Title
Return on Investment for a Diabetes Prevention Program: Merced California Accountable Communities for Health Initiative

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UNIVERSITY OF CALIFORNIA, MERCED

Return on Investment for a Diabetes Prevention Program**:** Merced California Accountable Communities for Health Initiative

A dissertation submitted in partial satisfaction of the requirements
for the degree Doctor of Philosophy

in

Public Health

by

Ravi Ashmit Singh

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2020

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University of California, Merced

2020

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Explanation of Acronyms

Acronym	Explanation
ABC	Activity Based Costing
ACH	Accountable Communities for Health
CACHI	California Accountable Communities for Health Initiative
CAG	Community Advisory Group
CBA	Cost Benefit Analysis
CDC	Centers for Disease Control and Prevention
CEA	Cost Effectiveness Analysis
CHIS	California Health Interview Survey
COI	Cost of Illness
CUA	Cost Utility Analysis
DCE	Discrete Choice Experiment
ICER	Incremental Cost Effectiveness Ratio
LHD	Local Health Department
MCACHI	Merced California Accountable Communities for Health Initiative
MCDPH	Merced County Department of Public Health
NDPP	National Diabetes Prevention Program
NH	Non-Hispanic
OSHPD	Office of Statewide Health Planning and Development
PBMA	Program Budgeting and Marginal Analysis
QALY	Quality Adjusted Life Year
RCB	Resource Based Costing
RCC	Ratio of Cost to Charges
RCT	Randomized Control Trial
ROI	Return on Investment
RVU	Relative Value Unit
SEER	Surveillance, Epidemiology, and End Results Program
SES	Socioeconomic Status
SJV	San Joaquin Valley
ToC	Theory of Change
WTP	Willingness to Pay

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Abstract

University of California, Merced

Return on Investment for the Merced California Accountable Communities for Health Initiative

A dissertation submitted in satisfaction of the requirements

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by Ravi Singh

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The use of return on investment (ROI) analysis in public health is steadily increasing in recent years. Local health departments (LHDs) have started using ROIs more frequently to secure funding for their program and initiatives, as ROIs are viewed to be more attractive to potential funders compared to other evaluations. The Merced California Accountable Communities for Health Initiative (MCACHI) focused on reducing diabetes, heart disease, and associated depression in Merced County by implementing the National Diabetes Prevention Program (NDPP). The purpose of this three-paper dissertation was to estimate the ROI for the MCACHI, while providing a framework for researchers and LHDs for using ROIs for chronic disease prevention programs working closely with a community advisory group (CAG) .The reason the MCACHI was interested in estimating the ROI was to use it as a way of presenting to potential funders in the region that the program is a good investment, hoping the project can become sustainable. The second chapter aims to place a value by the general population for public health programs done in their communities, using a discrete choice experiment (DCE). The third chapter aims to cost out the entire MCACHI, estimating costs for the actual program as well as costing out the program if more people completed it and if it was implemented more efficiently. The fourth chapter of this dissertation aimed to calculate the ROI for the MCACHI, using information from the second and third chapter, while also providing a framework for using two methodologies for placing monetary values on health outcomes. The first method used information from the DCE in chapter two to estimate the willingness to pay (WTP) for the diabetes prevention program, and the second method used quality adjusted life years (QALYs) to place a monetary value on the health outcomes. This study found that the ROI is sensitive to many parameters and has the potential to show the program was a good investment over a longer time horizon.

Keywords: LHD, QALYs, ROI, WTP

Chapter 1: Introduction

Section 1: Introduction

1.1: Context

The California Accountable Communities for Health Initiative (CACHI) is a three-year initiative funded by four California foundations to test the feasibility and effectiveness of a more expansive, connected, and prevention-oriented health care system. In September 2016, six California communities (Imperial, Merced, San Diego, San Joaquin, Santa Clara, and Sonoma counties) began developing the innovative model, called Accountable Communities for Health (ACH), designed to transform the health of entire communities, not just individuals. The overall goal of the ACH is to bring together the most valuable community institutions, which includes hospitals, public health, public safety agencies, schools, local businesses, parks, along with local residents, to create a new vision for the health system. By implementing upstream prevention and social interventions to improve the health of the entire community, it will decrease the need for downstream services.

In Merced County, the Merced California Accountable Communities for Health Initiative (MCACHI), chose to focus on three chronic conditions: cardiovascular disease, diabetes, and diabetes related depression. The prevalence along with the annual cost of these conditions is significant in Merced County, with estimates of just under 70,000 people suffering from cardiovascular disease, over 18,000 from diabetes, and over 26,000 from depression in the county. The cost to the county is over 250 million, 109 million, and 70 million respectively (P. Brown, Singh, & Boyajian, 2018). These health conditions were not only selected because the annual costs and loss of life are significant, but also because clinical, community, community-clinical linkage and policy, system and environmental interventions are currently underway in many of the geographic focus areas to address these health conditions and/or the lifestyle factors that contribute to them through Merced County Department of Public Health (MCDPH) and partner organizations. Many of the intended audiences for interventions designed to address these three conditions are patients of current clinic partners who will be essential to the implementation and evaluation of the ACH effort.

A unique and central aspect to the MCACHI is that they be sustainable at the end of the three-year period. A program is considered sustainable when its relevant activities and resources continue in the direction of its primary objective (Scheirer, 2005). In order to be sustainable, a key component of the MCACHI is to create a wellness fund which is designed to attract and weave funding and resources (Our Vision: United Leaders for Health, 2018). Potential funders include employers in the region, private foundations, insurers with health plans, local officials, or state or federal funders.

1.2: Overview

The MCACHI targets diabetes, heart disease, and diabetes related depression by promoting physical activity and healthy lifestyles. Currently, there are a number of programs available for those living in Merced that provide support and instruction in ways to increase their physical activity and healthy lifestyles. Some of these available programs are sponsored by county agencies and others via employers in the region through worksite wellness programs. The MCACHI can be viewed as a community-wide wellness program that seeks three things:

- To support businesses and employers in the Merced region who already have or are interested in starting a wellness program for their employees.
- Support and identify other at-risk individuals in the Merced region.
- Identify and advocate for changes in the physical environment that would support physical activity as well as healthy lifestyles.

The NDPP is the primary mechanism of the MCACHI for supporting both physical activity and healthy lifestyles. The NDPP was chosen to be the primary mechanism because it is an evidence-based series of modules that provides people with information and necessary tools which are needed to help reduce their risk for diabetes, heart disease, and diabetes related depression (Ali, Echouffo-Tcheugui, & Williamson, 2012). The MCACHI will make these classes available to those who have been identified as being at risk. The MCACHI will also monitor the success of people in completing the program as well as changing their lifestyles, ultimately evaluating whether the program was successful at reducing diabetes, heart disease, and diabetes related depression not only in the short term, but also in the future.

Section 2: Program Evaluation

2.1: What is it and why it is important?

Public health programs have become more and more complex as their task of aiming to prevent or control different diseases, injuries, and even death has become more complex. Often, public health programs are tasked with trying to deal with changing people's attitudes and behaviors in order to improve health, where in the past they might have focused on improving sanitary systems or providing flu vaccines. This transition in the focus of public health programs has increased the complexity of the programs. To make things more complicated, the context in which public health programs operate has become more complex. Programs may have more success in certain settings while failing in others because of the fiscal, socioeconomic, demographic, interpersonal, and inter-organizations settings in which they are planted (Centers for Disease Control and Prevention, 2011).

Because of these changes and increasing complexity in how public health programs operate, program evaluation is now more important than ever before and is even one of the ten essential public health services (The Public Health System & the 10 Essential Public Health Services, 2018). Program evaluation can be defined as a systematic way to improve and account for public health actions by involving procedures that are useful, feasible, ethical and accurate (A Framework for Program Evaluation, 2018). Although this might sound similar to just ongoing informal assessments, there is one key difference that distinguishes program evaluation. Program evaluations are conducted according to a set of guidelines, unlike most informal assessments (Centers for Disease Control and Prevention, 2011).

Some reasons to evaluate public health programs include; to monitor progress towards the program's goals, to determine whether the program components are producing the desired progress on outcomes, to permit comparisons among groups, particularly among populations with disproportionately high risk factors and adverse health outcomes, to justify the need for further funding and support, to find opportunities for continuous quality improvement, and to ensure that effective programs are maintained and resources are not wasted on ineffective programs (Centers for Disease Control and Prevention, 2011). Local health departments (LHDs) will often have to make decisions on what programs or interventions they want to prioritize. Program evaluation is critical for public health departments in order to make sure the limited resources that they have available are maximized, in terms of health outcomes. However, maximizing health outcomes is not always the priority of public health departments, as sometimes effectiveness and or efficiency is sacrificed in order to address health equity (Cookson, Drummond, & Weatherly, 2009).

Section 3: Types of Evaluations for Public Health Interventions

3.1: Process Evaluation

Process evaluation determines whether program activities have been implemented as intended and resulted in certain outputs (Salabarría-Peña, Apt, & Walsh, 2007). This type of evaluation focuses on the implementation process of an intervention or program and occurs once the program implementation has started. Process evaluations are valuable, but are infrequently conducted compared to other evaluation strategies. Baranowski & Stables (2000) provide a thorough explanation of the various components of process evaluation. The eleven components of process evaluation are described below:

1. Recruitment: attracting agencies, implementers, or potential participants to participate in corresponding parts of the program.
2. Maintenance: keeping participants involved in the programmatic and data collection aspects of a program.
3. Context: aspects of the environment of an intervention.
4. Resources: the materials or characteristics of agencies, implementers, or participants necessary to attain project goals.
5. Implementation of program: extend to which the program was implemented as designed.
6. Reach: extend to which the program contacted or was received by the targeted group.
7. Barriers: problems encountered in reaching participants.

8. Exposure: the extent to which participants viewed or read the materials that reached them.
9. Initial use: extend to which a participant conducted activities specified in the materials.
10. Continued use: extent to which a participant continued to do any of the activities.
11. Contamination: extend to which participants received interventions from outside the program; extent to which the control group received the treatment.

3.2: Effectiveness/Outcome Evaluation

Effectiveness evaluation, also referred to as outcome evaluation, is used to determine how well a program is achieving the desired outcomes (Design for Effectiveness Evaluations, 2018). This is done by comparing the actual outcomes achieved by the program to the desired outcomes that were initially established when designing the program. Outcomes can be short or long term. The key to this type of evaluation is to be able to show that the program's outcomes are directly because of the program, and not other external factors. It is important to demonstrate how the outcomes relate to the inputs (Three Keys to Improving Your Program Effectiveness Evaluation, 2018).

3.3: Efficiency Evaluation

Efficiency evaluations are concerned with comparing the program inputs with the program outputs and determining how to maximize outputs for the allocated resources (Design for Efficiency Evaluations, 2018). For example, an efficiency evaluation would examine if a particular program's activities are being produced with the least amount of required resources needed to perform the activities (Centers for Disease Control and Prevention, 2011). Not only do the activities need to be produced, but they need to be produced at an acceptable quality and quantity based on the amount of resources that are devoted to the activities.

3.4: Economic Evaluation

Economic evaluation is defined as "the systematic appraisal of costs and benefits of projects, normally undertaken to determine the relative economic efficiency of programs" (Health Economics Information Resources: A Self-Study Course, 2014). These types of evaluations assess whether an intervention represents good value for the money. It considers both consequences/outcomes from the intervention and the resources used/costs. This means that it is an outcome evaluation. There are two levels of economic evaluation: partial and full. In partial economic evaluations, program or disease costs are measured, but does not compare the program with an alternative program (Rabarison, Bish, Massoudi, & Giles, 2015). Cost of illness and program cost analysis are examples of partial economic evaluations. Full economic evaluations compare two or more public health interventions through examining the costs of inputs and outcomes (Rabarison et al., 2015). Examples of full economic evaluations include cost benefit analysis, cost effectiveness analysis, and cost utility analysis. There are several types of economic evaluations, which are described below:

1. Cost effectiveness analysis (CEA): estimates costs and outcomes of interventions and compares them. The outcome is usually a clinical or health outcome, and is expressed in natural units such as cases prevented or lives saved instead of converting outcomes to a monetary value (Lane & Soyemi, 2016). The key with CEA is that it must be conducted with interventions that impact the same health outcome (Lane & Soyemi, 2016). For example, two programs aimed at reducing A1C levels could be compared, even if each program focuses on a different way or method of reducing A1C levels. Usually an incremental cost effectiveness ratio (ICER) is used to report costs and outcomes in this type of analysis. ICER = (costs of program A – costs of program B) / (outcomes of program A – outcomes of program B).

2. Cost utility analysis (CUA): is a special form of cost effectiveness analysis. It differs because costs and consequences/outcomes are expressed as cost per a standardized morbidity and mortality measure, such as a quality-adjusted life-year (QALY) (Rabarison et al., 2015). CUA's are somewhat controversial because it puts a value on health status (World Health Organization, 2003). Because a CUA is expressed in cost per QALY, interventions with different health outcomes can be compared. This is especially helpful when a health agency is deciding between public health interventions with different health outcomes (Rabarison et al., 2015). CUA essentially uses an ICER like CEA, but is expressed as the incremental cost to gain an extra QALY (World Health Organization, 2003).

3. Cost benefit analysis (CBA): is used to value both incremental costs and outcomes in monetary terms (World Health Organization, 2003). By doing this, it allows a direct calculation of the net monetary cost of achieving the health outcome. This analysis is considered the gold-standard of economic evaluation because the costs and benefits are all converted to a common metric, for example, dollars (Rabarison et al., 2015). The benefit of this analysis is that it allows comparison of different programs with different consequences/outcomes.

4. Cost of illness (COI) analysis: typically includes the value of medical care resources used to treat a disease and the losses in productivity to society because of the illness (Lane & Soyemi, 2014). The costs included in this type of analysis are direct, indirect, and intangible (Byford, Torgerson, & Raftery, 2000). The output, which is in monetary terms, is an estimate of the total burden of an illness or disease to society (Byford et al., 2000). Examples of productivity losses includes days missed at work or anything associated with the illness or with receiving treatment for the illness (Lane & Soyemi, 2014).

5. Program Budgeting and Marginal Analysis (PBMA): is an economic framework used mostly internationally since the 1970's for priority setting

(Donaldson et al., 2001). The idea of PBMA is to go through all of the resources and outcomes of a set of programs that clearly have health related objectives to see if things can be done more efficiently by shifting resources from one program to another (Viney, Haas, Mooney, & Nsw, 1995).

6. Return on investment (ROI): is an economic measure that is used to indicate how much benefit there is from a program in relation to its costs (Brousselle, Benmarhnia, & Benhadj, 2016). ROI's have become increasingly popular in public health, as they are used to show that by investing money now into various public health programs, savings will result in the future. This type of analysis is commonly used in order to try and convince funders to give to public health programs. The way they are typically expressed is, for example, every $1 invested in childhood immunizations saves up to $22 in future health care costs (Michigan Association for Local Public Health, 2013). This is calculated by dividing the net return (return - investment) by the investment.

Section 4: Types of Modeling for Evaluating Public Health Interventions

4.1: Theory of Change (ToC)

ToC is a model that can be used to develop, implement, as well as evaluate large and complex public health interventions. Other names for a ToC include logic model, model of change, theoretical underpinning, roadmap, conceptual map, blueprint, rationale, program hypothesis, causal chain, program theory, and weight of evidence model (Centers for Disease Control and Prevention, 2011). A systematic review examining the use of ToC to design and evaluate public health interventions found that 49 of the 62 papers included in the review, or 79%, describe the use of ToC in the evaluation of the public health intervention (Breuer, Lee, De Silva, & Lund, 2016). A ToC map is similar to a logic model, but differs because it offers a non-linear map of the project, showing how various components are expected to interact, and the multiple pathways through which change is expected to happen (Silva MD, Lee L, & Ryan G, 2014). Using a ToC model for evaluating involves measuring indicators at all of the stages of implementation, not just the primary and secondary outcomes (Silva MD et al., 2014). ToC evaluation will require numerous methods to capture all of the indicators as the indicators will be measured through multiple methods. ToC is commonly developed by starting with the indicators that need to be measured and working backwards to decide the best methods for measuring these indicators (Silva MD et al., 2014). In other words, ToC starts with long term outcomes and then maps the required process of change and the short and medium term outcomes required to achieve the long term outcome (Anderson, 2005). There are six steps in using ToC to design an implementation strategy, which are described below (Silva MD et al., 2014).

1. For every intermediate and long-term outcome on the causal pathway, identify at least one indicator to measure its success.
2. Choose appropriate methods in order to capture every indicator on the map.

3. Group the indicators that can be collected using the same method. For example, group all the indicators that can be collected from qualitative interviews.

4. Group these methods into a smaller number of studies. For example, a cohort or qualitative study.

5. Decide the most appropriate analysis method to combine both process and outcome indicators into a single evaluation.

6. After completing the evaluation, redraw the ToC map in order to see if the intervention achieved, or did not achieve its intended outcomes.

4.2: Decision Tree

Decision trees are the simplest form of decision analytical modeling in economic evaluations (Petrou & Gray, 2011). Decision trees use distinct branches to represent a potential set of outcomes for an individual ("Decision Tree," 2016). In a decision tree there are 'nodes' where the branches meet. Each node can take the form of a 'choice', which is a decision about which of the interventions to use, or a 'probability', which an event is occurring or not occurring by chance ("Decision Tree," 2016). The probabilities must always add to one. Costs and outcomes are assigned to each section of every branch and the tree is 'rolled back' to a decision node and then the expected outcome and cost for each alternative can be compared ("Decision Tree," 2016). This type of model is often used to model interventions with distinct outcomes that can be measured at a specific time point ("Decision Tree," 2016).

4.3: Markov Modeling

Markov modeling is an analytical framework that is often used in decision analysis. It is the most common type of economic evaluation model used in health care interventions ("Markov Modeling," 2016). They represent random processes that evolve over time (Briggs & Sculpher, 1998). Markov models use disease states, often chronic diseases, to represent all possible consequences of the intervention ("Markov Modeling," 2016). Each individual that is represented in the model can be in only one disease state at a time, however, they can transition between various health states over time. A major advantage of Markov models is that they can handle both costs and outcomes, but more importantly they have a time component that can be discounted (Briggs & Sculpher, 1998).

Section 5: Interim Summary

There are many different strategies and ways of evaluating large public health interventions. Depending on the interested outcomes, available data, and other factors, certain types of evaluations may be more appropriate for a specific program or intervention. Because the overall goal of the MCACHI is to estimate the ROI for the diabetes prevention programs, the purpose of this section is to understand the differences between the various evaluation strategies. The goal of the next section of this paper is to go through the current state of literature of evaluating large public health interventions/programs using economic models, specifically focusing on CEA, CUA and ROI to determine how to do a ROI to ensure sustainability The focus on economic models for evaluating the MCACHI is because of the need to measure costs along with health outcomes in order to do a ROI analysis.

Section 6: Evaluating Large Public Health Interventions

6.1: CDC's Six Steps in Program Evaluation

According to the Centers for Disease Control and Prevention (CDC), there are six main steps in order to successfully evaluate a large public health program. Step one is to engage stakeholders. A stakeholder is a party that has interest in a company and can be affected or have an effect on the business, or in this case program ("What Is a Stakeholder?," 2018). It is important that stakeholders are engaged in the evaluation, as they ensure the right questions are being asked and that the evaluation results will be used to make a difference (Centers for Disease Control and Prevention, 2011). Stakeholders can have many different roles and can be involved in numerous ways. There are three main groups that key stakeholders fall into. The first group is those involved in program operations. This includes management, program staff, partners, funding agencies and coalition members. The second group is those served or affected by the program. This includes patients or clients, advocacy groups, community members and elected officials. The third group stakeholders fall into is those who are intended users of the evaluations findings, which includes people in a position to make decisions regarding the program such as partners, funding agencies, coalition members, and the general public or taxpayers (Centers for Disease Control and Prevention, 2011).

The second step to evaluate a large public health program, according to the CDC, is to describe the program. It is important to have a comprehensive program description that clarifies the different components, as well as the outcomes of the program in order to focus the evaluation on the most important questions (Centers for Disease Control and Prevention, 2011). The CDC identifies several components that a well thought of program description should include (Centers for Disease Control and Prevention, 2011):

- Need: What is the public health need/problem that the program aims to address?
- Targets: Which organizations need to take action in order to make progress on this public health problem?
- Outcomes: Exactly how and in what way do these organizations need to change?
- Activities: What will your program and its staff do to try and move these target groups to make changes and take action?
- Outputs: What products or tangible capacities will your program's activities produce?
- Resources/Inputs: For the activities to be mounted successfully, what is needed from the larger environment?

- Relationship of Activities and Outcomes: What activities are being implemented to produce progress on what specific outcomes?

Along with specifying each of these components, a discussion of these things must be included as well:

- Stage of Development: Is the program new, in an implementation stage, or has been underway for some time?
- Context: Are there factors and trends in the larger environment that can influence the success or failure of the program?

There are various types of tools and models, such as the ToC /logic model, which help depict these different program components. Although these models are often helpful, they are not necessary in order to develop a comprehensive program description.

The third step in the CDC Evaluation Framework for successfully evaluating a public health program is to focus the evaluation design. The most important aspect of this step is to identify the most important questions to evaluate. By identifying these key questions, it will help decide on what the most appropriate design for the particular evaluation is. The right evaluation of the program depends on the questions being asked, who is asking the questions, and also what will be done with the collected information (Centers for Disease Control and Prevention, 2011). Generally, evaluation questions for a program tend to fall into one of two groups; process and effectiveness/outcome evaluations. Refer to section three of this paper for the different evaluation types.

The fourth step to evaluate a large public health program, according to the CDC Evaluation Framework, is to gather credible evidence. There are five different components to consider when gathering evidence (Centers for Disease Control and Prevention, 2011):

- Indicators: These are specific and observable statements that can be measured. There are process indicators, which are for activities, and outcomes indicators which are for program outcomes. For each activity or outcome, there can be multiple indicators and the indicator must measure an important dimension of the outcome or activity. The indicator must be clear in terms of what it will measure and the change measured by the indicator should represent progress toward either implementing the activity or achieving the outcome (Centers for Disease Control and Prevention, 2011).
- Sources of evidence and data collection methods: Depending on what the interested questions and indicators of the evaluation are, either primary or secondary data collection may be most appropriate. Examples of secondary data sources are the US Census Bureau, California Health Interview Survey (CHIS), and Office of Statewide Health Planning and Development (OSHPD). For primary data collection, surveys, focus groups, and observation are examples of how this type of data can be collected. In some cases, a mixed methods approach might be most appropriate. There are several factors that need to be considered

when deciding what the best method for data collection is. The amount of resources available for the project, the timeline of when the data needs to be collected and the type of information all are examples of different factors that must be considered when deciding. Finding similar programs in the literature is another source of information that may be useful. Its usefulness depends on how similar the program is along with many other factors.

- Quality: An evaluation of high-quality produces data that is reliable, informative, and valid. It needs to repeatedly produce the same results, as well as measure what it originally intended to measure. It is important to decide at the beginning of the evaluation process the level of quality that is necessary to meet the stakeholder's standards.
- Quantity: It is important to determine how much data needs to be collected during the evaluation process.
- Logistics: Logistics are the methods, timing, and physical infrastructure for gathering and handling evidence (Centers for Disease Control and Prevention, 2011).

The fifth step in the CDC Evaluation Framework for successfully evaluating large public health programs is to justify conclusions. The primary focus of this step is to analyze the evidence collected and make claims by comparing evidence against stakeholder values (Centers for Disease Control and Prevention, 2011). It is important to note that this step involves more than just analyzing data. Evidence gathered for an evaluation does not necessarily speak for itself, conclusions become justified when analyzed and synthesized findings are interpreted through the standards that stakeholders bring (Centers for Disease Control and Prevention, 2011). If there is agreement between agencies, communities, and stakeholders regarding the conclusions, there are higher chances the evaluation results will be used to improve the program.

The sixth and final step in the CDC Evaluation Framework for evaluating large public health programs is to ensure use of evaluation findings and share lessons learned. Evaluation results can be used to show the overall effectiveness of the program, highlight ways of improving the program, modify program planning, demonstrate accountability, and also help justify funding (Centers for Disease Control and Prevention, 2011). There are other uses, such as demonstrating to policy makers that the resources being used on the program are well spent and to compare outcomes to previous years to see if the program has made any improvements.

Following these six steps from the CDC Evaluation Framework to evaluate a large public health intervention will help guide the process of planning and implementing evaluation strategies to your own program. By following this guide, it will ensure that all the various components of creating a successful evaluation strategy will be included. Although this guide should be considered when planning and implementing an evaluation strategy, it should not be the only guide used. It is important to look at other literature and see how others have evaluated large public health programs, especially if there is literature of evaluations that are like the program of interest.

6.2: National Association of Chronic Disease Directors' Seven Steps for Developing a ROI Analysis

ROI analysis needs to be thoughtfully and carefully planned in order to have the best chance of being successful. It requires many different components and needs to be incorporated into the program from the very beginning. The National Association of Chronic Disease Directors developed a guide for using ROIs, with an emphasis on doing them for public health programs. The first step for developing a ROI, according to the National Association of Chronic Disease Directors, is to prepare for ROI. It is important to determine if doing a ROI analysis is appropriate for the program of interest. This can be done by identifying the overall goal for doing a ROI analysis. This can include various things, such as justifying an existing project, building support for past, current or future expenditures, and persuading decision makers (Chronic Disease Directors, 2009). Next, it is important to establish a timetable for the ROI analysis. This includes making sure there is enough time and available resources. The next component is to lay down the groundwork by establishing individuals who can aid in conducting the ROI as well as members who are not as familiar with the process to educate them. Next, it is important to assemble the project team, establishing who will be in charge of specific tasks (Chronic Disease Directors, 2009).

The second step, according to the National Association of Chronic Disease Directors, is plan your work. It is important to establish strong objectives and formulate an evaluation plan in the beginning of the project which will help in selecting the most appropriate techniques such as deciding the most credible method for converting data to money (Chronic Disease Directors, 2009).

The third step is to gather credible evidence. There are several techniques for collecting data that can help gather the required information from credible sources. It is important to carefully consider all the various data sources and options, such as questionnaires, focus groups, and interviews. Using data from credible sources is extremely important in order to insure the ROI is credible (Chronic Disease Directors, 2009).

The fourth step, according to the National Association of Chronic Disease Directors, is to isolate program impact and justify conclusions. One of the most overlooked and challenging aspects of a ROI analysis is being able to isolate the effects of the program and answering the question, "How do you know it was your program that improves these measures (Chronic Disease Directors, 2009)?" If there is no way of isolating the impact of the program, there is no link that the outcomes improved because of the program and not by some other factor.

The fifth step for doing a ROI analysis is to do the math and calculate the ROI. The fundamental difference between a ROI analysis and other methods is all of the benefits of the program need to be converted to a monetary value (Chronic Disease Directors, 2009). This can be challenging for public health practitioners. When estimating the return or value of benefits, both hard and soft data can be used. Hard data is often preferred as it is thought of to be more credible, however soft data can of greater value in certain situations (Chronic Disease Directors, 2009). The most difficult and time-consuming aspect of conducting an ROI analysis for public health programs is determining the value of the benefits. It is important to place a monetary value on all the benefits of the program (Chronic Disease Directors, 2009). The formula for estimating the ROI is return (value of benefits) / investment (total cost of program) x 100.

The sixth step is communicating the results. As important as all the steps in estimating the ROI, communicating and understanding the results is just as critical. The ultimate use of the ROI is to show the economic value of the health program to stakeholders and any other potential decision makers (Chronic Disease Directors, 2009). When communicating the results, it is imperative to understand the different audiences that are given this information because some people will have a higher understanding of ROIs while others may have a lower understanding. The organization who requested the ROI should receive a detailed report whole the other organizations apart of the initiative should receive just the highlights (Chronic Disease Directors, 2009).

The seventh and final step for doing a ROI analysis, according to the Chronic Disease Directors, is making ROI routine. This is done by building it into the culture of the organization, with the goal that ROIs are viewed as necessary, essential and effortless (Chronic Disease Directors, 2009). This can be done by using existing templates.

6.3: Literature of Economic Evaluations

For the purpose of this paper, a literature search of economic evaluations of community-based diabetes prevention programs was conducted to examine if the programs were cost effective. Many papers that were found in the literature are randomized control trials (RCTs). These were not included. Table A1 (see appendix) is a summary of the different studies that were found in the literature that used economic evaluations in order to evaluate NDPPs like those that are a part of the MCACHI.

Economic evaluations for diabetes prevention programs were found. Of the 14 studies, nine used CEA, three used CUA, two used both CEA and CUA, and none used ROI. Most of the studies concluded that the diabetes prevention programs are cost effective. Most of the studies included some type of Markov modeling to simulate outcomes and costs of the program.

Section 7: Evaluating the Merced California Accountable Communities for Health Initiative

7.1: Overview of the Various Components of the MCACHI

The MCACHI will include three parts. The first component of the MCACHI is the community advisory group (CAG). This group consists of members of the community who represent the different key players involved with the development and implementation of the MCACHI. Monthly meetings where various things related to the MCACHI are presented and discussed, such as potential funding streams and mechanisms. Also, key decisions are voted on by this group. The CAG is a crucial aspect of the MCACHI and the monthly meetings are the driving force to keep the initiative moving forward. Community input has been an emphasis of the MCACHI from the beginning, and keeping the community involved in the development and implementation of the project has allowed a better understanding the types of things local residents want to see done in their communities.

The second part is the referral system. For the program to be successful, there needs to be a system for identifying and referring individuals to the NDPP. For the MCACHI, referrals to the NDPP come from a single source, which is the 211. For the 211, individuals who call into the system are identified as at-risk using a screening survey. The names of these individuals are then given to MCDPH staff, who contact them, offer and enroll those who are interested in the available classes. For the program to be successful, the MCACHI needs to monitor to ensure that the referral system identifies at risk individuals in the community, refers at risk individuals to an appropriate class, and maximizes enrollment capacity.

The third component of the MCACHI is the programs, which consists of the NDPP. Because several organizations already currently offer these classes, including the MCDPH, the MCACHI needs to ensure that the classes and the business wellness programs are following CDC guidelines for the NDPP. The NDPP is offered by four sites, which are all part of the MCACHI. It is important that NDPP is following the CDC guidelines because the CDC NDPP has been proven to be effective in reducing diabetes, so by following the guidelines it gives the MCACHI the best opportunity to be successful. The MCACHI needs to ensure individuals continue to attend the classes for the duration of the program as well. Lastly, the MCACHI needs to ensure that the classes are collecting common data metrics in order to be able to successfully evaluate the programs.

7.2: Sustainability

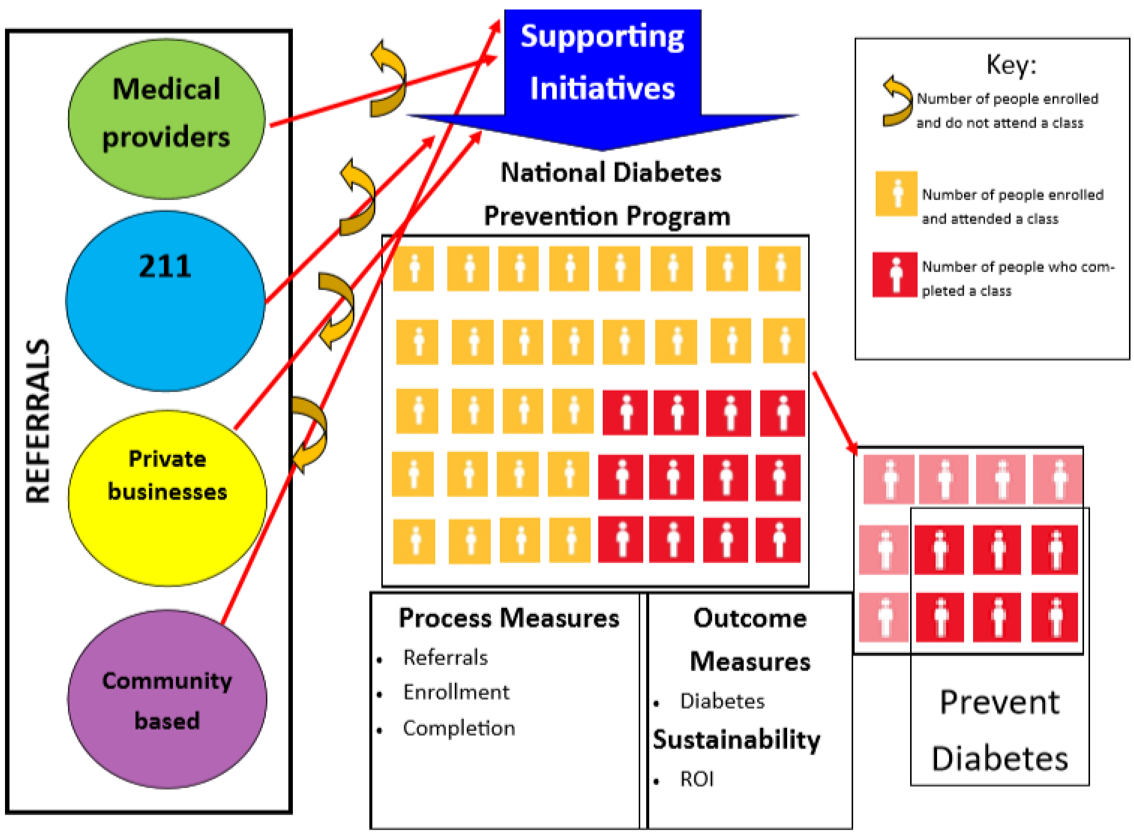
The aim of the program is to be sustainable, or at least be on the road to sustainability, by the end of the three-year period. The leadership team of the MCACHI has identified a number of components of a successful sustainability strategy, noting that the phasing and prioritizing will depend on context and overall approach.

The assumption underlying the inclusion of these factors is that the eventual funders of a wellness fund will want to see evidence that the program is successful and represents a good ROI. However, there are different potential funders, including local businesses, foundations, Medi-Cal purchasers and/or private insurance companies, grant agencies, county supervisors through general funds and taxpayers through a sugar tax.

These various entities may have different definitions of what they consider to be ‘successful,’ thus it is important to gauge the type of information that each group would want to see included as part of the evaluation and then to assess the level of achievement that would warrant contributions to the wellness fund.

Note also that a central assumption underlying the CACHI initiatives is that the funders will want to understand ROI. The aim of an ROI is to provide potential funders with information that will allow them to gauge whether the initiative represents "good value for the money." There are other types of economic analyses that might also be appropriate to address this question, including CEA, CUA, and CBA. The ROI analysis differs from these other types of analyses in that it focuses more on the cost of the intervention or program and the return to the stakeholder (in this case, the potential funders) from that investment. In addition, unlike CEA or CUA, the outcomes must be represented in a monetary value (rather than as health gains or other measures of morbidity or mortality). These aspects are reflected in the data collection described below.

7.3: Figure 1: MCACHI Theory of Change/Logic Model



7.4: Evaluation and Monitoring Framework for the Referral System

Now that the main components of the MCACHI have been overviewed, this next section will provide an evaluation and monitoring framework for the referral system and programs. For the referral system, 211, the key questions can be seen below. It is important to figure out each of these things, as well as costing out each.

a. How do we identify how each referral system approaches people?

b. Who do they approach?

c. How many people who are approached agree to participate?

d. How many people enroll in the classes?

The data collection strategy for the referral system will be discussed next. For 211, MCACHI staff needs to contact networks and identify how they ensure callers who are referred show up. As for data analysis, the basic idea is to compare the numbers referred to the numbers showing up to completing the program.

7.5: Evaluation and Monitoring Framework for the Programs

NDPP will be the initial focus of the portfolio evaluation to create measurable and obtainable outcomes. The key questions for monitoring this program are shown below. In general, monitoring short term outcomes, such as participation, is simple to do. Monitoring long term outcomes, such as lowering rates of diabetes, heart disease, and associated depression, is much more difficult.

a. How many people attend?

b. How many people start the program?

c. How many people drop out?

d. How many people completed an entire program?

The data collection strategy for the programs is to contact each programs staff and gather the surveys of people attending classes. Once the surveys are gathered, they need to be organized so that the survey data can be logged. The surveys that are taken before each class should be collected often (weekly or monthly). After collecting all the surveys throughout each program, the next step is to analyze the data in order to successfully answer the questions of interest shown above.

7.6: Evaluation and Monitoring Framework for Sustainability/Return on Investment

Information on the economic cost of chronic conditions is important for planning prevention and control efforts. Information on the direct costs of chronic illness, including the medical resources used to treat avoidable illness and productivity losses, provide information on the amount that could be saved if chronic conditions were prevented or controlled.

Understanding both the amount of money and health outcomes that can be saved can be used to understand the ROI from public health interventions. This allows state and LHDs to calculate their implicit return from investing in prevention and control efforts, and to identify which conditions they should focus on, in which areas, and for which populations. In short, information on the economic burden of chronic conditions at the local level provides policy makers with information needed to develop interventions and prevention programs.

In order to successfully estimate a ROI, four key pieces of information are needed. The first is the health care costs that are saved from preventing the disease. The second is the costs of the program/intervention. The third is the number of people who are impacted, and the fourth is the monetary value of the health outcomes.

The primary outcomes from the MCACHI will be reductions in heart disease, diabetes, and diabetes related depression at some point in the future. Improving health equity through the reduction of health disparities is an additional outcome that is central to the MCACHI. Consultations with potential funders will provide information on the extent to which they value these two outcomes (health gains and health equity) as well as the timing of these outcomes (e.g., the rate at which they discount the future). A core assumption of this evaluation is funders will care about the value their target population places on these outcomes and that these outcomes are to be represented in as a ROI.

Section 8: The Current Study

All agencies struggle with trying to sustain their programs/interventions/activities. Essentially, the problem these agencies are dealing with is trying to figure out how to allocate their resources. One approach to deal with this is the economic approach, which assesses whether an intervention represents good value for the money. CEA is one way of doing this. However, the downside of a CEA, as well as other typical economic evaluations, is that they tend to focus on the long-term costs/benefits/outcomes, which is why many local agencies do not use them. What local agencies, such as public health departments, seem to want is to be more focused on the ROI of the specific intervention or program. The advantage of using a ROI is that it is more focused on the direct benefits and costs to the agency. Within this, there are still several unanswered questions, such as what the time horizon is, how many people will complete the program, how effective the program is, and how to monetize the health outcomes. One of the assumptions agencies are making is that if they can successfully show a positive ROI it will lead to the program being sustained.

To estimate the ROI, the evaluation needs to consist of four things. The first is to identify what the potential funders' value. This includes the types of outcomes, timeline for seeing results, and the target population. The second is to assess the cost of the program. It is important to identify all the costs of the program/intervention. Although this may sound straightforward, this process can be quite complex. An activity-based costing approach (ABC) (also known as resource-based costing (RCB)) can be used in order to estimate the program costs. In this type of costing approach, all the resources or activities, such as products and services that are used in the program need to be assigned a cost. Both direct and indirect costs need to be assessed. The third step is to identify the ROI. To do this, it is important to model the short term and long-term costs and outcomes. In order to successfully do this, a monetary value needs to be assigned to the factors that potential funders value as well as identify the extent to which the MCACHI is on health equity. The fourth step is to approach potential funders with information about the ROI. This includes calculating the ROI, including a breakeven analysis, a timeline for achieving a positive ROI, clearly specifying who receives the direct and indirect benefits from the program, and lastly identifying who pays the costs of the program. This framework for estimating the ROI for LHD's for decision making is a contribution to the literature. What makes this unique is that no other studies have done a ROI in this specific context of working with community groups and trying to tie it to sustainability, which in this case is trying to get potential funders to donate to a wellness fund.

The purpose of this dissertation is to explore what public health departments really mean when they ask for a ROI. Do they just mean doing an economic evaluation where all the outcomes are monetized, like in a CBA, or do they want something different than this? I attempted to do a ROI in such a way that met all the specific requirements of this group. The contribution this dissertation makes to the literature to use principles and techniques of health economics to develop a ROI framework that can be used by researchers and practitioners to i) identify the value of public health interventions aimed at chronic disease prevention, ii) calculate the true cost of developing and running the program to the agency, and iii) calculate the ROI using parameters that are important to the agency. In addition, the study will report the extent to which this information translates into continued and sustained financial support for the program. No other study has done a ROI in this specific context of working with a community group and tying it to sustainability.

The MCACHI is a large public health intervention, with many complex and moving pieces. It contains several different interventions, referral pathways, key players, along with a sustainability aspect that must all work together in sync to be successful. The key research questions, and the aim of this dissertation is: What is the ROI for the MCACHI, how many people will need to complete the program for the ROI to be positive, did the ROI lead to funding for sustainability, while slso highlighting the process of developing the ROI with a (CAG).

The first study will estimate the value the community places on different public health programs. The study aims to understand the preferences of community members about being targeted for diabetes, heart disease, and depression programs.

The second study aims to get a sense of the all of the resources and costs that are involved in referring people to the MCACHI programs, the resources used in delivering the programs, and as investment costs in order to get a sense of the total costs involved.

The third study will use the information from the first two studies to estimate the ROI for the MCACHI using two approaches. The first approach will involve QALYs and the second approach will use the discrete choice experiment (DCE) from the first study to back out willingness to pay (WTP) estimates to monetize the outcomes. Together, these studies will help calculate the ROI for the MCACHI and will help make the case for potential funders to contribute to the wellness fund in order to help the MCACHI be sustainable.

CHAPTER 2: Understanding the Value of Public Health Programs

Introduction

Prioritization of health services, such as community programs targeting chronic diseases, is critical for decision makers, but can be very complex and challenging (Hauck, Smith, & Maria, 2004). This is often due to working with limited resources, which often results in some programs being funded, while other programs are not (Ham, 1997). It can be difficult to decide what programs should be chosen and ultimately invested in. Deciding what programs are needed and prioritized depends on several different things, such as the health needs of the specific population, a societal wish to maximize general population health, programs targeting vulnerable populations, programs targeting economically productive people, and others (Baltussen & Niessen, 2006). This decision is often based on if the program will be both effective, in terms of health outcomes, and efficient.

Economic evaluations, such as CEA, are often used to help guide priority setting for public health programs at both the local and national level (Hauck et al., 2004; Masters, Anwar, Collins, Cookson, & Capewell, 2017). The advantages of using economic evaluations is that it considers costs and outputs and allows for comparison of programs in terms of incremental, or marginal gains (Mitton, C., & Donaldson, C. 2009).

There are some limitations of using traditional economic evaluations. One of the limitations is that it is hard to incorporate equity (Mitton & Donaldson, 2004). Health equity is a term that is often used when discussing prioritization of health programs, especially by LHDs. In the context of priority setting, it is the idea that overall efficiency can be sacrificed if a program is targeting a group with additional needs (Stolk, Pickee, Ament, & Busschbach, 2005). For example, Program A might be more effective and have a lower dollar per improved health outcome compared to Program B, but because Program B targets people of low socioeconomic status (SES), it might be chosen. Because of situations such as this, it is important to include health equity along with efficiency and effectiveness of the programs when priority setting. Another limitation is that economic evaluations are typically done at the societal level and not the level of an organization. They tend to examine long term costs and outcomes regardless of the distribution of those costs and benefits. Although this may be appropriate in some instances, it may not be appropriate for agencies that are more concerned with their own direct costs and/or a much shorter time horizon.

Because of these challenges with typical economic evaluations, many health departments at the local level have begun using ROIs (Masters et al., 2017; Michigan Association for Local Public Health, 2013). A ROI is an economic measure that is used to indicate how much benefit there is from a program in relation to its costs (Brousselle et al., 2016). Economic evaluations and ROIs are generally very similar, however, have some important differences. Economic evaluations often focus on long term costs and outcomes and assess whether an intervention represents good value for the money. ROIs tend to focus more on the direct costs of the intervention or program and the return to the agency from that investment. The focus, in a ROI, depends on what outcomes the specific agency is interested in. Also, ROIs may have a shorter time horizon. One key distinction between economic evaluations and ROIs is that all the outcomes need to be in monetary terms for ROIs.

One of the challenges in estimating the ROI is understanding how much people value the benefits of being targeted by these types of programs and what aspects of the programs are most important to them. There are limited studies that have looked at measuring the value the community places on public health programs. There have been some studies internationally, but nothing really has been done in the United States or specifically in the San Joaquin Valley (SJV) region. There are two ways of monetizing outcomes. The first is using QALYs. The QALY is a generic measure of disease burden, including both the quality (morbidity) and the quantity (mortality) of life lived (Mehrez & Gafni, 1989). It assumes that health is a function of length of life, quality of life, and that these can be combined into single index number that represents an ordinal measure of health. The choice of a monetary value for a QALY depends in part on the preferences and resources available to the funder. In the US, the common value is often set at $50,000, although there is some evidence that it can be higher, and other evidence that it is now much less (Hirth, Chernew, Miller, Fendrick, & Weissert, 1997; Nimdet, Chaiyakunapruk, & Vichansavakul, 2015; Ryen & Svensson, 2015). A problem with using this value for QALYs is that it may not reflect the value that members of the community place on the outcomes. One key component that is often times overlooked when making these decisions is the general public's perspective of what programs they would like to see in their communities (Bruni, Laupacis, & Martin, 2008). The second way of placing the outcomes in monetary terms is to get a WTP estimate from a DCE. DCE also known as conjoint analysis, is a surveying technique that uses an attribute based survey method for measuring preferences for multiple benefits, or utility (Defechereux et al., 2012). This can be done by using a discrete choice survey to examine the factors people value most regarding public health programs, which will help place a value important in order to back out a ROI for investing in these types of programs. Also, an advantage of this approach compared to the first approach using QALYs is that equity can be incorporated.

The purpose of this study is to use a DCE to examine how much people in the region value different public health programs and what characteristics of the programs they prefer the most. The program being examined is the diabetes prevention program. Equity will be incorporated by one of the levels of the discrete choice. The end result from the study is there will be an estimate of the relative importance of each aspect of public health programs and an estimate of the marginal importance of these factors in terms of the cost (WTP) that will be used in chapter four to estimate the ROI of the MCACHI NDPP.

Methods

Sample and Data

500 people were surveyed through the online surveying system Qualtrics between August and September 2018. All surveyed were English-speaking adults 18 years or older who live in a ZIP code that falls in the SJV of California. All participants were compensated through Qualtrics for participating in the study. The study was approved by the Institutional Review Board at the University of California, Merced.

Discrete Choice Survey and Criteria Attributes

The survey elicits the surveyor’s preferences based on their stated preferences in hypothetical choices between three scenarios, or in the case of this study, two public health programs or the option of selecting no program. The selection of the attributes was informed by reviewing the literature on what people seem to value in public health programs when choosing between them. A discussion with key a CAG involved with the MCACHI project was held regarding the attributes that were found to be important in the literature. Feedback from the CAG, along with focusing on the outcomes needed in order to do the ROI, helped shape the final attributes and levels that were used in the survey. Table 1 describes the attributes and levels that were used.

Table 1: Attributes and levels for the Discrete Choice Experiment

Attributes	**Levels**				
Community Problem	Diabetes Prevention	Heart Disease Prevention	Depression Prevention	Violence Prevention	Hurricane Awareness
Targeted Group	Target all people in the community	Target people at high risk due to lifestyle choices	Target people at high risk due to living in poverty	People at high risk due to other factors	
Cost of the Program	$0 (free or no cost per person)	$50 per person	$500 per person	$1000 per person	$5000 per person
Program Funder	Taxpayers such as you	Businesses in the region	People who use the program (user charges)	Charitable foundations	Special tax on soft drinks
Effectiveness	1% of the targeted group in the community program will be helped	10% of the targeted group in the community program will be helped	50% of the targeted group in the community program will be helped	75% of the targeted group in the community program will be helped	All (100%) of the targeted group in the community program will be helped
Time till Results	0 to 6 months from now	2 years from now	5 years from now	10 years from now	20 years from now

The first attribute, community problem, was included because it was important to see what type of programs people valued more in the region. The idea for including the second attribute, targeted group, was to be able to get a sense if health equity was important to people in the region, and to be able to include a measure of health equity in the calculation of the ROI. Often health equity is not included when doing ROI's, or any economic evaluation, as it is difficult to include a way of measuring this. The third attribute, cost of the program, was included in order to see how sensitive people in the region are to the cost of the public health programs, and in order to be able to linearize cost for the purposes of calculating the ROI. The fourth attribute, program funder, was included to see if it mattered to people who was paying for the program. Program effectiveness, the fifth attribute included, was included in order to see if people in the region cared if the programs are effective in reducing/preventing the interested condition. This was also important to include because in the calculation of the ROI it was important to be able to linearize effectiveness. The sixth and final attribute included in the study was time till results, which was included because it is important to see if when the results of the program would be seen is important to people in the region, and also this was linearized in order to estimate the ROI. All these attributes were important to include in the study in order to help estimate the value placed on each of the different attributes in order to help back out and estimate the WTP, which was then used to calculate the ROI for the MCACHI.

The levels of the six attributes were varied systematically using Sawtooth Software Version 8.2.4. This allowed all sixteen choice sets to be balanced (D-efficiency 2,960). 10 different versions of the survey were developed. 16 choice sets were given to each participant. They were asked to choose between three options for each of the sixteen choice sets. The options included program one, program two, or neither program. See Figure 2 for an example of a DCE question. Following the DCE participants were asked to complete a questionnaire which included demographic questions, such as age, ethnicity, and gender.

Figure 2: Example of a Discrete Choice Survey question

Feature	***Community Program 1***	***Community Program 2***	**Don't like either Community Program**
Community Program	Diabetes prevention	Depression	
Target Group	People at risk due to genetic factors	People at risk due to lifestyle choices	
Cost	$100 per person in the program	$0 (free)	
Funder	Businesses in the region	Charitable foundation	
Effectiveness	95% of the people in the program will avoid diabetes	50% of the people in the program will avoid depression	
Time till results	10 years from now	2 years from now	

Prefer Community Program 1	**Prefer Community Program 2**	**Neither Community Program 1 nor 2**

CONTINUE FOR 16 CHOICES

Data Analysis

Descriptive statistics were computed for demographic measures, including gender, age, education, relationship status and race/ethnicity. Discrete choice data was analyzed using a fixed effects conditional logistic regression. This produces utility coefficients for each level of each attribute. Three options were given for each decision choice, so the "neither" option indicated the preference of no program. The first analysis modeled all the attributes as categorical variables. The second analysis was the same but cost, effectiveness, and time till results were modeled as linearized continuous variables. Next, the data was stratified by gender, race/ethnicity and education to see if there were differences between groups of people. Marginal probabilities were estimated for the best case, worst care, and realistic program in order to see the probability of a program being selected. Statistical inferences were made using an alpha level of .05 and all the analyses were done using Stata version 14.

Results

Sample

Of the 500 participants who completed the survey, 77.6% (n=388) were female (Table 2). The average age of respondents was 37.6 years (SD=14.73), ranging from 18 to 82. 51.2% of respondents reported as White, 22.6% as Hispanic/Latino, 11.6% as Asian/Pacific Islander, 8.2% as Black/African American, 4.6% as other, and 1.8% as Native American/Alaskan. Respondents were categorized as NH Whites/NH Other if they were Native American/Alaskan or other because of the low percentages of Native American/Alaskan and other for the various analyses. 8.2% of respondents completed less than high school, 68.8% completed high school or some college, and 23% earned a four-year college degree or higher.

Table 2: Demographics for entire sample

	N/Mean	% (SD)
Race/Ethnicity		
NH White/NH Other	288	57.60%
NH Black	41	8.20%
NH Asian	58	11.60%
Hispanic/Latino	113	22.60%
Sex		
Female	387	77.40%
Age	37.63	(14.73)
Education		
Less than High School	41	8.20%
High School/Some College	344	68.80%
College Graduate/Higher	115	23%
Marital Status		
Married/Remarried	171	34.20%
Diabetes		
Ever Diagnosed	43	8.98%
Ever Told at Risk	171	36.23%
Ever Enrolled in NDPP	19	3.80%
Heart Disease		
Ever Diagnosed	26	5.39%
Ever Told at Risk	109	23.09%
Depression		
Had Mild Psychological Distress Past Year	239	50.96%
Serious Psychological Distress Past Year	125	27.23%
Violence		
Ever Been Victim of Violence	204	41.89%

Discrete Choice Analysis

Table 3 summarizes the results from the discrete choice analysis for the entire sample for the categorical model and the results for the model with cost, effectiveness, and time till results linearized. When examining the decision of choosing between having a public health program in their community or not, the variable “neither option” shows a significant negative effect in both models. This suggests that, all things being equal, that the respondents were more likely to choose one of the public health programs, even a hurricane awareness program, compared to not having any program. Looking at the community problem attribute, responders preferred all of the programs more than the hurricane awareness program, with depression prevention programs as the most preferred ($\beta=0.83$, $p<.001$), followed by violence prevention programs ($\beta=0.74$, $p<.001$), then heart disease prevention programs ($\beta=0.71$, $p<.001$), and finally diabetes prevention programs

(β=0.60, p<.001). When examining the targeted group attribute, respondents preferred programs that target all people in the community compared to those that target specific groups, although target people at high risk due to other factors was not significant at the .05 level but is marginally significant (β=-0.08, p=.06) in the categorical model. In the linear model, target people at high risk due to lifestyle choices as well as target people at high risk due to living in poverty were not significant. Participants preferred programs that were $0 (free) over programs that were more expensive. When linearized, increased cost was associated with significantly decreased preference in the selection of the public health program (β=-0.0001, p<.001). Participants were most likely to choose programs funded by businesses in the region (β=0.185, p<.001), followed by charitable foundations (β=0.183, p<.001) and then a special tax on soft drinks (β=0.133, p=.001) compared to programs funded by tax payers. In the linear model, special tax on soft drinks was not found to be significant. Respondents prefer programs that are the most effective. When linearized, increased effectiveness was associated with significantly increased preference in the public health program (β=0.0007, p<.001). Lastly, when looking at the attribute of time till results, respondents prefer programs where the results are seen the soonest compared to programs where the results are not seen until many years later. In the linear model, increased time when the results of the program were seen is associated with a significantly decreased preference (β=-0.03, p<.001).

Table 3: Discrete Choice results for entire sample

Attribute/Level	Categorical Model		Linear Model	
	Estimate	Standard Error	Estimate	Standard Error
'Neither Option'	-0.38***	(0.09)	-0.16*	(0.07)
Community Problem				
Hurricane Awareness	Omitted		Omitted	
Diabetes Prevention	0.60***	(0.06)	0.57***	(0.06)
Heart Disease Prevention	0.71***	(0.05)	0.67***	(0.05)
Depression Prevention	0.83***	(0.05)	0.84***	(0.05)
Violence Prevention	0.74***	(0.05)	0.69***	(0.05)
Targeted Group				
All People in Community	Omitted		Omitted	
High Risk Due to Lifestyle	-0.14**	(0.04)	-0.13**	(0.04)
High Risk Due to Living in Poverty	-0.10*	(0.05)	-0.07	(0.04)
High Risk Due to Other Factors	-0.08†	(0.04)	-0.04	(0.04)
Cost of the Program				
$0 (Free)	Omitted		Omitted	
$50 Per Person	-0.22***	(0.05)		
$500 Per Person	-0.50***	(0.05)		
$1000 Per Person	-0.71***	(0.05)		
$5000 Per Person	-0.93***	(0.05)		
Linear Cost			-0.00***	(0.00)
Program Funder				
Taxpayers	Omitted		Omitted	
Businesses in the Region	0.18***	(0.05)	0.15**	(0.05)
People Who Use the Program	0.05	(0.05)	0.05	(0.05)
Charitable Foundations	0.18***	(0.05)	0.13*	(0.05)
Special Tax on Soft Drinks	0.13**	(0.05)	0.07	(0.05)

Program Effectiveness				
1% Helped	Omitted		Omitted	
10% Helped	0.22***	(0.05)		
50% Helped	0.45***	(0.05)		
75% Helped	0.68***	(0.05)		
100% Helped	0.72***	(0.05)		
Linear Program Effectiveness			0.01***	(0.00)
Time till Results				
0 to 6 Months from Now	Omitted		Omitted	
2 Years from Now	-0.06	(0.05)		
5 Years from Now	-0.26***	(0.05)		
10 Years from Now	-0.44***	(0.05)		
20 Years from Now	-0.70***	(0.05)		
Linear Time till Results			-0.03***	(0.00)

N=500; †p<.10, *p<.05, **p<.01, ***p<.001

Next, the data was stratified by gender, race/ethnicity, and education. Only the model with linearized continuous variables was stratified. Table 4 shows the results of the discrete choice analysis when stratifying the data by both male and female respondents. Both males and females prefer all of the programs over the hurricane awareness program, but females most prefer depression prevention programs (β=0.91, p<.001), followed by violence prevention programs (β=0.78, p<.001), then heart disease prevention programs (β=0.71, p<.001), and lastly diabetes prevention programs (β=0.63, p<.001), while men most prefer programs targeting depression (β=0.60, p<.001), followed by heart disease (β=0.54, p<.001), violence (β=0.40, p<.001), and then diabetes (β=0.35, p=.002). Females least prefer programs targeting people at high risk due to lifestyle choices (β=-0.12, p=.014) while none of the levels of this attribute were significant for males. Females prefer programs that are funded by charitable foundations (β=0.19, p=.002) and businesses in the region (β=0.18, p=.002) compared to programs funded by taxpayers. Special tax on soft drinks was marginally significant (β=0.10, p=.076), suggesting that this way of funding is more preferred than taxpayers paying for the programs. None of the levels in this attribute were significant for males. Both females and males prefer less costly programs, more effective programs, and programs that the results are seen sooner rather than later.

Table 4: Discrete Choice results stratified by sex

Attribute/Level	Male		Female	
	Estimate	Standard Error	Estimate	Standard Error
'Neither Option'	-0.44**	(0.14)	-0.07	(0.08)
Community Problem				
Hurricane Awareness	Omitted		Omitted	
Diabetes Prevention	0.35**	(0.11)	0.63***	(0.06)
Heart Disease Prevention	0.54***	(0.11)	0.71***	(0.06)
Depression Prevention	0.60***	(0.11)	0.91***	(0.06)
Violence Prevention	0.40***	(0.11)	0.78***	(0.06)
Targeted Group				
All People in Community	Omitted		Omitted	
High Risk Due to Lifestyle	-0.12	(0.09)	-0.12*	(0.05)
High Risk Due to Living in Poverty	-0.07	(0.09)	-0.06	(0.05)
High Risk Due to Other Factors	-0.05	(0.09)	-0.03	(0.05)
Cost of the Program				
Linear Cost	-0.00***	0.00	-0.00***	(0.00)
Program Funder				
Taxpayers	Omitted		Omitted	
Businesses in the Region	0.05	(0.11)	0.18**	(0.06)
People Who Use the Program	-0.04	(0.10)	0.08	(0.06)
Charitable Foundations	-0.08	(0.11)	0.19**	(0.06)
Special Tax on Soft Drinks	-0.04	(0.10)	0.10†	(0.06)
Program Effectiveness				
Linear Program Effectiveness	0.00***	0.00	0.01***	(0.00)
Time till Results				
Linear Time till Results	-0.03***	0.00	-0.03***	(0.00)

N=387 Females and 113 Males; †p<.10, *p<.05, **p<.01, ***p<.001

Table 5 shows the results of the discrete choice analysis when stratifying the data by NH White/NH Other, Hispanic/Latino, NH Black, and NH Asian/NH Pacific Islander. NH White/NH Other (β=0.97, p<.001), Hispanic/Latino (β=0.75, p<.001), and NH Asian/NH Pacific Islander (β=0.67, p<.001) all most prefer programs that target depression, while NH Black (β=0.57, p=.002) most prefer diabetes prevention programs. NH White/NH Other (β=0.83, p<.001) and NH Asian/NH Pacific Islander (β=0.59, p<.001) prefer programs targeting heart disease prevention next, while Hispanic/Latino (β=0.72, p<.001) prefer violence prevention programs next and NH Black (β=0.46, p=.008) prefer depression prevention programs next. The third and fourth most preferred is violence prevention for both NH White/NH Other (β=0.80, p<.001) and NH Asian/NH Pacific Islander (β=0.51, p=.001) followed by diabetes prevention for NH White/NH Other (β=0.64, p<.001) and NH Asian/NH Pacific Islander (β=0.36, p=.025).

Hispanic/Latino value diabetes prevention (β=0.52, p<.001) and heart disease prevention (β=0.51, p<.001) as the third and fourth most preferred, respectively. NH White/NH Other prefer programs that target people at high risk due to lifestyle choices (β=-0.14, p=.019) less than programs that target all people in the community, while NH Asian/NH Pacific Islander least prefer programs that target people at high risk due to living in poverty (β=-0.34, p=.009) followed by people at high risk due to other factors (β=-0.23, p=.067), which was marginally significant. NH White/NH Other prefer programs funded by charitable foundations (β=0.20, p=.006) and businesses in the region (β=0.19, p=.006) over programs funded by taxpayers. All race/ethnicity groups prefer programs that cost less, are more effective, and the results are seen sooner, except for NH Black which was not significant for effectiveness.

Table 5: Discrete Choice results stratified by race/ethnicity

Attribute/Level	NH White/NH Other		NH Black		Hispanic/Latino		NH Asian/NH Pacific Islander	
	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error
'Neither Option'	0.08	(0.09)	-0.67*	(0.24)	-0.37**	(0.15)	-0.56**	(0.21)
Community Problem								
Hurricane Awareness	Omitted		Omitted		Omitted		Omitted	
Diabetes Prevention	0.64***	(0.08)	0.57**	(0.19)	0.52***	(0.11)	0.36*	(0.16)
Heart Disease Prevention	0.83***	(0.07)	0.18	(0.18)	0.51***	(0.11)	0.59***	(0.15)
Depression Prevention	0.97***	(0.07)	0.46**	(0.17)	0.75***	(0.11)	0.67***	(0.15)
Violence Prevention	0.80***	(0.07)	0.21	(0.18)	0.72***	(0.11)	0.51**	(0.15)
Targeted Group								
All People in Community	Omitted		Omitted		Omitted		Omitted	
High Risk Due to Lifestyle	-0.14*	(0.06)	-0.15	(0.15)	-0.09	(0.09)	-0.21†	(0.13)
High Risk Due to Living in Poverty	-0.06	(0.06)	-0.01	(0.15)	-0.01	(0.09)	-0.34**	(0.13)
High Risk Due to Other Factors	-0.04	(0.06)	0.08	(0.15)	0.02	(0.09)	-0.23†	(0.13)
Cost of the Program								
Linear Cost	-0.00***	0.00	-0.00***	(0.00)	-0.00***	0.00	-0.00***	(0.00)
Program Funder								

Taxpayers	Omitted		Omitted		Omitted		Omitted	
Businesses in the Region	0.19**	(0.07)	0.27	(0.17)	0.09	(0.10)	0.10	(0.15)
People Who Use the Program	0.06	(0.07)	-0.15	(0.17)	0.11	(0.10)	0.05	(0.15)
Charitable Foundations	0.20**	(0.07)	-0.13	(0.18)	0.07	(0.11)	0.09	(0.16)
Special Tax on Soft Drinks	0.15*	(0.07)	0.02	(0.17)	-0.09	(0.10)	-0.00	(0.15)
Program Effectiveness								
Linear Program Effectiveness	0.01***	0.00	0.00	(0.00)	0.01***	0.00	0.01***	(0.00)
Time till Results								
Linear Time till Results	-0.04***	0.00	-0.03***	(0.00)	-0.03***	0.00	-0.03***	(0.01)

Table 6 shows the results of the discrete choice analysis when the data was stratified by less than high school, high school/some college, and college graduate or higher. All these groups most prefer depression prevention programs, while less than high school (β=0.40, p=.023) and high school/some college (β=0.71, p<.001) prefer violence prevention programs in second. Those that are a college graduate or higher value heart disease prevention programs second (β=0.86, p<.001) followed by violence prevention programs (β=0.77, p<.001) and diabetes prevention programs (β=0.76, p<.001). High school/some college prefer heart disease prevention programs third (β=0.68, p<.001), and programs targeting diabetes in fourth (β=0.57, pp<.001). Those with high school/some college prefer programs that target people at high risk due to lifestyle choices (β=-0.16, p=.003) less than programs that target all people in the community. This same group also prefers programs funded by charitable foundations (β=0.17, p=.01) and businesses in the region (β=0.16, p=.007) more than programs funded by taxpayers. All groups prefer programs that cost less, are more effective, with results seen sooner, except effectiveness was not significant for less than high school.

Table 6: Discrete Choice results stratified by education

Attribute/Level	Less Than High School		High School/Some College		College Graduate or Higher	
	Estimate	Standard Error	Estimate	Standard Error	Estimate	Standard Error
'Neither Option'	-0.36	(0.24)	-0.14	(0.09)	-0.13	(0.15)
Community Problem						
Hurricane Awareness	Omitted		Omitted		Omitted	
Diabetes Prevention	0.10	(0.19)	0.57***	(0.07)	0.76***	(0.12)
Heart Disease Prevention	0.07	(0.17)	0.68***	(0.06)	0.86***	(0.11)
Depression Prevention	0.51**	(0.18)	0.85**	(0.06)	0.93***	(0.11)
Violence Prevention	0.40*	(0.17)	0.71***	(0.06)	0.77***	(0.11)
Targeted Group						
All People in Community	Omitted		Omitted		Omitted	
High Risk Due to Lifestyle	0.22	(0.15)	-0.16**	(0.05)	-0.14	(0.09)
High Risk Due to Living in Poverty	0.01	(0.16)	-0.06	(0.05)	-0.07	(0.09)
High Risk Due to Other Factors	0.21	(0.15)	-0.06	(0.05)	-0.04	(0.09)
Cost of the Program						
Linear Cost	-0.00**	0.00	-0.00***	(0.00)	-0.00***	0.00
Program Funder						
Taxpayers	Omitted		Omitted		Omitted	
Businesses in the Region	0.10	(0.18)	0.16**	(0.06)	0.12	(0.11)
People Who Use the Program	0.15	(0.17)	0.08	(0.06)	-0.08	(0.11)
Charitable Foundations	0.09	(0.18)	0.17*	(0.06)	0.02	(0.11)
Special Tax on Soft Drinks	-0.10	(0.18)	0.07	(0.06)	0.08	(0.10)
Program Effectiveness						
Linear Program Effectiveness	0.00	0.00	0.01***	(0.00)	0.01***	0.00

Time till Results						
Linear Time till Results	-0.03***	0.01	-0.03***	(0.00)	-0.03***	0.00

Willingness to Pay

Discrete choice analysis provides information about how strong the preferences are for each of the attributes. The key with using WTP is that it gives a monetary value for each attribute, which can then be compared across attributes to see what people value when making decisions on choosing between programs. The WTP estimates are a key component to estimating the relative importance of each aspect of the public health programs of the MCACHI for those living in the region, which is important for estimating the ROI for the MCACHI, since ROI's require all the outcomes to be monetized. The most important factor, for the entire sample, is for depression prevention programs at $5,776. This shows that this program has the highest monetary value to the respondents. The second most important factor was violence prevention programs at $4,778. followed by heart disease prevention programs at $4,601, and then diabetes prevention programs at $3,913. Table 7 shows the WTP estimates for the entire sample and by gender, while Table 8 shows the estimates by race/ethnicity and Table 9 by education.

Table 7: Willingness to Pay estimates for entire sample and by sex

Attribute/Level	Entire Sample	Males	Females
		Willingness to Pay	
'Neither Option'	-$1,087	-$3,489	-$475
Community Problem			
Hurricane Awareness		Omitted	
Diabetes Prevention	$3,913	$2,799	$4,184
Heart Disease Prevention	$4,601	$4,287	$4,675
Depression Prevention	$5,776	$4,779	$6,017
Violence Prevention	$4,778	$3,222	$5,158
Targeted Group			
All People in Community		Omitted	
High Risk Due to Lifestyle	-$863	-$994	-$813
High Risk Due to Living in Poverty	-$452	-$596	-$406
High Risk Due to Other Factors	-$272	-$379	-$225
Program Funder			
Taxpayers		Omitted	
Businesses in the Region	$1,058	$409	$1,201
People Who Use the Program	$355	-$327	$514
Charitable Foundations	$878	-$640	$1,242
Special Tax on Soft Drinks	$476	-$321	$671
Cost of the Program			
Linear Cost	-$1	-$1	-$1
Program Effectiveness			
Linear Program Effectiveness	$49	$58	$47
Time till Results			
Linear Time till Results	-$228	-$244	-$223

Table 8: Willingness to Pay estimates by race/ethnicity

Attribute/Level	Hispanic/Latino	African American	Asian	White/ Other
		Willingness to Pay		
'Neither Option'	-$3,588	-$4,379	-$3,941	$497
Community Problem				
Hurricane Awareness		Omitted		
Diabetes Prevention	$5,057	$3,680	$2,540	$3,875
Heart Disease Prevention	$4,904	$1,144	$4,176	$5,034
Depression Prevention	$7,276	$2,978	$4,746	$5,926
Violence Prevention	$6,928	$1,371	$3,562	$4,874
Targeted Group				
All People in Community		Omitted		
High Risk Due to Lifestyle	-$824	-$986	-$1,490	-$845
High Risk Due to Living in Poverty	-$62	-$53	-$2,403	-$342
High Risk Due to Other Factors	$199	$539	-$1,637	$264
Program Funder				
Taxpayers		Omitted		
Businesses in the Region	$878	$1,730	$683	$1,150
People Who Use the Program	$1,078	-$1,000	$356	$379
Charitable Foundations	$668	-$839	$611	$1,196
Special Tax on Soft Drinks	-$915	$104	-$8	$899
Cost of the Program				
Linear Cost	-$1	-$1	-$1	-$1
Program Effectiveness				
Linear Program Effectiveness	$51	$16	$65	$51
Time till Results				
Linear Time till Results	-$263	-$198	-$214	-$225

Table 9: Willingness to Pay estimates by education

Attribute/Level	Less than High School	High School/ Some College	College Graduate/Higher
'Neither Option'	-$3,373	-$909	-$929
Community Problem			
Hurricane Awareness		Omitted	
Diabetes Prevention	$962	$3,775	$5,227
Heart Disease Prevention	$681	$4,505	$5,956
Depression Prevention	$4,838	$5,627	$6,420
Violence Prevention	$3,727	$4,695	$5,306
Targeted Group			
All People in Community		Omitted	
High Risk Due to Lifestyle	$2,120	-$1,032	-$955
High Risk Due to Living in Poverty	$53	-$421	-$463
High Risk Due to Other Factors	$1,940	-$426	-$292
Program Funder			
Taxpayers		Omitted	
Businesses in the Region	$900	$1,089	$813
People Who Use the Program	$1,392	$522	-$584
Charitable Foundations	$825	$1,094	$151
Special Tax on Soft Drinks	-$950	$482	$537
Cost of the Program			
Linear Cost	-$1	-$1	-$1
Program Effectiveness			
Linear Program Effectiveness	$16	$49	$61
Time till Results			
Linear Time till Results	-$279	-$221	-$236

Marginal Probabilities

Marginal analysis shows the relative importance of each factor, and in this case the probability that one program made up of the various attributes and levels will be selected over another program by the surveyor. This is useful, particularly in this study, because it allows the comparison of two public health programs with varying levels, or characteristics, to see what program has the higher probability of being selected. Below are examples of a hypothetical ‘best case’ program, ‘worst case’ program, and a ‘realistic case’ of public health programs to see the probability that the program would be selected compared to not having a program at all. Regarding the ‘best case’ program, the probability of it being chosen over not having a program is 86%. For the ‘worst case’ program, the probability of the program being chosen over not having a program is only 26%. For the ‘realistic case’ program, people are expected to choose it 69% of the time over not having any program. Table 10 describes the details of the attributes and levels of these three hypothetical programs.

Table 10: Marginal probabilities for best case, worst case, and realistic program

Attribute	Best Program	No Program	Realistic Program	No Program	Worst Program	No Program
Community Problem	Depression		Diabetes		Hurricane	
Targeted Group	All People in the Community		All People in the Community		High Risk Due to Lifestyle	
Program Funder	Businesses in the Region		Taxpayers		Taxpayers	
Cost of the Program	$0		$50 per Person		$5000 per Person	
Program Effectiveness	100%		50%		1%	
Time till Results	0 (Results Now)		5 Years		20 Years	
Sum of Part-Worth Utilities	1.71	-0.16	0.76	-0.16	-1.28	-0.16
Predicted Selection	86.62%	13.38%	71.39%	28.61%	24.60%	75.41%

Conclusion

The purpose of this study was to examine how much people in the region value public health programs and the different aspects of them, while also estimating the WTP for various components of the programs that will be used to calculate the ROI for the MCACHI. The results suggest that people in the region highly value public health programs that target their communities. For the entire sample, depression prevention programs had the highest value compared to all the other programs. People also tend to value programs that target all people in the community compared to those that target specific groups. This is interesting, as the issue of efficiency vs equity is often discussed when trying to prioritize programs (Guindo et al., 2012). In this study, health equity was not a major concern for the sample. People prefer programs where the results are seen sooner. The results also suggest that people value programs that are less expensive and programs that are more effective in reducing negative health outcomes. Interestingly, the results suggest that people in the region prefer programs that are funded by businesses in the region over other forms of funding.

The data was then stratified by gender, race/ethnicity, and education to see if there were differences in what characteristics of the programs are more valued. The results suggest that there are differences between the groups. Regarding gender, males and females value depression prevention programs the most. However, males value heart disease prevention programs the second most while females value violence prevention programs. A possible explanation for why males might value heart disease prevention programs more highly compared to females is that cardiovascular disease is perceived to be more prominent amongst males, even though cardiovascular disease is the major cause of death in women (Maas & Appelman, 2010). The third most preferred programs for males was violence prevention programs, while for females was heart disease prevention programs. Both males and females valued diabetes prevention programs the least, except compared to hurricane awareness programs. When examining if who the program is targeting is important to males and females, the results suggest that men are indifferent, while females do not prefer programs that target people at high risk due to lifestyle choices. Regarding who is funding the program, women prefer programs that are funded by charitable foundations and businesses in the region, while men are once again indifferent when it comes to who is paying for the program. Interestingly, a special tax on soft drinks, often called a sugar tax, was marginally significant in women, suggesting that even this way of funding the programs is more preferred than taxpayers paying for the programs. Both women and men preferred cheaper programs that are highly effective, with the results coming sooner.

The data was also stratified by race/ethnicity, and once again differences between groups was found. NH Whites/NH Others, Hispanics/Latinos, and NH Asians/NH Pacific Islanders all valued depression prevention programs the most, while NH Blacks valued diabetes prevention programs the most. This is particularly interesting because NH Blacks have the highest prevalence of diabetes in both California, as well as the SJV, of these different races/ethnicities (UCLA Center for Health Policy and Research, 2017). What this finding implies is that NH Blacks are aware that they are at a higher risk for diabetes, which could be why they value diabetes prevention programs the most compared with all the other programs. The results of this analysis also suggest that NH Whites/NH Others value programs that target all people in the community, especially over programs that only target people at high risk due to lifestyle choices. NH Asians/NH Pacific Islanders, while they too value programs targeting all members of the community, they do not prefer programs that target people at high risk due to living in poverty or even people at high risk due to other factors, which was marginally significant.

Lastly, the data was stratified by education, which was categorized as less than high school, high school/some college, and college graduate or higher. All the groups valued depression prevention programs the most, and hurricane awareness programs the least. The results suggest that the two groups with lower education value violence prevention programs the second most, while college graduates/or higher prefer heart disease prevention programs second. This could potentially be due to those who have lower levels of education earn less income, resulting in living in potentially more dangerous/violent areas compared to those with higher levels of education. This could possibly explain why violence prevention programs might have a higher value for this group of people, while higher educated individuals are more worried about chronic conditions such as heart disease prevention programs.

Regarding the WTP analysis, the purpose was to examine the characteristics of the programs are valued more to people in the region, in monetary terms. The reason for doing this was to be able to place a monetary value on the outcomes for people in the region regarding different characteristics of public health programs. This is important in order to calculate the ROI for the MCACHI, as one of the key pieces of information needed when calculating the ROI is monetizing the outcomes of the programs. Based on the findings from the DCE, the WTP for a diabetes prevention program that targets all people in the community, is paid for by businesses in the region, is 58% effective in reducing diabetes in five years is $7,788 per person who completes the program. The marginal probabilities analysis showed that people will choose a public health program, made up of a realistic set of characteristics, at a much higher probability compared to not having any program at all. Also, the marginal probabilities analysis showed that if the public health program being offered has a poor set of characteristics, such as a low effectiveness rate and is very expensive, the public will choose to not have a program instead. This finding shows that although the public sees the value in public health programs, the programs need to consist of certain characteristics.

Previous studies have examined the preferences of the general public regarding priority setting in healthcare (Bowling, 2005; Bpharm et al., 2007; Bruni et al., 2008; Dolan & Tsuchiya, 2012; Lees, Scott, Scott, Macdonald, & Campbell, 2002; Mossialos & King, 1999; Shah, 2009), but none have followed a similar methodology as this study in measuring the value of public health programs for the general public. These types of studies are much more common internationally. A study that was done in Uganda explored what criteria had a higher weight for priority setting amongst the general public (Kapiriri & Norheim, 2004). This study found that severity of the disease, benefit of the intervention, cost of the intervention, cost effectiveness, quality of data on effectiveness, patients age, place of residence, lifestyle, importance of providing equity of access to health care, and the community’s views were all highly valued by the public for priority setting. Many of these criteria were similar to the attributes as part of the DCE in this study, such as cost of the program, effectiveness and equity (who the program is targeting).There are limited studies that have looked at measuring the value of public health programs, especially in the context of doing a ROI analysis. There are studies that state that the public should be involved when setting priorities in health as they are one of the most important stakeholders in the health care system (Bruni et al., 2008).

Limitations

A limitation of the study is that the MCACHI is targeting people in the Merced County region, while the study surveyed those who live in the SJV. Although the SJV includes Merced County, it includes many other areas. The data was stratified in order to deal with this potential issue, to see if the different populations by sex, ethnicity/race, and education yielded differences in how much they value these types of public health programs. Another limitation of this study is that it was done using the online surveying system, Qualtrics, which does not target harder to reach populations, such as those with no access to a computer or internet. The survey was also only given in English, which is a limitation as well, as Spanish is the primary language of many people in this region who might not speak English fluently.

Implications

This study represents an initial attempt to estimate the value the public places on public health programs in the SJV. This information is valuable to public health departments when making decisions on the types of public health programs to invest in and offer their communities. This study found that people in this region tend to favor programs that have a better value in terms of costs and effectiveness.

The next chapter, chapter three, will focus on costing out the MCACHI. The chapter will review the existing literature on methods for costing out public health programs and then apply the best fit methods to the MCACHI. Estimating the program costs are critical in order to calculate the ROI from the MCACHI. The chapter will include a discussion of why the specific costing methods were used and will also estimate the total investment costs of the MCACHI as of June 2019, operating costs, referral system costs, as well as the costs of running the programs. A cost per person of completing the program will also be estimated in the chapter.

Chapter 3: Merced California Accountable Communities for Health Initiative Costing Analysis

Introduction

In the evaluation section of the introduction to this dissertation various evaluation and monitoring frameworks for the different components of the MCACHI were stated. Included in this section was a framework for evaluating the referral system as well as the programs of the MCACHI. The referral system for the MCACHI consists of the 211 call in system. The NDPP is the main program of the MCACHI. The focus of this paper is to cost out the 211-referral system, the NDPP, along with estimating the total startup costs for the MCACHI.

Estimating the costs of public health programs is important for health departments. This information can be used in order to assess the program of interest to improve the performance by reallocating resources and is a critical component of conducting economic evaluations. One study attempted to systematically estimate program costs for health interventions in different areas of the world (Johns, Baltussen, & Hutubessy, 2003). They found that program costs varied by the type of program as well as the region. Another key finding from this study was that program costs are a large percentage of overall costs for health inventions and should not be ignored in the economic evaluation of health programs, as they often are.

There are different ways of estimating the costs of health programs by LHDs. One way is by reported costs, which involves examining the financial records of the LHD. The advantage of using this method to estimate program costs, or costs of services, is LHDs tend to keep track of costs. Because health departments often will maintain their financial records, this information can be obtained rather quickly. The disadvantage of using their financial records to cost out their programs or services is there is no standard procedure for reporting the costs of programs or services, so these estimates can potentially be much higher or lower than the true cost of running the programs or delivering services (Bernet & Singh, 2015).

Another way of estimating the costs of health programs and services is to use a method in which the value of resources that are required to deliver a program or service are identified. There are three common costing methods that use this type of strategy. The ratio-of-costs-to-charges method (RCC) estimates costs by applying the ratio of treatment costs to charges to revenues generated, while the relative value unit (RVU) establishes standard measures of treatment intensity based on the complexity of the procedure, how many resources are used, and the amount of time spent delivering the treatment or service (West, Balas, & West, 1996). While RCC and RVU are more commonly used for costing out physician services, ABC is more commonly used to cost out health programs. Also, ABC, also known as RBC, has been found to be the most accurate costing strategy of the three (West et al., 1996). With this approach it is important to determine all of the resources used in order to deliver the programs, and then apply a cost to each of these resources (Rajabi & Dabiri, 2012). Some advantages of this approach are that it is one of the most accurate and reliable ways of costing programs out (Kuchta & Sabina, 2011), while one of the biggest disadvantages is that this approach is timely (Khodadadzadeh, 2015). This could explain why most health departments tend to favor reported costs when costing out their programs, because of a lack of time and resources, such as staff, available to conduct a RBC approach.

To ensure the MCACHI is sustainable, a ROI is needed in order to attract potential funders, showing the program has a good value for the money. In order to successfully estimate the ROI, costing out each aspect of the MCACHI is required. The purpose of this study is to estimate the total costs of the MCACHI, which include startup costs, operating costs, referral costs and the cost of providing the NDPPs. The data from the MCACHI will be compared to what if analyses in order to see if the costs of the MCACHI would be lower if it was done more efficiently and to see what would happen if the MCACHI had more people enroll and complete the programs. Section 3.3 of the introduction to this dissertation discusses evaluating programs to see whether they are efficient or not, but the general idea is to see if a program's activities are being produced with the least amount of required resources in order to perform the activities (Centers for Disease Control and Prevention, 2011). For example, by offering less classes but making sure a minimum of 25 people attend each class of the NDPP instead of having a small number of people in each class and having a more cost-effective referral system. By doing these things, the MCACHI would be much more efficient, resulting in the cost per person being less while the number of people who complete the program being greater. Accurate costing information is important, as the more accurate the costing estimates are the more accurate the ROI estimations will be.

Methods

The MCDPH is the LHD that participated in the project. This is because the MCDPH is the backbone organization of the MCACHI. A mixed methods approach was used, which involved a qualitative interview and quantitative analysis of data to identify the investment costs, the process in which services were delivered and the resources that were required by these services. The study was approved by the Institutional Review Board at the University of California, Merced.

Process Map

A semi-structured interview was used to identify the pathway by which an at-risk person is referred and enrolled in the diabetes prevention programs. The interview was with the Division Manager of the MCDPH, who oversees the MCACHI. Although the Division Manager only oversees the NDPP that is done at the MCDPH, the costs and resources from the MCDPH NDPP were applied to all the other sites administering the NDPP as part of the MCACHI in order to have a standardized cost. The NDPP follows a strict curriculum, meaning all the classes at the various sites part of the MCACHI are the same in the resources and costs associated with them.

The interview was transcribed and the information was used to refine a process map that shows the pathway in which an at-risk person is referred and enrolled in the diabetes prevention programs of the MCACHI. Once the process map was developed it was then shown to the Division Manager to verify the key steps in the process and to confirm its accuracy. The process maps were developed showing the pathways that at-risk people would follow to reach each potential outcome node. For the diabetes prevention programs, the outcomes included completing or not completing the NDPP, and whether the participants became diabetics or not. Part of the interview for developing the process map was to have the Division Manager identify the resources required to complete each part of the process. The Division Manager of the MCDPH was able to describe the staff required to administer the NDPP and the amount of time it took in order to prepare for administering the classes.

Categories of costs

- *Startup costs:* The startup cost, or investment cost of the MCACHI, was calculated using reported costing information provided by the MCDPH. This involved interviews with the Division Manager as well as discussions with the MCACHI CAG to decide what costs should be included in these estimations. The final reported cost estimates were shown to this group to verify its accuracy. It is understood that the MCDPH invested other resources into the MCACHI, but the costs were estimated from the perspective of the funder, thus only including the funds they directly invested. Below is a list of the various positions and expenses that were included as investment costs.
    - *Director:* From MCDPH
    - *Program Manager:* From MCDPH
    - *Epidemiologist:* From MCDPH
    - *Supervising Health Educator:* From MCDPH
    - *Office Assistance:* From MCDPH
    - *Miscellaneous Expenses:* From MCDPH
    - *Consultants:* From MCDPH
- *Operating costs:* The operational costs were estimated using reported costing information from the MCDPH. These included any staff and resources needed in order to continue the operation of the MCACHI for subsequent years.
    - *Director:* From MCDPH
    - *Support Staff:* From MCDPH
    - *Meetings:* From MCDPH
    - *Travel:* From MCDPH
    - *Miscellaneous:* From MCDPH
    - *Promotoras:* From MCDPH
- *Classes*
    - *Recruitment:* The 211-referral system was the way in which people were recruited and enrolled in the NDPPs. The cost of implementing the 211 was estimated using reported costing information provided by the MCDPH.
    - *Classes:* Four key things were done in order to estimate the cost of the MCACHI NDPPs using a RBC approach (Reynoso & Brown, 2018). The first was to identify the process by which each service is provided. The second was to identify the amount of staff time and other resources needed to estimate the cost at each stage of the process. The third was to assign a

unit price to each resource at each stage, and the fourth was to apply a common indirect or overhead cost. Because the cost of providing the NDPPs is not affected by the number of people enrolled or participating in the classes, there was no need to estimate the cost per person and then multiply this by the number of people who participated in the programs. Instead, after estimating the cost of running the NDPPs, this was divided by the number of people who completed the program to estimate how much it costs per person.

- *Support:* Promotoras, a Spanish term for community health workers, were used in order to support those who were enrolled in the NDPPs ("Community Health Workers (Promotores)," 2019). The main purpose of the promotoras was to support attendance and provide accountability to class principles.

Analysis

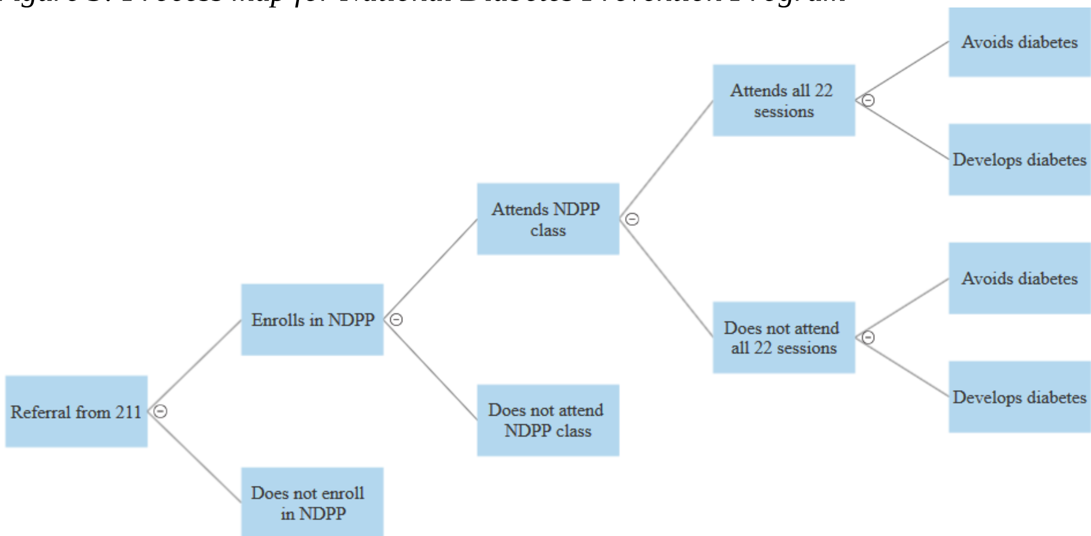
The results are presented as the total investment cost, operating costs, and costs of delivering the NDPPs for the MCACHI. Additionally, the cost per NDPP class and the cost per person of offering the classes based on both the number of people enrolled as well as the number of people who completed the program. The cost of delivering the NDPPs are calculated using a RBC approach, while the startup, operating, and recruitment costs are calculated using reported costs. Cost estimations were also calculated to compare the actual MCACHI to if the program was done more efficiently by using a more efficient referral system and a fewer number of classes, as well as if more people were to enroll and complete the programs.

Results

Process

The process by which an at-risk individual is referred and enrolled in the NDPPs that are part of the MCACHI can be seen in Figure 3. The process involved an individual calling into the 211-referral system where they are identified as at risk using a screening survey. The names of these individuals are then given to MCDPH staff who contact them, offer and enroll those who are interested in the available NDPP classes. Since there are four MCACHI sites that offer the NDPP, individuals are offered a class that is closest to their residence or is most convenient for them to attend.

Figure 3: Process map for National Diabetes Prevention Program



Investment/Startup Costs

Table 11 breaks down the total investment cost per year over the three years of developing the MCACHI. The various staff that worked on establishing the MCACHI, along with the various consultants hired, and expenses for meetings and travel were all factored into the yearly calculations. Overheads were estimated to be 50% of the total costs. For 2016/2017 the total investment cost per year is $317,971. For 2017/2018 the cost is $377,459. For 2018/2019 the cost is $418,676. The total three-year investment cost is $1,114,105.

Table 11: Merced California Accountable Communities for Health Initiative startup/investment costs

	2016/17			2017/18			2018/19		
	FTE	Salary	Cost	FTE	Salary	Cost	FTE	Salary	Cost
Director	0.10	$80,000	$8,000	0.10	$80,000	$8,000	0.10	$80,000	$8,000
Program Manager	0.40	$103,033	$41,213	0.50	$113,150	$56,575	0.50	$118,777	$59,388
Epidemiologist	0.30	$70,573	$21,172	0.15	$80,940	$12,141	0.25	$85,386	$21,347
Supervising Health Educator	0.00	$0	$0	0.00	$0	$0	0.45	$83,166	$37,425
Office Assistance	0.10	$37,320	$3,732	0.10	$40,940	$4,094	0.10	$40,940	$4,094
Miscellaneous Expenses									
* Meetings	12.00	$292	$3,500	12.00	$467	$5,600	12.00	$319	$3,824
* Travel			$5,000			$5,000			$5,000
* Miscellaneous			$10,000			$10,000			$10,000
Consultants									
* 1			$25,000			$21,369			$15,000
* 2			$59,000			$30,000			$31,000
* 3			$35,363			$23,860			$8,000
* 4			$0			$75,000			$76,039
Subtotal			$211,980			$251,639			$279,117
Overheads (50%)			$105,990			$125,820			$139,559
Total per year			$317,971			$377,459			$418,676

Operating costs

The operational costs of the MCACHI included the cost of having a full-time director, along with part time support staff, meetings, travel and overheads (50%). The total yearly operating costs for the MCACHI was estimated to be $161,550. A what if analysis was also completed in order to examine how the operating costs would change if the MCACHI was run more efficiently with the same number of people enrolling and completing the program, along with if more people enrolled and completed the program. The operating costs would be the same except that there would be additional money spent on promotoras if they were used for both recruitment and support. If there were 750 people enrolled and promotoras were used, the total operating cost would $386,550, and if 3,000 people enrolled the operating cost would be $836,550. Table 12 displays the annual operating costs and cost of the classes in more detail for both the actual program as well as the operating costs for more efficient programs.

Table 12: Merced California Accountable Communities for Health Initiative operating and class costs

	Actual	Efficient				
	124 enrolled	124 enrolled	750 enrolled	750 enrolled	3,000 enrolled	3,000 enrolled
	43 completed	43 completed	250 completed	500 completed	1,000 completed	2,000 completed
Operating costs						
·Director	$80,000	$80,000	$80,000	$80,000	$80,000	$80,000
·Support staff	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000
·Meetings	$2,700	$2,700	$2,700	$2,700	$2,700	$2,700
·Travel	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
·Miscellaneous	$10,000	$10,000	$10,000	$10,000	$10,000	$10,000
·Promotoras	0	0	0	$150,000	0	$450,000
·Overheads 50%	$53,850	$53,850	$53,850	$128,850	$53,850	$278,850
Total Operating costs	$161,550	$161,550	$161,550	$386,550	$161,550	$836,550
211 Referral	$30,000					
Efficient referral ($100 per enrollee)		$12,400	$75,000		$300,000	
NDPP Classes						
·Number of classes	7	5	30	30	120	120
·Total cost of classes	$10,284	$7,346	$44,075	$44,075	$176,299	$176,299
·(Reimbursements)	$3,870	$3,870	$22,500	$45,000	$90,000	$180,000
Net Class cost	$6,414	$3,476	$21,575	($925)	$86,299	($3,701)

Total per year	$197,964	$177,426	$258,125	$385,625	$547,849	$832,849
Total per year/enrollee	$1,596	$1,431	$344	$514	$183	$278
Total per year/completed	$4,604	$4,126	$1,032	$771	$548	$416

Cost of classes

The RBC is based on 43 out of 124 people completing the program, which is just below a 35% completion rate. Table 13 shows the number of people who completed the program as well as the number of people who enrolled in the program for each site part of the MCACHI.

Table 13: Number of people who completed and enrolled in the National Diabetes Prevention Programs

	2018		
Class providers	Number of classes	Number of enrollees	Number who completed
Site 1	1	6	1
Site 2	3	50	10
Site 3	2	55	29
Site 4	1	13	3

- *Recruitment:* The 211 referral system costs $30,000 annually to operate and is not affected by the number of calls received or referrals to the NDPPs. In the what if analysis a more efficient referral system was estimated to cost $100 per person enrolled, since the 211-referral system cost just under $242 per person enrolled based on 124 people enrolling in the program. Also, a what if analysis was completed based on using promotoras instead of the 211 system for recruitment. One promotora would cost an estimated $50,000 per year, with roughly one promotora needed for every 250 people enrolled.
- *Classes:* For each of the four sites offering the NDPP, one community health specialist is in charge of preparing and delivering each class. There is a total of the 22 sessions for each NDPP, which spans over 22 weeks. On average, a community health specialist spends two hours per week preparing for each class, which is one hour long. Since there are four sites for the MCACHI providing seven NDPPs, there are seven community health specialists spending roughly three hours in total per week on preparing and delivering the class. For the MCACHI, this equates to 21 hours spent per week for administering NDPPs, and over the course of 22 weeks a total of 462 hours spent across all the sites. Table 15 shows the resources and costs for providing the NDPPs. The total cost of providing one NDPP is roughly $1,469. Because there are four sites as part of the MCACHI offering a total of seven NDPPs, the cost estimates of the MCDPH NDPP was applied to the other NDPPs. Based on this estimate of the MCDPH NDPP, the total cost of the MCACHI NDPPs is approximately $10,284. Because the NDPP is reimbursable by the Centers

for Medicare and Medicaid Services (CMS) if someone completes a minimum of nine core sessions, this was factored into the net cost of the NDPPs by multiplying the number of people who completed the program by the reimbursement rate of $90 per person and subtracting it from the total cost of $10,284 ("CMS Medicare Diabetes Prevention Program," n.d.). The total reimbursement is $3,870 and net cost of the classes is $6,414. In the what if analysis the program costs were estimated based on 25 people per class, which would decrease the number of classes offered from seven to five. This would help reduce the cost of the classes to $7,345 with a net cost of $3,475 compared to a net cost of $6,414 for having seven classes.

Table 14: National Diabetes Prevention resources and costs

Resource	Average Hourly Salary	Class Preparation (per session in hours)	Class Session (hours)	Number of Class Sessions
Community Health Specialist	$22	2	1	22
Total Cost of Providing One NDPP	$1,469			

- *Support:* Originally the plan was to have promotoras help provide support for those enrolled in the programs. Although this was discussed, promotoras were never used, resulting in a cost of $0. The what if analysis, mentioned previously in the recruitment section, estimated the cost of using one promotora per 250 people enrolled. Although using promotoras is more costly compared to using the 211 system or even a more efficient referral system costing $100 per person enrolled, it would increase the number who complete the program since they would be providing those enrolled in the programs much more support. In turn, this would lead to a lower total cost per year for each person who completed the programs.

Total costs

The total investment cost for the three-year period is $1,114,105. Based on the 43 out of 124 people completing the program, the total cost of providing the NDPPs, including both recruitment and support costs is approximately $197,964 per year. Adding both the investment and the total cost of providing the NDPPs, the total cost is $1,311,799.

Various what if analyses were done to see how the total costs would be impacted if the program was implemented more efficiently in order to compare the costs to the estimates for the actual MCACHI. The total cost per year using the same number of people enrolled and completing the program as the actual program, but using a more efficient recruitment strategy (estimated at $100 per person enrolled compared to using the 211 system which was estimated to be $242 per person enrolled) and two less classes (five instead of seven) would be $177,425, which would result in a savings of over $20,000. The total costs were also estimated if 750 people enrolled and 250 completed the programs using an efficient referral process ($100 per person enrolled) and having 30 NDPP classes (25 people per class). The total cost per year would be $258,124. If the same number of people enrolled in the program but instead promotoras were used for recruitment and support, it would be expected that the number of people who complete the programs would increase to potentially 500, which would cost $385,624. Another what if analysis was done to compare the total cost per year if 3,000 people were enrolled in the programs using promotoras or an efficient referral system. This would involve 120 NDPP classes and would cost $547,849 per year using a referral cost of $100 per person enrolled and would cost $832,849 per year if promotoras were used instead. The actual total cost per year for the MCACHI along with the various what if analyses costs can be found in Table 12.

Cost per person

Based on 43 people completing the program in 2018 for the MCACHI, an estimate of how much it costs per person who completed the NDPPs can be calculated. Based on the total annual cost for the MCACHI, it cost roughly $4,603 per person who completed the program. If the three-year investment/startup costs are included along with the total annual cost for the MCACHI in the calculation of the per person cost estimation for those who completed the program, the cost is $30,513 per person who completed the program. Based on 124 people enrolled in the MCACHI for 2018, the cost per person who enrolled in the program is $1,596 not including startup costs, and $10,581 if the three-year investment costs are included. If the same program was done more efficiently by using a more efficient referral process instead of the 211 call in system, as well as had five classes instead of seven, the cost per enrollee would be $1,430 and cost per person who completed would be $4,126. If 750 people enrolled in the MCACHI and an efficient referral system was used while providing 30 NDPP classes the cost per enrollee would be $344 and the cost per person who completed the program would be $1,032 based on 250 people completing. If the same number of people enrolled in the program, but instead of a referral system promotoras were used, the number of people who complete the program would be expected to increase to 500. In this scenario, the cost per enrollee would be $514, while the cost per person who completed the program would be $771. In the case that 3,000 people enrolled in the MCACHI and an efficient referral system was used while providing 120 classes, the cost per enrollee would be $182, while the cost per person who completed the program would be $547, based on 1,000 people completing the program. Using promotoras instead of a referral system in this same scenario, the total cost per enrollee would be $277, while the cost per person who completed the program would be $416, based on 2,000 people completing the program. Table 12 displays the total costs per enrollee and per person who completed the programs for the different scenarios.

Table 15 shows the cost for providing the NDPPs for each site based on the number of NDPPs they offered. Also, shown in Table 15, is the cost per person for those who enrolled and completed the programs at the various sites. Site two offered the most NDPPs which resulted in them having the highest total costs at $4,407, while both site one and site four had the lowest cost since they only offered one NDPP ($1,469). Based on the cost for providing the NDPPs at each site, site three had the lowest cost per person who enrolled in the program ($53), while site one had the highest cost per person who enrolled in the program ($245). For the cost per person who completed the programs, site three had the lowest ($101), while site one had the highest cost per person who completed the program ($1,469). These cost per person estimates do not include the 211 referral system costs, the investment/startup costs, or operating costs. They only include the costs of providing the NDPPs.

Table 15: National Diabetes Prevention Program costs by site

Class providers	Cost of providing NDPPs	Cost per person who completed	Cost per person who enrolled
Site 1	$1,469	$1,469	$245
Site 2	$4,407	$441	$88
Site 3	$2,938	$101	$53
Site 4	$1,469	$490	$113

Conclusion

The purpose of this study was to examine the total costs associated with the MCACHI, which includes the investment/startup costs, operating costs, cost of referring and providing the NDPPs. Using both reported costs and a RBC approach, the total cost for delivering the programs (including operating costs and the cost of the 211 referral system) for all four sites was estimated to be $197,964 per year. The cost of running one NDPP for the MCACHI, using a RBC approach, was $1,469. Using reported costs, the total investment cost of the MCACHI over the three-year period was $1,114,105. The total cost, including both the investment and operating cost of the MCACHI, was $1,312,070.

In order to estimate the ROI for the MCACHI, the investments costs are needed. This is because it is important to consider all the resources that went into the planning and development of the MCACHI when estimating the ROI as of June 2019, even though the investment costs are not needed if the program is continued in the future. Although the startup costs are large, the operating costs, 211 referral system costs, and the cost of the NDPPs are not.

There are some key things that could help lower the cost per person. One key to lowering the cost per person is to have a higher number of people going through and completing the programs. Another key to lowering the per person costs is to have a much more efficient referral system. For the number of people enrolled in the MCACHI the

$30,000 spent on the 211 system was not a good value. Just by implementing a more efficient referral system could have reduced the cost per enrollee by over $165, and over $475 for the cost per person who completed the program, based on the what if analysis using the actual number of people who enrolled and completed the program. Promotoras were discussed to be used to support those in the programs but were never implemented. Another key would be to use promotoras, as they could potentially have helped increase the number of people who completed the programs as well as helped enroll more people. These various ways of lowering the cost per person are different strategies that would increase the overall efficiency of the MCACHI, thus lowering the cost per person.

Because only 43 people completed the MCACHI NDPPs, the cost per person is relatively high. The goal should be to i) increase the number of people who enroll and complete the programs for the next year, ii) use a more cost-effective referral system, and iii) potentially use promotoras for both support as well as recruiting people into the programs. These things would drastically reduce the cost per person and make the MCACHI much more cost efficient.

Limitations

There are a number of limitations in this study. The estimates are based on information provided to us from the MCDPH, and as such, are dependent on the accuracy of their data. In addition, the estimates for the program costs of the MCDPH NDPP were applied to the other three sites that were part of the MCACHI. The assumption was that since the NDPP has a strict curriculum, the costs for delivering the program would be very similar across sites. However, this was not verified.

Implications

The information from this study was useful for the MCDPH because it allowed them to see how much money they have invested thus far in the MCACHI and how much it will cost them to continue offering the NDPPs. Additionally, the costing methods can be useful for other LHDs that are interested in costing out their programs using reported and RBC. This is valuable information which can help health departments estimate how much they are spending on their programs or health interventions, which can help them decide if they should be increasing or decreasing the resources for providing the programs to their communities. It is also useful if they are planning on doing an economic evaluation, or ROI analysis, as estimating their program costs is a vital piece of information needed for these types of evaluations.

The next chapter of this dissertation, chapter four, will focus on using the information from chapter two and chapter three to calculate the ROI of the MCACHI. The chapter will provide a framework on how to do a ROI for these types of programs using two different methodologies for monetizing health outcomes. The first methodology will use a WTP estimate from a DCE and the second methodology will use QALYs. This next chapter will apply the ROI framework to the MCACHI to estimate a ROI. A what if analysis will be used to examine what parameters have a more significant effect on the ROI. Additionally, a breakeven analysis will be estimated in order to see how many people needed to complete the programs for the ROI to be positive. Lastly, the chapter will estimate the ROI as of June 2019 for the MCACHI.

Chapter 4: Return on Investment for the Merced California Accountable Communities for Health Initiative Community-Based Diabetes Prevention Program: A Framework for Estimating ROI for Chronic Disease Prevention Programs

Introduction

Recently, there has been an increase in the use of ROI analysis, especially by health providers and local health organizations (Crawley-Stout, Ward, See, & Randolph, 2016). Previously ROIs have been commonly used in the businesses world, however in recent years is becoming more popular within public health (Chronic Disease Directors, 2009). Cuts to public health budgets and spending are issues often discussed and funding is often difficult to acquire for public health departments (Freedman, Kuester, & Jernigan, 2013). Although public health programs have been proven to improve the health of populations, more funding goes towards medical care (Robert Wood Johnson Foundation, 2013). Because of this, LHDs are often tasked with trying to acquire funding for programs and interventions to implement in their communities.

LHDs believe that ROIs are more attractive to potential funders and investors compared to typical economic evaluations. This is because ROI methodology is consistent and credible and has been used for evaluating businesses for hundreds of years (Chronic Disease Directors, 2009). As with CBA, ROI analysis requires outcomes to be measured in dollar values, with the ROI representing the percentage return on an investment relative to the size of the investment. LHDs argue that ROI analysis is typically easier for potential funders to understand compared to other economic evaluations. They are often worded as one dollar invested saves xxx dollars in the future. The need for ROIs for determining whether a program is a good value has become more imperative for supporting chronic disease prevention programs (Chronic Disease Directors, 2009). ROIs have the potential to change the narrative that the public health budget is seen as an investment instead of as an expense because they can show programs to be profitable over time (Brousselle et al., 2016).

ROI analysis is similar to CBA because both require all outcomes to be monetized. ROIs, however, differ because they are used to convey the impact on a specific organization rather than society. Another difference is that ROIs treat investment costs as independent from other costs and convey the results as a ROI (rather than net monetary value). ROI analysis is attractive to local health organizations because it allows them to specify what factors they want to include when making decisions, including; the number of years they want to follow the target of the intervention; the discount rate for costs and outcomes; and other facts that might be important to them such as health equity.

There are several challenges with using ROI analysis for evaluating chronic disease prevention programs. One problem is there is little consistency on how to do ROIs for chronic disease prevention programs. There are several difficulties that can arise from ROI analysis, such as it is difficult to identify what to include or not include when calculating both costs and outcomes. Another difficulty is deciding timelines, such as how many years to include health outcomes for. A key problem with ROIs is that it is difficult to monetize outcomes based on the interested parameters. These types of decisions are critical when estimating a ROI and can have a significant impact on the final ROI estimations. A risk of using ROIs is that comparisons will be made to other programs to see which program has the higher ROI (Brousselle et al., 2016). Although a program has a higher ROI, it does not mean it should always be funded over programs with a lower ROI. There are other factors to consider besides only funding programs with higher ROIs.

The MCACHI decided to implement the NDPP because of its documented success in lowering diabetes if people complete the program. The goal from the beginning was to provide potential funders a ROI as they believed this would help them secure funding and keep the program sustainable. By showing the MCACHI yielded a positive ROI, the hope was this would be enough evidence for local businesses in the region to want to contribute to the wellness fund which would be used to sustain the program.

The purpose of this study is to estimate the ROI for the NDPP for the MCACHI. The study will also provide a framework on how to do ROIs for chronic disease prevention programs using two different strategies for monetizing health outcomes. ROI estimates for the MCACHI using WTP estimates and QALYs for monetizing health outcomes will be compared. Several what if analyses will be done in order to examine how the ROI for the MCACHI would vary if the program was done more efficiently and if more people were enrolled in the programs. Breakeven analyses will be estimated to see the number of people needed to complete the MCACHI programs for the ROI to be positive.

Methods

Sources of information

- Diabetes incidence rates were obtained from the literature (DeJesus et al., 2017). The one-year diabetes incidence rate for those with prediabetes was 38.6 per 1000 person-years. The five-year diabetes incidence rate was 40.24 per 1000 person-years. These numbers were extrapolated in order to estimate diabetes incidence rates per year.
- Estimates of the cost of diabetes in Merced County were obtained from the chronic disease cost calculator tool developed by Dr. Paul Brown, Ravi Singh and colleagues. Briefly, the following formula was used to estimate the number of people with each chronic condition in each California county.

Number of people in the county for each age, gender, and ethnicity
x
Prevalence rate for each condition by each age, gender, and ethnicity
= Number of people with the chronic disease in the county by *age, gender, and ethnicity*

Estimates of the prevalence for the six chronic conditions for California were derived from various data sources, which include the CHIS, Surveillance Epidemiology and End Results Program (SEER), and CDC. The number of people in each country was estimated using US Census data. The following formula was used for estimating the cost per county:

Number of people with the chronic disease in the county by *age, gender, and ethnicity*
x
Cost per case for that chronic disease by age and gender
= Cost of each chronic disease per county

The cost per case for each chronic disease was estimated using the CDC's Cost Calculator. These estimates were adjusted for price differences in healthcare services between counties and for inflation. The cost for a case of diabetes in Merced County is included in the calculation for the return/benefit of the ROI for the NDPP to help measure the positive impact of providing the program (P. Brown et al., 2018).

- Diabetes prevention program effectiveness was obtained from the study, *The Diabetes Prevention Program Outcomes Study* (Diabetes Prevention Program Research Group, 2009). Based on this study, the diabetes prevention programs tend to have a 58% reduction in diabetes incidence rates between two to eight years after participants completed the program, and a 34% reduction after 10 years compared with placebo.
- NDPP reimbursement rates were obtained from the CMS ("CMS Medicare Diabetes Prevention Program," n.d.). $90 was reimbursed for each person who completed a minimum of nine core sessions of the NDPP.
- Utility scores for both healthy and those with diabetes were obtained from a meta-analysis (Singh et al., 2020).

Parameters included in the ROI and where the information came from

The information needed for the parameters included in the ROI were obtained from the MCACHI, the sites, or were simulated because the information was not available. Estimates for the average age for those who enrolled in the program, ethnicity, sex, number of years for the ROI, and the year diabetes was developed were selected to best represent the characteristics of the MCACHI.

- Age—simulated
- Ethnicity—simulated
- Sex—simulated

- Number who completed program—from sites
- Investment costs—from MCACHI
- Referral costs—from MCACHI
- Operating costs—from MCACHI
- Program costs—from MCACHI
- Number of years for the ROI—simulated
- Year diabetes was developed—simulated
- Discount rate—standard
- Value of health outcomes
  - *QALYs approach:* Details of the method for calculating the utility scores for chronic diseases and health counterparts are described elsewhere (Singh, Carroll, Sandhu, & Brown, 2020). Briefly, a predictive model for the estimation of health utility scores for several chronic diseases based on age, gender, and ethnicity were determined after a meta-analyzed 385 health utility scores from 30 different studies for one of six chronic diseases: arthritis, asthma, cancer, depression, diabetes, and heart disease (including stroke and hypertension). A conditional random-effects multilevel meta-analytic model was fitted to develop a predictive model to aid in producing utility estimates. The utility values for a healthy 40 year-old were used as the starting point for the analysis, with the probability of contracting diabetes within one, five, and 10 years taken from existing literature (DeJesus et al., 2017). The difference in utility scores between an adult without diabetes and an adult with diabetes were multiplied by the projected effectiveness of the program and then summed (discounted three percent) over five years as well as the projected life span of an adult with and without diabetes to estimate the QALYs gained from the program. A value of $50,000 per QALY gained was used as per previous studies (Hirth et al., 1997). A value of $20,000 per QALY gained was also used in order to examine the impact on health outcomes if a smaller monetary value was used. *QALYs.* The QALYs gained and monetary value per person for the NDPP can be found in Table 16. The average utility value for a healthy 40-year-old was estimated to be 0.87, while the average for the same person but with diabetes was estimated to be 0.74. To monetize the health outcomes, these estimates were multiplied by the standard $50,000 per QALY gained, as well as a lower value of $20,000 per QALY gained, in order to examine the impact on health outcomes if a smaller monetary value is used and how this will affect the ROI estimates for the MCACHI. Both values were also discounted three percent. For a 40-year-old person that developed diabetes in year one, the utilities lost over five years is 0.69 and 0.63 when discounted three percent. The utilities lost over the lifetime is 6.96, and 3.86 when discounted three percent. The per capita value using $50,000 per QALY is $29,040 for the five-year projection, and $119,095 over the lifetime. Using a lower value of $20,000 per QALY the per capita value over five years is $11,616 and $47,638.18 over the lifetime. The utilities lost if the same person developed diabetes in five years instead of one year is 0.14 over five years and

0.12 if discounted three percent. The utilities lost over the lifetime is 6.41 and 3.35 when discounted three percent. When monetized, the per person estimate over five years is $5,265 and $95,319 over the lifetime using the value of $50,000 per QALY gained. Using $20,000 per QALY, the per capita value over five years is $2,106 and $38,128 over the lifetime. If the same person developed diabetes in 10 years, the utilities lost over five years is 0 (since they have not developed diabetes yet). The utilities lost over the lifetime is 5.68 and 2.76 when discounted. The monetary value per person, using the $50,000 value, is $0 over five years and $71,295 over the lifetime. Using the $20,000 per QALY, the five-year monetary value is $0 and $28,518 over the lifetime.

- *DCE approach:* Details of the method for using a WTP marginal analysis for a DCE in order to estimate monetary values for the various attributes and levels can be found in chapter two of this dissertation. The WTP values used were for both five-year and lifetime estimates, discounted three percent. For diabetes prevention programs that target all people in the community, are paid for by businesses in the region, are 58% effective in five years, the WTP is $1,543 per person who completes the program projected out five years and is $7,788 per person who completes the program over their lifespan. The WTP values were developed in consultation with the CAG and using evidence on the effectiveness of the NDPP program in reducing diabetes. These values were chosen for the WTP estimates because they best represent the parameters for the specific community-based diabetes prevention program that was done in the SJV. In order to examine the sensitivity of the WTP estimates, WTP estimates for five-year and lifetime projections were derived for time till results from the program are seen in 10 years and time till the results are seen in one year for a diabetes prevention program. If the results from the program are seen in 10 years, a diabetes prevention program with all the same values as the realistic case except time till results being 10 years, the WTP would be $1,317 per person who completes the program projected out five years and $6,648 per person who completes the program over their lifespan. Alternatively, if the results from the program are seen in one year for a diabetes prevention with all the same values except time till results being one year, the WTP would be $1,723 per person who completes the program projected out over five years and $8,699 per person who completes the program over their lifespan. The WTP estimates can be found in Table 16.

Table 16: Quality Adjusted Life Years and Willingness to Pay monetized outcomes, per capita

Time when diabetes developed (QALYs); time till results are seen (WTP)	QALYs lost	QALYs lost (discounted)	$50,000 per QALY (discounted)	$20,000 per QALY (discounted)	WTP estimates (NDPP)
5-year timeline					
1-year	0.69	0.63	$29,041	$11,616	$1,724
5 years	0.14	0.12	$5,265	$2,106	$1,543
10 years	0	0	0	0	$1317
Lifetime timeline					
1-year	6.96	3.86	$119,095	$47,638	$8,700
5 years	6.41	3.35	$95,319	$38,128	$7,788
10 years	5.68	2.76	$71,295	$28,518	$6,648

Data Analysis

To compute the ROI for the MCACHI initiative, the following formulas were used:

- Return on Investment = net return / investment
- Net Return = return – investment

Estimations for the ROI were calculated for the MCACHI as of June 2019. ROI estimations including startup/investment costs along with ROI estimations not including these startup costs and only costs associated with continuing to offer the programs were calculated. Various what if analyses were used to vary how the ROI would change for the MCACHI if different parameters were varied comparing the actual program to more efficiently run programs. The parameters include the number of people who enrolled and completed the programs, along with different types of referral systems. Shorter vs longer time horizons, such as when a person would develop diabetes and the number of years the participants of the programs would be followed for, were varied as well. A breakeven analysis was estimated in order to see how many people needed to enroll and complete the program for the ROI to be positive. A comparison of the ROI estimations using QALYs and WTP estimates for health outcomes was also done.

Results

Monetized health outcomes for MCACHI, WTP

Of the 124 people who enrolled in the MCACHI for 2018, 43 completed the programs. Using the WTP per person who completed the program estimates from above, monetized outcomes specific to the MCACHI were estimated for both five-year and lifetime timelines. The total monetary health outcomes using the realistic (results from program seen in five years) WTP estimates for the five-year timeline for the MCACHI is $66,351, and $334,887 over the lifetime. Using the estimates for if the results from the program are seen in 10 years, the total for the MCACHI is $56,640 and $285,871 for the five-year and lifetime timelines, respectively. For the WTP estimates if the results are seen in one year, the total is $74,116 for the five-year timeline and $374,099 for the lifetime. Table 17 displays the monetized outcomes using WTP for the MCACHI.

Table 17: Monetized health outcomes for MCACHI and efficient MCACHI, WTP

	Actual	Efficient				
Enrolled	124	124	750	750	3,000	3,000
Completed	43	43	250	500	1,000	2,000
Monetary value 5-Year						
WTP (Time till Results 5 Years)	$66,351	$66,351	$385,760	$771,520	$1,543,040	$3,086,080
WTP (Time till Results 10 Years)	$56,640	$56,640	$329,300	$658,600	$1,317,200	$2,634,400
WTP (Time till Results 1 Year)	$74,116	$74,116	$430,908	$861,815	$1,723,630	$3,447,260
Monetary value lifetime						
WTP (Time till Results 5 Years)	$334,887	$334,887	$1,947,018	$3,894,035	$7,788,070	$15,576,140
WTP (Time till Results 10 Years)	$285,871	$285,871	$1,662,043	$3,324,085	$6,648,170	$13,296,340
WTP (Time till Results 1 Year)	$374,099	$374,099	$2,174,995	$4,349,990	$8,699,980	$17,399,960

Monetized health outcomes for MCACHI, QALYs

Based on 43 people completing the programs, total health outcomes for the MCACHI were estimated. The total monetized health outcomes were estimated for the MCACHI for both five-year and lifetime timelines. The total QALYs gained (discounted three percent) if diabetes was developed in one year is 0.64 for the five-year timeline and 17.71 for the lifetime. Using the $50,000 per QALY threshold the total value for the MCACHI is $29,145 for the five-year timeline, and $546,506 over the lifetime, if the person developed diabetes in one year. Using $20,000 per QALY, the total value is $11,658 for the five-year and $218,602 over the lifetime for a person who developed diabetes in one year.

The total QALYs gained (discounted) if diabetes was developed in five years is 0.12 and 15.36, for the five-year and lifetime timelines, respectively. Using $50,000 per QALY, the total for the MCACHI is $5,283 for the five-year timeline and $437,401 over the lifetime. For the lower threshold of $20,000 per QALY, the total is $2,113 and $174,961 for the five-year and lifetime timelines, respectively.

If diabetes was developed in 10 years, the total QALYs gained for the MCACHI is 0 for the five-year timeline, and 12.65 over the lifetime. For the five-year timeline the total monetary value, using $50,000 per QALY, is $0 and $327,161 over the lifetime. Using the $20,000 per QALY threshold, the total monetary value of the MCACHI is $0 and $130,864 for the five-year and lifetime timelines, respectively. The QALYs gained for the MCACHI can be found in Table 18 and the monetized health outcomes using QALYs can be found in Table 19.

Table 18: QALYs gained for MCACHI and efficient MCACHI

	Actual	Efficient				
Enrolled	124	124	750	750	3,000	3,000
Completed	43	43	250	500	1,000	2,000
QALYs gained diabetes in 1-year (5 year)	0.64	0.64	3.70	7.39	14.78	29.57
QALYs gained diabetes in 5 years (5 year)	0.12	0.12	0.71	1.42	2.85	5.70
QALYs gained diabetes in 10 years (5 year)	0.00	0.00	0.00	0.00	0.00	0.00
QALYs gained diabetes in 1-year (Lifetime)	17.71	17.71	102.94	205.89	411.77	823.55
QALYs gained diabetes in 5 years (Lifetime)	15.36	15.36	89.30	178.60	357.20	714.41
QALYs gained diabetes in 10 years (Lifetime)	12.65	12.65	73.57	147.13	294.26	588.52

Table 19: Monetized health outcomes for MCACHI and efficient MCACHI, QALYs

	Actual	Efficient				
Enrolled	124	124	750	750	3,000	3,000
Completed	43	43	250	500	1,000	2,000
Monetary value 5-Year						
Value per QALY ($20,000) (developed in 1-year)	$11,658	$11,658	$67,779	$135,558	$271,117	$542,234
Value per QALY ($50,000) (developed in 1-year)	$29,145	$29,145	$169,448	$338,896	$677,792	$1,355,584
Value per QALY ($20,000) (developed in 5 years)	$2,113	$2,113	$12,287	$24,574	$49,149	$98,298
Value per QALY ($50,000) (developed in 5 years)	$5,283	$5,283	$30,718	$61,436	$122,872	$245,744
Value per QALY ($20,000) (developed in 10 years)	$0	$0	$0	$0	$0	$0
Value per QALY ($50,000) (developed in 10 years)	$0	$0	$0	$0	$0	$0
Monetary value lifetime						
Value per QALY ($20,000) (developed in 1-year)	$218,602	$218,602	$1,270,945	$2,541,889	$5,083,779	$10,167,558

Value per QALY ($50,000) (developed in 1-year)	$546,506	$546,506	$3,177,362	$6,354,724	$12,709,448	$25,418,897
Value per QALY ($20,000) (developed in 5 years)	$174,961	$174,961	$1,017,212	$2,034,425	$4,068,850	$8,137,699
Value per QALY ($50,000) (developed in 5 years)	$437,401	$437,401	$2,543,031	$5,086,062	$10,172,124	$20,344,248
Value per QALY ($20,000) (developed in 10 years)	$130,864	$130,864	$760,839	$1,521,678	$3,043,357	$6,086,713
Value per QALY ($50,000) (developed in 10 years)	$327,161	$327,161	$1,902,097	$3,804,195	$7,608,390	$15,216,780

Monetized health outcomes for efficient MCACHI, WTP

Various analyses were conducted to examine how the monetized outcomes would be different if the MCACHI was done more efficiently (see chapter three). For the efficient program based on the actual number of people enrolling and completing the program (43 out of 124), the total QALYs and monetized health outcomes would be the same as the actual program. If the program was done on a much larger scale where 750 people were enrolled and 250 people completed the programs, the total monetized health outcomes would be different. For this program where 250 people completed it, the total monetary health outcomes using the realistic WTP estimates for the five-year timeline is $385,760 and $1,947,018 over the lifetime. Using the estimates for if the results from the program are seen in 10 years, the total is $329,300 and $1,662,043 for the five-year and lifetime timelines, respectively. For the WTP estimates if the results are seen in one year, the total is $430,908 for the five-year timeline, and $2,174,995 over the lifetime.

If this same program with 750 people enrolled used promotoras instead of the referral system, the number of those who would complete the program would be expected to increase to 500. Based on 500 people completing the program, the total monetary health outcomes using the realistic WTP estimates is $771,520 for the five-year timeline, and $3,894,035 over the lifetime. If the estimates for if the results from the program are seen in 10 years were used, the total is $658,600 and $3,324,085 for the five-year and lifetime timelines, respectively. Using the WTP estimates if the results are seen in one year, the total is $861,815 and $4,349,990 for the five-year and lifetime timelines, respectively.

If the MCACHI had 3,000 people enrolled and 1000 people completed the programs, the total monetary health outcomes would be $1,543,040 for the five-year timeline, and $7,788,070 over the lifetime, using the realistic WTP estimates. Using the estimates for if the results from the program are seen in 10 years, the total is $1,317,200 for the five-year and $6,648,170 for lifetime. For the estimates if the results are seen in one year, the totals are $1,723,630 and $8.699,980 for the five-year and lifetime timelines, respectively.

If the MCACHI had this same number of people enrolled, but 2,000 people completed the programs instead of 1,000 because of using promotoras, the total monetary health outcomes for the realistic WTP would be $3,086,080 for the five-year and $15,576,140 for the lifetime. For the estimates for if the results from the program are seen in 10 years, the total would be $2,634,400 and $13,296,340 for the five-year and lifetime timelines, respectively. Using the WTP estimates if the results are seen in one year, the total monetary health outcomes is $3,447,260 for the five-year and $17,399,960 for the lifetime timelines. Table 17 displays these estimates for the efficient MCACHI.

Monetized health outcomes for efficient MCACHI, QALYs

For the analyses if the MCACHI was done more efficiently, the health outcomes would not be different for a program that had the same number of people enroll and complete the programs as the actual program. However, if 750 people enrolled in the program and 250 completed, then the total QALYs gained and the monetary value of the health outcomes would be different. The total QALYs gained (discounted) if diabetes was developed in one year is 3.70 and 102.94 for the five-year and lifetime timelines, respectively. Using $50,000 per QALY, the total for the MCACHI is $169,448 for the five-year timeline and $3,177,362 over the lifetime. Using the lower threshold value of $20,000 per QALY gained, the total is $67,779 and $1,270,945 for the five-year and lifetime timelines, respectively. The total QALYs gained if diabetes was developed in five years is 0.71 and 89.30 for the five-year and lifetime timelines, respectively. Using $50,000 per QALY gained, the total monetized health value would be $30,718 for the five-year and $2,543,031 over the lifetime. For $20,000 per QALY gained, the total monetary value would be $12,287 and $1,017,212 for the five-year and lifetime timelines, respectively. If diabetes was developed in 10 years, the total QALYs gained would be 0 for the five-year timeline and 73.57 over the lifetime. Using $50,000 per QALY, the total would be $0 and $1,902,097 for the five-year and lifetime timelines, respectively. Using $20,000 per QALY gained, the total monetary value would be $0 for the five-year timeline and $760,839 over the lifetime.

For the same number of people enrolling in the MCACHI, but instead 500 out of 750 complete the programs, the total QALYs gained if diabetes was developed in one year is 7.39 for the five-year timeline and 205.89 over the lifetime. Using $50,000 per QALY gained, the total monetary health outcomes would be $338,896 and $6,354,724 for the five-year and lifetime timelines, respectively. Using the threshold of $20,000 per QALY, the total would be $135,558 for the five-year timeline and $2,541,889 over the lifetime. If a person developed diabetes in five years instead, the total QALYs gained would be 1.42 and 178.60 for five-year and lifetime timelines, respectively. Using $50,000 per QALY gained, the total value would be $61,436 for five-year timeline and $5,086,062 over the lifetime. For the lower threshold value of $20,000, the total would be $24,574 and $2,034,425 for five-year and lifetime timelines, respectively. If diabetes was developed in 10 years, the total QALYs gained would be 0 for the five-year timeline, and 147.13 over the lifetime. For $50,000 per QALY gained, the total value would be $0 and $3,804,195 for five-year and lifetime timelines, respectively. Using the $20,000 threshold, the total monetary value would be $0 for five years and $1,521,678 over the lifetime.

If the program was bigger and had 3,000 people enrolled and 1,000 of which complete the programs, the total QALYs gained if diabetes was developed in one year would be 14.78 for five years and 411.77 over the lifetime. Using the threshold of $50,000 per QALY gained, the total monetized health outcomes would be $677,792 and $12,709,448 for five-year and lifetime timelines, respectively. For $20,000 per QALY, the total would be $271,117 for five years and $5,083,779 for lifetime. If diabetes was developed in five years instead of one, the total QALYs gained would be 2.85 for five years and 357.20 for the lifetime. The monetary value, using $50,000 per QALY, would be $122,872 and $10,172,124 for five-year and lifetime timelines, respectively. Using $20,000 per QALY, the total value would be $49,149 for five years and $4,068,850 over the lifetime. If diabetes was developed in 10 years, the total QALYs gained for this program would be 0 for five years and 294.26 over the lifetime. Using $50,000 per QALY gained, the total monetary value would be $0 and $7,608,390 for five-year and lifetime timelines, respectively. Using $20,000 per QALY gained, the total would be $0 for five years and $3,043,357 over the lifetime.

If this same program of 3,000 enrolled had 2,000 instead of 1,000 complete the programs the QALYs gained if diabetes was developed in one year would be 29.57 for five-year and 823.55 for lifetime timelines. For the $50,000 per QALY threshold, the total monetary value of the health outcomes would be $1,355,584 and $25,418,897 for five-year and lifetime timelines, respectively. Using $20,000 as the threshold, the total value would be $542,234 and $10,167,558 for five-year and lifetime timelines, respectively. If diabetes was developed in five years, the total QALYs gained from the MCACHI would be 5.70 for the five-year timeline and 714.41 over the lifetime. Using $50,000 per QALY gained, the total would be $245.744 and $20,344,248 for five-year and lifetime timelines, respectively. The total, using $20,000 per QALY gained, would be 98,298 and $8,137,699 for five-year and lifetime timelines, respectively. If diabetes was developed in 10 years the total QALYs gained would be 0 for five years and 588.52 over the lifetime. The total monetary value of the health outcomes, using $50,000 per QALY gained, would be $0 for five-year and $15,216,780 for lifetime timelines. Using $20,000 per QALY as the threshold, the total would be $0 and $6,086,713 for five-year and lifetime timelines, respectively. The QALYs gained for the efficient MCACHI can be found in Table 18 and the monetized health outcomes using QALYs can be found in Table 19.

Cost savings for MCACHI

The cost savings for the MCACHI are displayed in Table 20. The annual health care costs of a 40-year-old person with diabetes in Merced County was estimated to be $3,143. In order to estimate the cost savings for avoided cases of diabetes, this estimate was used and discounted three percent each year. For the actual MCACHI program, the cost savings for 43 out of 124 people completing the program is $14,446 for five years and $328,968 over the lifetime if diabetes was developed in one year. If diabetes was developed in five years, the cost savings is $2,721 and $275,355 for five-year and lifetime timelines, respectively. If diabetes was instead developed in 10 years, the cost savings is $0 and $216,667 for five-year and lifetime timelines, respectively.

Table 20: Cost savings for MCACHI and efficient MCACHI

	Actual	Efficient				
Enrolled	124	124	750	750	3,000	3,000
Completed	43	43	250	500	1,000	2,000
Diabetes in 1-year costs avoided (5 year)	$14,446	$14,446	$83,990	$167,979	$335,959	$671,918
Diabetes in 1-year costs avoided (Lifetime)	$328,968	$328,968	$1,912,605	$3,825,209	$7,650,418	$15,300,836
Diabetes in 5 years costs avoided (5 year)	$2,721	$2,721	$15,820	$31,640	$63,279	$126,559
Diabetes in 5 years costs avoided (Lifetime)	$275,355	$275,355	$1,600,904	$3,201,807	$6,403,614	$12,807,228
Diabetes in 10 years costs avoided (5 year)	$0	$0	$0	$0	$0	$0
Diabetes in 10 years costs avoided (Lifetime)	$216,667	$216,667	$1,259,693	$2,519,386	$5,038,771	$10,077,542

Cost savings for efficient MCACHI

Using the same estimate of $3,143, the cost savings were estimated for the efficient MCACHI. For the efficient MCACHI with the same number of people enrolling and completing the program as the actual program, the cost savings did not differ. For the efficient programs with more people enrolled and completed, the cost savings varied. For the efficient program where 750 people enrolled and 250 people completed it, the cost savings if diabetes was developed in one year is $83,990 for five-year and $1,912,605 for lifetime timelines. If diabetes was developed in five years, the cost savings is $15,820 and $1,600,904 for five-year and lifetime timelines, respectively. The cost savings, if diabetes was developed in 10 years, is $0 for five years and $1,259,693 over the lifetime.

For this same MCACHI program with 750 people, if 500 people completed the programs instead, the cost savings if diabetes was developed in one year is $167,979 for five-year and $3,825,209 over the lifetime. If diabetes was developed in five years, the total cost savings is $31,640 and $3,201,807 for five-year and lifetime timelines, respectively. The total cost savings, if diabetes was developed in 10 years, is $0 for five-year and $2,519,386 over the lifetime.

If the MCACHI enrolled 3,000 people and 1,000 completed the programs, the total cost savings if diabetes was developed in one year is $335,959 for five years and $7,650,418 over the lifetime. If diabetes was developed in five years, the total cost savings is $63,279 and $6,402,614 for five-year and lifetime timelines, respectively. The total cost savings, if diabetes was developed in 10 years, is $0 for five years and $5,038,771 over the lifetime.

If this same program with 3,000 people enrolled had 2,000 people complete the program, the total cost savings if diabetes was developed in one year is $671,918 for five years and $15,300,836 over the lifetime. If diabetes was developed in five years, the cost savings is $126,559 and $12,807,228 for five-year and lifetime timelines, respectively. The cost savings, if diabetes was developed in 10 years is $0 and $10,077,542 for five-year and lifetime timelines, respectively. The cost savings for the efficient MCACHI can be found in Table 19.

MCACHI program costs

More details on the methodology of costing out the MCACHI can be found in chapter three of this dissertation. It is important to note that the total net cost of providing the classes in chapter three was estimated by taking the gross cost of providing the classes and subtracting the NDPP reimbursements. This estimates the true cost of providing the classes, however when estimating the ROI it is important to include the NDPP reimbursement as a return and not part of the investment.

To briefly summarize chapter three, the MCACHI startup costs were estimated to be $1,114,105 for the three-year period. The operating costs were $161,550, the referral costs were $30,000 and the total gross cost of providing the classes was $10,284 (not including the reimbursements for those who completed the program). The total costs, including startup costs, was $1,315,939 and the total annual costs, not including the startup costs, was $201,834. The NDPP reimbursements was $3,870 and was based on 43 people completing the program. The MCACHI program costs can be found in Table 21.

Table 21: MCACHI and efficient MCACHI program costs

	Actual	Efficient				
Enrolled	124	124	750	750	3,000	3,000
Completed	43	43	250	500	1,000	2,000
Startup costs	$1,114,105	$1,114,105	$1,114,105	$1,114,105	$1,114,105	$1,114,105
Operating costs	$161,550	$161,550	$161,550	$386,550	$161,550	$836,550
Referral costs	$30,000	$12,400	$75,000	$0	$300,000	$0
Total cost of classes	$10,284	$7,346	$44,075	$44,075	$176,299	$176,299
Reimbursement from classes	$3,870	$3,870	$22,500	$45,000	$90,000	$180,000
Total costs (w/startup)	$1,315,939	$1,295,401	$1,394,730	$1,544,730	$1,751,954	$2,126,954
Total costs (w/o startup)	$201,834	$181,296	$280,625	$430,625	$637,849	$1,012,849

Efficient MCACHI program costs

All the efficient programs have the same startup costs as the actual program. The efficient MCACHI with 43 people completing the program out of 124 people enrolled had the same costs as the actual program, except for the referral costs being $12,400 and the gross total cost of providing the classes being $7,346. The total cost, including startup costs, was $1,295,401 and $181,296 if startup costs are not included.

The efficient MCACHI with 750 enrolled and 250 people completing the programs had an operating cost of $161,550, a referral cost of $75,000, a cost of $44,075 for proving the classes, and a reimbursement of $22,500. The total cost, including startup costs, was $1,394,730 and the total cost, excluding startup costs, was $280,625. For the efficient MCACHI with the same number of people enrolled, but 500 people completing, the costs were the same except the operating cost was $386,550, the referral cost was $0 and the reimbursement from the classes was $45,000. The total cost was $1,544,730 including startup costs, and $430,625 excluding startup costs.

For the efficient MCACHI with 3,000 enrolled and 1,000 completing the programs, the operating cost was $161,550, the referral system cost was $300,000, the total cost of the classes was $176,299, and the NDPP reimbursement was $90,000. The total cost, including startup costs, was $1,751,954 and the total cost, excluding startup costs, was $637,849. For the efficient MCACHI with the same number of people enrolled, but instead 2,000 people completed the programs, the costs were the same except the operating cost was $836,550, the referral costs were $0, and the NDPP reimbursement was $180,000. The total cost was $2,126,954 including startup costs, and $1,012,849 excluding startup costs. Table 21 displays the costs for the efficient MCACHI.

Return on Investment and breakeven analysis for MCACHI using WTP

Several ROIs were estimated for the MCACHI. The ROI for the MCACHI, for the five-year timeline using the WTP estimates for if the results from the program are seen in 10 years, is -$0.95 including startup costs with a breakeven of 1,866 people needing to complete the program and -$0.70 not including startup costs with a breakeven of 287. The ROI, using the lifetime timeline and the estimates for if the results from the program are seen in 10 years, is -$0.62 including startup costs with a breakeven of 223 people and $1.51 not including startup costs with a breakeven of 34. Using the realistic case WTP, the ROI for the five-year timeline is -$0.94 including startup costs with a breakeven of 1,548 people and -$0.64 excluding startup costs with a breakeven of 238. For the lifetime timeline using the realistic WTP, the ROI including startup costs is -$0.53 with a breakeven of 184 and $2.04 with a breakeven of 28 for the ROI excluding startup costs. Using the WTP estimates if the results are seen in one year, the ROI using the five-year timeline, including startup costs, is -$0.93 with a breakeven of 1,222 people and a ROI of -$0.54 with a breakeven of 188 when excluding startup costs. For the lifetime timeline using the WTP estimates if the results are seen in one year, the ROI including startup costs is -$0.46 with a breakeven of 160 people, while the ROI excluding startup costs is $2.50 with a breakeven of 25.

Table 22: Return on Investment for MCACHI and efficient MCACHI using WTP

	Actual	Efficient				
Enrolled	124	124	750	750	3,000	3,000
Completed	43	43	250	500	1,000	2,000
ROI using WTP (results seen in 10 years) (5-year timeline)						
ROI w/ startup	-$0.95	-$0.95	-$0.75	-$0.54	-$0.20	$0.32
ROI w/o startup	-$0.70	-$0.67	$0.25	$0.63	$1.21	$1.78
Breakeven w/ startup	1,866	1,837	1,978	2,190	2,484	3,016
Breakeven w/o startup	287	258	398	611	905	1,436
ROI using WTP (results seen in 5 years) (5-year timeline)						
ROI w/ startup	-$0.94	-$0.94	-$0.70	-$0.45	-$0.03	$0.60
ROI w/o startup	-$0.64	-$0.60	$0.51	$0.97	$1.66	$2.35
Breakeven w/ startup	1,548	1,524	1,641	1,817	2,061	2,502
Breakeven w/o startup	238	214	331	507	751	1192
ROI using WTP (results seen in 1 year) (5-year timeline)						
ROI w/ startup	-$0.93	-$0.93	-$0.61	-$0.30	$0.23	$1.02
ROI w/o startup	-$0.54	-$0.49	$0.92	$1.50	$2.37	$3.24
Breakeven w/ startup	1,222	1,203	1,295	1,434	1,626	1,974
Breakeven w/o startup	188	169	261	400	592	941
ROI using WTP (results seen in 10 years) (lifetime timeline)						
ROI w/ startup	-$0.62	-$0.61	$1.11	$2.81	$5.72	$10.07
ROI w/o startup	$1.51	$1.79	$9.49	$12.67	$17.46	$22.26
Breakeven w/ startup	223	220	237	262	297	361
Breakeven w/o startup	34	31	48	73	108	172
ROI using WTP (results seen in 5 years) (lifetime timeline)						

ROI w/ startup	-$0.53	-$0.53	$1.56	$3.62	$7.15	$12.43
ROI w/o startup	$2.04	$2.39	$11.72	$15.58	$21.39	$27.20
Breakeven w/ startup	184	181	195	216	245	298
Breakeven w/o startup	28	24	39	60	89	142
ROI using WTP (results seen in 1 year) (lifetime timeline)						
ROI w/ startup	-$0.46	-$0.45	$1.95	$4.32	$8.38	$14.46
ROI w/o startup	$2.50	$2.90	$13.65	$18.09	$24.77	$31.46
Breakeven w/ startup	160	158	170	188	213	259
Breakeven w/o startup	25	22	34	53	75	123

Return on Investment and breakeven analysis for MCACHI using QALYs

Using $50,000 per QALY gained, the ROI using the five-year timeline if diabetes was developed in one year is -$0.96 including startup costs with a breakeven of 2,370 people and -$0.71 with a breakeven of 356 if not including startup costs. Using the lifetime timeline, the ROI including startup costs is -$0.32 with a breakeven of 128 people and $3.41 with a breakeven of 19 if startup costs are excluded. If diabetes was developed in five years instead of one, the ROI for the five-year timeline is -$0.99 with a breakeven of 9,507 people if startup costs are included, and -$0.94 with a breakeven of 1,459 excluding startup costs. Using the lifetime timeline, the ROI is -$0.46 with a breakeven of 158 people with startup costs included, and $2.55 with a breakeven of 24 not including startup costs. If diabetes was developed in 10 years, the ROI, again using the threshold of $50,000 per QALY, is -$1.00 with a breakeven of 29,170 for the five-year timeline with startup costs included, and -$0.98 with a breakeven of 4,474 when startup costs are excluded. Using the lifetime instead of the five-year timeline, the ROI is -$0.58 with a breakeven of 207 when including startup costs, and $1.71 with a breakeven of 32 excluding startup costs.

Using the lower threshold of $20,000 per QALY gained, the ROI for the five-year timeline if diabetes was developed in one year is -$0.98 with a breakeven of 3,767 people when startup costs are included and -$0.85 with a breakeven of 578 when excluding startup costs. For the lifetime timeline, the ROI is -$0.58 with a breakeven of 205 people when including startup costs and $1.73 with a breakeven of 31 when startup costs are not included. If diabetes was developed in five years, the ROI, including startup costs, is -$0.99 with a breakeven of 12,970 people, and excluding startup costs the ROI is -$0.96 with a breakeven of 1,990 for the five-year timeline. Using the lifetime timeline, the ROI, including startup costs, is -$0.65 with a breakeven of 249 and $1.25 with a breakeven of 38 when startup costs are excluded. If diabetes was developed in 10 years, the ROI for the five-year timeline is -$1.00 with a breakeven of 29,170 people if startup costs are included and -$0.98 with a breakeven of 4,474 when excluding startup costs. Using the lifetime timeline, the ROI is -$0.73 with a breakeven of 322 people including startup costs and $0.74 with a breakeven of 49 when startup costs are excluded. Table 23 displays the ROIs for the MCACHI using the $50,000 per QALY gained threshold and Table 24 displays the ROIs using $20,000 per QALY gained.

Table 23: Return on Investment for MCACHI and efficient MCACHI using $50,000 per QALY

	Actual	Efficient				
Enrolled	124	124	750	750	3,000	3,000
Completed	43	43	250	500	1,000	2,000
ROI using QALYs $50,000 diabetes in 1 year (5-year timeline)						
ROI w/ startup	-$0.96	-$0.96	-$0.77	-$0.61	-$0.27	$0.12
ROI w/o startup	-$0.71	-$0.70	$0.14	$0.38	$1.01	$1.35
Breakeven w/ startup	2,370	2,335	2,482	2,753	3,007	3,685
Breakeven w/o startup	356	322	468	739	994	1,671
ROI using QALYs $50,000 diabetes in 5 years (5-year timeline)						
ROI w/ startup	-$0.99	-$0.99	-$0.95	-$0.91	-$0.84	-$0.74
ROI w/o startup	-$0.94	-$0.93	-$0.75	-$0.68	-$0.57	-$0.45
Breakeven w/ startup	9,507	9,359	10,076	11,160	12,657	15,366
Breakeven w/o startup	1,459	1,310	2,028	3,111	4,609	7,318
ROI using QALYs $50,000 diabetes in 10 years (5-year timeline)						
ROI w/ startup	-$1.00	-$1.00	-$0.98	-$0.97	-$0.95	-$0.92
ROI w/o startup	-$0.98	-$0.98	-$0.92	-$0.90	-$0.86	-$0.82
Breakeven w/ startup	29,170	28,715	30,917	34,242	38,835	47,148
Breakeven w/o startup	4,474	4,019	6,221	9,546	14,139	22,452
ROI using QALYs $50,000 diabetes in 1 year (lifetime timeline)						
ROI w/ startup	-$0.32	-$0.32	$2.70	$5.65	$10.77	$18.31
ROI w/o startup	$3.41	$3.89	$17.38	$22.85	$31.34	$39.55
Breakeven w/ startup	128	126	134	149	163	199
Breakeven w/o startup	19	17	25	40	54	90

ROI using QALYs $50,000 diabetes in 5 years (lifetime timeline)						
ROI w/ startup	-$0.46	-$0.45	$1.99	$4.39	$8.51	$14.67
ROI w/o startup	$2.55	$2.95	$13.85	$18.35	$25.13	$31.91
Breakeven w/ startup	158	156	167	185	210	255
Breakeven w/o startup	24	22	35	51	77	121
ROI using QALYs $50,000 diabetes in 10 years (lifetime timeline)						
ROI w/ startup	-$0.58	-$0.58	$1.28	$3.12	$6.27	$10.98
ROI w/o startup	$1.71	$2.02	$10.35	$13.79	$18.97	$24.15
Breakeven w/ startup	207	203	219	242	275	334
Breakeven w/o startup	32	29	44	68	100	159

Table 24: Return on Investment for MCACHI and efficient MCACHI using $20,000 per QALY

	Actual	Efficient				
Enrolled	124	124	750	750	3,000	3,000
Completed	43	43	250	500	1,000	2,000
ROI using QALYs $20,000 diabetes in 1 year (5-year timeline)						
ROI w/ startup	-$0.98	-$0.98	-$0.88	-$0.77	-$0.60	-$0.34
ROI w/o startup	-$0.85	-$0.83	-$0.38	-$0.19	$0.09	$0.38
Breakeven w/ startup	3,767	3,708	3,992	4,420	5,015	6,088
Breakeven w/o startup	578	519	804	1,233	1,826	2,899
ROI using QALYs $20,000 diabetes in 5 years (5-year timeline)						
ROI w/ startup	-$0.99	-$0.99	-$0.96	-$0.93	-$0.88	-$0.81
ROI w/o startup	-$0.96	-$0.95	-$0.82	-$0.76	-$0.68	-$0.60
Breakeven w/ startup	12,970	12,767	13,746	15,224	17,267	20,962
Breakeven w/o startup	1,990	1,787	2,766	4,244	6,287	9,982
ROI using QALYs $20,000 diabetes in 10 years (5-year timeline)						
ROI w/ startup	-$1.00	-$1.00	-$0.98	-$0.97	-$0.95	-$0.92
ROI w/o startup	-$0.98	-$0.98	-$0.92	-$0.90	-$0.86	-$0.82
Breakeven w/ startup	29,170	28,715	30,917	34,242	38,835	47,148
Breakeven w/o startup	4,474	4,019	6,221	9,546	14,139	22,452
ROI using QALYs $20,000 diabetes in 1 year (lifetime timeline)						
ROI w/ startup	-$0.58	-$0.57	$1.30	$3.15	$6.32	$11.06
ROI w/o startup	$1.73	$2.04	$10.42	$13.89	$19.11	$24.32
Breakeven w/ startup	205	202	217	241	273	331
Breakeven w/o startup	31	28	44	67	99	158
ROI using QALYs $20,000 diabetes in 5 years (lifetime timeline)						

ROI w/ startup	-$0.65	-$0.65	$0.89	$2.42	$5.03	$8.93
ROI w/o startup	$1.25	$1.51	$8.41	$11.26	$15.56	$19.86
Breakeven w/ startup	249	245	264	292	331	402
Breakeven w/o startup	38	34	53	82	121	192
ROI using QALYs $20,000 diabetes in 10 years (lifetime timeline)						
ROI w/ startup	-$0.73	-$0.73	$0.46	$1.65	$3.66	$6.68
ROI w/o startup	$0.74	$0.94	$6.28	$8.49	$11.81	$15.14
Breakeven w/ startup	322	317	341	378	428	520
Breakeven w/o startup	49	44	69	106	156	248

Return on Investment for efficient MCACHI using WTP (43 out of 124 completed)

For the efficient MCACHI that had the same number of people enrolled and completing the programs, the same ROI analyses were estimated. The ROI using the estimates for if the results from the program are seen in 10 years and five-year timeline is -$0.95 with a breakeven of 1,837 people including startup costs, and -$0.67 with a breakeven of 258 when startup costs are excluded. Using the WTP estimates for if the results from the program are seen in 10 years but with the lifetime timeline, the ROI is -$0.61 with a breakeven of 220 people including startup costs and $1.79 with a breakeven of 31 when not including startup costs. Using the realistic WTP, the ROI for the five-year timeline is -$0.94 with a breakeven of 1,524 people when including startup costs and -$0.60 with a breakeven of 214 when startup costs are excluded. Using the lifetime timeline and realistic WTP, the ROI is -$0.53 with a breakeven of 181 people when including startup costs, and $2.39 with a breakeven of 24 when startup costs are not included. The ROI, using the WTP estimates if the results are seen in one year and the five-year timeline, is -$0.93 with a breakeven of 1,203 when startup costs are included, and -$0.49 with a breakeven of 169 when startup costs are excluded. Using the lifetime timeline and the WTP estimates if the results are seen in one year, the ROI is -$0.45 with a breakeven of 158 when including startup costs and $2.90 with a breakeven of 22 when startup costs are excluded. These estimates can be found in Table 22.

Return on Investment for efficient MCACHI using QALYs (43 out of 124 completed)

Using $50,000 per QALY gained, the ROI using the five-year timeline if diabetes was developed in one year is -$0.96 including startup costs with a breakeven of 2,335 people and -$0.70 with a breakeven of 322 if not including startup costs. Using the lifetime timeline, the ROI including startup costs is -$0.32 with a breakeven of 126 people and $3.89 with a breakeven of 17 if startup costs are excluded. If diabetes was developed in five years instead of one, the ROI for the five-year timeline is -$0.99 with a breakeven of 9,359 people if startup costs are included, and -$0.93 with a breakeven of 1,310 excluding startup costs. Using the lifetime timeline, the ROI is -$0.45 with a breakeven of 156 people with startup costs included, and $2.95 with a breakeven of 22 not including startup costs. If diabetes is developed in 10 years, the ROI, again using the threshold of $50,000 per QALY, is -$1.00 with a breakeven of 28,715 for the five-year timeline with startup costs included, and -$0.98 with a breakeven of 4,019 when startup costs are excluded. Using the lifetime instead of the five-year timeline, the ROI is -$0.58 with a breakeven of 203 when including startup costs, and $2.02 with a breakeven of 29 excluding startup costs. Table 23 displays these estimates.

Using the threshold of $20,000 per QALY gained, the ROI for the five-year timeline if diabetes was developed in one year is -$0.98 with a breakeven of 3,708 people when startup costs are included and -$0.83 with a breakeven of 519 when excluding startup costs. For the lifetime timeline, the ROI is -$0.57 with a breakeven of 202 people when including startup costs and $2.04 with a breakeven of 28 when startup costs are not included. If diabetes was developed in five years, the ROI, including startup costs, is -$0.99 with a breakeven of 12,767 people, and excluding startup costs the ROI is -$0.95 with a breakeven of 1,787 for the five-year timeline. Using the lifetime timeline, the ROI, including startup costs, is -$0.65 with a breakeven of 245 and $1.51 with a breakeven of 34 when startup costs are excluded. If diabetes was developed in 10 years, the ROI for the five-year timeline is -$1.00 with a breakeven of 28,715 people if startup costs are included and -$0.98 with a breakeven of 4,019 when excluding startup costs. Using the lifetime timeline, the ROI is -$0.73 with a breakeven of 317 people including startup costs and $0.94 with a breakeven of 44 when startup costs are excluded. This is displayed in Table 24.

Return on Investment for efficient MCACHI using WTP (250 out of 750 completed)

The ROI using the worst-case WTP and five-year timeline is -$0.75 with a breakeven of 1,978 people including startup costs, and $0.25 with a breakeven of 398 when startup costs are excluded. Using the WTP estimates for if the results from the program are seen in 10 years but with the lifetime timeline, the ROI is $1.11 with a breakeven of 237 people including startup costs and $9.49 with a breakeven of 48 when not including startup costs. Using the realistic WTP, the ROI for the five-year timeline is -$0.70 with a breakeven of 1,641 people when including startup costs and $0.51 with a breakeven of 331 when startup costs are excluded. Using the lifetime timeline and realistic WTP, the ROI is $1.56 with a breakeven of 195 people when including startup costs, and $11.72 with a breakeven of 39 when startup costs are not included. The ROI, when using the WTP estimates for if the results from the program are seen in one year and the five-year timeline, is -$0.61 with a breakeven of 1,295 when startup costs are included, and $0.92 with a breakeven of 261 when startup costs are excluded. Using the lifetime timeline and the same WTP estimate, the ROI is $1.95 with a breakeven of 170 when including startup costs and $13.65 with a breakeven of 34 when startup costs are excluded. These estimates can be found in Table 22.

Return on Investment for efficient MCACHI using QALYs (250 out of 750 completed)

Using $50,000 per QALY gained, the ROI using the five-year timeline if diabetes was developed in one year is -$0.77 including startup costs with a breakeven of 2,482 people and $0.14 with a breakeven of 468 if not including startup costs. Using the lifetime timeline, the ROI including startup costs is $2.70 with a breakeven of 134 people and $17.38 with a breakeven of 25 if startup costs are excluded. If diabetes was developed in five years instead of one, the ROI for the five-year timeline is -$0.95 with a breakeven of 10,076 people if startup costs are included, and -$0.75 with a breakeven of 2,028 excluding startup costs. Using the lifetime timeline, the ROI is $1.99 with a breakeven of 167 people with startup costs included, and $13.85 with a breakeven of 35 not including startup costs. If diabetes was developed in 10 years, the ROI, using the threshold of $50,000 per QALY, is -$0.98 with a breakeven of 30,917 for the five-year timeline with startup costs included, and -$0.92 with a breakeven of 6,221 when startup costs are excluded. Using the lifetime instead of the five-year timeline, the ROI is $1.28 with a breakeven of 219 when including startup costs, and $10.35 with a breakeven of 44 excluding startup costs. These ROIs can be found in Table 23.

Using the threshold of $20,000 per QALY gained, the ROI for the five-year timeline if diabetes was developed in one year is -$0.88 with a breakeven of 3,992 people when startup costs are included and -$0.38 with a breakeven of 804 when excluding startup costs. For the lifetime timeline, the ROI is $1.30 with a breakeven of 217 people when including startup costs and $10.42 with a breakeven of 44 when startup costs are not included. If diabetes was developed in five years, the ROI, including startup costs, is -$0.96 with a breakeven of 13,746 people, and excluding startup costs the ROI is -$0.82 with a breakeven of 2,766 for the five-year timeline. Using the lifetime timeline, the ROI, including startup costs, is $0.89 with a breakeven of 264 and $8.41 with a breakeven of 53 when startup costs are excluded. If diabetes was developed in 10 years, the ROI for the five-year timeline is -$0.98 with a breakeven of 30,917 people if startup costs are included and -$0.92 with a breakeven of 6,221 when excluding startup costs. Using the lifetime timeline, the ROI is $0.46 with a breakeven of 341 people including startup costs and $6.28 with a breakeven of 69 when startup costs are excluded. This can be found in Table 24.

Return on Investment for efficient MCACHI using WTP (500 out of 750 completed)

The ROI using the WTP if the results from the program are seen in 10 years and five-year timeline is -$0.54 with a breakeven of 2,190 people including startup costs, and $0.63 with a breakeven of 611 when startup costs are excluded. Using the same WTP but with the lifetime timeline, the ROI is $2.81 with a breakeven of 262 people including startup costs and $12.67 with a breakeven of 73 when not including startup costs. Using the realistic WTP, the ROI for the five-year timeline is -$0.45 with a breakeven of 1,817 people when including startup costs and $0.97 with a breakeven of 507 when startup costs are excluded. Using the lifetime timeline and realistic WTP, the ROI is $3.62 with a breakeven of 216 people when including startup costs, and $15.58 with a breakeven of 60 when startup costs are not included. The ROI, when using the WTP for if the program results are seen in one year and the five-year timeline, is -$0.30 with a breakeven of 1,434 when startup costs are included, and $1.50 with a breakeven of 400 when startup costs are excluded. Using the lifetime timeline and this same WTP, the ROI is $4.32 with a breakeven of 188 when including startup costs and $18.09 with a breakeven of 53 when startup costs are excluded. This can be seen in Table 22.

Return on Investment for efficient MCACHI using QALYs (500 out of 750 completed)

Using $50,000 per QALY gained, the ROI using the five-year timeline if diabetes was developed in one year is -$0.61 including startup costs with a breakeven of 2,753 people and $0.38 with a breakeven of 739 if not including startup costs. Using the lifetime timeline, the ROI including startup costs is $5.65 with a breakeven of 149 people and $22.85 with a breakeven of 40 if startup costs are excluded. If diabetes was developed in five years instead of one, the ROI for the five-year timeline is -$0.91 with a breakeven of 11,160 people if startup costs are included, and -$0.68 with a breakeven of 3,111 excluding startup costs. Using the lifetime timeline, the ROI is $4.39 with a breakeven of 185 people with startup costs included, and $18.35 with a breakeven of 51 not including startup costs. If diabetes was developed in 10 years, the ROI, is -$0.97 with a breakeven of 34,242 for the five-year timeline with startup costs included, and -$0.90 with a breakeven of 9,546 when startup costs are excluded. Using the lifetime instead of the five-year timeline, the ROI is $3.12 with a breakeven of 242 when including startup costs, and $13.79 with a breakeven of 68 excluding startup costs. This can be found in Table 23.

Using the lower threshold of $20,000 per QALY gained, the ROI for the five-year timeline if diabetes was developed in one year is -$0.77 with a breakeven of 4,420 people when startup costs are included and -$0.19 with a breakeven of 1,233 when excluding startup costs. For the lifetime timeline, the ROI is $3.15 with a breakeven of 241 people when including startup costs and $13.89 with a breakeven of 67 when startup costs are not included. If diabetes was developed in five years, the ROI, including startup costs, is -$0.93 with a breakeven of 15,224 people, and excluding startup costs the ROI is -$0.76 with a breakeven of 4,244 for the five-year timeline. Using the lifetime timeline, the ROI, including startup costs, is $2.42 with a breakeven of 292 and $11.26 with a breakeven of 82 when startup costs are excluded. If diabetes was developed in 10 years, the ROI for the five-year timeline is -$0.97 with a breakeven of 34,242 people if startup costs are included and -$0.90 with a breakeven of 9,546 when excluding startup costs. Using the lifetime timeline, the ROI is $1.65 with a breakeven of 378 people including startup costs and $8.49 with a breakeven of 106 when startup costs are excluded. These ROI estimates are shown in Table 24.

Return on Investment for efficient MCACHI using WTP (1,000 out of 3,000 completed)

The ROI using the WTP for if the program results are seen in 10 years and five-year timeline is -$0.20 with a breakeven of 2,484 people including startup costs, and $1.21 with a breakeven of 905 when startup costs are excluded. Using this same WTP but with the lifetime timeline, the ROI is $5.72 with a breakeven of 297 people including startup costs and $17.46 with a breakeven of 108 when not including startup costs. Using the realistic WTP, the ROI for the five-year timeline is -$0.03 with a breakeven of 2,061 people when including startup costs and $1.66 with a breakeven of 751 when startup costs are excluded. Using the lifetime timeline and realistic WTP, the ROI is $7.15 with a breakeven of 245 people when including startup costs, and $21.39 with a breakeven of 89 when startup costs are not included. The ROI, when the WTP estimate for if the program results are seen in one year and the five-year timeline, is $0.23 with a breakeven of 1,626 when startup costs are included, and $2.37 with a breakeven of 592 when startup costs are excluded. Using the lifetime timeline and this same WTP estimate, the ROI is $8.38

with a breakeven of 213 when including startup costs and $24.77 with a breakeven of 75 when startup costs are excluded. Table 22 displays these ROI estimates.

Return on Investment for efficient MCACHI using QALYs (1,000 out of 3,000 completed)

Using $50,000 per QALY gained, the ROI using the five-year timeline if diabetes was developed in one year is -$0.27 including startup costs with a breakeven of 3,007 people and $1.01 with a breakeven of 994 if not including startup costs. Using the lifetime timeline, the ROI including startup costs is $10.77 with a breakeven of 163 people and $31.34 with a breakeven of 54 if startup costs are excluded. If diabetes was developed in five years instead of one, the ROI for the five-year timeline is -$0.84 with a breakeven of 12,657 people if startup costs are included, and -$0.57 with a breakeven of 4,609 excluding startup costs. Using the lifetime timeline, the ROI is $8.51 with a breakeven of 210 people with startup costs included, and $25.13 with a breakeven of 77 not including startup costs. If diabetes was developed in 10 years, the ROI, once again using the $50,000 per QALY threshold, is -$0.95 with a breakeven of 38,835 for the five-year timeline with startup costs included, and -$0.86 with a breakeven of 14,139 when startup costs are excluded. Using the lifetime instead of the five-year timeline, the ROI is $6.27 with a breakeven of 275 when including startup costs, and $18.97 with a breakeven of 100 excluding startup costs. Table 23 shows these estimates.

Using the lower threshold of $20,000 per QALY gained, the ROI for the five-year timeline if diabetes was developed in one year is -$0.60 with a breakeven of 5,015 people when startup costs are included and $0.09 with a breakeven of 1,826 when excluding startup costs. For the lifetime timeline, the ROI is $6.32 with a breakeven of 273 people when including startup costs and $19.11 with a breakeven of 99 when startup costs are not included. If diabetes was developed in five years, the ROI, including startup costs, is -$0.88 with a breakeven of 17,267 people, and excluding startup costs the ROI was -$0.68 with a breakeven of 6,287 for the five-year timeline. Using the lifetime timeline, the ROI, including startup costs, is $5.03 with a breakeven of 331 and $15.56 with a breakeven of 121 when startup costs are excluded. If diabetes was developed in 10 years, the ROI for the five-year timeline is -$0.95 with a breakeven of 38,835 people if startup costs are included and -$0.86 with a breakeven of 14,139 when excluding startup costs. Using the lifetime timeline, the ROI is $3.66 with a breakeven of 428 people including startup costs and $11.81 with a breakeven of 156 when startup costs are excluded. These ROI estimates can be found in Table 24.

Return on Investment for efficient MCACHI using WTP (2,000 out of 3,000 completed)

The ROI using the WTP for is the results from the program are seen in 10 years and five-year timeline is -$0.32 with a breakeven of 3,016 people including startup costs, and $1.78 with a breakeven of 1,436 when startup costs are excluded. Using this same WTP estimate but with the lifetime timeline, the ROI is $10.07 with a breakeven of 361 people including startup costs and $22.26 with a breakeven of 172 when not including startup costs. Using the realistic WTP, the ROI for the five-year timeline is $0.60 with a breakeven of 2,502 people when including startup costs and $2.35 with a breakeven of 1,192 when startup costs are excluded. Using the lifetime timeline and realistic WTP, the ROI is $12.43 with a breakeven of 298 people when including startup costs, and $27.20 with a breakeven of 142 when startup costs are not included. The ROI, when using the WTP for if the program results are seen in one year and the five-year timeline, is $1.02 with a breakeven of 1,974 when startup costs are included, and $3.24 with a breakeven of 941 when startup costs are excluded. Using the lifetime timeline and the same WTP estimate, the ROI is $14.46 with a breakeven of 259 when including startup costs and $31.46 with a breakeven of 123 when startup costs are excluded. This is displayed in Table 22.

Return on Investment for efficient MCACHI using QALYs (2,000 out of 3,000 completed)

Using $50,000 per QALY gained, the ROI using the five-year timeline if diabetes was developed in one year is $0.12 including startup costs with a breakeven of 3,685 people and $1.35 with a breakeven of 1,671 if not including startup costs. Using the lifetime timeline, the ROI including startup costs is $18.31 with a breakeven of 199 people and $39.55 with a breakeven of 90 if startup costs are excluded. If diabetes was developed in five years instead of one, the ROI for the five-year timeline is -$0.74 with a breakeven of 15,366 people if startup costs are included, and -$0.45 with a breakeven of 7,316 excluding startup costs. Using the lifetime timeline, the ROI is $14.67 with a breakeven of 255 people with startup costs included, and $31.91 with a breakeven of 121 not including startup costs. If diabetes was developed in 10 years, the ROI, is -$0.92 with a breakeven of 47,148 for the five-year timeline with startup costs included, and -$0.82 with a breakeven of 22,452 when startup costs are excluded. Using the lifetime instead of the five-year timeline, the ROI is $10.98 with a breakeven of 334 when including startup costs, and $24.15 with a breakeven of 159 excluding startup costs. These ROI estimates can be found in Table 23.

Using the threshold of $20,000 per QALY gained, the ROI for the five-year timeline if diabetes was developed in one year is -$0.34 with a breakeven of 6,088 people when startup costs are included and $0.38 with a breakeven of 2,899 when excluding startup costs. For the lifetime timeline, the ROI is $11.06 with a breakeven of 331 people when including startup costs and $24.32 with a breakeven of 158 when startup costs are not included. If diabetes was developed in five years, the ROI, including startup costs, is -$0.81 with a breakeven of 20,962 people, and excluding startup costs the ROI is -$0.60 with a breakeven of 9,982 for the five-year timeline. Using the lifetime timeline, the ROI, including startup costs, is $8.93 with a breakeven of 402 and $19.86 with a breakeven of 192 when startup costs are excluded. If diabetes was developed in 10 years, the ROI for the five-year timeline is -$0.92 with a breakeven of 47,148 people if startup costs are included and -$0.82 with a breakeven of 22,452 when excluding startup costs. Using the lifetime timeline, the ROI is $6.68 with a breakeven of 520 people including startup costs and $15.14 with a breakeven of 248 when startup costs are excluded. Table 24 displays these ROI estimates.

Conclusion

The purpose of this study was to estimate the ROI for the MCACHI as of June 2019. The study also provides a framework for estimating ROIs for chronic disease prevention programs using two different methodologies for placing a monetary value on health outcomes. The value for the WTP depends on what parameters of the DCE are selected, such as who the program targets and who is funding the program. The main advantage of using the WTP for monetizing health outcomes is the estimates are more tailored to the specific ROI and the interests of the agency, such as health equity. When using QALYs to monetize health outcomes, the value depends highly on what threshold value is used per QALY gained. There has been much debate around this value and how much a QALY gained is worth. In the US, $50,000 per QALY gained is typically used when monetizing health outcomes for economic evaluations, but there are criticisms whether this value is too high or low (Hirth et al., 1997; Nimdet et al., 2015; Ryen & Svensson, 2015). Comparing the ROIs using both methodologies, the WTP ROI estimates and QALY ROI estimates using $50,000 per QALY gained and diabetes developed in one year are very similar for the actual MCACHI as well as the efficient MCACHI analyses. When using the $20,000 per QALY gained value, the ROIs tend to differ slightly more compared to the WTP estimates. The findings from this study support the $50,000 per QALY gained threshold, as the WTP ROIs are more closely aligned with the ROIs using this value compared to the values when using a lower threshold of $20,000 per QALY gained. This study demonstrates the importance of timelines when estimating ROI, as the ROI for five-year timelines tend to be low. Using the lifetime timelines instead of five-year timelines yielded much higher ROIs. This is because when dealing with chronic disease prevention programs, such as diabetes, many of the health benefits of the programs are not seen until many years later. Because of this, it is difficult to show any monetary returns due to health improvements in a short time horizon, especially in a program like this where the costs are high and not very many people enrolled and completed the programs.

The results from this study also suggest that there are many parameters to consider when estimating ROIs for chronic disease prevention programs, as they can greatly impact the final ROI. Parameters such as shorter vs longer timelines, when a person develops the disease, and the value per QALY gained all impact the final ROI estimates. For the actual MCACHI program as of June 2019, only 43 people completed the program of the 124 who enrolled. This study showed that the ROI for the five-year time horizon was negative, regardless of which WTP estimates were used, or what value of a QALY gained ($50,000 or $20,000) was used, or whether startup costs were included or excluded from the investment costs. This strongly suggests that using shorter time horizons for ROIs will not likely show positive returns for chronic disease prevention programs. For the MCACHI, the startup costs were high and as a result the ROI was much lower when including these costs. If the program was to continue, the ROI would be much higher as it would not include startup costs. When looking at the ROIs for the actual MCACHI for the lifetime timelines, all the ROIs that excluded startup costs were above $1 except for the analysis done when diabetes was developed in 10 years using the threshold value of $20,000 per QALY gained. This means that for every dollar invested, the returns are greater than a dollar, except for the one estimate mentioned.

Several what if analyses were estimated to examine how the MCACHI ROI would change based on if more people enrolled and completed the programs, as well as if the programs were done more efficiently. The efficient program with the same number of people enrolled and completing the program as the actual program showed only marginal gains in terms of the various ROIs. This demonstrates that the main issue was not enough people enrolled and completed the program, because even if it was done more efficiently the ROIs only marginally improved. For the other what if analyses, two programs, one with 750 people enrolled and the other with 3,000 people enrolled, were compared to programs with the same number of people enrolled but with more people completing the programs because of different referral strategies. The programs that had more people complete them used promotoras. These programs yielded much higher ROIs across all the various estimations compared to programs with the same number of people enrolled. Promotoras are shown to increase the access of care, especially for low-income individuals (Pérez & Martinez, 2008). As a result, the participation of people enrolled in health programs would dramatically increase, which is why the simulations for the programs using promotoras had more people complete the programs. For the programs with 750 people enrolled, the ROIs in the five-year timeline were all below $1, except for when the best-case ROI was used for the program with 500 people completing it. This demonstrates that the program is not much better compared to its less efficient counterpart in terms of its ROI, particularly in the shorter time horizon. However, when comparing the lifetime time horizons, the ROIs for the programs with 750 enrolled were all above $1 for both programs for ROIs, both including and excluding startup costs, with the exception of the program with 250 people completing having a ROI less than $1 when using $20,000 per QALY gained and diabetes developing in five years and 10 years. The ROIs for the program with 250 people completing are lower than the program with 500 people completing. For the programs that enroll 3,000 people the ROIs are over $1 in the five-year time horizon when using the WTP estimates and excluding the startup costs. When using the shorter time horizon and QALYs, the ROIs are all below $1 for the programs with 3,000 people enrolled except for using $50,000 per QALY, excluding startup costs and diabetes developing in one year. The ROIs were found to be much more positive when using the lifetime time horizon.

Previous studies have used DCEs in order place monetary values on health programs (Roux, Ubach, Donaldson, & Ryan, 2004; Ryan & Gerard, 2003; Veldwijk et al., 2013). There has been much speculation on how to monetize health outcomes for economic analyses, as most studies use QALYs. There have been some proposed alternative methods for placing a monetary value on health outcomes, with one method being discrete choice models (Beresniak & Dupont, 2016). However, none of the studies have applied the DCEs in the context of ROIs, particularly for monetizing health outcomes for a chronic disease prevention program. Also, none of the studies have estimated ROIs for chronic disease programs using both methodologies, comparing ROIs using WTP estimates from a DCE and traditional QALYs.

Limitations

This study is not without limitations. One limitation is when doing economic evaluations many assumptions are made, such as what timelines to use and when a person develops the health condition. To deal with this potential issue, the ROIs were estimated under many different assumptions to compare how the ROIs would differ between these things. However, one assumption was the average age of a person in the program was 40 years old, so all the utility values and cost savings were estimated based on this. Also, several data sources were used for various estimates, which could impact the ROIs. Estimates for the effectiveness of the NDPP as well as diabetes incidence rates were used since this data was unavailable from the MCACHI. Depending on the monetary values used for the health outcomes, the ROI estimates could be different for the MCACHI. Therefore, different threshold values were used to estimate the ROI using QALYs, as well as the ROIs using WTP estimates.

Implications

The information from this study was useful for the MCACHI because the goal from the beginning of the initiative was to estimate a ROI, with the idea that a ROI is what potential funders would be interested in seeing. ROIs are increasingly attractive as the outcomes can be transparently tailored to the preferences of the local decision maker. The results from this study show the challenges when using ROIs with shortened timelines to make decisions regarding funding and investing in chronic disease prevention programs. Funders typically are interested in seeing their investment into these types of programs yield benefits, both financial and health, sooner rather than later. Programs where the results are seen in a shorter time horizon seem to be more attractive to potential funders. This study also compares the ROIs for the MCACHI using the traditional $50,000 per QALY gained as well as WTP estimates from a DCE. The DCE includes a way of capturing health equity when monetizing health outcomes, which is not done using QALYs. Health equity is an important aspect to many public health departments when decision making and using a DCE can incorporate equity into the monetized health outcomes. The study also provides a framework for estimating ROIs for chronic disease programs, which is not only useful for trying to acquire funding but also aids in a way for priority setting for choosing between different public health programs.

ROIs can be compared across programs to see which programs should be implemented over others.

Chapter 5: Discussion

The purpose of this dissertation was to explore how to integrate economic evaluations, specifically a ROI analysis, for prioritization. This dissertation makes two significant contributions to the literature. First, it provides a methodology for using ROIs for chronic disease prevention programs. There are guides for doing ROIs for these types of programs (Chronic Disease Directors, 2009), however they do not provide the framework from a methodological standpoint needed to estimate the various pieces required for a ROI analysis. Second, this dissertation explores the process of working with a CAG to develop the ROI, which has not been done before. This process included working closely with the CAG, figuring out the important pieces of information needed, collecting this data and calculating the ROI, and finally translating the results of the ROI back to the CAG. I explored how ROIs can be used for local decision making. Several steps were required to estimate the ROI for the MCACHI. First, I needed to find a way of monetizing the health outcomes from the NDPP that factored in health equity. Second, I needed to gather all the costing information for establishing and running the NDPPs. The three studies of this dissertation highlight all the technical aspects of how I did this.

Chapter two presented the results of a DCE done in the SJV of California. This chapter identified the value people living in this region place on public health programs that target their communities. One of the challenges in estimating the ROI for the MCACHI was to understand how much people value the benefits of being targeted by these programs and what aspects of the programs are most important to them. This study used a discrete choice survey to examine the factors people value most regarding public health programs, which allowed for monetizing the outcomes, which was important in order to estimate a ROI for investing in these types of programs. Typically, when placing a monetary value on health outcomes, a value of $50,000 per QALY gained is used. Although this value is widely used, it is not specific to the target population. Additionally, health equity is not incorporated in traditional economic evaluations when using QALYs, and by using a DCE of the region it allowed me to incorporate the monetary value people in the region place on the importance of health equity, as health equity was an important aspect from the very beginning of the initiative.

Chapter three is a costing study that focused on costing out the MCACHI. This included estimating investment/startup costs, operating costs, costs of providing the NDPPs, and referral system costs. Using both reported costing and RBC methods, the true costs of implementing the MCACHI were estimated. In order to calculate the ROI for the MCACHI, accurate costing information is critical. Cost estimates were calculated for the actual MCACHI, as well as simulations for if the MCACHI was implemented more efficiently. One of the underlying questions when costing out the initiative was whether it could potentially be more efficient if implemented again or was to continue being implemented. By varying the number of people who enrolled and completed the program, the type of referral system, and using promotoras I was able to simulate what the costs of the MCACHI would be if the program was done more efficiently.

Chapter four used information and the results from chapters two and three in order to estimate the ROI for the MCACHI as of June 2019, as well as if the MCACHI was done more efficiently. WTP estimates from chapter two were used to place a monetary value on the diabetes prevention program outcomes in order to compare the ROIs using two different methodologies for monetizing health outcomes. ROIs using WTP estimates were compared to ROI estimates using QALYs. This chapter also provided a framework for calculating ROIs for chronic disease prevention programs.

From the beginning of the MCACHI, the emphasis has been on estimating a ROI, with the hope that it will provide convincing evidence to local businesses in the region and potential funders to invest in the program. Various decisions were made along the way in order to be able to do a ROI analysis. Decisions such as what types of attributes and levels should be included in the DCE in order to place a value on public health programs from using a marginal analysis to obtain WTP estimates, deciding how many years the ROI timeline should be, deciding the monetary value per QALY gained, the NDPP effectiveness, diabetes incidence rates, and the decision to ultimately use the NDPP in order to lower heart disease, diabetes, and associated depression in the region. These decisions were made by me, with input from the CAG. All these decisions impact the final ROI estimations, which is why many analyses were estimated using the various parameters. By doing this, it allowed the ROIs to be compared to get a sense of how different the estimates are. Over the three-year startup period the decisions necessary to estimate a ROI were made and the program was shaped for a ROI analysis, there was an underlying assumption that the program would clearly show a positive ROI. What the results of this dissertation suggest is that regardless of the methodology used for monetizing health outcomes, it is very challenging to show a positive ROI in the shorter time horizon. Typically, economic evaluations, such as CUA, use lifetime health gains when examining the impact of health programs. The logic behind using a ROI was that potential funders would be more interested in investing their money in the program if they were seeing returns within five years. The ROI for the MCACHI was high in the longer time horizon, which provides evidence that the initiative is a good investment in the long run. However, the returns from the program would not lead to a positive ROI until many years into the future. Although it is not clear whether the ROI for the MCACHI helped them acquire funding, it provided evidence to the CAG that the initiative was a good investment for the region and helped them with decision making along the way.

There is limited literature about using ROIs for chronic disease prevention programs, especially working closely with a CAG. Of the available research, there is no standard for how to estimate ROIs for these types of programs. The main issue with using ROIs for chronic disease prevention programs is determining how to most accurately monetize all the health outcomes. Not only can ROI information be used to help secure funding for health programs, but it can be a valuable tool for priority setting for LHDs. An advantage of using ROIs to compare programs is you can compare different types of programs targeting different public health issues. For example, a ROI for a diabetes prevention program can be compared to a ROI for a tobacco cessation program, whereas when using CEA, the comparison must be made between programs that target the same health outcomes. A challenge of using ROIs for decision making is that it is timely and requires a high amount of resources. If a health department is trying to decide between two programs which program they want to invest and implement, having to do a ROI analysis for each program would require many resources and would be time consuming. Often these types of decisions must be made rather quickly with few available resources.

Recommendations for future research

This dissertation provides ROI estimates for the MCACHI as well as a framework using principles and techniques of health economics for researchers and practitioners to do a ROI analysis for a chronic disease prevention program. With a growing interest in ROI analysis for public health programs in recent years, it is important to follow a consistent methodology for doing ROIs. By using the framework proposed in this dissertation, LHDs can use this framework to help guide their efforts for priority setting and make the case for certain programs to be invested in compared to other programs. Future research should aim to do a ROI analysis from the perspective of a LHD for a chronic disease prevention program in another region or for another program using the framework described in this dissertation. By deciding a ROI analysis should be done from the very beginning when developing a program, the program can focus on being done most efficiently in order to maximize the resources. By focusing on keeping overall costs down and using resources efficiently, the program has the best chance of showing a positive ROI and even potentially for a shorter time horizon. The MCACHI has very high startup/investment costs and operating costs, so if a program can find a way to have lower costs it can potentially make the case for a positive ROI. Also, the framework on placing a value on public health programs can be used for other economic evaluations where it is important to place a monetary value on public health programs by people living in the region where the program will be implemented instead of using the general $50,000 per QALY or value that is not specific to the particular population. Chapter three provides a guide to costing out LHD programs that can be useful for LHDs trying to get a true estimate of how much they are spending on their programs, which is not only benefit for conducting economic evaluations but also for other evaluations such as efficiency evaluations.

One of the advantages of using a ROI analysis is being able to tailor it to the specific funder. This can possibly explain why the ROI did not have as significant of an impact on helping the MCACHI acquire funding as anticipated. The ROIs were not tailored specifically to any of the potential funders. In the beginning of the initiative, I proposed to the CAG that the first step should be to do a ROI using the value from the local community, and then the second step would have been to go and find interested businesses and potential funders in the region and find out what types of programs and characteristics of the programs they were interested in, regarding timelines and other factors important in the ROI. Although there was interest amongst the CAG to go out in the community and find out what types of things potential funders would be interested in, it was never followed through.

In this dissertation a DCE was used to examine the preferences of people in the region regarding public health programs that target their communities. Ideally, this survey could be administered to supervisors, businesses in the region, or any potential funder to understand what their preferences are. The problem is that it is difficult to get a sample size large enough for this type of analysis if only targeting specific groups of interest, such as local businesses. What is needed to implement this type of work into practice is to find a more efficient way of obtaining preferences. Future research should explore strategies for using different methods for getting preferences, such as qualitative strategies. This would allow for the ROI to be more tailored to the specific funder and could potentially be used since it would not require such a large sample like a DCE does.

Conclusion

As the use of ROIs amongst researchers and LHDs becomes more popular for public health programs, such as chronic disease prevention programs, it is important that they follow an accurate methodology and framework for doing ROIs using parameters that are specific to the interested agency. From the experience working with the MCACHI and CAG, it became clear that they were not familiar with ROIs and what is required to do them. Along with estimating the ROI for the MCACHI, I prepared presentations over the three-year period and tried to involve the CAG with the ROI process and decisions. Although there was high interest among the CAG and a great effort was made to teach the ROI process, if the project was repeated it would make sense to not worry about teaching the CAG the ROI process and just to focus on presenting the group the final ROI estimates. One of the main takeaways from this experience is I learned that the decision-making process that LHDs use is very different compared to how health economists make these types of decisions. LHDs might ask for a certain type of evaluation, such as a ROI, and might refer to it when making decisions, but they do not place nearly as much importance on these types of evaluations for decision making. They just end up focusing on what the community is interested in.

Prior to this dissertation, a framework for doing this type of evaluation was not established. The research conducted in this dissertation outlines a framework for the necessary components of doing a ROI analysis for a chronic disease prevention program working closely with a CAG, using the MCACHI as an example. Although the numbers and other parameter estimates are specific to the MCACHI, the methodology can be applied to other programs to accurately estimate the ROI using parameters that are specific to the agency. Now that a framework has been established, LHDs can be more confident when conducting ROI analyses and use them more frequently for priority setting and for obtaining funding to make their programs sustainable. Decision making is a complicated process, and ROIs can aid in this process. In the case of the MCACHI it was unsure whether the ROI lead to secured funding for the initiative moving forward, however, ROIs can be used to provide evidence and a strong argument for investing in public health programs, as they have generally be shown to be a good investment (Brown, 2016).

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Veldwijk, J., Lambooij, M. S., Van Gils, P. F., Struijs, J. N., Smit, H. A., & De Wit, G. A. (2013). Type 2 diabetes patients' preferences and willingness to pay for lifestyle programs: A discrete choice experiment. *BMC Public Health*, *13*(1), 1–8. https://doi.org/10.1186/1471-2458-13-1099

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Appendix

Table A1: Literature review for economic evaluations of community-based diabetes prevention programs

Citation	**Systematic review (# studies)**	**Evaluation type**	**Cost effective/cost savings**
Jacobs-van der Bruggen, M. A., Bos, G., Bemelmans, W. J., Hoogenveen, R. T., Vijgen, S. M., & Baan, C. A. (2007). Lifestyle interventions are cost-effective in people with different levels of diabetes risk: results from a modeling study. Diabetes care, 30(1), 128-134.	No	Cost effectiveness	Yes
Herman, W. H., Hoerger, T. J., Brandle, M., Hicks, K., Sorensen, S., Zhang, P., ... & Ratner, R. E. (2005). The cost-effectiveness of lifestyle modification or metformin in preventing type 2 diabetes in adults with impaired glucose tolerance. Annals of internal medicine, 142(5), 323-332.	No	Cost utility	Yes
Roberts, S., Craig, D., Adler, A., McPherson, K., & Greenhalgh, T. (2018). Economic evaluation of type 2 diabetes prevention programmes: Markov model of low-and high-intensity lifestyle programmes and metformin in participants with different categories of intermediate hyperglycaemia. BMC medicine, 16(1), 16.	No	Cost utility	Yes

Roberts, S., Barry, E., Craig, D., Airoldi, M., Bevan, G., & Greenhalgh, T. (2017). Preventing type 2 diabetes: systematic review of studies of cost-effectiveness of lifestyle programmes and metformin, with and without screening, for pre-diabetes. BMJ open, 7(11), e017184.	Yes (27)	Cost effectiveness and cost utility	Yes
Diabetes Prevention Program Research Group. (2012). The 10-year cost-effectiveness of lifestyle intervention or metformin for diabetes prevention: an intent-to-treat analysis of the DPP/DPPOS. Diabetes care, 35(4), 723-730.	No	Cost effectiveness	Yes
Ackermann, R. T., Marrero, D. G., Hicks, K. A., Hoerger, T. J., Sorensen, S., Zhang, P., ... & Herman, W. H. (2006). An evaluation of cost sharing to finance a diet and physical activity intervention to prevent diabetes. Diabetes care, 29(6), 1237-1241.	No	Cost utility	Yes
Li, R., Zhang, P., Barker, L. E., Chowdhury, F. M., & Zhang, X. (2010). Cost-effectiveness of interventions to prevent and control diabetes mellitus: a systematic review. Diabetes care, 33(8), 1872-1894.	Yes (56)	Cost effectiveness and cost utility	Yes
Diabetes Prevention Program Research Group. (2003). Within-trial cost-effectiveness of lifestyle intervention or metformin for the primary prevention of type 2 diabetes. Diabetes Care, 26(9), 2518-2523.	No	Cost effectiveness	Yes

Brownson, C. A., Hoerger, T. J., Fisher, E. B., & Kilpatrick, K. E. (2009). Cost-effectiveness of diabetes self-management programs in community primary care settings. The Diabetes Educator, 35(5), 761-769.	No	Cost effectiveness	Yes
Roberts, M. S., Kramer, M. K., Orchard, T. J., & Piatt, G. A. Cost-Effectiveness Analysis of Efforts to Reduce Risk of Type 2 Diabetes and Cardiovascular Disease in Southwestern Pennsylvania, 2005-2007.	No	Cost effectiveness	Yes
Gilmer, T. P., Roze, S., Valentine, W. J., Emy-Albrecht, K., Ray, J. A., Cobden, D., ... & Palmer, A. J. (2007). Cost-effectiveness of diabetes case management for low-income populations. Health services research, 42(5), 1943-1959.	No	Cost effectiveness	Yes
Li, R., Qu, S., Zhang, P., Chattopadhyay, S., Gregg, E. W., Albright, A., ... & Pronk, N. P. (2015). Economic evaluation of combined diet and physical activity promotion programs to prevent type 2 diabetes among persons at increased risk: a systematic review for the Community Preventive Services Task Force. Annals of internal medicine, 163(6), 452-460.	Yes (28)	Cost effectiveness	Yes

Zhuo, X., Zhang, P., Gregg, E. W., Barker, L., Hoerger, T. J., Pearson-Clarke, T., & Albright, A. (2012). A nationwide community-based lifestyle program could delay or prevent type 2 diabetes cases and save $5.7 billion in 25 years. Health affairs, 31(1), 50-60.	No	Cost effectiveness	Yes
Norris, S. L., Nichols, P. J., Caspersen, C. J., Glasgow, R. E., Engelgau, M. M., Jack Jr, L., ... & Briss, P. (2002). The effectiveness of disease and case management for people with diabetes: a systematic review. American journal of preventive medicine, 22(4), 15-38.	Yes (35 for effectiveness and 2 for costs)	Cost effectiveness	Yes