Enhanced access cost \$34,000 per QALY, individually adapted cost \$73,000 per QALY, and community campaign cost \$110,000 per QALY. Results were sensitive to intervention-related costs and efficacy.

**Conclusion:** For adults, social support offered the best value for money. However, compared with other well-accepted preventive strategies, all physical activity promotion strategies evaluated offered good value for money.

**18. Secker-Walker RH, Holland RR, Lloyd CM, Pelkey D, Flynn BS. Cost-effectiveness of a community based research project to help women quit smoking. *Tobacco Control*. 2005; 14:37-42.**

**Objective:** To estimate the cost-effectiveness of a 4-year, multifaceted, community-based research project shown previously to help women quit smoking.

**Design:** A quasi-experimental matched control design.

**Setting:** Two counties in Vermont and two in New Hampshire, USA.

**Subjects:** Women aged 18 to 64.

**Methods:** Costs were the grant-related expenditures converted to 2002 U.S. dollars. Survey results at the end of the intervention were used to estimate the numbers of never smokers, former smokers, light smokers, and heavy smokers in the intervention and comparison counties, and 1986 life tables for populations of U.S. women categorized by smoking status to estimate the gain in life expectancy.

**Main Outcome Measures:** Cost-effectiveness ratios, as dollars per life-year saved, for the intervention only and for total grant costs (intervention, evaluation and indirect costs).

**Results:** The cost-effectiveness ratio for the intervention, in 2002 US\$ per life-year saved, discounted at 3%, was \$1,156 (90% confidence interval [CI] \$567 to infinity), and for the total grant, \$4,022 (90% CI \$1,973 to infinity). When discounted at 5%, these ratios were

\$1,922 (90% CI \$1,024 to \$15,647), and \$6,683 (90% CI \$3,555 to \$54,422), respectively.

**Conclusion:** The cost-effectiveness ratios of this research project are economically attractive and are comparable with other smoking cessation interventions for women. These observations should encourage further research and dissemination of community based interventions to reduce smoking.

**19. Secker-Walker RH, Worden JK, Holland RR, Flynn BS, Detsky AS. A mass media programme to prevent smoking among adolescents: costs and cost-effectiveness. *Tobacco Control*. 1997; 6:207-212.**

**Objective:** To examine costs and cost-effectiveness ratios of a 4-year mass media program previously shown to prevent the onset of smoking among adolescents.

**Design:** A matched control design.

**Setting:** Two cities in Montana, one in New York, and one in Vermont, USA.

**Subjects:** Students in grades 10 through 12 (ages 15 to 18).

**Intervention:** A 4-year mass media campaign to prevent the onset of smoking.

**Main Outcome Measures:** Cost per student potentially exposed to the mass media campaign, cost per student smoker potentially averted, and cost per life-year gained. Cost estimates were also made for a similar campaign that would be broadcast nationally in the United States.

**Results:** In 1996 dollars, the cost of developing and broadcasting the mass media campaign was \$759,436, and the cost per student potentially exposed to the campaign (n=18,600) was \$41. The cost per student smoker averted (n = 1,023) was \$754 (95% CI = \$531-\$1,296). The cost per life-year gained discounted at 3% over the life expectancy for young adult smokers was \$696 (95% CI = \$445-\$1,269). The estimated cost of developing and broadcasting a similar 4-year mass media campaign in all 209 American media markets would be approximately \$84.5 million, at a cost of \$8 per student potentially exposed to a national campaign, \$162 per student smoker averted, and \$138 (95% CI = \$88-\$252) per life-year gained.

**Conclusion:** Estimates of the cost-effectiveness ratios of this mass media campaign in preventing the onset of smoking showed it to be economically attractive and to compare favorably with other preventive and therapeutic strategies.



**20. Sevick MA, Dunn AL, Morrow MS, Marcus BH, Chen GJ, Blair SN. Cost-effectiveness of lifestyle and structured exercise interventions in sedentary adults: results of project ACTIVE. Am J Prev Med. 2000; 19(1):1-8.**

**Background:** Project *ACTIVE* was a randomized clinical trial comparing two physical activity interventions: lifestyle and traditional structured exercise. The two interventions were evaluated and compared in terms of cost-effectiveness and ability to enhance physical activity among sedentary adults.

**Design:** This was a randomized clinical trial.

**Setting/Participants:** The study included 235 sedentary but healthy community-dwelling adults.

**Intervention:** A center-based lifestyle intervention that consisted of behavioral skills training was compared to a structured exercise intervention that included supervised, center-based exercise.

**Main Outcome Measures:** The main outcome measures of interest included cost, cardio respiratory fitness, and physical activity.

**Results:** Both interventions were effective in increasing physical activity and fitness. At 6 months, the costs of the lifestyle and structured interventions were, respectively, \$46.53 and \$190.24 per participant per month. At 24 months, these costs were \$17.15 and \$49.31 per participant per month. At both 6 months and 24 months, the lifestyle intervention was more cost-effective than the structured intervention for most outcomes measures.

**Conclusions:** A behaviorally-based lifestyle intervention approach in which participants are taught behavioral skills to increase their physical activity by integrating moderate-intensity physical activity into their daily lives is more cost-effective than a structured exercise program in improving physical activity and cardio respiratory health. This study represents one of the first attempts to compare the efficiency of intervention alternatives for improving physical activity among healthy, sedentary adults.

**21. Sullivan SD, Weiss KB, Lynn H, Mitchell H, Kattan M, Gergen PJ, Evans R. The cost-effectiveness of an inner-city asthma intervention for children. J Allergy Clin Immunol. 2002; 110(4):576-581.**

**Background:** Comprehensive management efforts to reduce asthma morbidity among children in urban areas with high levels of poverty and large minority populations have been inconclusive. The National Cooperative Inner-City Asthma Study (NCICAS) demonstrated improved symptom outcomes but did not evaluate cost-effectiveness in this population.

**Objective:** We sought to examine the incremental cost-effectiveness of a comprehensive social worker-based education program and environmental control in children with asthma stratified by baseline level of asthma control.

**Methods:** We performed a prospective cost-effectiveness analysis alongside a randomized trial. A total of 1,033 children and their families residing in eight inner-city urban areas in the United States were enrolled in the NCICAS. Outcomes included symptom-free days, cost per symptom-free day gained, and annual costs of asthma morbidity compared by baseline symptom control, previous hospitalization, and previous unscheduled physician visits.

**Results:** The NCICAS intervention significantly reduced asthma symptoms. First-year intervention costs were \$245 higher for the intervention children compared with those receiving usual care. There were no additional intervention-related costs during the second year. When compared with usual care, the intervention improved outcomes at an average additional cost of \$9.20 per symptom-free day gained (95% CI: -\$12.56 to \$55.29). The intervention was cost saving in three strata of children with increasing asthma severity.

**Conclusions:** A multifaceted asthma intervention program reduced symptom days and was cost-effective for inner-city children with asthma. In children with more severe disease, the intervention was substantially more effective and reduced costs compared with that seen in control children. Organizations serving this population should consider this strategy as part of a comprehensive disease-management program for asthma.

**22. Sweat M, O'Donnell C, O'Donnell L Cost-effectiveness of a brief video-based HIV intervention for African American and Latino sexually transmitted disease clinic clients AIDS. 2001; 15:781-787.**

**Background and Objectives:** Decisions about the dissemination of HIV interventions need to be informed by evidence of their cost-effectiveness in reducing negative health outcomes. Having previously shown the effectiveness of a single-session video-based group intervention (VOICES/VOCES) in reducing incidence of sexually transmitted diseases (STDs) among male African American and Latino clients attending an urban STD clinic, this study estimates its cost-effectiveness in terms of disease averted.

**Methods:** Cost-effectiveness was calculated using data on effectiveness from a randomized clinical trial of the VOICES/VOCES intervention along with updated data on the costs of intervention from four replication sites. STD incidence and self-reported behavioral data were used to make estimates of reduction in HIV incidence among study participants.

**Results:** The average annual cost to provide the intervention to 10,000 STD clinic clients was estimated to be US\$447,005, with a cost per client of US\$43.30. This expenditure would result in an average of 27.69 HIV infections averted, with an average savings from averted medical costs of US\$5,544,408. The number of QALYs saved averaged 387.61, with a cost per HIV infection averted of US\$21,486.

**Conclusions:** This brief behavioral intervention was found to be feasible and cost saving when targeted to male STD clinic clients at high risk of contracting and transmitting

infections, indicating that this strategy should be considered for inclusion in HIV prevention programming.

**23. Tao G, Remafedi G. Economic evaluation of an HIV prevention intervention for gay and bisexual male adolescents. *J Acquir Immune Defic Syndr Hum Retrovirol.* 1998; 17:83-90.**

The objective of this study was to evaluate the cost-effectiveness of an HIV prevention intervention for gay and bisexual male adolescents. The intervention included individualized risk assessment and counseling, peer education, optional HIV testing, and referrals to needed services. From 1989 to 1994, 501 male volunteers, 13 to 21 years of age, who self-identified as gay/bisexual or as having had sex with men, completed pre-intervention and post-intervention surveys to assess changes in HIV risk behavior. An HIV transmission model was constructed to project the HIV seroprevalence in the target population over a 10-year period from the self-reported number of partners for unprotected anal intercourse. Cost-effectiveness was analyzed from a societal perspective. Total costs of the intervention, including medical treatment costs saved, were projected to be US\$1.1 million for the 10-year period. The number of HIV infections averted and QALYs saved were projected to be 13 and 180, respectively. An incremental cost-effectiveness ratio was projected to be US\$6,180 per QALY saved. The intervention was found to be cost-effective from the societal perspective. In addition, HIV prevalence in the target population was projected to be 6.1% without and 5.6% with intervention by the end of the 10-year period. This study highlights that an HIV prevention program can be cost-effective even if the effects on behavior are partial and short term.

**24. Tosteson ANA, Weinstein MC, Hunink MGM, Mittleman MA, Williams LW, Goldman PA, Goldman L. Cost-effectiveness of population wide educational approaches to reduce serum cholesterol levels. *Circulation.* 1997; 95:24-30.**

**Background:** The aim of this study was to estimate the cost-effectiveness of population-wide approaches to reduce serum cholesterol levels in the U.S. adult population.

**Methods and Results:** This cost-effectiveness analysis used data from the literature and the Coronary Heart Disease Policy Model and was based on the U.S. population aged 35 to 84. Study interventions were population-wide programs to reduce serum cholesterol levels with costs and cholesterol-lowering effects similar to those reported from the Stanford Three-Community Study, the Stanford Five-City Project, and in North Karelia, Finland. The main outcome measures were cost-effectiveness ratios, defined as the change in projected cost divided by the change in projected life-years when the population receives the intervention compared with the population without the intervention. A population wide program with the costs (\$4.95 per person per year) and cholesterol-lowering effects (an average 2% reduction in serum cholesterol levels) of the Stanford Five-City Project would prolong life at an estimated cost of only \$3,200 per year of life saved. Under a wide variety of assumptions, a population-wide program would achieve health benefits at a cost

equivalent to that of many currently accepted medical interventions. Such programs would also lengthen life and save resources under many scenarios, especially if the program affected persons with preexisting heart disease or altered other coronary risk factors.

**Conclusions:** Population-wide programs should be part of any national health strategy to reduce coronary heart disease.

- 25. Wang G, Macera CA, Scudder-Soucie B, Schmid T, Pratt M, Buchner D. Cost-effectiveness of a bicycle/pedestrian trail development in health promotion Preventive Medicine. 2004; 38:237-242.**

**Background:** A persistently low population level of physical activity is a challenge for public health. Data on cost-effectiveness of environmental interventions are needed to inform the development and implementing of such interventions.

**Objective:** To conduct cost-effectiveness analysis of bicycle/pedestrian trails.

**Design:** The costs of trail development and number of users of four trails in Lincoln, Nebraska, were obtained. The costs were adjusted to 2003 dollars. The physical activity-related outcomes/items are number of users who were more physically active since they began using the trails, number of users who were physically active for general health, and number of users who were physically active for weight loss. Cost-effectiveness measures were derived. Sensitivity analysis was performed.

**Results:** The annual trail development cost US\$289,035, 73% of which was construction cost. Of the 3,986 trail users, 88% were active at least 3 days a week. The average annual cost for persons becoming more physically active was US\$98 (range US\$65–\$253); the cost was US\$142 (range US\$95–\$366) for persons who are active for general health and US\$884 (range US\$590–\$2,287) for persons who are active for weight loss.

**Conclusion:** This analysis provides basic cost-effectiveness measures of bicycle/pedestrian trails. Policy makers can use this information in making resource allocation decisions.

- 26. Wang LY, Crossett LS, Lowry R, Sussman S, Dent CW. Cost-effectiveness of a school-based tobacco-use prevention program. Arch Pediatr Adolesc Med. 2001 Sep; 155:1043-1050.**

**Objective:** To determine the cost-effectiveness of a school-based tobacco-use prevention program.

**Design:** Using data from the previously reported 2-year efficacy study of the Project Toward No Tobacco Use (TNT), we conducted a decision analysis to determine the cost-effectiveness of TNT. The benefits measured were life years saved, QALYs saved, and medical care costs saved, discounted at 3%. The costs measured were program costs. We quantified TNT's cost-effectiveness as cost per life year saved and cost per QALY saved.

**Intervention:** A 10-lesson curriculum designed to counteract social influences and misconceptions that lead to tobacco use was delivered by trained health educators to a cohort of 1,234 seventh grade students in eight junior high schools. A two-lesson booster session was delivered to the eighth grade students in the second year. The efficacy evaluation was based on 770 ninth grade students who participated in the program in the seventh and eighth grades and in both the baseline and the 2-year follow-up survey.

**Results:** Under base-case assumptions, at an intervention cost of \$16,403, TNT prevented an estimated 34.9 students from becoming established smokers. As a result, we could expect a saving of \$13,316 per life year saved and a saving of \$8,482 per QALY saved. Results showed TNT to be cost saving over a reasonable range of model parameter estimates.

**Conclusions:** TNT is highly cost-effective compared with other widely accepted prevention interventions. School-based prevention programs of this type warrant careful consideration by policy makers and program planners.

**27. Wang LY, Yang Q, Lowry R, Wechsler H. Economic analysis of a school-based obesity prevention program. *Obesity Research*. 2003; 11(11):1313-1324.**

**Objective:** To assess the cost-effectiveness and cost-benefit of Planet Health, a school-based intervention designed to reduce obesity in youth of middle-school age children.

**Research Methods and Procedures:** Standard cost-effectiveness analysis methods and a societal perspective were used in this study. Three categories of costs were measured: intervention costs, medical care costs associated with adulthood overweight, and costs of productivity loss associated with adulthood overweight. Health outcome was measured as cases of adulthood overweight prevented and QALYs saved. Cost-effectiveness ratio was measured as the ratio of net intervention costs to the total number of QALYs saved, and net-benefit was measured as costs averted by the intervention minus program costs.

**Results:** Under base-case assumptions, at an intervention cost of \$33,677 or \$14 per student per year, the program would prevent an estimated 1.9% of the female students (5.8 of 310) from becoming overweight adults. As a result, an estimated 4.1 QALYs would be saved by the program, and society could expect to save an estimated \$15,887 in medical care costs and \$25,104 in loss of productivity costs. These findings translated to a cost of \$4,305 per QALY saved and a net saving of \$7,313 to society. Results remained cost-effective under all scenarios considered and remained cost-saving under most scenarios.

**Discussion:** The Planet Health program is cost-effective and cost-saving as implemented. School-based prevention programs of this type are likely to be cost-effective uses of public funds and warrant careful consideration by policy makers and program planners.

**28. Weaver M, Krieger J, Castorina J, Walls M, Ciske S. Cost-effectiveness of combined outreach for the pneumococcal and influenza vaccines. Arch Intern Med. 2001; 161(1):111-120.**

**Background:** We conducted a cost-effectiveness analysis as part of a randomized, controlled trial of a community-based outreach initiative to promote the pneumococcal and influenza vaccines for people aged 65 years or older.

**Methods:** The analysis was based on primary data from the trial on the increase in vaccination rates and cost of the intervention, and published estimates of the effectiveness of the vaccines and cost of treatment. We performed partial stochastic analyses based on the confidence intervals (CIs) of the effectiveness of the intervention and of the vaccines.

**Results:** The cost-effectiveness ratio of the combined-outreach initiative as implemented was \$35,486 per QALY, whereas it was \$53,547 per QALY for the pneumococcal vaccine and \$130,908 per QALY for the influenza vaccine. In partial stochastic analyses, the quasi-CI of the combined-outreach initiative ranged from \$15,145 to \$152,311 per QALY. The cost-effectiveness ratio of the intervention targeted to people who had never received the pneumococcal vaccine or who had not received the influenza vaccine in the previous year was \$11,771 per QALY, with a quasi-CI of \$3,330 to \$46,095 per QALY. With the use of the projected cost of replicating the intervention, the cost-effectiveness ratio was \$26,512 per QALY for the initiative as implemented and \$7,843 per QALY for a targeted initiative.

**Conclusions:** The community-based outreach initiative to promote the pneumococcal and influenza vaccines was reasonably cost-effective. Further improvements in cost-effectiveness could be made by targeting the initiative or through lessons learned during the first year that would reduce the cost of the initiative in subsequent years.

**29. Zarkin GA, Lindrooth RC, Demiralp B, Wechsberg W. The cost and cost-effectiveness of an enhanced intervention for people with substance abuse problems at risk for HIV. Health Serv Res. 2001; 36(2):335-357.**

**Objective:** To estimate the costs, effectiveness, and cost-effectiveness of prevention interventions for out-of-treatment substance abusers at risk for HIV. This is the first cost-effectiveness study of an AIDS intervention that focuses on drug use as an outcome.

**Study Design:** We examined data from the North Carolina Cooperative Agreement site (NC CoOp). All individuals in the study were given the revised NIDA standard intervention and randomly assigned to either a longer, more personalized enhanced intervention or no additional intervention. We estimated the cost of each intervention and, using simple means analysis and multiple regression models, estimated the incremental effectiveness of the enhanced intervention relative to the standard intervention. Finally, we computed cost-effectiveness ratios for several drug use outcomes and compared them to a "back-of-the-envelope" estimate of the benefit of reducing drug use.

**Principal Findings:** The estimated cost of implementing the standard intervention is \$187.52, and the additional cost of the enhanced intervention is \$124.17. Cost-effectiveness ratios range from \$35.68 to \$139.52 per reduced day of drug use, which are less than an estimate of the benefit per reduced drug day.

**Conclusions:** The additional cost of implementing the enhanced intervention is relatively small and compares favorably to a rough estimate of the benefits of reduced days of drug use. Thus, the enhanced intervention should be considered an important additional component of an AIDS prevention strategy for out-of-treatment substance abusers.

**30. Zhou F, Euler GL, McPhee SJ, Nguyen T, Lam T, Wong C, Mock J. Economic analysis of promotion of hepatitis B vaccinations among Vietnamese-American children and adolescents in Houston and Dallas. *Pediatrics*. 2003 Jun;111(6 Pt 1):1289-1296.**

**Objective:** To ascertain the cost-effectiveness and benefit-cost ratios of two public health campaigns conducted in Dallas and Houston in 1998–2000 for “catch-up” hepatitis B vaccination of Vietnamese-Americans born 1984–1993.

**Design:** Program evaluation.

**Setting:** Houston and Dallas, Texas.

**Participants:** A total of 14 349 Vietnamese-American children and adolescents.

**Interventions:** Media-led information and education campaign in Houston, and community mobilization strategy in Dallas. Outcomes were compared with a control site in Washington, DC.

**Main Outcome Measures:** Receipt of 1, 2, or 3 doses of hepatitis B vaccine before and after the interventions, costs of interventions, cost-effectiveness ratios for intermediate outcomes, intervention cost per discounted year of life saved, and benefit-cost ratio of the interventions.

**Results:** The number of children who completed the series of 3 hepatitis B vaccine doses increased by 1176 at a total cost of \$313,904 for media intervention, and by 390 and at \$169,561 for community mobilization. Costs per child receiving any dose, per dose, and per completed series were \$363, \$101, and \$267 for media intervention and \$387, \$136, and \$434 for community mobilization, respectively. For media intervention, the intervention cost per discounted year of life saved was \$9,954 and 131 years of life were saved; for community mobilization, estimates were \$11,759 and 60 years of life. The benefit cost ratio was 5.26:1 for media intervention and 4.47:1 for community mobilization.

**Conclusion:** Although the increases in the number of children who completed series of three doses were modest for both the Houston and Dallas areas, both media education and,

to a lesser degree, community mobilization interventions proved cost-effective and cost-beneficial.



## **APPENDIX C: QUANTIFYING PROGRAM COSTS**

To quantify the costs of the program to participants, the following information can be collected from participants: arrival time, travel costs, and other out-of-pocket expenses. This can be assessed using the following questions (Haddix, Corso, and Gorsky, 2003):

1. How far did you travel (in miles)?
2. Where did you begin your travel (home, work, school...)?
3. What time did you leave that place?
4. What time did you arrive at the program site?
5. What time did you leave the program site?
6. What expenses did you incur in order to come to the program site (e.g., bus fare, tolls, gas, child care)?

To determine the costs to participants, the amount of time participants spent getting to and participating in the program should be multiplied by the median hourly wage of a population similar to program participants; this dollar figure should then be added to the sum of the out-of-pocket expenses participants incur for taking part in the program (Haddix, Corso, and Gorsky, 2003).



*Instructions*

1. In Column A, fill in the name and job title of each individual who contributes noncontract time to the program.
2. In Column B, fill in the hourly wage (including benefits, if applicable) of this individual. For salaried staff, an estimate of their hourly wage can be determined by dividing the annual salary by 2,000 hours (the approximate number of hours in a work year) and multiplying by 1.33 to provide an estimate of hourly compensation that includes benefits (for individual receiving health and retirement benefits). If the individual is a volunteer, her market salary must first be determined before estimating the hourly wage.
3. In Column C, fill in the number of hours worked within the specified time period on Activity 1.
4. In Column D, the labor costs of Activity 1 (for the individual in Column A) are equal to the hourly wage (Column B) times the number of hours spent on Activity 1 (Column C).
5. Columns E through H can be completed as indicated in #3 and #4 above. (Note that, although this example only includes 3 activities, you should include as many activities as your program performs).
6. In Column I, add up the number of hours each individual has worked in the specified time period.
7. In Column J, multiply the total number of program hours (Column H) by the individual's hourly wage (Column B). Column J reflects the labor costs of this individual during the specified time period.
8. In the last row of the table, add the labor costs of each activity to get the total labor costs for each activity and for all activities in the reporting period.

**Table C-2. Contracted Services and Materials/Supplies Costs**

**Reporting Period**

Begin Date: 01/01/05

End Date: 06/30/05

To complete Table C-2, identify the contracted services or materials and supplies purchased, donated, or not funded by the program during this reporting period, and identify to which activity the service or material/supply corresponds. Then, enter the costs for the services and materials/supplies purchased.

**Contracted Services Section**

Activity	Service Contracted	Date Purchased	Number of Units Purchased	Unit Price	Total Cost
Activity 1	Radio Advertisement	MM/DD/YYYY	10	\$15	\$150
<b>Total Contracted Services Cost</b>					<b>\$150</b>

**Materials/Supplies Section**

Activity	Material or Supply	Date Purchased	Number of Units Purchased	Unit Price	Total Cost
Activity 1	Flyers	MM/DD/YY	300	\$0.20	\$60
<b>Total Materials/Supplies Cost</b>					<b>\$60</b>

Note: If contracted services or materials/supplies are shared across activities, the costs can be apportioned to each activity by determining the proportion of total program hours devoted to a specific activity and attributing that proportion to the costs. For example, if a clinic contracted to provide screening spent 20% of its total reported hours on follow-up, then 20% of the contracted service cost can be allocated to this activity.

**Table C-3. Building and Facilities Costs**

**Reporting Period**

Begin Date: 01/01/05

End Date: 06/30/05

<b>Activity</b>	<b>Building or Facility</b>	<b>Hours Used For Activity</b>	<b>Total Hours Building or Facility Used</b>	<b>Payment for Building or Facility</b>	<b>Total Cost</b>
<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F=(C/D)*E</b>
Activity 1	Southside Civic Center	80	160	\$1,000	\$500
Activity 2	Southside Civic Center	16	160	\$1,000	\$100
<b>Total Building/Facilities Cost</b>					<b>\$600</b>

To complete Table C-3, identify the buildings and facilities used during this reporting period. Include the buildings and facilities donated to the program and those not funded by the program.

*Instructions*

1. In Columns A and B, determine which buildings or facilities were used for program activities during the reporting period indicated above.
2. In Column C, enter the number of hours the program used the building (or facility).
3. In Column D, enter the number of total hours the building (or facility) was used during this reporting period.
4. In Column E, enter the payment for the building for the reporting period. For example, if you pay a monthly rent or mortgage payment and the reporting period is a week long, then divide by 4.
5. In Column F, you can determine the cost for the time the building is used for the activity in Column A. First, divide the number of hours used (Column C) for the activity by the number of total hours used (Column D) in the building to find the fraction of time the building is used for that activity; then, multiply this fraction by the payment (Column E) to determine the building cost for the specified activity.

**Table C-4. Sample Cost Reports**

Using the costs from Tables C-1 through C-3, total program costs can be calculated and summarized, as shown below. Table C-4 provides a sample cost report from the WISEWOMAN program.

**Total Program Costs**

**Program:** WISEWOMAN  
**Begin Date:** 1/1/2005  
**End Date:** 6/30/2005

Cost Component	Recruiting	Screening	Intervention	Oversight/ Administration	TOTAL COST
<b>Noncontract Labor</b>	\$12,175	\$17,350	\$59,870	\$70,360	<b>\$159,755</b>
<b>Contracted Services</b>	\$1,500	\$53,570	\$12,750	\$1,250	<b>\$69,070</b>
<b>Materials/Supplies</b>	\$1,250	\$15,980	\$4,950	\$22,350	<b>\$44,530</b>
<b>Building/Facilities</b>	\$8,325	\$27,000	\$30,000	\$69,000	<b>\$134,325</b>
<b>Donated Labor and Resources not Funded by Program</b>	\$2,500	\$20,000	\$16,030	\$17,290	<b>\$55,820</b>
<b>TOTAL COST</b>	<b>\$25,750</b>	<b>\$133,900</b>	<b>\$123,600</b>	<b>\$180,250</b>	<b>\$463,500</b>

If the WISEWOMAN program with total costs presented above served 1,030 women during the period for which these costs were collected, then the per capita costs for each activity and for the program can be calculated by dividing total costs by the number of participants (presented below). These values can be used in the cost-effectiveness analysis of the program, as described in Chapter 5.

**Per Capita Program Costs**

**Program:** WISEWOMAN  
**Begin Date:** 1/1/2005  
**End Date:** 6/30/2005

**Number of Participants:** 1,030

	Recruiting	Screening	Intervention	Oversight/ Administration	TOTAL COST
<b>PER CAPITA COST</b>	<b>\$25</b>	<b>\$130</b>	<b>\$120</b>	<b>\$175</b>	<b>\$450</b>