Investing In Our Future Health

The Case for a California Prevention and Wellness Trust

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Executive Summary

About This Report

Millions of Californians are at risk of preventable diseases and injuries, and each year thousands become ill or die prematurely from cardiovascular disease, diabetes, and cancer. Too many Californians live in communities characterized by poverty and violence, which in turn promote tobacco and alcohol use, poor quality diets, and physical inactivity. Residents in these communities stand a far higher risk of being affected by chronic diseases and have poorer health outcomes. Children living in these communities can suffer lifelong consequences when exposed to adverse events early in life. The cost of these diseases and injuries place a growing burden on the California health care system.

These health conditions can, in large part, be prevented or delayed, and their costs avoided. However, this will require investments that tackle tobacco use, poor nutrition, physical inactivity, community violence, and other underlying risks for health. ***This means investing in healthy communities***. And we know what works. Evidence based strategies that have been demonstrated to be cost effective or cost saving can help decision makers develop and invest in comprehensive approaches to prevent chronic disease and injury, improve quality of life, and save money.

This report examines the cost of chronic diseases associated with tobacco use, poor nutrition, and physical inactivity and provides state and county level estimates of risk factors. It also explores what is known about the effectiveness and value of interventions that have been tried in the U.S. and other developed countries and identifies “best buy” prevention strategies.

The goal of this report is to demonstrate the value of prevention and assist policy makers in designing balanced portfolios of prevention investments with the funding mechanisms to support them. It summarizes the existing knowledge on the value of effective prevention strategies for the selected issues. As new knowledge is generated it can continue to inform and further strengthen prevention investments. For example, emerging research shows that addressing social determinants of health and adverse childhood experiences must become an essential component of California’s prevention strategy. In the long run, these sustained investments in a prevention portfolio can improve the health of Californians. and reduce health care costs.

Key Findings

1. The cost of not investing in prevention is too high. Preventable chronic diseases are placing an increasing burden on families, the health care system, and on state expenditures.

- In 2017, health care for cardiovascular disease, Type 2 diabetes, and cancer, cost an estimated $83 billion in California, of which Medi-Cal paid $17.5 billion.
- These three diseases can often be prevented or delayed by eliminating tobacco use, eating healthy diets, and engaging in physical activity.
- Just a 10 percent reduction in these three conditions would save over $8 billion of health care costs in California annually and save Medi-Cal $1.8 billion.

2. Examples of “best buy” interventions to address tobacco use, nutrition and physical activity include:

- Taxes on tobacco, alcohol and sugar sweetened beverages
- Child care, school, and after school policies and programs
- Mass media campaigns
- Smoke-free policies
- Workplace wellness programs
- Community exercise programs for older adults
- State and community programs to increase access to healthy foods and opportunities for exercise.

3. Many factors contribute to the selection of prevention strategies.

- Many prevention strategies, when bundled together, have synergistic and reinforcing effects that improve their value
- Strategies may be chosen because they promote health equity
- Strategies may have other valuable outcomes including social, environmental, and economic benefits

4. ROI of prevention interventions can vary because of differences in

- Local prevalence of key risk factors
- Population characteristics
- Cultural acceptance of interventions
- Local implementation costs

Introduction

U.S. health care costs continue to increase at a rapid pace. Since the passage of the Affordable Care Act in 2010, state Medicaid programs have seen dramatic increases in enrollment and expenditures. California health care expenditures have increased at a faster pace than the national average.[1] By some estimates, 80 percent of these expenditures are for people with one or more chronic health conditions. In 2010, 38 percent of Californians had at least one chronic health condition and 187,000 died from a chronic disease or injury.[1,2]

Yet most chronic diseases are preventable, or can be delayed, including 80 percent of cardiovascular disease, stroke, type 2 diabetes, and 30 percent of cancers.[2] These diseases are leading causes of premature illness and death and of health disparities. Eliminating tobacco use, adopting healthy diets, and staying physically active can prevent much of this health and economic burden. Californians can still make progress towards this goal. In 2015, 10.5 percent of adults still smoked cigarettes,[3] 67 percent of whom began smoking by age 18.[4] In 2016, 13.6 percent of high school students reported using tobacco, [5] and 61 percent of California adults were overweight or obese, a troubling number of whom were overweight as children. More than a third of Californians of all ages ate less than one serving of fruit or vegetables daily and 17 percent got no daily exercise in 2016.[6] Not surprisingly, in 2018 it was reported that over a tenth of the population characterizes their health as poor or fair.[7]

Chronic disease is not spread evenly over the state's population. In the 2015 *Portrait of Promise: The California Statewide Plan to Promote Health and Mental Health Equity*, the California Department of Public Health, Office of Health Equity reported that lower educational attainment, unemployment, poverty, violence, poor quality and unsafe housing, and limited access to healthy food and quality health care—also known as the social determinants of health—are taking their toll on health and well-being.[8] Neighborhoods with lower educational attainment, higher unemployment, and higher poverty have lower life expectancy and a greater burden of illness and premature death. Such neighborhoods also have limited access to places to exercise and stores that sell healthy food, while unhealthy products such as tobacco, alcohol, and sugar-sweetened beverages are often aggressively promoted. The report also notes that California residents of lower socioeconomic status, regardless of race or ethnicity, are two to four times more likely to smoke tobacco.[8]

Nationally, less than four percent of health expenditures are for public health and prevention programs.[9] Yet we know what works. Evidence-based strategies and programs need the investment to go to scale with the assurance of sustained funding. Expanding prevention and wellness programs to the places we live, work, and play; building bridges with the clinical health care system; and bringing new multi-sector partners to the prevention table can turn this tide.

This report examines the cost of three leading chronic diseases in California and provides examples of evidence-based “best buy” interventions that can help reduce the burden of tobacco use, poor nutrition, and physical inactivity. It also includes a detailed review of the literature on the value of strategies to address tobacco use, poor nutrition, and physical inactivity (Appendix A).

Current Health Care Expenditures in California: The Economic Case for Prevention

In 2014, California spent $292 billion dollars on health care; $7,549 for each California resident. Twenty-one percent ($62 billion) was paid for by Medi-Cal, the state Medicaid program. In recent years, health spending in California has been growing faster than for the nation as a whole. California's Medicaid program spending sharply increased following implementation of the Affordable Care Act and the subsequent expansion of Medi-Cal.[1]

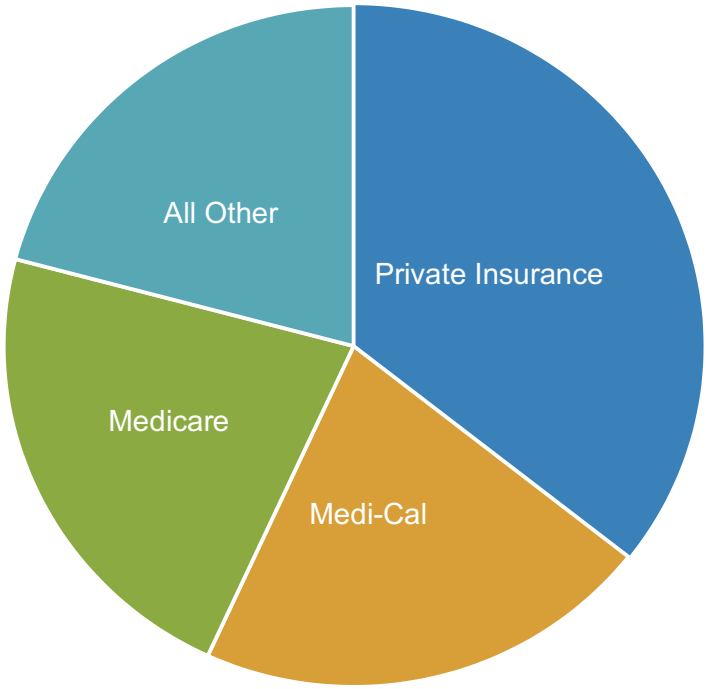

Figure 1. Who pays for California's Healthcare? CMS Health Spending by State of Residence, 1991-2014[1]

The California Department of Public Health estimates that 80 percent of California's health care expenditures were for persons with chronic health conditions. Chronic diseases are the leading causes of death, disability, and poor health in California and are largely preventable. Eighty percent of cardiovascular disease, stroke, and Type 2 diabetes, and 30 percent of cancers can be prevented or delayed by stopping smoking, improving diets, and increasing physical activity.[2]

"Treatment without prevention is simply unsustainable."

-Bill Gates

Tobacco use causes cancers, cardiovascular disease, stroke, and respiratory diseases. Unhealthy diets and physical inactivity are risk factors for obesity, diabetes, cardiovascular disease, stroke, and certain cancers. These three risk factors are considered the leading causes of death and illness of Californians. In 2015 and 2016, 61 percent of California adults were overweight or obese, 10.5 percent of adults smoked tobacco, and only 23 percent of adults met the recommended physical activity guidelines.[3,6,7]

In California, the rates of chronic disease, their outcomes and risk factors vary by county, as do their costs. They are also associated with socioeconomic factors such as education, employment, poverty, and housing, as well as personal life history. Factors such as adverse early childhood experiences also can increase the risk for a wide range of illnesses later in life.[10-12] Table 1 illustrates county differences in 2017 for five selected indicators reported each year for all counties in the United States by *County Health Rankings and Roadmaps*, a project of the Robert Wood Johnson Foundation.[7] Understanding county-level health outcomes and behaviors are important for communities allocating resources for prevention programs.

*Table 1. Selected Health Outcomes, Health Behaviors, and Socioeconomic Factors from the 2017 County Health Rankings and Roadmaps**

County	Adult Smoking	Adult Obesity	Physical Inactivity	Poor or Fair Health	Children in Poverty
California	12%	23%	17%	12%	20%
Alameda	10%	20%	16%	11%	14%
Alpine	16%	23%	19%	17%	36%
Amador	11%	26%	18%	13%	20%
Butte	15%	26%	19%	16%	24%
Calaveras	12%	24%	19%	12%	21%
Colusa	13%	25%	16%	20%	19%
Contra Costa	11%	25%	18%	12%	13%
Del Norte	15%	26%	19%	18%	34%
El Dorado	11%	21%	16%	12%	12%
Fresno	14%	27%	21%	23%	36%
Glenn	14%	27%	19%	20%	26%
Humboldt	16%	26%	15%	16%	23%
Imperial	14%	26%	21%	27%	31%
Inyo	12%	23%	18%	15%	20%
Kern	15%	30%	24%	23%	31%
Kings	15%	26%	20%	23%	28%
Lake	15%	26%	21%	18%	30%
Lassen	14%	24%	18%	14%	20%
Los Angeles	12%	21%	18%	19%	24%
Madera	15%	27%	20%	23%	32%
Marin	10%	19%	12%	11%	9%
Mariposa	12%	24%	17%	14%	24%
Mendocino	13%	22%	17%	17%	27%
Merced	15%	30%	25%	27%	36%
Modoc	14%	23%	19%	17%	31%
Mono	13%	23%	16%	14%	17%
Monterey	11%	22%	17%	22%	22%
Napa	12%	24%	16%	14%	12%
Nevada	12%	21%	17%	12%	16%
Orange	10%	20%	16%	15%	17%
Placer	10%	22%	15%	12%	9%
Plumas	13%	23%	15%	14%	23%
Riverside	13%	26%	20%	20%	23%
Sacramento	13%	27%	17%	17%	23%
San Benito	12%	23%	17%	18%	14%
San Bernardino	14%	28%	19%	22%	27%
San Diego	11%	19%	16%	15%	18%

County	Adult Smoking	Adult Obesity	Physical Inactivity	Poor or Fair Health	Children in Poverty
San Francisco	10%	16%	16%	13%	14%
San Joaquin	13%	28%	21%	19%	24%
San Luis Obispo	12%	25%	14%	14%	15%
San Mateo	9%	21%	16%	11%	10%
Santa Barbara	11%	18%	14%	18%	20%
Santa Clara	8%	20%	15%	12%	9%
Santa Cruz	11%	20%	13%	16%	18%
Shasta	14%	27%	19%	14%	27%
Sierra	12%	23%	16%	14%	17%
Siskiyou	14%	23%	19%	17%	31%
Solano	12%	30%	18%	16%	16%
Sonoma	12%	21%	14%	14%	14%
Stanislaus	14%	33%	20%	20%	27%
Sutter	12%	29%	22%	18%	24%
Tehama	14%	27%	25%	17%	32%
Trinity	15%	25%	20%	16%	32%
Tulare	14%	33%	22%	26%	36%
Tuolumne	13%	20%	17%	13%	22%
Ventura	10%	20%	18%	15%	14%
Yolo	12%	23%	15%	16%	17%
Yuba	15%	25%	16%	18%	32%

* Confidence intervals for estimates in the table can be found at http://www.countyhealthrankings.org

Opportunities for Investment

"Best Buy" Prevention Strategies

Investments in programs that promote prevention and wellness for Californians can improve the overall health of the state and reduce health disparities. Fortunately, there is a large selection of interventions with proven effectiveness and demonstrated value to consider. For over 20 years, the Centers for Disease Control's (CDC) *Guide to Community Preventive Services (Community Guide)* has evaluated a wide range of interventions including those that address tobacco use, poor nutrition, physical inactivity, and obesity.

New research and community innovation continue to generate knowledge on effective strategies for community-based prevention of disease. While this report focuses on three key and better-studied risk factors, using or developing effective approaches to other known risk factors is also an important part of a balanced approach to prevention. For example, the Community Guide recommends taxation of alcohol and other alcohol policies as effective strategies for reducing alcohol related chronic disease. [17] Interventions that address social determinants of health will also help communities achieve goals for health equality.

The list of "best buy" interventions shown in Table 2 was developed from a literature review of economic evaluations of interventions that address tobacco use, poor nutrition, and physical inactivity. "Best buys" are interventions with the highest effectiveness and value. The literature review includes studies of interventions implemented in the U.S. and other high-income countries.

Cost saving interventions are those for which the economic value of the benefits is greater than the cost of the intervention.

Cost-effective interventions are those for which the net cost of the intervention (economic value of the benefits minus the intervention cost) divided by the health outcomes produced is within an acceptable range. The generally accepted threshold used by most high-income countries is less than $50,000 per QALY saved or DALY gained.[18] (QALY - quality adjusted life-year, DALY - disability adjusted life-years).

ROI stands for "return on investment." It is a financial measure that compares the dollars invested in something to the benefits produced by that investment:

- ROI = (benefits of investment - amount invested) /amount invested
- When ROI equals 0, the program pays for itself.
- When ROI is greater than 0, the program is producing savings that exceed the cost of the program.

Adapted from Trust for America's Health: Prevention for a Healthier America. 2009.

Information is drawn from reports and peer-reviewed studies comparing interventions for a wide range of health conditions, systematic reviews of interventions targeting specific risk factors (tobacco use, unhealthy diet, and physical inactivity), and evaluations of interventions focused on specific risk factors or health conditions. Details on each of the studies are provided in Appendix A.

The examples of "best buy" interventions include policies and programs that can be feasibly implemented and provide opportunities for people at all stages of life, from policies in childcare settings to community exercise programs for older adults. The tables and references in the literature review have been organized to easily locate more detailed information on each. The list of "best buy" interventions is not by any means exhaustive. It only includes those that were assessed for economic value. Unlike clinical interventions such as drugs and medical devices, there is no ready market for prevention interventions and this has limited funding for economic studies. Many promising strategies exist that have not yet been examined for value and this list will surely expand as new studies become available. Effective strategies can be implemented by a wide range of partners, from state and local government to community organizations and healthcare providers.

Economic evaluations provide a good indication of the types of interventions that will improve health for a reasonable value. However, the costs and benefits in one study may not apply to other settings. Before final selection of an intervention is completed, an assessment of how the intervention will likely perform is valuable. Information on the impact of site-specific demographics, risk factor and disease prevalence, and intervention costs on value should be considered. Insights from the published studies'

sensitivity analyses can help inform whether an intervention is likely to be cost effective under different conditions.

Financial Factors are Not the Only Consideration

Many factors go in to building a prevention portfolio: financial impact is only one consideration. Understanding the underlying goals for prevention and wellness programs is critical to selecting which interventions to fund. While “Is the intervention cost saving?” often seems of overriding importance, other questions may have more weight. “Will the intervention reduce health disparities?” “How broad is the reach of the intervention?” “Does the intervention have other benefits such as improving the environment, promoting economic development and employment, or addressing safe and affordable housing?” “How are the costs and benefits distributed?” Though this information is often not included in economic studies found in the literature, all of these factors should be considered in building a portfolio for action.

Establishing clear investment goals that reflect the organization’s health, social, environmental, economic, and social justice mission should also preface the selection of prevention interventions. A “Health in All Policies” analysis of potential interventions may be useful for identifying multi-sector approaches, partners and stakeholders as well as examining other benefits in addition to health improvement. Investing in a portfolio or package of interventions that work together to address a specific risk factor or health problem may increase the value of the individual interventions. Above all, selecting interventions that meet clear goals of all stakeholders and are projected to be cost effective in California settings is key to developing the strongest possible prevention portfolio.

Table 2. "Best Buy" Interventions to Reduce Tobacco Use, Promote Healthy Diets, and Encourage Physical Activity

Focus of Intervention	Cost Saving Interventions	Cost-effective Interventions
Reduce Tobacco Use	– Taxes on tobacco products – State Comprehensive Tobacco Control Programs – Smoke-free housing policies – Programs to prevent tobacco initiation in youths	– Tobacco Quit Lines with reduced price or free nicotine replacement therapy products – Mass media campaigns on tobacco use
Promote Healthy Diets	– Taxes on unhealthy food and beverages – Limits on salt intake – School food and beverage standards for foods sold outside the cafeteria – Access to water in schools	– SNAP Fruit and Vegetable Incentives program – Certain elementary and middle-school programs that encourage physical activity and healthy eating
Encourage Physical Activity	– Exercise-based community falls prevention programs for older adults – After school physical activity programs – Promotion of active transportation including zoning and walking and cycling paths	– Workplace physical activity programs – Mass media campaigns promoting physical activity – Community walking, exercise, and nutrition programs

Smoke-Free Public Housing Policies in Merced County

Today, the 1,100 tenants at all public housing properties in Merced County are protected from second-hand smoke. With funding from the Centers for Disease Control, the Merced County Department of Public Health worked to educate the Merced County Housing Authority on the dangers of second-hand smoke. In 2016 the Housing Authority adopted 100% smoke-free policies at all 10 public housing properties.

"I like the (smoke-free) policy because when people are permitted to smoke it can trigger an asthma attack in my son. Normally he's fine, but if he smells smoke, he has to use his inhaler." -Merced County public housing resident

Small Investments Produce Big Returns

Perhaps a more important insight from the literature review was that when multiple interventions are evaluated as a package, synergistic and reinforcing effects can create a positive ROI for the package whereas the individual interventions in the package, if implemented alone, might not be cost saving. The package approach was evaluated in the Trust for America's Health report, *Prevention for a Healthier America: Investments in Disease Prevention Yield Significant Savings, Stronger Communities*; Milstein's systems dynamics modeling of several health protection and promotion scenarios in 2011; and the evaluation of the CDC's *Communities Putting Prevention to Work* (*CPPW*) program published in 2015.[20-22]

In 2010-2012, the CDC invested $403 million in 28 communities for programs to reduce tobacco use and to promote healthy eating and physical activity.[23] The communities spent the funds over a three-year period on developing, promoting, and implementing policies to:

- reduce the harmful effects of secondhand smoke exposure in workplaces, restaurants, schools, multi-unit housing complexes, campuses, parks, and beaches
- improve access to healthy food and beverage options in schools, afterschool programs, childcare settings, workplaces, and other community settings
- create opportunities for physical activity in schools, afterschool programs, childcare settings, workplaces and other community settings.

The Communities Putting Prevention to Work program reached 55 million people in urban and rural areas including in three tribal nations. After three years, CDC staff used the Prevention Impacts Simulation Model (PRISM) to project the impacts of the CPPW program in 10 years (2010-2020). The PRISM model is an interactive, systems dynamics simulation model of cardiovascular disease that can be used to estimate the number of premature deaths prevented, health care savings, and the value of lost productivity by implementing these policies. The researchers assumed that investments in the program would be sustained for ten years, although the CDC funding ended after three years. The results looked promising. The model predicted that if the initial $403 million federal investment was sustained over 11 years (at a total cost of $1.42 billion), 14,000 premature deaths would be prevented, $2.4 billion in health care costs would be saved, and $9.5 billion in lost productivity would be averted.[22] The ROI for total investment would be about 7.4 for every dollar invested.

Another report, published by the Trust for America's Health in 2008 demonstrated that a $10 per capita investment in prevention programs could produce as much as $18 billion in benefits over twenty years. The ROI after 5 years would be 5.6 for every dollar invested and within 10 to 20 years, 6.2 for every dollar invested.[20] A comprehensive and sustained approach to prevention investments has the potential for improving the health of Californians and slowing the growth of health care costs.

Los Angeles, California Communities Putting Prevention to Work Program Tackles Tobacco Use and Obesity*

"Providing healthy food and beverage options at school meals, along with education on healthy eating and active living, have the potential to improve the health of students, reduce rates of childhood and adolescent obesity, and improve academic performance. These benefits are likely to be long lasting as healthy behaviors adopted in childhood often continue into adulthood, resulting in decreased risk of chronic diseases and the costs associated with these preventable diseases." -Paul Simon, MD, MPH, Chief Science Officer and Director of the Division of Assessment, Planning, and Quality, Los Angeles County Department of Public Health

Los Angeles County is the most populous county in the United States with 9.8 million people. Almost twenty four percent of adults and 23% of children are obese. The County has embarked on a campaign to make it easier for residents to make healthy choices. To promote physical activity, Los Angeles County has created the Model Street Design Manual for Living Streets, a regional bicycle master plan, and joint-use agreements for shared use of public property or facilities. The county has also designated three hospitals as baby-friendly to support breastfeeding and ten cities in the county have adopted healthy food service guidelines for their institutions and facilities, impacting an estimated 258,739 residents.

**https://www.cdc.gov/nccdphp/dch/programs/communitiesputtingpreventiontowork/communities/profiles/pdf/cppw_communityprofile_b2_losangelescounty_ca_508.pdf*

Conclusion

The prevalence of largely preventable chronic diseases and injuries in California creates an unacceptable burden on residents' health and well-being and on the health care expenditures of families, the state and local government. Yet only limited funding has been dedicated to addressing the underlying causes. Smoking, poor nutrition, and lack of physical activity are examples of major risk factors that are not being adequately addressed, even though proven strategies and interventions are available. The existing research on the cost effectiveness of interventions to prevent chronic disease, and an understanding of the health care costs of these largely preventable health conditions, provide a strong basis on which to develop a portfolio of prevention investments and a funding strategy to support them. As new knowledge is generated, it can continue to inform and strengthen prevention investments. Although this review focused on three leading and better studied behavioral risk factors, effective approaches to other known risk factors, including social determinants of health and adverse childhood experiences, are also essential components of a balanced approach to prevention.

Key Messages

1. The cost of not investing in prevention is too high. Preventable chronic diseases are placing an increasing burden on families, the health care system, and on state expenditures.

- In 2017, health care for cardiovascular disease, Type 2 diabetes, and cancer, cost an estimated $83 billion in California, of which Medi-Cal paid $17.5 billion.
- These three diseases can often be prevented or delayed by eliminating tobacco use, eating healthy diets, and engaging in physical activity.
- Just a 10 percent reduction in these three conditions would save California over $8 billion of health care costs annually and save Medi-Cal $1.8 billion.

2. Examples of "best buy" interventions to address tobacco, use, nutrition and physical activity include:

- Taxes on tobacco, alcohol and sugar sweetened beverages
- Child care, school, and after school policies and programs
- Mass media campaigns
- Smoke-free policies
- Workplace wellness programs
- Community exercise programs for older adults
- State and community programs to increase access to healthy foods and opportunities for exercise.

3. Many factors contribute to the selection of prevention strategies.

- Many prevention strategies when bundled together have synergistic and reinforcing effects that improve their value.
- Strategies may be chosen because they promote health equity.
- Strategies may have other valuable outcomes including social, environmental, and economic benefits.

4. The benefits on any strategy depend upon the situation in which it is implemented. Cost effectiveness can vary because of differences in

- Local prevalence of key risk factors
- Population characteristics
- Cultural acceptance of interventions
- Local implementation costs.

References

1. Centers for Medicare and Medicaid Services, National Health Expenditure Data, Health Expenditures by State of Residence 1991-2014.

2. California Wellness Plan 2014. https://www.cdph.ca.gov/Programs/CCDPHP/DCDIC/CDCB/Pages/CaliforniaWellnessPlanImplementation.aspx#

3. California Department of Public Health, California Tobacco Control Program. Behavioral Risk Factor Surveillance System, 1996-2015. Sacramento, CA: California Department of Public Health; 2016.

4. California Department of Public Health, California Tobacco Control Program. Behavioral Risk Factor Surveillance System, 2015. Sacramento, CA: California Department of Public Health; 2016.

5. California Department of Public Health, California Tobacco Control Program. California Student Tobacco Survey, 2015-2016. Sacramento, CA: California Department of Public Health; 2016.

6. Centers for Disease Control and Prevention.

https://www.cdc.gov/nccdphp/dnpao/data-trends- maps/index.html

7. County Health Rankings and Roadmaps. http://www.countyhealthrankings.org

8. Portrait of Promise: The California Statewide Plan to Promote Health and Mental Health Equity. A Report to the Legislature and the People of California by the Office of Health Equity. Sacramento, CA: California Department of Public Health, Office of Health Equity; August 2015.

9. Miller G, Roehrig C, Hughes-Cromwick P, Lake C. Quantifying national spending on wellness and prevention. Adv Health Econ Health Serv Res. 2008;19:1-24.

10. Felitti VJ, Anada RF, Nordenberg D, et al. Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults: The Adverse Childhood Experiences (ACE) Study. American J of Prev Med. 1998;14: 245-258.

11. Gilbert LK, Breiding MJ, Merrick MT, Parks SE, Thompson WW, Dhingra SS, Ford DC. Childhood adversity and adult chronic disease: An update from ten states and the District of Columbia, 2010. Am J Prev Med. 2015;48:345-349.

12. Su S, Jimenez MP, Roberts CTF, Loucks EB. The Role of Adverse Childhood Experiences in Cardiovascular Disease Risk: a Review with Emphasis on Plausible Mechanisms. Current cardiology reports. 2015;17:88.

13. Brown PM, Gonzalez ME, Sandhu R, Conroy SM, Wirtz S, Peck C, Nuñez de Ybarra JM. 2015. California Department of Public Health. Economic Burden of Chronic Disease in California 2015. Sacramento, California.

14. Brown PM, Gonzalez M, Dhaul RS. Cost of chronic disease in California: estimates at the county level. J Public Health Practice. 2015;21:E10-E19.

15. E-1 population estimates for cities, counties, and the state – January 1, 2016 and 2017. http://www.dof.ca.gov/Forecasting/Demographics/Estimates/E-1/

16. U.S. Bureau of Labor Statistics. https://www.bls.gov/cpi/factsheets/medical-care.htm

17. Elder RW, Lawrence B, Ferguson A, et al. The Effectiveness of Tax Policy Interventions for Reducing Excessive Alcohol Consumption and Related Harms. American journal of preventive medicine. 2010;38:217-229.

18. Grosse SD. Assessing cost-effectiveness in healthcare: history of the $50,000 per QALY threshold. Expert Rev Pharmacoecon Outcomes Res 2008;8:165-78.

19. Masters R, Anwar E, Collins B, Cookson R, Capewell S. Return on investment of public health interventions: a systematic review. J Epidemiol Community Health. 2017;71:827-834.

20. Trust for America's Health. Prevention for a Healthier America: Investments in Disease Prevention Yield Significant Savings, Stronger Communities. Trust For America's Health. 2008.

21. Milstein B, Homer J, Briss P, Burton D, Pechacek T. Why behavioral and environmental interventions are needed to improve health at a lower cost. Health Affairs. 2011;30:823-32.

22. Soler R, Orenstein D, Honeycutt A, Bradley C, Trogdon J, Kent CK, Wile K, Haddix A, O'Neil D, Bunnell R. Community-based interventions to decrease obesity and tobacco exposure and reduce health care costs: Outcome estimates from Communities Putting Prevention to Work for 2010-2020. Prev Chron Dis. 2015;13(E47):1-9.

23. CDC. Communities Putting Prevention to Work. https://www.cdc.gov/nccdphp/dch/programs/communitiesputtingpreventiontowork/index.htm

Appendix B: What is the Value of Prevention? A Review of the Literature

Introduction

This literature review assesses the publications in the scientific literature and other reports on the economic value of community preventive services that address three key chronic disease risk factors: tobacco use, healthy eating, and physical activity. These three risk factors are considered three top ranked actual causes of death and illness in the United States. (Mokdad et. al. 2005) In 2015 and 2016, 61 percent of California adults were overweight or obese, 10.5 percent of adults smoked tobacco, and only 23 percent of adults met the recommended physical activity guidelines. (California Department of Public Health, California Tobacco Control Program 2016; Centers for Disease Control and Prevention 2017; County Health Rankings and Roadmaps 2017). This review supports the work of the California Alliance for Prevention Funding.

The review focuses on policy, systems and environmental change strategies that could be implemented statewide, in communities, workplaces, schools and early child education settings. The review is limited to primary prevention strategies designed to address a health problem before clinical symptoms of disease are present. Although we included strategies that may have a clinical partnership, we did not include strategies that were primarily implemented in a clinical setting.

Community prevention strategies for a limited set of behaviors and health conditions were examined. These included strategies to:

- Prevent tobacco use among adults and adolescents and tobacco cessation strategies
- Prevent and control obesity in children and adults
- Increase physical activity in children and adults
- Increase the consumption of healthy food and decrease the consumption of unhealthy food by children and adults
- Alter the built environment to address health.

The quality and usefulness of any economic evaluation is dependent on the evidence for effectiveness of the interventions under scrutiny. The review focuses on interventions recommended by the Guide to Community Preventive Services (Community Guide). The Community Guide uses a set of rigorous criteria to assess the evidence of effectiveness of community interventions and is recognized in the U.S. Affordable Care Act as the definitive source for effective community preventive services. The Community Guide includes 27 recommendations for three of the topic areas in this literature review: tobacco, physical activity, and obesity and healthy eating. However, the Community Guide does not take economic factors into consideration.

Methods

The literature review explored three categories of publications:

- Reports and publications assessing the comparative value of a wide range of prevention and treatment strategies, generally assessed in the context of national impact
- Systematic reviews of economic evaluations of select prevention strategies or groups of strategies designed to address a specific health concern
- Individual economic evaluations of prevention strategies utilizing a variety of methodologies including modeling.

The review initially focused on the U.S. literature but because so few quality U.S. economic evaluations are available, the review was broadened to include both U.S. and international studies. Comparative value reports and systematic reviews from both domestic and international sources are included, however international studies are limited to those from other high-income countries.[1] The review of individual economic evaluations is limited to domestic interventions.

Economic Evaluations Defined

Economic evaluations of prevention interventions are studies that examine the relationship between the cost of an intervention and the benefits it produces. These benefits may be expressed as health and monetary outcomes. The outcomes included and the methods of valuation depend on the type of economic evaluation being performed. Most commonly, economic evaluations of prevention strategies include the health care costs that are saved by and the health outcomes that result from the prevention strategy. The types of economic evaluations with the most commonly used abbreviation) in this review include:

- Budgetary impact analysis (BIA)
- Cost analysis (CA)
- Cost-benefit analysis (CBA)
- Cost-effectiveness analysis (CEA)
- Cost-of-illness analysis (COI)
- Cost-utility analysis (CUA)
- ROI analysis (ROI)

1 Countries with a gross national income of $12,476 or more. https://blogs.worldbank.org/opendata/new-country-classifications-2016

Budgetary impact analysis (BIA) is an economic assessment that estimates the financial consequences of adopting a new intervention within a specific budget time period. It included the costs of the intervention and the costs saved by the intervention that are incurred by the entity of interest. Budgetary impact analyses are most commonly done by government entities and are done to examine the impact of legislation or regulations.

Cost analysis (CA) is a study that estimates the cost of implementing a prevention strategy or intervention.

Cost-benefit analysis (CBA) is a type of economic analysis in which all of the costs and all of the benefits are converted into monetary (dollar) values and results are expressed as either the net present value or the dollars of benefits per dollars of costs expended. Cost-benefit analysis often includes non-health benefits and valuations of benefits not traded in the marketplace. The three most common summary measures for CBAs are the cost benefit ratio (CBR), the benefit cost ratio (BCR), and the net present value (NPV).

Cost-effectiveness analysis (CEA) is an economic analysis in which all of the costs are related to a single common health outcome. Results are usually stated as additional cost expended per additional health outcome achieved. The incremental cost-effectiveness ratio (ICER)is the net cost (costs saved by the intervention minus the cost of the intervention) divided by the number of health outcomes prevented by the intervention. Cost effectiveness ratios in this review are frequently expressed as the cost per QALY saved.

Cost-of-illness (COI) analysis is an approach used to estimate the costs of a health condition in which two types of costs are collected: the direct medical and nonmedical costs associated with the illness, injury, or health condition and the indirect costs associated with lost productivity due to morbidity and premature mortality. Cost-of-illness analyses are done to estimate the cost per patient or the cost of a health condition for a population.

Cost-utility analysis (CUA) is a type of cost-effectiveness analysis in which benefits are expressed as the number of life years saved adjusted to account for loss of quality from morbidity of the health outcome or side effects of the intervention. The most common outcome measure in CUA is the quality-adjusted life year (QALY).

Return-on-investment (ROI) is a form of financial analysis that calculates the ratio between the net profit and cost of investment. A high ROI means that the investment's gains compare favorably to its cost. ROI = (benefits of investment - amount invested) divided by the amount invested. When ROI equals 0, the program pays for itself. When ROI is greater than 0, the program is producing savings that exceed the cost of the program. ROI analyses are most commonly done in business settings. Unlike CBA, ROI analyses only include financial investments and returns and excludes valuations of nonmarket benefits such as the value of health.

Two Other Key Economic Evaluation Terms Used in the Review

Economic evaluations frequently refer to the *perspective* of the analysis. *Perspective* refers to the viewpoint from which the analysis is conducted and determines which costs and benefits are included. The societal perspective, which is the perspective of society as a whole, includes all of the costs and all of the benefits regardless of who incurs them and who receives them. The health or healthcare system perspective only includes intervention costs and health care costs saved. The results from studies done from different perspectives are difficult to compare unless adjustments are made.

The *quality-adjusted life year (QALY)* is a frequently used outcome measure that incorporates the quality or desirability of a health state with the duration of survival. Quality of life is integrated with length of life using a multiplicative formula. Because morbidity and mortality from any health condition can be converted to a QALY, the use of this outcome measure makes it possible to compare the cost effectiveness of prevention strategies that address a wide range of health problems. Another outcome measure in this category is the (*disability-adjusted life year DALY)*. The DALY incorporates a weight for disability but does not include a preference weight reflecting impact of a health condition on quality of life.

Results

Comparative Value Analyses and Reports

This section reviews studies that compare a wide range of prevention interventions, often for country or regional priority setting exercises and for the promotion of prevention investments overall. Table 1 summarizes the studies reviewed in this section.

Prevention for a Healthier America: Investments in Disease Prevention Yield Significant Savings, Stronger Communities (Trust for America's Health 2008)

This report presented national and state-by-state estimates of health care savings resulting from investments in community preventive services. The report focused on interventions to increase physical activity, promote healthier eating, and to reduce tobacco use. Health care savings were from reduced morbidity from cancer, heart disease and stroke, COPD, high blood pressure, diabetes, and arthritis. Savings were estimated for one to two years, five years, and ten to twenty years. Intervention costs were estimated to cost $10 per person. Net savings ranged from $2.8 billion for one to two years to $18 billion over twenty years. All costs were presented in 2004 U.S. dollars. The ROIs ranged from 0.96:1 in the short term to 6.2:1 in the long term.

The Case for Investing in Public Health. A Public Health Summary Report for EPHO 8. (WHO 2014)

This report for the World Health Organization's (WHO) eighth essential public health operation (EPHO8)—Assuring Sustainable Organizational Structures and Financing—was developed for policy makers and public health planners in support of Health 2020, the WHO Europe policy framework for essential public health operations. Its objectives were to describe the economic and health benefits of investments in prevention and the costs associated with not making those investments. The backdrop for this report were the rapidly escalating costs of preventable diseases in Europe driven in part by the costs of widening health inequalities. The report shows that prevention can be cost effective, in both the short and long term. Several of the WHO "best buy" interventions address chronic diseases including tobacco and alcohol legislation, reducing salt, and increasing physical activity. Interventions that address social and environmental determinants of health such as promoting walking and cycling, green spaces, safer transport and housing investments can also provide early returns on investment. The WHO estimates that an additional investment of one to four percent of current health spending is needed to reduce rising health care costs, with the current prevention investment currently at three percent of total health care spending.

ACE-Prevention: Assessing Cost-Effectiveness in Prevention. Australia, 2010 (Vos et al. 2010)

This report summarizes the findings of a five-year project to assess cost-effectiveness of prevention strategies and services to improve the ability of the Australian government to make informed purchases. The project conducted a comprehensive evaluation of 150 interventions and prevention packages for non-communicable diseases in Australia. Costs included intervention costs and costs of downstream disease treatment and health outcomes were measured in disability-adjusted life years (DALYs). The cost effectiveness summary ratio was expressed as cost per DALY averted. The study used the best evidence from the international literature and modeled how interventions would be implemented in Australia. The study found that the largest impact on population health would be achieved from a limited number of interventions including:

- Taxation of tobacco, alcohol, and unhealthy food,
- Mandatory limit on salt,
- Improving the efficiency of blood pressure and cholesterol-lowering drugs,
- Gastric banding,
- Intensive SunSmart campaign to prevent skin cancer.

The study categorized interventions by cost effectiveness categories but generally did not provide specific ratios.

National Commission on Prevention Priorities (NCPP) U.S. (Maciosek et al. 2017)

The NCPP was created in 1998 to address the problem of underutilization of clinical preventive services. It later expanded to include community preventive services. The NCPP evaluated the preventive services recommended by the U.S. Task Force on Clinical Preventive Services at estimated the population health impact and cost effectiveness for each service. It then ranked the services using a combined score for the two criteria. Since 1998, the NCPP has released three sets of rankings, most recently in January 2017. In addition to the rankings, the services with the greatest potential for improving population health, given their current utilization rates, are identified. In the most recent ranking two services relevant to this review were identified: tobacco use prevention for youth and counseling for adults who are obese. Both services are potentially cost saving.

Return on investment of public health interventions: a systematic review. United Kingdom (Master et al. 2017)

This systematic review examines the ROI for a wide range of public health investments in high-income countries and adapts the findings to the United Kingdom (UK) to address the impact of public sector austerity programs. The median ROI for public health interventions was 14.3:1. The authors

categorized interventions by type and found that national investments had much higher ROI than local investments. The highest ROIs were from legislative interventions (46.5) and health protection interventions (34.2). The lowest were from health promotion (2.2) and social determinants interventions (5.6). Because the findings were from a very limited number of studies it was hard to generalize to the UK.

Why behavioral and environmental interventions are needed to improve health at a lower cost. U.S. (Milstein et al. 2011)

The Milstein study demonstrates that an integrated health care and prevention approach that addresses the underlying cause of poor health may be the most effective long run strategy for improving population health and decreasing health care costs. The study created a dynamic simulation model of the US health system to test three proposed strategies to reduce deaths and improve the cost-effectiveness of interventions. The strategies were expanding health insurance coverage, delivering better preventive and chronic care, and protecting health by enabling healthier behavior and improving environmental conditions. The study found that each alone could save lives and provide good economic value, but they are likely to be more effective in combination. Although providing better health insurance coverage and care save lives in the short run, they increase costs. In the longer term, prevention lowers the number of deaths and reduces costs. However, only the protection scenario slows the rate of growth of chronic disease prevalence. When protection was combined with coverage and care, the combined scenario could save 90 percent more lives and reduce costs by 30 percent in year 10 than coverage alone.

Community-based interventions to decrease obesity and tobacco exposure and reduce health care costs: Outcome estimates from Communities Putting Prevention to Work for 2010-2020. U.S. (Soler et al. 2015)

Like the Milstein study, Soler and colleagues project that sustained and integrated investments in reducing two of the leading contributors to chronic disease—tobacco use and obesity—combined with building a strong community infrastructure can have a long term impact on health care costs and health. This study used the PRISM systems dynamics model to examine the health and economic impact of the $403 million investment in tobacco and obesity prevention strategies in 28 communities participating in the Communities Putting Prevention to Work program, begun in 2010. If investments were maintained through 2020, this program would save $2.4 billion in health care costs and prevent 14,000 premature deaths.

Interventions to Prevent and Reduce Tobacco Use

The Community Guide has issued ten recommendations for strategies to prevent or reduce tobacco use and its health effects including those caused by exposure to second hand smoke. Six of these recommendations can be classified as policies, systems, and environmental changes:

- Comprehensive tobacco control programs
- Mass-reach health communication interventions
- Interventions to increase unit price for tobacco products
- Smoke free policies
- Campaigns that include mass media and health related product distribution
- Community mobilization with additional interventions to restrict minors' access to tobacco products

A summary of the studies reviewed in this section is provided in Table 2.

Comprehensive Tobacco Control Programs

Comprehensive tobacco control programs are defined as statewide evidence-based comprehensive control programs that employ educational, clinical, regulatory, economic, and social strategies. Their goals are to establish smoke free policies and social norms to promote and assist tobacco users to quit, to prevent initiation of tobacco use, and to protect nonsmokers from harm from secondhand smoke exposure.

Three studies have examined the health and economic impact for statewide programs. (Dilley et al. 2012, Lightwood and Glantz 2010, 2013) The multicomponent programs have shown to have positive ROIs when costs and benefits are projected over a time period ranging from none to 20 years. Health care cost savings ranged from $1.5 billion over ten years in Washington to $134 billion over 20 years in California. ROIs were 5:1 for Washington, 10:1 for the Arizona program and 56:1 for the California program, which invested $2.6 billion over 20 years.

Mass Reach Health Communications Interventions

Only one economic evaluation was found for mass media campaigns. (Seckler-Walker et al. 1997) This was a four year campaign combined with a school-based tobacco education program. The media campaign targeted students age 10 to 13. The mass media program cost almost $1 million and targeted 18,600 students. The authors estimated that cost per smoker averted was $754 and the cost per life year saved was $696. The authors also projected the cost of a national mass media campaign

and estimated that it would cost $84.5 million or $162 per smoker averted and with a cost per life year saved of $138.

Interventions to increase unit price for tobacco products

Studies of interventions to increase the price of tobacco products focus on the use of tax policies. Tobacco taxes are viewed as low cost interventions that reduce the risk of tobacco related disease, health care utilization, and health care costs. Several studies have simulated the impact of tax increases on the consumption of tobacco products, and the health and economic outcomes. One simulation model of smokers in California (Ahmad et al. 2005) predicted that, over 75 years, a 20% cigarette tax increase would save $220 billion in health care costs and produce $12 billion in tax revenue. Another California study examined how cigarette tax increases would affect health over 75 years. (Kaplan et al. 2001) A $0.50 tax increase would save 8,389 QALYs; a $1.00 increase would save 25,380 QALYs. This model was static and did not account for population changes over time.

Two studies examined the impact of a federal tobacco tax increase. Ahmad modeled the impacts of a 40% increase in the federal cigarette tax over a 20-year period. He predicted that the tax would save $137 billion in health care costs, 7 million life years, and 13 million QALYs. The tax would generate $365 billion in revenue. Fishman examined the cost effectiveness of a one-dollar federal tax increase combined with a nationwide mass media campaign. Using a tobacco simulation model developed Rivara, he estimated that the mass media campaign and tax increase would save 630,925 life years at accost of $599 to $4,646 per life year. When tax revenues were included, the intervention became cost saving. (Fishman et al. 2005, Rivara et al. 2004)

Two systematic reviews of tobacco and other health taxes report similar findings. Contreary et al. (2015) examined global evidence of the relationship between tobacco taxes and health and found that taxes raised significant revenues while positively impacting health and reducing health care costs. Wright and colleagues analyzed tax policy for tobacco products, alcohol, and unhealthy foods. They concluded that if the primary goal is to reduce consumption of unhealthy products, then to be effective taxes should increase product prices by at least 20%. Earmarking tax revenues for health spending can create public support for taxes increases as long as voters are confident that policy makers will follow through. (Wright et al. 2017)

Smoke Free Policies

Much of the economic literature on smoke free policies focuses on policies to ban smoking in public and private multi-unit housing. Two studies evaluate smoke free policies in public housing. The first is a government regulatory impact analysis in support of the 2016 Housing and Urban Development rule requiring smoke free public housing. (DHUD 2016) This analysis estimated that implementing the policy would create $207 million in net benefits annually from reduced repairs and maintenance and in

residents' well-being. It did not explicitly include health benefits. The second public housing study estimated that the health care costs associated with secondhand smoke exposure range from $183 to $267 million annually. It did not include the cost or effectiveness of implementing smoke free policies. (Mason et al. 2015) Ong and associates (2012) estimated that owners of private multi-housing properties in California would realize $18 million annually in reduced repair and maintenance costs if multi-housing smoke free policies were put in place.

Campaigns that include mass media and health related product distribution

There are four economic evaluations of strategies with the combined elements of a mass media campaign, quit lines, and the promotion of free or reduced-price nicotine replacement therapy (NRT). (Bauer et al. 2006, Cummings et al. 2006, Fellows et al. 2007, and McAlister et al. 2004) McAlister conducted a cost analysis of the Texas quit line program and found that quit line counseling increased the chances that a caller would stop smoking. The cost was $60 per caller or $1,300 per caller who stopped smoking. Both the Bauer and Cummings studies examined the quit line and voucher program in New York. Vouchers were offered for different lengths of NRT in addition to the quit line counseling. Both studies determined that the addition of vouchers increased the chances of callers quitting and were likely cost effective. They did not provide estimates of health care costs saved. Fellows examined the cost effectiveness of the voucher and quit line counseling in Oregon compared to counseling alone. He estimated that the addition of vouchers to counseling saved $2,688 or $86 per life years saved. The study did not include health care costs averted, which would likely have made the program cost saving.

Community mobilization with additional interventions to restrict minors' access to tobacco products

No studies could be located that examined the economic impacts of restricting minors' access to tobacco products. Two studies examined the health and economic impact of school-based education programs targeting adolescents. (Tengs et al. 2001, Li et al. 2001) Tengs estimated that an intensive school-based education program, if it retained its effectiveness over 4 years, would cost $20,000 per QALY. Li examined a school-based program combined with a targeted media campaign. This program would cost $13,301 per life years saved or $8,482 per QALY saved.

One additional study reviewed examined the five-year health and economic impacts of reducing smoking rates in the federal workforce. (Assay et al. 2017) Assay estimated that if prevalence dropped 17 percent, the federal government would save $59 million in health care costs, $332 million in absenteeism costs, and $117 million in productivity.

Interventions to Prevent and Control Obesity and Promote Healthy Eating

This section reviews the economic evidence in support of interventions that are designed prevent and control obesity and promote healthy eating. Interventions that focus on physical activity are included in the physical activity section. The Community Guide recommends eight strategies to address obesity in children and adults. Of these, three are policy, systems, and environmental change strategies. All target children, either in schools or in early education and childcare settings.

- Meal and fruit and vegetable snack interventions to increase healthier foods and beverages in schools
- Multicomponent interventions to increase availability of healthier foods and beverages in schools. (Placement, price, promotion)
- Behavioral interventions that aim to reduce recreational sedentary screen time among children.

A summary of the studies reviewed in this section is provided in Table 3.

This first section reviews the seven studies from the Childhood Obesity Intervention Cost Effectiveness Study (CHOICES). (Barrett et al. 2015, Craddock et al. 2017, Gortmaker et al. 2015, Gortmaker et al. 2015, Long et al. 2015, Sonneville et al. 2015, Wright et al. 2015) The objective of the CHOICES project is to reverse the course of childhood obesity in the U.S. by identifying high value, effective interventions. The CHOICES project has created a framework for policy, systems, and environmental change strategies to address childhood obesity. (Lyn et al. 2013) From this they developed a simulation model of the U.S. population that can project body mass index (BMI) changes and the cost of associated health outcomes for 10 years for the population cohort studied. This model is then used to predict the effectiveness and cost effectiveness of various interventions. Because all of the analyses use the same model, their results should be comparable with each other. The CHOICES project also conducted systematic reviews of the scientific literature and uses this information in cost effectiveness analyses.

The CHOICES project has examined the cost effectiveness of eight interventions:

- Taxes on sugar-sweetened beverages
- Removal of federal tax subsidies on advertising of unhealthy food targeted at children
- Addition of nutritional information on restaurant menus
- Nutritional standards for school meals
- Nutritional standards for food and beverages sold in schools outside of the cafeteria

- Early childhood education (ECE) guidelines for food and beverages, screen time, and physical activity
- Physical education (PE) policies in elementary schools
- Bariatric surgery

Craddock and colleagues examined the impact of a range of in-school, after-school and early childhood education interventions to encourage physical activity. They estimated that over 10 years, these programs would prevent from 2,500 to 110,000 cases of childhood obesity. (Craddock et al. 2016) Only the programs in aftercare settings were cost saving.

Long and colleagues examined the 10-year impact of a $0.01 per ounce sugar-sweetened beverage tax on the U.S. population over 10 years of age. They projected that the cost would be $51 million in the first year, raise $12.5 billion in tax revenues over 10 years, and save $23.1 billion in health care costs. The tax would save 871,000 QALYs. (Long et al. 2015). Overall, the tax would save $55 in health care costs for every dollar invested.

The economic analysis of the removal of the federal tax subsidy on advertising unhealthy food to children showed that it would be cost saving. The study examined the impact on U.S. children age 2 to 19 and showed that removing the subsidy would cost $2.47 million, save $352 million in health care costs, and save 4,538 QALYs over 10 years. (Sonneville et al. 2015)

Economic analysis also projected that ECE regulations would be cost saving. ECE regulations establishing guidelines for nutritional standards for food and beverages, screen time, and physical activity would affect 6.5 million preschool children a year at a cost of $4.82 million annually but would save $57.8 million in health care costs over 10 years. (Wright et al. 2015)

PE in schools was moderately cost effective, although not cost saving. Nationwide implementation of PE for school children age 6 to 11 would cost $70.7 in the first year and $235 million over 10 years. It would save $60.5 million in health care costs or $401 per unit of BMI reduced. (Barrett et al. 2015)

In two studies published in 2016, Gortmaker and colleagues conducted a systematic review of the scientific literature for the CHOICES project interventions and a cost effectiveness analysis comparing them. (Gortmaker et al. 2016a, Gortmaker et al. 2016b) They determined that three of the seven interventions were cost saving—taxes on sugar-sweetened beverages, removal of the federal tax subsidy on advertising unhealthy food targeted at children, and nutrition standards for foods and beverages sold outside the school cafeteria. Each of these interventions would prevent 129,000 to 576,000 cases of childhood obesity by 2025. In contrast to earlier CHOICE project findings, ECE regulations were determined likely to be cost-effective, but not cost saving in these analyses.

Bariatric surgery was not cost effective when compared with the prevention alternatives and had only a negligible impact on child obesity.

The CHOICES project findings on the value of a penny-per-ounce sugar sweetened beverage tax are supported by an analysis by Wang and colleagues using the Coronary Heart Disease Policy Model. They predict that the ten-year impact of a tax would be $17 billion savings in health care spending, $13 billion in tax revenues, and 26,000 premature deaths prevented. (Wang et al. 2012) Early examination of change in sales following the implementation of a sales tax in Berkeley, California indicated that there has been a 9.6% reduction in sales of taxed beverages and an increase in sales of beverages not subject to the tax, with a 20% not statistically significant decline in self-reported intake. (Silver et al. 2017). Falbe and colleagues found a 21% decline in SSB consumption in low-income residents. (Falbe et al 2016)

Three other studies have modeled the economic impact of school-based obesity programs. (An et al. 2017, Wang LY et al. 2003 and 2008) The Community Guide has not yet been evaluated for effectiveness. An examined the impact of a New York school intervention that would make plain water available to students on lifetime medical costs. The study found that the intervention produced a net benefit of $174 per student and, if implemented nationwide, would produce a $13.1 billion cost savings; a CBR of 14.5:1. (An 2017) Wang conducted two analyses of packages of school programs that promoted healthy eating and physical activity. An elementary after-school program implemented in Georgia cost $317 per student and was deemed likely to be cost effective although not assessed. (Wang et al. 2008) A cost effectiveness analysis of the Planet Health program was found to be cost saving. (Wang et al. 2003)

Two studies modeled the cost effectiveness of a 30% subsidy for fruit and vegetable purchases in the Supplemental Nutrition Assistance Program (SNAP). (An 2015, Sung et al. 2017) The incentive program was first funded as a pilot in 2008 and then expanded in 2012., Both studies constructed decision models using data from the USDA Healthy Incentives Pilot to estimate the impact of nationwide expansion of a subsidy on fruit and vegetable consumption and subsequent health outcomes. An found that the lifetime per capita cost of the program would be $1,323 for a cost effectiveness ratio of $16,172 per QALY gained. (An 2015) A later study predicted greater reductions in Type 2 diabetes and cardiovascular disease and found that the subsidy would be cost saving. (Sung et al. 2017)

Interventions to Promote Physical Activity

The Community Guide recommends nine groups of services designed to increase physical activity in children and adults, six of which can be classified as policy, systems, and environmental change

strategies. These range from individual and family interventions to those that focus on place modification: schools, worksites, the community, and the broader built environment. This section reviews the literature supporting the economic case for the following recommendations.

- Built environment approaches combining transportation system interventions with land use and environmental design
- Enhanced school-based physical education
- Campaigns that include mass media wand health-related product distribution
- Point-of-decision prompts to encourage use of stairs
- Creating or improving places for physical activity
- Social support interventions in community settings

Interventions designed to increase physical activity can reduce the risk of chronic health conditions including Type II diabetes, coronary heart disease, kidney disease, stroke, and some cancers. Physical activity interventions may also be designed to prevent injuries, such as falls in older adults, and to improve mental well-being.

Physical activity interventions range from individual counseling to modifications of the built environment. In addition to their health benefits, these interventions may also have other quantifiable and qualitative benefits including environmental benefits, enhanced economic activity, and improvements in community well being and cohesion.

This section reviews the findings from systematic reviews of economic evaluations for wide range of physical activity interventions. Although the original intent was to limit the reviews to US studies, it was quickly determined that the paucity of studies would seriously limit the review. Additionally, almost all systematic reviews that include U.S. studies also include other developed countries. Excluding these would limit this literature review. Individual studies of quality and those that addressed interventions not generally included in the systematic review are also included.

The review identified 21 publications of which 18 were published in the peer-review literature and three were organizational reports; this included sixteen systematic reviews, two cost benefit analyses, two cost effectiveness analyses, and one cost analysis. The systematic reviews included a range of economic evaluation methods including CAs, COI analyses, ROI, CBA, and CEA studies. Because the literature assessed findings from multiple countries, costs were reported in various currencies. All costs are presented in US dollars using exchange rates from the year reported in the study. A summary of the studies reviewed in this section is provided in Table 4.

Roux et al. (2008) specifically analyzed the physical activity strategies recommended in the Community Guide. Community-wide campaigns, individually-adapted behavior change, community social-support interventions, and the creation of or enhanced access to physical activity information and activities had CERs ranging from $14,000 to $69,000 per QALY gained. The authors note that these results were sensitive to intervention costs and effect size.

Built environment interventions appear to be some of the most cost saving and cost effective interventions designed to promote physical activity (Abu Omar et al., Brown et al., Cavill et al., Han et al., Laine et al., Muenig et al., Müller-Riemenschneider et al., Roux et al., Wang et al.). These are primarily the construction of walking and cycling trails and improvements to pedestrian safety. All of the built environment studies are site specific with widely varying intervention costs and would need to be adapted to new settings.

Other cost effective interventions include school-based programs and community and mass-media campaigns (Abu-Omar et al., Garrett et al., Lewis et al., Roux et al., Windle et al. Wolfenstetter et al.). The literature is less conclusive on the cost effectiveness of individually based exercise courses with nutrition programs and brief clinic interventions, some of which refer the individual to community programs (GC et al., Garrett et al., Lewis et al., Müller-Riemenschneider et al. Wu et al.). Garrett et al. (2011) found that although these interventions had cost effectiveness ratios ranging from $1,500 to $21,252, even the least cost effective provided better value that many pharmaceutical interventions (glucose control $43,697/QALY gained and cholesterol control $78,902/QALY gained).

Much of the physical activity literature focuses on increasing physical activity levels to reduce the risk of diabetes, heart disease, and other chronic conditions. However, several studies evaluate the economic value of physical activity programs designed to reduce the risk of injuries from falls in older adults (Abu-Omar et al., Balzer et al., Carande-Kulis et al., Davis et al., Wolfenstetter et al.). The interventions, delivered in community settings and home-based, are strongly cost effective and often cost saving.

All of the systematic reviews of physical activity economic evaluations identify the lack of studies, lack of methodological standardization, poor quality of evidence on intervention effectiveness, and lack of information on study-specific target populations, risk factor and disease prevalence, and intervention costs, which makes it difficult to generalize from these findings. Very few of the analyses evaluated interventions implemented in the US. Lack of transparency in methods also makes it difficult to replicate findings, which are often contradictory.

Over half of the studies (12) did not report ratios with health outcomes, two reported intermediate health outcomes, and seven reported QALYs, DALYs, or LYGs. Lack of consistent ratios makes it difficult to compare interventions and to determine the impact of interventions on the health burden associated with physical inactivity.

Conclusions

This review of the economic evaluation literature included 65 studies addressing the value of interventions to prevent and reduce tobacco use, prevent and control obesity, and promote health eating and physical exercise. The review included built environment interventions and falls prevention interventions for older adults. It also examined several studies and reports that compared a wide range of preventive services, often as a country or regional priority setting exercise.

The number of studies in each category was highly variable and may reflect research budgets and difficulties in health outcomes assessments. Quality of studies varied widely; lack of standardization of methodology made it very difficult to compare studies. However, there appear to be emerging themes for cost saving and cost effective interventions that will provide public health practitioners with a reasonable starting point for developing a portfolio of interventions to improve population health. Table 5 list these interventions based on evidence from the studies reviewed.

Although the information from the reviewed studies offers good guidance, none of the ROI, CBA, and CEA ratios can be transferred directly. Results depend on each program's starting point: risk factor prevalence, site-specific intervention costs, population reach, and cultural acceptability of the intervention among other variables. Decision makers and implementers should attempt to project their own ratios using both local information and that in published studies. Finally, economic evaluations are lacking for many interventions, in particular emerging efforts. Lack of evidence does not imply that these interventions are without value but are ready for additional study.

Table 1. Studies that Compare the Value of Multiple Interventions

Author	Report/Publication	Study Description	Key Findings
Maciosek et al. 2017	Updated priorities among effective clinical preventive services.	This study models the potential health impact and cost effectiveness of 28 evidence-based clinical preventive services for the US population. Used cost/QALY gained and preventable burden. Only study to examine both value and population health impact.	The three highest-ranking preventive services (score of 10 so all cost saving) were immunizing children, counseling to prevent tobacco initiation in youth, and tobacco use screening and brief intervention in adults. Increasing tobacco use services to optimal utilization levels would have the greatest population health impact.
Masters R et al. 2017	Return on investment of public health interventions: a systematic review	Examines the ROI for a wide range of public health investments in high income countries to address impact of public sector austerity programs in the UK.	The median ROI for public health interventions was 14.3:1. National investments had much higher ROI than local investments. Highest ROI from legislative interventions (46.5) and health protection interventions, e.g., vaccines, lead control (34.2).Lowest were from health promotion, e.g., social marketing campaigns, family planning services (2.2) and social determinants (5.6). Findings from a very limited number of studies.
Milstein B et al. 2011	Why behavioral and environmental interventions are needed to improve health at a lower cost	This study created a dynamic simulation model of the US health system to test three proposed strategies to reduce deaths and improve the cost-effectiveness of interventions: expanding health insurance coverage, delivering better preventive and chronic care, and protecting health by enabling healthier behavior and improving environmental conditions.	The study found that each alone could save lives and provide good economic value, but they are likely to be more effective in combination. Although coverage and care save lives quickly, they tend to increase costs. The impact of protection grows more gradually, but it is a critical ingredient over time for lowering both the number of deaths and reducing costs. The study found that only the protection scenario slows the rate of growth of chronic disease prevalence. When protection was combined with coverage and care, protection could save 90 percent more lives and reduce costs by 30 percent in year 10. Health and economic savings were even greater by year 25.

Owen L et al. 2011	The cost-effectiveness of public health interventions	The goal of this study was to produce a comprehensive list of cost-effectiveness estimates for public health guidance analyses by NICE for the English National Health Service. Used cost/QALY	Interventions for tobacco counseling and cessation were mostly cost saving and cost effective; Eighty-five percent were at the £20,000 ($31,092) per QALY threshold and 89% were at £30,000 ($46,638) per QALY threshold. Workplace physical activity programs were cost effective. Promoting physical activity for children was substantially less cost effective. Differences in methodologies for the various cost-effectiveness studies limits findings, especially the base case scenario and assumptions.
Soler R et al. 2015	Community-based interventions to decrease obesity and tobacco exposure and reduce health care costs: Outcome estimates from Communities Putting Prevention to Work for 2010-2020	This study used the PRISM systems dynamic model to examine the health and economic impact of the $403 million investment in tobacco and obesity prevention strategies in 28 communities participating in the Communities Putting Prevention to Work program, begun in 2010.	If investments have been maintained through 2020, this program would save $2.4 billion in health care costs and prevent 14,000 premature deaths. Extrapolation indicates that the ROI would be 7.4 for each dollar invested.
Trust for America's Health 2008	Prevention for a Healthier America: Investments in Disease Prevention Yield Significant Savings, Stronger Communities	Presents national and state-by-state estimates of health care savings resulting from investments in community services to prevent chronic diseases. Based on literature review and modeling exercise.	Savings were estimates for one to two years, five years, and ten to twenty years. Intervention costs were estimated to be $10 per capita. National net savings ranged from $2.8 billion for one to two years to $18 billion over twenty years. The ROI ranged from 0.96:1 to 6.2:1.

Vos T et al. 2010	Assessing Cost-Effectiveness in Prevention (ACE-Prevention)	Goal of the project was to assess the cost-effectiveness of prevention strategies and services to improve the ability of the Australian government to make informed purchase decisions. Evaluated 150 NCD interventions for cost/DALY averted.	A large impact on population health could be achieved from a limited number of cost-effective interventions including taxation on tobacco, alcohol, and unhealthy food, mandatory limits on salt, improving the efficiency of blood pressure and cholesterol-lowering drugs, gastric banding, and an intensive SunSmart campaign. These interventions, all below the AUD$ 50,000 (USD$48,905) per DALY prevented threshold, if implemented nationwide would prevent 20,000 (blood pressure treatment) to 270,000 DALYs (30% tobacco tax).
WHO 2014	The Case for Investing in Public Health: A Public Health Summary Report for EPHO 8	Report summarized evidence for a wide range of cost-effectiveness health promotion and prevention interventions that can be delivered by the public health sector. Studies are primarily from a number of high-income countries.	Best buys included expanding green space (£7.35 for every £1 invested) , promoting active transport (in urban England and Wales saves (£17 over 20 years), safer transport (speed reductions in U.S. would save $13 billion per year) and housing interventions ($17,910 per DALY gained) Tobacco legislation, community-based youth tobacco control interventions, policies reducing salt and trans fats, raising public awareness of healthy diets, increasing physical activity through mass media awareness, and community falls prevention programs would all cost less than the GDP per person.

Table 2. Interventions to Prevent and Reduce Tobacco Use

Author	Intervention	Method	Intervention Cost	Costs Averted	Health Outcome	Ratios/Results
Ahmad et al. 2005	20% cigarette tax increase in California	Policy analysis	n/a	$220 billion; $12 billion raised in tax revenues	Prevalence drop from 17% to 12%	n/a
Ahmad et al. 2008	Federal tax increase up to 100% (40% base case)	Policy analysis	n/a	$317 billion health care costs over 25 years	7 m life years saved, 13 m QALYs	Generates $365 billion in tax revenue
Asay et al. 2017	Cost of the health effects of smoking in federal workforce	COI	n/a	$59 m health care, $332 million absenteeism, $117 million productivity	Decreased smoking prevalence 17%	n/a
Bauer et al. 2006	Two promotion strategies for Quit line plus voucher for nicotine replacement (NRT) therapy in New York	CEA	n/a	n/a	n/a	Twenty-two percent of smokers who called quitline and received free NRT voucher reported they were no longer smoking compared to 12% who called quitline but did not receive NRT voucher. Voucher more effective at getting smokers to quit- likely cost effective
Contreary et al. 2015	Cigarette taxes	Review	0.005%-0.02% of GNP in high income countries (Ranson 2002)	$109.92 million (van Baal 2007)	0.5-2 million deaths averted (Ranson 2002); 34,000 QALYs (van Baal 2007)	$116 - $3,884 per DALY

Cummings et al. 2006	Quit line plus nicotine replacement therapy (NRT) in New York	CEA	n/a	n/a	n/a	Smokers who received free NRT patches or gum had higher quit rates (21%-35%) than smokers who did not receive free NRT products (12%). NRT with quitline is more effective at getting smokers to quit and likely to be cost effective
Dilley et al. 2012	Washington State Tobacco Control Program	ROI	$259.7 over 10 years	$1.5 billion	36,000 hospitalizations prevented	ROI = $5 for every $1 invested
DHUD 2016	Federal smoke free public housing regulation	CBA	$103.7 million	$309 million	Reduced maintenance = $21.3 m, reduced fire risk=$4.7 million, well being=$283 million	NB=$207 million
Fellows et al. 2007	Oregon quit line + free NRT	CEA	n/a	Saved $2,688 per quitter compared to quitline alone	n/a	$86 per life year saved
Fishman et al. 2005; Rivara et al. 2004	$1 increase in federal cigarette tax and combined media campaign	CEA	n/a	n/a	630,925 life years	$599 to $4,646 per life year; excludes tax revenues
Kaplan et al. 2001	California cigarette tax increase	Policy analysis	n/a	n/a	8,389 ($0.50 tax increase)- 25,380 ($1 tax increase) QALYs in first year	n/a
Lightwood, Glantz 2001	Arizona State Tobacco Control Program	Costs and Savings Analysis	$2.3 billion over 10 years	$2.33 billion over 10 years	Cumulative reduction of 200 million cigarette packs sold	ROI = $10 for each $1 invested

Lightwood, Glantz 2013	California State Tobacco Control Program	Costs and Savings Analysis	$2.4 billion	$134 billion	n/a	Not calculated
Mason et al. 2015	Cost of second hand smoke in US public housing	Cost of Illness	No intervention	n/a	n/a	$183 million - $267 million in health care costs for 38,000- 51,000 ill children and adults
McAlister et al. 2004	Texas quit lines	Cost Analysis	$60 per caller	n/a	n/a	$1,300 per smoker who stopped smoking
Ong et al. 2012	Benefits to property owners of multi-housing smoke free policies	Cost Analysis	n/a	$18 million for 4 million housing units		Total cost of smoking $37.8 million, policies would avert $18 million
Secker-Walker et al. 1997	Mass media campaign targeting tobacco use in adolescents	CEA	Community campaign $75,900 (18,600 students) or $41 per exposed student; US –wide campaign $84.5 million or $8 per exposed student	n/a	n/a	Community $754 per student smoker averted, $696 per life year gained; US $162 per student smoker averted; $138 per life year gained
Tengs et al. 2001	School-based intensive anti-tobacco education program	CEA	n/a	n/a	n/a	$23,440 per QALY based on 30% effectiveness over 4-years

Verughese et al. 2014	National mass media campaigns for NRT and tobacco cessation with quitlines	Systematic review	Various depending on form of media, type of NRT, cost of quitline calls, and population in study	n/a	n/a	Mass media campaigns with quitlines and free or reduced-price NRT can be effective in encouraging smokers to quit and are cost effective interventions. One study, the Oregon Quitline Initiative, which included NRTs, projected long term health outcomes. It was cost effective at $98 per life year saved.
Wang et al. 2001	School-based tobacco use program (TNT)	CEA mixed model	$16,403 for 770 students	n/a	Prevented 35 students from becoming established smokers	$13,310 per life year saved; $8,482 per QALY saved
Wright et al. 2017	Health taxes on tobacco, alcohol, and other unhealthy products in Europe	Systematic Review	n/a	n/a	n/a	If the primary goal is to reduce consumption of unhealthy products, then to be effective taxes should increase product prices by at least 20%. Public support for such taxes increases when the tax revenues are earmarked for health spending as long as voters are confident about the willingness of policy makers to follow through. Taxes that deter consumption may not produce additional revenues. Policy makers must be clear on goals for such a tax.

Table 3. Interventions to Prevent and Control Obesity and Promote Healthy Eating

Author	Intervention	Method	Time Horizon	Intervention Cost	Costs Averted	Health Outcomes	Results
Cradock et al. 2016	Physical activity in schools, afterschool, childcare	CEA	10 years	The annual cost per child reached ranged from $4.26 (Active PE) to $53.87 (Healthy Afterschool). The New Afterschool program had no intervention cost.	Health care cost savings over 10 years ranged from $4.01 million (Healthy Afterschool) to $185 million (New Afterschool program).	2,500 to 110,000 cases childhood obesity prevented	Cost per MET-hour/day increases ranged from cost saving (New Afterschool program) to $3.14 per MET-hour/day (Healthy Afterschool). New Afterschool would have greatest reduction in childhood obesity and would be cost saving with a projected net savings over 10 years of $.6 billion. The 10-year net costs for other interventions ranged from $47 million for Healthy Afterschool programs to $15 billion for Active School Day programs.
Gortmaker et al. 2015	SSB* tax, advertising subsidy, restaurant menu labeling, school nutrition standards, school food & beverages standards, improved ECE, adolescent bariatric surgery	Syste-matic Review	10 years	First year intervention costs were $51 million for SSB tax, $1.1 million for eliminating subsidy on advertising unhealthy food, and $4.8 million for ECE policy changes.	SSB tax would avert $23.6 billion in health care costs over, eliminating tax subsidy would save 10 years $352 million, and ECE policy changes would save $52 million.	129,000 to 576,000 cases childhood obesity prevented	SSB tax, advertising tax subsidy eliminated, and ECE policy changes had positive ROI. The net cost per $ spent were $55, $38, and $6, respectively.

Long et al. 2015	SSB tax	CEA	10 years	$51million in year 1; $430 million over 10 years	$23.6 billion health care costs averted	871,000 QALYs gained	Cost saving $55 for every $1 invested
Sonneville et al. 2015	Eliminate advertising subsidy for unhealthy food	CEA	10 years	$2.47million	$352m over 10 years	4,538 QALYs gained	Cost saving
Wright et al. 2015	Multi-component childcare regulations on beverages, physical activity, screen time	CEA	10 years	$4.82million year 1; $8.39 million over 10 years	$51.6 million health care costs averted	n/a	Cost saving $5.15 for every $1 invested
Barrett et al. 2015	Elementary school active PE policy	CEA	10 years	$70.7million year 1; $235million over 10 years	$60.5 million saved	n/a	$401/BMI unit reduced
An 2015	SNAP fruit and vegetable incentive program	CEA	Lifetime	$1323 per capita lifetime	n/a	0.082 QALYs per SNAP recipient	$16,172 per QALY gained
Choi et al. 2017	SNAP fruit and vegetable incentive program	CEA	Lifetime	$1,324 per SNAP user; $202 per capita; $857 million annually	$7,554 per capita	0.52 QALYs gained per SNAP user; 0.24 QALYs gained per capita	Cost saving
An et al. 2017	Water access in schools in New York	CEA	Lifetime	$18 per student	$192 per student	n/a	NY NB=$174 per student, national CBR or cost saved per dollar spent was $14.5

Wang et al. 2013	Planet Health middle school-based obesity prevention program	CEA	Lifetime	$33,677 or $14 per student	$15,887 in medical costs, $24,104 in productivity losses	4.1 QALYs	$4305/QALY saved considering health care costs, net savings of $7313 considering both health care costs and productivity losses
Wang et al. 2008	FitKid after-school program for healthy eating and physical activity in Georgia elementary schools	Cost Analysis	One year	$956 per student for program, $639 for student not in program	n/a	n/a	Incremental program cost was $317 per student
Wang et al. 2012	Penny per ounce SSB tax	CEA	10 years	n/a	$17 billion	2.4 million diabetes person years, 95,000 coronary events, 8000 strokes, 26,000 premature deaths	Would save $17 billion in health care costs and raise $13 billion in tax revenue

*Sugar sweetened beverages (SSB)

Table 4. Interventions to Promote Physical Activity

Author	Intervention	Method	Intervention Cost	Costs Averted	Ratios
Abu-Omar et al. 2017	Physical activity promotion interventions targeting healthy individuals in a variety of settings	Systematic reviews of CEAs	n/a	n/a	Cost saving interventions included those that promote active transport, some physical activity promotion programs, some falls prevention programs, and some worksite health promotion programs. Cost effective interventions include most school-based interventions except promotion of active transport for children and adolescents, fall prevention programs in older people, environmental approaches, and mass media campaigns. Specific ratios were not provided.
Balzer et al. 2012	Programs for exercise to improve physical functioning in older adults	Systematic review	n/a	n/a	Multidimensional exercise programs can be cost effective in terms of falls prevented and may be cost saving if continued beyond 6 months.
Brown et al. 2016	Active transport interventions that include physical activity benefits	Systematic review	n/a	n/a	Adding health effects and their associated health care costs can improve the cost effectiveness of active transport interventions.
Candari et al. 2017	Costs of unhealthy diets and low physical activity and presents a framework for costing studies using population attributable risk	COI	n/a	n/a	Rapid assessment of US (half of studies) found annual per capita cost of low physical activity ranged from $1.14 to $212.

Carande-Kulis et al. 2015	Three exercise programs focusing on falls prevention: Otago Exercise Program, Tai Chi: Moving for Better Balance, and Stepping On	ROI	Ranged from $104 to $339 per participant per year	Ranged from $346 to $768 per participant	Otago net benefit $122 ROI 36%; Tai Chi $530 509%; Stepping On $134 64%. Home-based Otago for 80+ net benefit $429, ROI 127%.
Cavill et al. 2008	Transport-related physical activity interventions	Systematic review	n/a	n/a	Benefit cost ratios for nine studies reporting "value to new walker or cyclist" ranged from $187 to $1,899 (converted to US 2008 $).
Davis et al. 2009	Fall prevention interventions for adults 80+	Systematic review	n/a	n/a	Nine studies. Three were cost saving: 1) individually customized multi-factorial program, home-based Otago exercise program, 3) home safety program. Otago program provided best value in 80+.
Garrett et al. 2011	RCTs of interventions in primary care and the community to increase walking	Systematic review	Not all studies reported intervention costs, reported intervention cost ranged from $444 to $1282 (20120 US $)	Unsure, not reported	Community walking programs, exercise and nutrition programs, and brief counseling with exercise on prescription had most favorable ratios although instructor led and supervised exercise programs fell within an accepted range of cost effectiveness. Based on the higher quality studies, it is possible to delivery an intervention for $1500 to $21,252 per QALY gained. This is cheaper than many pharmaceutical interventions (cholesterol control $78,902, intensive glucose control $43,697, case management $55,546).

GC et al. 2016	Brief interventions to promote physical activity in primary and community settings including exercise referral and prescriptions, brief advice and counseling, pedometer-based counseling, motivational interviews	Systematic review	n/a	n/a	Studies with final outcome measures reported cost-effectiveness ratios ranging from $84 to$23,208 per either QALY, DALY, or Life Year gained. The authors stated that it is difficult to rank order interventions due to heterogeneous study design and delivery characteristics.
Han et al. 2005	Walking and cycling trail	CBA	Construction and maintenance of 4.9 mile trail	$440 to $1,400 per newly active user,	Net Present Value of $63 million to $183 million over 25 years.
Korber et al. 2015	Health promotion programs to encourage physical activity including programs in community settings and multi component programs	Systematic review	Not all studies reported intervention costs	Not all studies included costs saved	Wide variation from $11.59 per person to be active to $669,138/DALY saved (2011 US$).

Laine et al. 2014	Interventions to promote physical activity in community settings including environment, built environment, sports clubs and enhanced access, schools, mass media and community based, and workplace	Systematic review	n/a	Not included	The most efficient interventions to increase physical activity were community trails ($.006/MET-h), pedometers ($0.014/MET-h gained), and school health education programs ($0.056/MET-h gained).
Lewis et al. 2010	Wide range of interventions delivered in primary care settings, built environment, workplace, mass media campaigns	Systematic review	Various	Various	Brief interventions in primary care including motivational interviews, lifestyle interventions, face-to-face and telephone, referrals to programs ranged from $314 to $691/QALY gained; built environment interventions to promote active travel ranged from $141 to $39,250 per QALY gained; workplace health promotion consultation for walking program cost $89,490 and was projected to save $489,129 over lifetime of individuals; mass media was most cost effective, physical activity increased by 16.6%, cost $116 per person, gain 0.736 QALYs per person and save $3,925 per person.
Muennig et al. 2014	Improved street crossing as part of New York City Safe Routes to School initiative	CEA	$10.3 million	$230 million	Net societal savings of $224 million, for an approximate ROI of $22 for each $1 invested.

Muller et al. 2009	Behavioral and environmental population based interventions to promote physical activity	Systematic review	n/a	n/a	Behavioral interventions in which participants meet recommended physical activity requirements can cost around $1,176 per participant per year, environmental interventions have the potential to be more cost effective.
Roux et al. 2008	Interventions from the Task Force on Community Preventive Services: community-wide campaigns, individually adapted health behavior change, community social-support interventions, and enhanced access to physical activity information and activities	CEA	Ranged from $1,239 to $5,308/person	Net cost averted $195,000 to $198,000 per person	$14,000 to $69,000/QALY gained, sensitivity analysis showed that changes in intervention costs and effect size had the most influence on the CEA ratio.
van Dongen et al. 2012	Worksite physical activity and nutrition programs (6 studies)	Systematic review	Range but not relevant across countries	n/a	Only intervention costs were considered so no ratios. All interventions were more costly than and were more or less effective than usual care. Thus, it was not possible to calculate summary measures and select cost effective options. More study is needed.
Wang et al. 2004	Bike and walking trails in Lincoln NE	CA	$26,000 to $248,000	n/a	$5,735 to $54,017 per mile, annual cost/user $235

Windle et al. 2010	Exercise and physical activity interventions	Systematic review, meta analysis, economic model	n/a	n/a	$11,461 to $18,997/QALY for community walking and exercise programs, respectively.
Wolfenstetter et al. 2010	Physical activity programs in clinical and community settings	Systematic review	n/a	n/a	Wisewoman screening and counseling program (US) $5,000/life year gained; Otago home-based exercise program $8,670/injurious fall prevented, cost saving in over 80, New Zealand and Canadian worksite programs cost saving, Taiwanese walking program $15,103/QALY gained, New Zealand Green Prescription program $2,180/QALY gained, UK free exercise class $26,995/QALY gained.
Wu et al. 2011	Physical activity interventions in community settings including point-of-decision prompts, school-based interventions; creation of and enhanced access to places for physical activity, community campaigns, individually adapted behavior change, and social support	Systematic review	n/a	Not included	Point-of-decision prompts appear most cost effective (0.07/MET-h gained (2% of recommended physical activity), school-based programs $0.42/MET-h gained (16% of recommended physical activity), least cost effective were individually adapted behavior change $0.84/MET-h gained and social support programs $1.16/MET-h gained, however they had largest effect sizes (35-43%).

Table 5. Potentially Cost Saving and Cost Effective Tobacco, Obesity, Healthy Eating, Physical Activity Interventions

Cost Saving Interventions*	Cost Effective Interventions**
Tobacco taxes	Workplace physical activity programs
Taxes on unhealthy food and beverages	Tobacco quit lines with free or reduced price NRT
Limits on salt intake	Mass media campaigns on tobacco use
Community falls prevention programs for older adults	SNAP Fruit and Vegetable Incentives
State comprehensive tobacco control programs	Certain elementary and middle-school programs to encourage physical activity and healthy eating
Smoke free housing policies	Community walking, exercise, and nutrition programs
After school physical activity programs	Mass media campaigns promoting physical activity
School food and beverage standards for foods sold outside of cafeterias	
Eliminating tax subsidy on advertising of unhealthy food targeting children (federal)	
Water access in schools	
Programs to prevent tobacco initiation in youths	
Promotion of active transportation including walking and cycling paths	

* A cost saving intervention is one for which the savings from the intervention are greater than the cost to implement it.

**A cost effective intervention is one that delivers good value for the health improvement although the savings from the intervention are less than the cost of implementing the intervention. Generally, an intervention with a cost effectiveness ratio of less than $50,000 per QALY saved is considered cost effective.

References

Abu-Omar K, Rütten A, Burlacu I, Schätzlein V, Messing S, Suhrcke M. The cost-effectiveness of physical activity interventions: A systematic review of reviews. Prev Med Reports. 2017; 8:72-78.

Ahmad S, Franz GA. Raising Taxes to Reduce Smoking Prevalence in the US: A Simulation of the Anticipated Health and Economic Impacts. Public Health. 2008;122:3-10.

Ahmad S. Increasing excise taxes on cigarettes in California: a dynamic simulation of health and economic impacts. Prev Med. 2005;41:276-283.

An R, Xue H, Wang L, Wang Y. Projecting the impact of a nationwide school plain water access intervention on childhood obesity: a cost benefit analysis. Pediatr Obes. 2017;doi:1111/ijpo.12236.

An R. Nationwide expansion of a financial incentive program on fruit and vegetable purchases among Supplemental Nutrition Assistance Program participants: a cost-effectiveness analysis. Soc Sci Med. 2015;147:80-88.

Asay GRB, Homa DM, Abramsohn EM, Xu X, O'Connor EL, Wang G. Reducing smoking in the US federal workforce: 5-year health and economic impacts from improved cardiovascular disease outcomes. Public Health Reports. 2017;132:646-653.

Balzer K, Bremer M, Schramm S, Lühmann D, Raspe H. Falls prevention for the elderly. GMS Health Techno Assess 8. 2012;8:Doc01. doi:10.3205/hta000099.

Barrett JL, Gortmaker SL, Long MW, Ward ZJ, Resch SC, Moodie ML, Carter R, Sacks G, Swinburn BA, Wang YC, Cradock AL. Cost Effectiveness of an Elementary School Active Physical Education Policy. Am J Prev Med. 2015;49:148-59.

Bauer JE, Carlin-Menter SM, Celestino PB, Hyland A, Cummings KM. Giving away free nicotine medications and a cigarette substitute (Better Quit (R)) to promote calls to a Quitline. J Public Health Manag Pract. 2006;12:60-66.

Brown V, Diomedi BZ, Moodie M, Veerman JL, Carter R. A systematic review of economic analyses of active transport interventions that include physical activity benefits. Transp Policy. 2016;45:190-208.

California Department of Public Health, California Tobacco Control Program. Behavioral Risk Factor Surveillance System, 1996-2015. Sacramento, CA: California Department of Public Health; 2016.

Candari CJ, Cylus J, Nolte E. Assessing the economic costs of unhealthy diets and low physical activity: an evidence review and proposed framework. Health policy series, 47. 2017. WHO Regional Office for Europe, Copenhagen, Denmark. ISBN 9789289050425.

Carande-Kulis V, Stevens JA, Florence CS, Beattie BL, Arias I. A cost-benefit analysis of three older adult fall prevention interventions. J Safety Research. 2015;52:65-70.

Cavill N, Kahlmeier S, Rutter H, Racioppi F, Oja P. Economic analyses of transport infrastructure and policies including health effects related to cycling and walking: a systematic review. Transp Policy. 2008;15:291–304.

Centers for Disease Control and Prevention. https://www.cdc.gov/nccdphp/dnpao/data-trends-maps/index.html

Choi SM, Seilman H, Basu S. Cost effectiveness of subsidizing fruit and vegetable purchases through the Supplemental Nutrition Assistance Program. Am J Prev Med. 2017;52:el47-el55.

Contreary KA, Chattopadhyay SK, Hopkins DP, Chaloupka FJ, Forster JL, Grimshaw V, Holmes CB, Goetzel RZ, Fielding JE, CG, Community Preventive Services Task Force. Economic impact of tobacco price increases through taxation: A Community Guide systematic review. Am J Prev Med. 2015;49:800-808.

County Health Rankings and Roadmaps. http://www.countyhealthrankings.org

Cradock AL, Barrett JL, Kenney EL, Giles CM, Ward ZJ, Long MW, Resch SC, Pipito AA, Wei ER, Gortmaker SL. Using cost-effectiveness analysis to prioritize policy and programmatic approaches to physical activity promotion and obesity prevention in childhood. Prev Med. 2016: S0091-7435(16)30339-5.

Cummings KM, Fix B, Celestino P, Carlin-Menter S, O'Connor R, Hyland A. Reach, efficacy, and cost-effectiveness of free nicotine medication giveaway programs. J Public Health Manag Pract. 2006;12:37-41.

Davis JC, Robertson MC, Ashe MC, Liu-Ambrose T, Khan KM, Marra CA. Does a home based strength and balance programme in people aged ≥80 years provide the best value for money to prevent falls? A systematic review of economic analyses of falls prevention interventions. Br J Sports Med. 2009;44:80–89.

DHUD. 21 CFR Parts 965 and 966, Instituting Smoke-Free Public Housing, Final Rule. 2016. https://www.hud.gov/sites/documents/SMOKEFREEPHFINALRULE.PDF

Dilley JA, Harris JR, Boysun MJ, Reid TR. Program, Policy, and Price Interventions for Tobacco Control: Quantifying the Return on Investment of a State Tobacco Control Program. *American Journal of Public Health*. 2012;102:e22-e28. doi:10.2105/AJPH.2011.300506.

Falbe J, Thompson HR, Becker CM, Rojas N, McCulloch CE, Madsen KA. Impact of the Berkeley excise tax on sugar-sweetened beverage consumption. Am J Public Health. 2016;106:1865-1867.

Fellows JL, Bush T, McAfee T, Dickerson J. Cost effectiveness of the Oregon quitline “free patch initiative”. Tob Control. 2007;16(Suppl 1):i47.

Fishman PA, Ebel BE, Garrison MM, Christakis DA, Wiehe SE, Rivara FT. Cigarette tax increase and media campaign: Cost of reducing smoking-related deaths. Am J Prev Med. 2005;29:19-26.

Garrett S, Elley CR, Rose SB, O'Dea D, Lawton BA, Dowell AC. Are physical activity interventions in primary care and the community cost-effective? A systematic review of the evidence. Br J Gen Pract. 2011;61;e125-e133.

Gortmaker SL, Long MW, Resch SC, Ward ZJ, Cradock AL, Barrett JL, Wright DR, Sonneville KR, Giles CM, Carter RC, Moodie ML, Sacks G, Swinburn BA, Hsiao A, Vine S, Barendregt J, Vos T, Wang YC. Cost Effectiveness of Childhood Obesity Interventions: Evidence and Methods for CHOICES.Am J Prev Med. 2015;49:102-111.

Gortmaker SL, Wang YC, Long MW, Giles CM, Ward ZJ, Barrett JL, Kenney EL, Sonneville KR, Afzal AS, Resch SC, Cradock AL. Three Interventions That Reduce Childhood Obesity Are Projected To Save More Than They Cost To Implement. Health Affairs. 2015;34:1932-1939.

Hans M, Marchesani S, Watson C, Whittaker L. Building Trails: A Benefit-Cost Analysis. The College of William and Mary, Thomas Jefferson Program on Public Policy. Dec 2005.

Kahende JW, Loomis BR, Adhikari B, Marshall L. A Review of Economic Evaluations of Tobacco Control Programs. *International Journal of Environmental Research and Public Health*. 2009;6:51-68. doi:10.3390/ijerph6010051.

Kaplan RM, Ake CF, Emery SL, Navarro AM. Simulated effect of tobacco tax variation on population health in California. Am J Public Health. 2001;91:239-244.

Korber K. Quality assessment of economic evaluations of health promotion programs for children and adolescents—a systematic review using the example of physical activity. Health Econ Rev. 2015;5:1-35.

Laine J, Kuvaja-Köllner V, Pietilä E, Koivuneva M, Valtonen H, Kankaanpää E. Cost-effectiveness of population-level physical activity interventions: a systematic review. Am J Health Promot. 2014;29:71-80.

Lewis C, Ubido J, Holford R, Scott-Samuel A. Prevention programmes cost-effectiveness review. Liverpool Public Health Observatory Report Series Number 83. Cost Effectiveness Review Series Number 1. 2010.

Lightwood J, Glantz S. Effect of the Arizona Tobacco Control Program on Cigarette Consumption and Healthcare Expenditures. Social science med. 2011;72:166-172. doi:10.1016/j.socscimed.2010.11.015.

Lightwood J, Glantz SA. The effect of the California Tobacco Control Program on smoking prevalence, cigarette consumption, and healthcare costs: 1989-2008. PLoS One. 2013;8:e47145.

Long MW, Gortmaker SL, Ward ZJ, Resch SC, Moodie ML, Sacks G, Swinburn BA, Carter RC, Claire Wang Y. Cost Effectiveness of a Sugar-Sweetened Beverage Excise Tax in the U.S. Am J Prev Med. 2015;49:112-123.

Lyn R, Aytur S, Davis TA, Eyler AA, Evenson KR, Chriqui JF, Cradock AL, Goins KV, Litt J, Brownson RC. Policy, systems, and environmental approaches for obesity prevention: a framework to inform local and state action. J Public Health Manag Pract. 2013;19(3 Suppl 1):S23-33

Maciosek M, LaFrance A, Dehmer S, McGree DA, Flottemesch TJ, Xu Z, Solberg LI. Updated priorities among effective clinical preventive services. Ann Fam Med. 2017; 15:14-22.

Mason J, Wheeler W, Brown MJ. The economic burden of exposure to secondhand smoke for child and adult never smokers residing in U.S. public housing. Pub Health Rep. 2015;130:230-244.

Masters R, Anwar E, Collins B, Cookson R, Capewell S. Return on investment of public health interventions: a systematic review. J Epidemiol Community Health. 2017;71:827-834.

McAlister AL, Rabius V, Geiger A, Glynn TJ, Huang P, Todd R. Telephone assistance for smoking cessation: one year cost effectiveness estimations. Tob Control. 2004;13:85-86.

Milstein B, Homer J, Briss P, Burton D, Pechacek T. Why behavioral and environmental interventions are needed to improve health at a lower cost. Health Affairs. 2011;30:823-32.

Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000. JAMA. 2005;291:1238-1245.

Muennig PA, Epstein M, Li G, DiMaggio C. The Cost-Effectiveness of New York City's Safe Routes to School Program. American Journal of Public Health. 2014;104:1294–1299.

Müller-Riemenschneider F, Reinhold T, Willich SN. Cost-effectiveness of interventions promoting physical activity. Br J Sports Med. 2009;43:70–76.

Ong MK, Diamant AL, Zhou Q, Park HY, Kaplan RM. Estimates of smoking related property costs in California multiunit housing. Am J Public Health. 2012;102:490-493.

Owen L, Morgan A, Fischer A, Ellis S, Hoy A, Kelly MP. The cost-effectiveness of public health interventions. J Public Health. 2012;34:37-45.

Ranson MK, Jha P, Chaloupka FJ, Nguyen SN. Global and regional estimates of the effectiveness and cost-effectiveness of price increases and other tobacco control policies. Nicotine Tob Res. 2002;4:311-319.

Rivara FP, Ebel BE, Garrison MM, Christakis DA, Wiehe SE, Levy DT. Prevention of smoking-related deaths in the United States. Am J Prev Med. 2004;27:118-125.

Roux L, Pratt M, Tengs T, Yore M, Yanagawa TL, Van Den Bos J, Rutt C, Brownson RC, Powell KE, Health G, Kohl III HW, Teutsch S, Cawley J, Lee IM, West L, Buchner DM. Cost effectiveness of community-based physical activity interventions. Am J Prev Med. 2008;35:578-588.

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

Silver LD, Ng SW, Ryan-Ibarra S, Taillie LS, Induni M, Miles DR, Poti JM, Popkin BM. Changes in prices, sales, consumer spending, and beverage consumption one year after a tax on sugar-sweetened beverages in Berkeley, California, US: A before-and-after study. PLoS Med. 2017;14:e1002283

Soler R, Orenstein D, Honeycutt A, Bradley C, Trogdon J, Kent CK, Wile K, Haddix A, O'Neil D, Bunnell R. Community-based interventions to decrease obesity and tobacco exposure and reduce health care costs: Outcome estimates from Communities Putting Prevention to Work for 2010-2020. Prev Chron Dis. 2015;13(E47):1-9.

Sonneville KR, Long MW, Ward ZJ, Resch SC, Wang YC, Pomeranz JL, Moodie ML, Carter R, Sacks G, Swinburn BA, Gortmaker SL. BMI and Healthcare Cost Impact of Eliminating Tax Subsidy for Advertising Unhealthy Food to Youth.
Am J Prev Med. 2015;49:124-134.

Tengs TO, Osgood ND, Chen LL. The cost-effectiveness of intensive national school-based anti-tobacco education: results from the tobacco policy model. Prev Med. 2001;33:558-570.

Trust for America's Health. Prevention for a Healthier America: Investments in Disease Prevention Yield Significant Savings, Stronger Communities. Trust For America's Health. 2008.

van Baal PHM, Brouwer WBF, Hoogenveen RT, Feenstra TL. Increasing tobacco taxes: a cheap tool to increase public health. Health Policy. 2007;82:142-152.

Van Dongen JM, Proper KI, Van Wier MF, van der Beek AJ, Bongers PM, van Mechelen W, van Tulder MW. Systematic review of the financial return on worksite health promotion programmes aimed at improving nutrition and/or increasing physical activity. Obes Rev. 2011;12:1031-1049.

Verughese J, Chattopadhysy SK, Elder RW, Robinsom MN, Tansil KA, Soler RE, Labre MP, Mercer SL, Community Preventive Services Task Force. Economics of mass media health campaigns with health-related product distribution: A Community Guide systematic review. Am J Prev Med. 2014;47:348-359.

Vijay GC, Wilson EC, Suhrcke M, Hardeman W, Sutton F. Are brief interventions to increase physical activity cost-effective? A systematic review. Br J Sports Med. 2016;50:408-417.

Vos T, Carter R, Barendregt, Mihalopoulos C, Veerman L, Magnus A, Cobiac L, Bertram M, Wallace A. Assessing Cost-Effectiveness in Prevention (ACE-Prevention). Final Report, 2010.

Wang G, Macera C, Scudder-Soucie B, Schmid T, Pratt M, Buchner D, Heath G. Cost analysis of the built environment: The case of bike and pedestrian trials in Lincoln, Neb. Am J Public Health. 2004;94:549-553.

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

Wang LY, Gutin B, Barbeau P, Moore JB, Hanes J, Johnson MH, Cavnar M, Thornburg J, Yin Z. Cost-effectiveness of a school-based obesity prevention program. J Sch Health. 2008;78:619-624.

Wang LY, Yang Q, Lowry R, Wechsler H. Economic analysis of a school-based obesity prevention program. Obes Res. 2003;11:1313-1324.

Wang YC, Coxson P, Shen YM, Goldman L, Bibbins-Domingo K. A penny-per-ounce tax on sugar-sweetened beverages would cut health and cost burden of diabetes. Health Affairs. 2012;31:199-207.

WHO Europe. The Case for Investing in Public Health: A Public Health Summary Report for EPHO 8, World Health Organization. 2014.

Windle G, Hughes D, Linck P, Russell I, Woods B. Is exercise effective in promoting mental well-being in older age? A systematic review. Aging Ment Health. 2010;14: 652–669.

Wolfenstetter SB, Wenig CM. Economic evaluation and transferability of physical activity programmes in primary prevention: a systematic review. Int J Environ Res Public Health. 2010;7:1622–1648.

Wright A, Smith KE, Hellowell M. Policy lessons from health taxes: a systematic review of empirical studies. BMC Pub Health. 2017;17:583-597.

Wright DR, Kenney EL, Giles CM, Long MW, Ward ZJ, Resch SC, Moodie ML, Carter RC, Wang YC, Sacks G, Swinburn BA, Gortmaker SL, Cradock AL. Modeling the Cost Effectiveness of Child Care Policy Changes in the U.S. Am J Prev Med. 2015;49:135-147.

Wright DR, Taveras EM, Gillman MW, Horan CM, Hohman KH, Gortmaker SL, Prosser LA. The cost of a primary care-based childhood obesity prevention intervention. BMC Health Serv Res. 2014;14:44. doi:10.1186/1472-6963-14-44.

Wu S, Cohen D, Shi Y, Pearson M, Sturm R. Economic Analysis of Physical Activity Interventions. Am J Prev Med. 2011;40:149-158.