Returns on Investment in California County Departments of Public Health

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Objectives. To estimate the average return on investment for the overall activities of county departments of public health in California.

Methods. I gathered the elements necessary to estimate the average return on investment for county departments of public health in California during the period 2001 to 2008–2009. These came from peer-reviewed journal articles published as part of a larger project to develop a method for determining return on investment for public health by using a health economics framework. I combined these elements by using the standard formula for computing return on investment, and performed a sensitivity analysis. Then I compared the return on investment for county departments of public health with the returns on investment generated for various aspects of medical care.

Results. The estimated return on investment from $1 invested in county departments of public health in California ranges from $67.07 to $88.21.

Conclusions. The very large estimated return on investment for California county departments of public health relative to the return on investment for selected aspects of medical care suggests that public health is a wise investment. (*Am J Public Health.* Published online ahead of print June 16, 2016: e1–e6. doi:10.2105/AJPH.2016.303233)

Is the public health system a good investment? Information about the return on investment for public health systems is an essential input to sound health policy decision-making, but has been difficult to ascertain. Determining the return on investment for the public health system as a whole—at least from the point of view of county departments of public health—requires 4 types of information: (1) a complete set of health outcomes that can be causally attributed to the expenditures of county departments of public health, (2) the time paths of these expenditures and outcomes, (3) the level of expenditures used to produce the outcomes, and (4) monetary valuations of each outcome. With this information, one could determine the discounted present value of both public health outcomes and the level of expenditures used to produce them, the components of return on investment for the public health system.

Each of these 4 types of information is now available via a series of research articles appearing in health economics journals and health services journals, which make it possible for the first time to estimate the return on investment for the public health system in California.[1–3] This series of research articles was generated as part of a larger project to develop a method for determining return on investment for public health by using a health economics framework. In this study, I draw together each of the 4 types of information necessary to estimate return on investment, briefly explain the manner in which each of the 4 types of information was determined, and then combine these to estimate return on investment.

METHODS

In this article, I define the "public health system" as the collection of all county departments of public health in California. County departments of public health in California are funded from multiple sources. Intergovernmental transfers from state and federal governments and taxation are the primary sources of funds, and user fees and other sources of funding make up the remainder.[1]

Information Types

Two recent studies have determined the causal effects of county public health expenditures in California on both general health status and mortality, including their time paths, which together make up a complete set of overall health outcomes.[1,2] Information not only on the health outcomes that resulted from county public health expenditures, but also on their time paths is important because improving population health takes time. Public health activities that occur in a given year will not only improve population health in that same year, but will also improve population health for many years into the future. Public health activities are designed to improve general health status in the short term and it is likely that it is this improved general health status that reduces mortality rates over the long term. Thus, it is necessary to account for the entire stream of health outcomes to properly estimate return on investment.

The first of the 2 studies mentioned in the previous paragraph examined the effect of changes in per capita public health expenditures on county-level general health status (percentage of the county population with health status that is good, very good, or

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excellent).[1] The analysis was based on county-level panel data in 40 counties covering the period 2001 to 2009 and included information on general health status, per capita public health expenditures, lagged per capita income, the lagged age structure of the population, the lagged educational structure of the population, the lagged racial/ethnic structure of the population, and the lagged proportions of the population covered by health insurance including Medicaid and related programs, Medicare, and private health insurance. These 40 counties represent 96% of the California population.

The relationship between per capita public health expenditures and general health status was estimated with a statistical technique designed to determine how long it takes for the full effect of public health services and programs on general health status to play out. This approach, known as the Koyck distributed lag model, showed that it takes approximately 4 years for the effect of public health activities on general health status to play out.[4]

This estimated relationship between per capita public health expenditures and general health status was designed to be interpreted as causal. This causal interpretation is made possible by the use of the instrumental variable technique that is combined with the Koyck distributed lag model. The instrumental variable technique is a standard approach for determining causal effects in empirical health economics and corrects for the effects of measurement error (random errors in the data), omitted variable bias (the omission of relevant variables associated with both health outcomes and per capita public health expenditures), and reverse causation (changes in per capita public health expenditures that may be attributable to changes in health outcomes).[4] The particular instrumental variables approach used in this study incorporated state-of-the-art techniques that are commonly employed in the recent peer-reviewed literature across academic disciplines.[5–18]

The major finding of that study is that, at current funding levels, each annual public health expenditure cycle causally results in more than 207 000 individuals being in the "good, very good, or excellent" categories of health status rather than the "poor or fair" categories of health status.

The extent to which public health funding has an impact on mortality over the long term was the subject of the second study.[2] The second study used parallel methodology to the first study, but examined the effect of changes in per capita public health expenditures on county-level all-cause mortality. The analysis was based on county-level panel data for 56 counties covering the period 2001 to 2008 and included information on all-cause mortality, lagged per capita public health expenditures, the lagged age structure of the population, a lagged proxy for the educational structure of the population, lagged population density, the lagged unemployment rate, the lagged crime rate, the lagged racial/ethnic structure of the population, and the lagged proportions of the population covered by health insurance including Medicaid and related programs, Medicare, and private health insurance. These 56 counties represent approximately 98% of the California population.

The major finding of this second study is that, at current funding levels, each annual public health expenditure cycle results in approximately 27 000 lives being saved, with this effect playing out over approximately a decade. The results of these 2 studies thus show that each year of public health activities in California first improves general health status and then decreases mortality with positive health effects still being seen approximately a decade later.

The cost of this increase in health status and decrease in mortality is simply the total expenditures of county departments of public health in California during a given year. The levels of total expenditures are available in the second study.[2]

Determining return on investment requires placing a monetary valuation on avoided deaths. County departments of public health save lives by reducing the statistical mortality risk in the populations that they serve. Thus, the appropriate valuation in this context is the number of lives that are saved as a result of reductions in mortality risk: statistical lives. A statistical life is different from any specific person's life primarily in the sense that county departments of public health generally do not know the specific identities of the people who do not die as a result of public health activities. Nevertheless, the number of lives saved because of public health activities can be estimated.

Placing a monetary value on a particular good or service is usually done by determining its market value. However, there is no market for human life. Yet, there is a market that is linked to mortality: the labor market in which there is occupational variation in both the market wage and the risk of mortality. By using this information, it is possible to estimate statistically the implicit average trade-off that individuals make between levels of mortality risk and wage levels.[19] A large literature attests to the validity of this approach and it is the method used by the US federal government to determine the value of a statistical life for purposes of evaluating the costs and benefits of regulation.[19–21] For example, the US Environmental Protection Agency recommends a value for a statistical life of $9.6 million in 2010 dollars, and the US Department of Transportation recommends a value for a statistical life of $8.86 million in 2010 dollars.[22,23] We adopt these standard valuations to value the statistical lives saved by the activities of county departments of public health.

The final valuation needed is the monetary value of improved general health status. Like human life, there is no market for general health status. However, in contrast to the value of a statistical life, which is based on the well-understood relationship between occupational wages and the risk of mortality, the relationship between occupational wages and general health status is not well understood, suggesting that an alternative approach to valuing general health status is necessary.

One such alternative approach is the subjective well-being valuation method. The subjective well-being valuation method has been applied broadly to value numerous things for which no market exists such as air pollution, climate, floods, droughts, and noise, as well as the proximity to waste facilities, coastlines, and transportation routes.[24–31] The subjective well-being valuation method has also been used to determine the value of cardiovascular disease, migraine headaches, various chronic illnesses, mental health, chronic pain, and general health status.[3,32–36] This last valuation, the valuation of general health status, is most relevant to this study.

Applying the subjective well-being valuation method to value general health status involves estimating a happiness equation that is a function of gender, age, race, marital status, education, year, season, general health status, and family income adjusted for family size. A reduction in general health status reduces happiness and an increase in family income increases happiness. A decrease in general health status that reduces happiness is statistically valued by the amount of family income it would take to completely reverse this reduction in happiness so that happiness is the same as it was before the decrease in general health status occurred. To correct bias attributable to potential measurement error, omitted variables, and reverse causation, the instrumental variable approach, which produces consistent valuations of general health status, was used. The implications of this study are that moving from poor or fair health to good or excellent health (a single year of improved health status) can be valued at $41 654 (2010 constant dollars), other things equal.[3]

Return on Investment

The return-on-investment analysis takes the point of view of county departments of public health, departments that are focused on 2 things: their own expenditures and the value of changes in mortality and health status that are produced as a result of their activities. However, we must first make some adjustments to the information presented previously. Because estimates of the number of individuals whose general health status was improved or whose life was saved as a result of public health activities was based on less than the full number of California counties, these estimates must be slightly scaled up to account for the full improvement in population health in California. We must similarly slightly scale up total expenditures of county departments of public health in California.

To compute return on investment, I used the following formula, (Equation 1), where return on investment is equal to

$$(1)\quad \frac{\sum_{i=1}^{10}(\text{PV of avoided deaths})+\sum_{i=1}^{4}(\text{PV of improved health status})-(\text{PV of expenditures})}{(\text{PV of expenditures})}$$

where *PV* is present value. Note, although it may be the case that improvements in general health status are long-lasting, to be conservative we assume that improvements in general health status only last 1 year because we have no information on the age distribution of the individuals whose general health status is improved.

Return on investment is calculated by using a 3% real discount rate with sensitivity analysis performed using 0%, 5%, and 7% real discount rates. The use of each of these discount rates is recommended by the US Public Health Service.[37] Real discount rates represent the inflation-adjusted rate of return that could be obtained if public health expenditures were invested in alternative investments. All dollars are inflation-adjusted and expressed as 2010 constant dollars. Note that the return on investment will be the same regardless of the year to which dollars are standardized. A set of spreadsheets that includes the complete details of the analysis is available as a supplement to the online version of this article at http://www.ajph.org.

On the basis of the studies discussed previously, improvement in general health status attributable to a single year of public health expenditures is modeled to occur over a 4-year period, and avoided deaths attributable to a single year of public health expenditures are modeled to occur over a 10-year period. The present value of avoided deaths comes from combining the value of a statistical life used by either the Environmental Protection Agency or the Department of Transportation with the parameter values measuring the causal links between avoided mortality and public health expenditures. The present value of improved health status comes from combining the standard valuation of improved health status with the parameter values measuring the causal links between the percentage of the population that has improved health status and public health expenditures. The present value of expenditures for county departments of public health is calculated on the basis of data from the study on county public health expenditures and avoided mortality.[2] I performed sensitivity analysis with 2 alternative values of a statistical life.

RESULTS

The overall pattern of human benefit from the activities of California county departments of public health begins with the growth in the number of individuals whose general health status improves by moving from poor or fair health to good, very good, or excellent health. Most of the impact of public health activities on general health status is felt in the same year that the public health activities are performed, resulting in an estimated 190 388 individuals with improved health. Impacts of base-year public health activities are also felt in future years, but are much smaller, with an estimated additional 22 847 people experiencing improved health in the following year, and an estimated additional 2742 and 329 people experiencing improved health in the third and fourth years, improving health for an estimated 216 306 people overall from a single year of county public health activities. These figures have been scaled up from 40 counties to account for all 58 counties.

Figure 1 presents the estimated pattern of lives saved from the same base year of public health activities that resulted in the pattern described previously. The initial impact on general health status in the base year is followed by an estimated 8863 and 6293 avoided deaths in the following 2 years (cumulative annual figures are shown in Figure 1). This diminishing reduction in mortality plays out for approximately a decade, with the number of additional lives saved slowly decreasing each year, for an estimated 29 567 total statistical lives being saved over a 10-year period. These figures have been scaled up from 56 counties to account for all 58 counties.

The total public health spending that produced this improved general health status and lives saved is $3.28 billion (when we scale up the original analysis to account for all 58 county departments of public health) measured in 2010 dollars as presented in Table 1. The total value of the improved general health status ranges from $8.93 billion to $9.01 billion, depending on the discount rate used. As noted previously, I used 2 values of a statistical life, one from the Environmental Protection Agency ($9.6 million) and one from the Department of Transportation ($8.86 million), such that

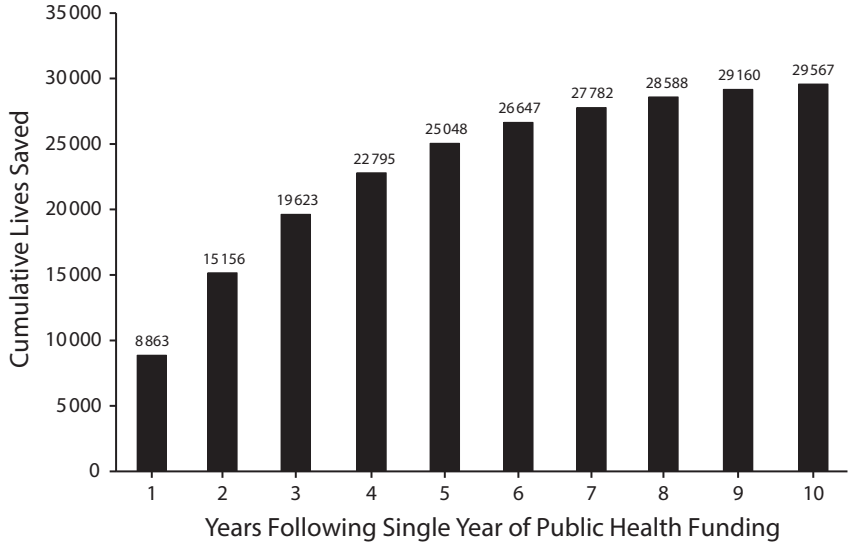

FIGURE 1—Estimated Cumulative Lives Saved as a Result of a Single Year of County Public Health Spending in California

the total value of avoided deaths ranges from $214.5 billion to $283.84 billion, depending on the discount rate used.

When I used the 0%, 3%, 5%, and 7% real discount rates and the inflation-adjusted value of a statistical life used by the Environmental Protection Agency, the return from a $1 investment in county departments of public health in California was $88.21, $80.77, $76.44, and $72.53, respectively, in 2010 dollars. When I changed the value of a statistical life to the inflation-adjusted value of a statistical life used by the Department of Transportation, these returns, respectively, were $81.55, $74.68, $70.68, and $67.07. Additional details are available in the supplement to the online version of this article at http://www.ajph.org.

DISCUSSION

In this study, I estimated the return on investment for overall expenditures in county departments of public health in California by using recent causal estimates of the impact of public health expenditures on mortality and general health status in California, a standard set of valuations of a statistical life used by the federal government, and a new standardized valuation of general health status.[1–3] The return on investment from $1 invested in county departments of public health is estimated to range from $67.07 to $88.21 when one uses a range of real discount rates recommended by the US Public Health Service. Although the period analyzed in this data set was bracketed by national recessions, one ending in November 2001 and one beginning in December 2007, the time period used in this analysis is unfortunately not suitable to answer the important question of whether the effects found in this study would be modified by an economic recession.[38]

This study is not without limitations. This study focused on county departments of public health and only includes the contributions of state and federal health agencies to the extent that county public health funding comes from state and federal health agencies. Other important contributions of state and federal health agencies to health outcomes are not included. In addition, the causal estimates of the links between county-level public health expenditures and both mortality and general health status, although they are state-of-the-art, may be sensitive to the particular years for which data were available. Also, the estimated time over which mortality is prevented, which is based on the econometric model estimated, extends slightly past the years for which data were actually available.[2] This estimated number of time periods may also be sensitive to the particular years for which data were actually available.

Another potential limitation is that the causal estimates of the links between county-level public health expenditures and both mortality and general health status were generated from analyses performed on finite samples.[1,2] To account for this, I applied finite sample size adjustments to the robust variance–covariance matrix in each analysis, kept the number of instrumental variables used in each analysis purposefully small, and removed weak instrumental variables.[1,2] However, it is possible that some finite sample bias may still be present.

TABLE 1—Estimated Average Returns on Investment in California County Departments of Public Health by Using 2 Values of a Statistical Life and Constant Total County Public Health Expenditures for a Single Base Period: United States, 2001 to 2008–2009

	Discount Rates			
Summed Present Value of a Statistical Life	0%	3%	5%	7%
A. Avoided deaths over 10 periods ($billions)				
US Environmental Protection Agency	283.84	259.45	245.25	232.43
US Department of Transportation	261.96	239.45	226.34	214.50
B. Improved health status over 4 periods ($billions)	9.01	8.97	8.95	8.93
Return on $1 investment[a]				
US Environmental Protection Agency	$88.21	$80.77	$76.44	$72.53
US Department of Transportation	$81.55	$74.68	$70.68	$67.07

Note. All amounts expressed in 2010 constant dollars. There is only 1 available value of improved health status, so this is not varied in the analysis.

[a](A+B–$3.28 billion)/$3.28 billion.

The estimate of the value of general health status is based on a time period far wider than the data used in the other studies, which may have an impact on the valuation of general health status.[3] The value of general health status is also generated at the level of the entire United States and may be somewhat different than if generated for California alone.[3]

Finally, although this study emphasizes the return on investment of public health activities as a whole, it does not address important issues such as what the most cost-effective bundle of public health services may be. Important efforts are currently underway to determine the costs of foundational public health services as are efforts to collect county-level health outcomes information, which will assist in addressing this important issue.[39,40]

The estimated range of return on investment found in this study compares favorably to investments in medical care. Estimates of the return on investment from Medicare's investment in 4 major health conditions (heart attacks, type 2 diabetes, stroke, and breast cancer) range from $1.10 to $4.80.[41] The return on investment from innovation in medical care, based on an evaluation of 23 studies, ranges from $1.12 to $38.00.[41]

Given the high return on investment for public health, and what we know to be low levels of public health funding relative to medical care funding, an increase in public health funding would be a valuable investment.[42] Although marginal returns on investment in public health are likely to diminish with continued investment in public health, it may be the case that a great deal of investment can occur before the return on investment for public health even approaches the return on investment for medical care. Public health is an excellent investment opportunity and great improvements in health are likely if these investments occur.

Public health activities are fundamentally about preventing poor health outcomes that develop over long periods of time. Success in public health is thus measured in terms of the number of poor health outcomes that did not happen as a result of public health interventions. Thus, only by using rigorous research methods can we know whether public health activities are achieving their goals. Investment in such research must go hand in hand with investment in public health activities to obtain the long-term improvements in population health that we all work toward. AJPH

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HUMAN PARTICIPANT PROTECTION

All data upon which this study is based are publicly available and de-identified. Because of this, no review was required by the institutional review board of the University of California, Berkeley.

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