A NEW VISION FOR CALIFORNIA'S HEALTHCARE SYSTEM:

Integrated Care with Aligned Financial Incentives

Appendix VIII. Physical Activity (Initiative Memorandum)

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See "Appendix IV: Introduction to Appendices V-XI" for brief background on this Appendix.

Executive Summary

Inadequate physical activity creates an enormous burden on health and healthcare. Lee et al. recently estimated that 5.3 million of 57 million premature deaths globally in 2008 could be attributed to physical inactivity.[1] Lack of exercise has been associated with an array of chronic diseases; for example, the World Health Organization estimates that physical inactivity is linked to between 21% and 25% of breast and colon cancers, 27% of diabetes and 30% of coronary heart disease cases.[2]

Over the past decade, the Behavioral Risk Factor Surveillance System (BRFSS) has found a high rate of physical inactivity among Californians. Based on BRFSS data, 54.2% of Californians in 2001 failed to meet the U.S. Department of Health and Human Services' Healthy People 2020 goal of at least 30 minutes of moderate activity, five days per week. Based on the same indicator, BRFSS data shows that 48.7% of Californians were physically inactive in 2007.[3] While trending in the right direction in recent years, BRFSS data suggests that about half of Californians remain physically inactive.

In this analysis, we provide an estimate of the potential reduction in California's healthcare expenditures that might occur if a higher percentage of residents were physically active, potentially via a statewide walking and physical activity campaign. To estimate the expenditure reductions associated with this initiative, we referred to studies that estimate the share of healthcare expenditures directly attributed to physical inactivity. These studies were conducted in differing years and geographies, but reached similar conclusions, i.e. that between 2.5% and 3.9% of healthcare expenditures are due to physical inactivity.

Under the "Current Developments Scenario," we assume that the current modest improvement in activity levels will continue and that 5% fewer Californians will be inactive by 2022. We estimate a midpoint healthcare expenditures reduction of $3.4 billion in current-year dollars, or 0.08% of total California healthcare expenditures, during this period. Under our "Forum Vision" scenario, we envision that a concerted multi-stakeholder initiative will decrease inactivity levels by 10% over the same period. Under this scenario and its accompanying higher savings rate assumed due to a broader and deeper initiative, we estimate a reduction of $8.2 billion, or 0.19% of total healthcare expenditures, between 2013 and 2022. As we expect that physical inactivity rates will continue to decline through 2022, the estimated reduction under the Forum Vision scenario reaches 0.29% of total healthcare expenditures in 2022.

[1] Lee, et al. (2012).
[2] World Health Organization (2012).
[3] Behavioral Risk Factor Surveillance System (2012).

The Underlying Situation

The percentage of Californians who are physically inactive decreased from 54.2% in 2001 to 48.7% in 2007.[4] Despite this improvement, California still faces a major challenge from physical inactivity and the toll it takes on health and the healthcare system.

Significant improvement in physical activity levels requires a coordinated, multi-stakeholder effort that touches all Californians where they live, work and play. Regular walking is considered an effective way to increase physical activity because it does not require special equipment, skills or facilities, and has demonstrated significant health benefits. In some communities, though, regular walking may be more challenging, due to insufficient lighting, lack of walkable areas and unsafe neighborhoods.

Established in 1996 and renamed in 2004, California Active Communities is a major program by the state government to encourage physical activity. The group leads several initiatives targeted at encouraging children to walk to school and adults to walk to work.[5] The California Obesity Prevention program, run by the Department of Public Health, gives community grants to physical activity programs.[6] The California Endowment sponsors several programs to encourage more active lifestyles and healthier eating in low-income communities. One such effort, Healthy Communities, is a 10-year, $1 billion program that addresses a range of social and economic issues in 14 communities, including supporting safe neighborhoods that encourage physical activity.[7]

At the local level, municipalities such as Pasadena offer classes on physical activity and nutrition through their public health department.[8] At the employer level, many large companies offer employees incentives to exercise and stay healthy, while others offer more comprehensive onsite wellness and activity programs. However, there is need for a broader, more sustained and more coordinated effort to increase physical activity among all Californians.

Previous Studies

Health Benefits of Physical Activity

Lack of physical activity has been linked to increased risk for a wide range of chronic diseases. Various studies provide strong evidence that regular physical activity contributes to primary and secondary prevention of cardiovascular disease (CVD), diabetes, certain cancers, osteoporosis, depression, obesity and hypertension.[9] The World Health Organization estimates that physical inactivity is the primary cause of 21%-25% of breast and colon cancers worldwide, 27% of type II diabetes cases and 30% of coronary heart disease cases.[10] In addition, the Colditz et al.,[11] Chenoweth,[12] and Katzmarzyk[13] studies all identify

[4] Ibid.
[5] California Department of Public Health (2007).
[6] California Department of Public Health (2010).
[7] California Endowment (2011).
[8] Nutrition and Physical Activity Program (PACE) (2012).
[9] Warburton, et al. (2006).
[10] World Health Organization (2012).

physical inactivity as a risk factor for CVD, stroke, depression, anxiety and sleep apnea. Numerous studies have linked physical activity to greater longevity and improved quality of life. In a 1995 Journal of the American Medical Association article, Blair et al. conducted a prospective study of nearly 10,000 men who were given physical examinations and fitness tests five years apart. Those men who had improved from unfit to fit experienced a 44% drop in all-cause mortality risk compared to those who remained unfit.[14] Paffenberger et al. completed a similar study on a cohort of Harvard alumni who completed two questionnaires ten years apart. Those men who took up any type of moderately vigorous sport or physical activity between the first and second survey experienced 23% lower levels of all-cause mortality compared to those who had not.[15]

Growing evidence shows that increases in exercise and physical activity can lead to very rapid improvements in key risk factors for chronic disease and mortality. Kraus et al. studied 111 sedentary, overweight men and women assigned to three different exercise groups for six months. The study found a clear and immediate impact on lipoproteins and lipoprotein sub-fractions from vigorous exercise. The study also found that even without significant weight loss, those in the highest-exercising group improved their overall lipoprotein profile, thus helping mitigate a key risk factor for cardiovascular disease.[16] Reviews of randomized trials on activity interventions show significant improvements in overall health-related quality of life in newly active individuals, such as improved functional capacity and mood states.[17]

Relationship Between Physical Activity and Healthcare Expenditures

Several studies have attempted to calculate the relationship between physical inactivity and healthcare expenditures by calculating population attributable risk (PAR). PAR estimates the effect of a single risk factor on the incidence of a given disease. The PAR calculation takes into account the prevalence of the risk factor (in this case, physical inactivity) in the population, as well as the relative risk of a given disease being caused by that particular risk factor.[18]

Table 1 shows estimates of healthcare expenditures attributed to physical inactivity, ranging from 2.5% to 3.9%. We discuss each of the three studies in turn. In 1999, Colditz conducted a literature review and

[11] Colditz (1999).
[12] Chenoweth (2005).
[13] Katzmarzyk, et al. (2004).
[14] Blair, et al. (1995).
[15] Lee, et al. (2001).
[16] Kraus, et al. (2002).
[17] Penedo, et al. (2005).
[18] PAR is useful for translating data on disease prevalence and relative risks into specific numbers that can help policy makers understand the potential benefits of addressing specific risk factors. PAR studies rely on meta-analyses to assign a portion of responsibility for a disease to a specific risk factor. Rockhill et al. (1998) caution that attributable risk factor calculations make several assumptions, including, "a causal relationship between the risk factors and disease and the immediate attainment, among those formerly exposed, of the unexposed disease risk following elimination of the exposures." Even with these limitations, the causation between physical activity and key chronic diseases is well established, thus validating the PAR approach. The PAR approach is translated into healthcare expenditures by first calculating the expenditures from treating a particular condition, for example, through claims data. Researchers then multiply the PAR fraction by the healthcare expenditures stemming from that condition. For example, Colditz estimate that 12% of the risk for diabetes stems from physical inactivity, and multiplies this figure by the $53.3 billion in expenditures for treating diabetes to attribute $6.2 billion in diabetes expenditures to physical inactivity.

utilized the PAR method to calculate the healthcare expenditures associated with obesity and physical inactivity.[19] Based on Colditz's definition of physical inactivity as the absence of any leisure-time physical activity during the previous month, 28.8% of Americans were considered inactive.[20] The study estimates that 22% of CVD, 22% of colon cancer, 22% of osteoporotic fractures, 12% of diabetes and hypertension, and 5% of breast cancer are attributable to lack of physical activity. Colditz uses these PAR estimates, along with data on the total healthcare expenditures linked to each of these diseases, to estimate that 2.5% of U.S. healthcare costs in 1995 could have been attributable to inactivity. Colditz also conducted a similar analysis assuming a 48% inactivity rate, in which 3.7% of healthcare expenditures were attributable to physical inactivity.

Katzmarzyk et al. conducted a similar PAR analysis and found that 2.5% of the healthcare expenditures in Canada in 1999 could be attributed to physical inactivity.[21] This study relied on a survey in which 62% of Canadians reported not meeting national guidelines for physical activity. In a 2004 update to the study using newly available data, Katzmarzyk attributed 2.6% of Canadian healthcare costs to inactivity, based on a nationwide inactivity rate of 54%. In the follow-up study, Katzmarzyk relied on a new definition of inactivity from the Canadian Community Health Survey. In the new definition, "inactivity" means not meeting the standard of one hour of low-intensity activity every day, or either 30 to 60 minutes of moderate-intensity activity or 20 to 30 minutes of vigorous-intensity activity four to seven days a week.

More recently, a 2005 study conducted by Chenoweth and Associates on behalf of the California Department of Health Services estimated that 3.9% of California's healthcare expenditures are attributed to physical inactivity.[22] Chenoweth created its own Proportional Risk Factor Cost Appraisal framework, a model similar to PAR, which was applied to medical claims data from 25,000 Californians, along with other data sources, to estimate the expenditures attributable to inactivity. The analysis assessed risk factor prevalence and inpatient and outpatient claims for each relevant diagnosis and the likelihood that an individual would be diagnosed with a relevant condition. Chenoweth used a state-specific complement to Behavioral Risk Factor Surveillance Survey (BRFSS) data, in which inactivity is defined as "no leisure time physical activity in the past month or irregular physical activity (fewer than three times per week or less than 20 minutes per session) in the past month." In 2001, 49.5% of Californians were inactive under this definition, which the study said was responsible for 3.9% of California healthcare costs.

[19] Colditz (1999).
[20] Others define inactivity as not undertaking at least three exercise sessions of 20 minutes each week.
[21] Katzmarzyk, et al. (2004).
[22] Chenoweth (2005).

Table 1: Estimated Share of Healthcare Expenditures Attributed to Physical Inactivity

Study	Estimated Share of Healthcare Expenditures Attributed to Physical Inactivity	Geographic Scope
Colditz, 1999	2.5% (48.5% inactivity rate)	USA
Katzmarzyk, 2004	2.6% (54% inactivity rate)	Canada
Chenoweth, 2005	3.9% (49.5% inactivity rate)	California

Effectiveness of Interventions to Increase Physical Activity

There is an emerging body of literature evaluating the effectiveness of various interventions intended to increase levels of physical activity, including walking. One of the most comprehensive analyses was published in 2002 in the American Journal of Preventative Medicine (AJPM). In connection with the CDC "Community Guide" website, Kahn et al. reviewed studies of three approaches to physical activity interventions:[23] Informational campaigns, social and behavioral approaches and environmental and policy approaches. Within these broad groupings, the review examined the effectiveness of specific interventions. The study had several key findings regarding the programs' effectiveness at increasing the number of physically active individuals:

- Certain types of informational campaigns, such as "point-of-decision prompts" in the workplace or school, were modestly effective in increasing physical activity, such as using the stairs or walking rather than driving (median net increase in physical activity of 4.2%)
- Social support interventions focused on changing physical activity behavior through social networks that provided supportive relationships for behavior change were especially effective (median net increase in physical activity of 44.2%)
- The interventions that provided both enhanced access to places for physical activity and informational outreach activities were the most effective at increasing physical activity levels (median net increase in physical activity of 48.4%)

Kahn's review concluded that some of the most effective campaigns were community-wide or multi-pronged initiatives. Because these campaigns often included efforts to reduce other risk factors for cardiovascular disease, including smoking and obesity, it is challenging to isolate their specific impact on inactivity. Multi-pronged community campaigns typically include some combination of social support, such as self-help groups, as well as risk factor screening and counseling. They also typically include an educational component that stresses the value of physical activity and that gives advice about becoming more active. These educational elements take place in a variety of settings, including at worksites,

[23] Kahn, et al. (2002).

schools and community events. Finally, they include the aforementioned strategy of environmental or policy changes, such as the creation of walking trails.

Recent literature continues to provide evidence for the effectiveness of multi-pronged workplace interventions. Naito et al. studied a five-year workplace intervention in Japan that sought to increase physical activity and improve other CVD risk factors through a workplace campaign.[24] The campaign involved frequent presentations on physical activity, enabled the use of pedometers twice per year to encourage walking, provided instructions on stretching and walking, hosted sporting events, constructed walking paths and distributed walking maps. The study found that the percent of employees who were active for fewer than 30 minutes per day decreased from 13.5% to 8.2%. The percent of participants who had decreased their walking time during the five-year period was 18.6% for the intervention group versus 25.7% for the control group. These encouraging results suggest that workplace interventions have the potential to improve and maintain activity rates, even for employees who are already relatively active.

Other studies shed light on newer types of interventions, such as the use of pedometers. For example, one study asked sedentary adult women to report their daily walking using a mobile phone and a pedometer.[25] Daily prompts delivered via mobile phones encouraged participants to increase the number of steps taken by 20%; over the course of the four-year intervention, average daily steps increased by 15% (800 steps). A 2007 meta-analysis of 26 studies on pedometers, with 2,767 participants, found that pedometer users significantly increased their physical activity, taking 2,491 steps per day more than control participants. The overall increase in activity was 26.9% over baseline. This meta-analysis included eight randomized controlled trials and 18 observational studies.[26]

Finally, some evidence exists that "lifestyle" interventions to encourage fitness and physical activity may be as effective as traditional "structured" interventions. Dunn et al. performed a randomized trial that placed previously sedentary adults into two different activity intervention groups for two years and then tracked their progress.[27] One group was enrolled in a "structured" program in which subjects were given individualized sessions with a trainer five days a week for the first six months. This group was then given the freedom to design their own program for the remaining 18 months, with trainer support available and with frequent reminders to maintain their regimens. Alternatively, the "lifestyle" intervention group received much less structured support. They were simply encouraged to exercise every day, or at least five days each week, for more than 30 minutes, but did not receive a gym membership or access to a trainer. Instead, they met weekly (later biweekly) in small group sessions with facilitators who helped develop cognitive and behavioral strategies to maintain their exercise regimen. Over 24 months, both the lifestyle and structured exercise groups significantly increased their total energy expenditure from their baselines. But the lifestyle group increased moderate-intensity physical activities nearly three

[24] Naito, et al. (2008).
[25] Fukuoka, et al. (2010).
[26] Bravata Dm, et al. (2007).
[27] Dunn Al (1999).

times more than structured group. These findings suggest there is a potential for less-expensive lifestyle interventions to yield more cost-effective results than costlier traditional "structured" interventions.

Cost Effectiveness of Interventions

The cost-effectiveness of interventions to improve levels of physical activity has been studied extensively. While estimates range widely, in general, most interventions are found to be cost-effective using any of a number of different valuation techniques.

A recent American Heart Association study reviewed a range of previous studies that calculated the cost effectiveness of interventions to decrease risk factors for cardiovascular disease.[28] Multi-pronged community-wide interventions to increase physical activity, improve nutrition and prevent smoking were found to save an average of $5.60 in healthcare expenditures for every $1 invested. Comprehensive worksite wellness programs, which include components to improve rates of physical activity, are estimated to decrease medical expenditures $3.27 for every $1 spent within the first 12-18 months of the program. Building new bike and pedestrian trails were found to have a return-on-investment of $3 for every $1 spent.

Other studies have measured intervention effectiveness in terms of cost per quality-adjusted life year (QALY). The Dutch Heart Health intervention for diabetics, which seeks to improve both nutrition and physical activity for 180,000 people in the city of Limburg, cost $4,000 to $5,000 per QALY gained.[29] This is considered a good return, given that most cost benefit analyses value a QALY at much more than $4,000. One literature review of cost effectiveness benchmarks found a range of $24,777 to $428,286 per QALY depending on the method of calculation.[30]

As previously discussed, investments facilities that encourage activity have been shown to be highly effective in increasing activity rates. But they are also generally expensive, requiring significant upfront capital as well as coordination across a range of agencies and officials. Portland has long been known for its extensive municipal support for bicycling. Recently, Gotschi et al. estimated that by 2040, the city's biking-related investments, which will be in the range of $138 million to $605 million, would result in direct healthcare savings of $388 million to $594 million, as well as savings in the value of statistical lives of $7 billion to $12 billion.[31] The study evaluated the cost of investments in biking capacity compared with healthcare cost savings and statistical life savings (QALYs) based on longevity. Portland's initiative is an encouraging example of a systematic, regional effort to promote increased physical activity within regular daily life.

[28] Weintraub, et al. (2011).
[29] Jacobs-van der Bruggen, et al. (2007).
[30] Hirth, et al. (2000).
[31] Gotschi (2011).

Proposed Initiative

Our proposed initiative would involve a multi-stakeholder effort across California to significantly increase rates of walking over the next 10 years, thus decreasing the number of Californians deemed to be physically inactive. The California Department of Public Health (CDPH) could lead the program with support and funding from employers, health plans and other healthcare stakeholders. The initiative should involve proven approaches to increasing physical activity, such as information campaigns, social support interventions, point-of-decision prompts, major urban and environmental improvements to support walking, and use of such technologies as pedometers and mobile phones. Based on the evidence available, effective implementation of such a program would significantly improve rates of physical activity. The program should reach the majority of Californians at their school or job. However, to ensure that all Californians can get involved, it should also include programming at community facilities such as libraries and places of worship.

Another successful model is known as a "wellness trust." This is a fund managed by an appointed board that is designed to support a specific set of public health initiatives. In the case of California, a state-level department, such as CDPH, could appoint a multi-stakeholder board to disburse the funding. Massachusetts's wellness fund, which is financed by a tax on insurers and a fee assessed on large hospitals, provides a blueprint for this approach. The Massachusetts Wellness and Prevention Trust will disburse $60 million for wellness initiatives across the state over four years, starting in this year.[32]

Modeling Approach and Assumptions

Based on the literature attempting to correlate physical inactivity with healthcare expenditures, we modeled the effects of an increase in physical activity rates in California under two scenarios. Under the "Current Developments" scenario, in which we assume that current trends, initiatives and policies will continue, we expect the number of physically inactive people to continue decreasing at a modest rate. Under this scenario, 5% fewer Californians would be physically inactive in 2022. Under the Forum Vision scenario of integrated delivery systems, aligned financial incentives and a prioritization of population health, we model the more ambitious goal of decreasing the percent of inactive Californians by 10%. This also aligns with the Healthy People 2020 goal to decrease the number of inactive Americans by 10%.

Costs of Inactivity

For the percent of healthcare expenditures due to physical inactivity in California, we used a lower bound of 2.5% from Colditz and an upper bound of 3.9% from Chenoweth.

Direct Relationship between Inactivity Levels and Cost

Our model assumes that as the proportion of physically inactive Californians decreases, there will be a proportional decrease in healthcare expenditures. For example, if the current 48.7% rate of physically

[32] Massachusetts Public Health Association (2012).

inactive Californians decreases 10% by 2022, only 43.8% of Californians would then be considered inactive. If we assume that 3.9% of California's healthcare expenditures are due to physical inactivity, then 10% of that 3.9% of projected 2022 expenditures will be reduced.

Uptake and Improvement Rates

Under both the Current Developments and Forum Vision scenarios, we envision a concerted campaign to encourage walking, starting this year. In doing so, we model an adoption curve that is steeper in the first five years than in the latter five years. This is because in its early years, a statewide physical activity campaign is likely to be effective at increasing activity among the "low-hanging fruit," while later years may see more modest take-up rates.

The Timing of Physical Activity Benefits

The studies shown in Table 1, which were used in our healthcare expenditures analysis, do not address the potential time lag between an increase in physical activity rates and its benefits, especially a reduction in healthcare expenditures. On that issue, one study of a range of modifiable health risks, including physical activity, concluded that statistically significant savings in direct healthcare expenditures emerge within 12 to 18 months of behavior change.[33]

Overall, however, there is minimal research that directly establishes the timing between physical activity increases and healthcare expenditure decreases. For the purpose of our analysis, we estimate a one-year lag.

The Cost of a Physical Activity Initiative

Our proposed initiative describes a multi-pronged campaign to increase walking and physical activity in the state. Given that many of the details of the initiative have not yet been worked out, to estimate its cost, we look to relevant cost-effectiveness analyses. We rely on the aforementioned Weintraub et al. meta-analysis that found that on average, community-wide multi-pronged physical activity interventions achieve $5.60 in savings for every $1 invested. We use this ratio and estimate that projected expenditure reductions are decreased by 17.9% ($1.00/$5.60) to account for the initiative cost.

Estimated Impact

As described in the above assumptions, we examined the potential reduction in total healthcare spending under two scenarios. Under the Current Developments scenario, we assume that small-scale efforts to increase physical activity continue in California over the next 10 years. This results in an overall 5% decrease in inactivity, similar to the trend observed between the 2000 and 2007 BRFSS data. Under the Forum Vision scenario, we envision a healthcare system that encourages greater physical activity. The result is a 10% decrease in physical inactivity rates by 2022, similar to the Healthy People 2020 goal.

[33] Pronk, et al. (1999).

Table 2: Healthcare Expenditure Reduction Estimates Under the Current Developments Scenario, 2013-2022

	2013		2022		2013 - 2022		
	Lower	Upper	Lower	Upper	Lower	Mid	Upper
Status Quo Expenditures (billions)	$327.6		$572.2		$4,387.1		
Expenditure Reduction (billions)	($0.0)	($0.0)	$0.5	$0.8	$2.6	$3.4	$4.1
Expenditure Reduction (%)	0.00%	0.00%	0.09%	0.15%	0.06%	0.08%	0.09%

Table 2 shows that under Current Developments, we use the midpoint results to estimate healthcare expenditures reductions of $3.4 billion in current-year dollars over the period 2013 and 2022 (or 0.08% of total expenditures during this period) due to increases in physical activity rates.

Table 3: Healthcare Expenditure Reduction Estimates Under the Forum Vision Scenario, 2013-2022

	2013		2022		2013 - 2022		
	Lower	Upper	Lower	Upper	Lower	Mid	Upper
Status Quo Expenditures (billions)	$327.6		$572.2		$4,387.1		
Expenditure Reduction (billions)	($0.0)	($0.0)	$1.1	$1.7	$5.3	$6.7	$8.2
Expenditure reduction (%)	0.00%	0.00%	0.19%	0.29%	0.12%	0.15%	0.19%

Table 3 shows that under the Forum Vision, we use the upper results to estimate healthcare expenditure reductions of $8.2 billion over the period 2013 and 2022 (or 0.19% of total healthcare expenditures during this period) due to decreases in physical inactivity rates.

Discussion

High physical inactivity rates continue to create an unnecessary burden on Californians' health status and healthcare system. Both the existing literature and numerous economic models suggest there is significant potential to decrease healthcare expenditures in California by promoting physical activity.

We estimate that a decrease in physical inactivity under the "Current Developments" scenario would reduce healthcare expenditures by about $3.4 billion in current-year dollars by 2022, or 0.08% of total healthcare expenditures during this period. In 2022 under "Current Developments, the reduction in healthcare expenditures averages $0.84 billion, or 0.15% of total expenditures in that year. Under the lower overall physical inactivity and savings rates assumed under the "Forum Vision" scenario, this initiative for the same period would reduce healthcare expenditures by about $8.2 billion, or 0.19% of total healthcare spending. In 2022, decreased physical inactivity would reduce healthcare expenditures by an estimated 0.29%.

In addition to reduced healthcare expenditures, we would expect other significant benefits from such an initiative. Inactivity takes a great physical and emotional toll on Californians who should be enjoying healthier lives. Physical activity has been linked to improved mood, lower rates of depression, lower rates of breast and colon cancer and various chronic conditions, along with general improved quality of life.

There are several limitations in our analysis. First, we based it on three major studies that link physical inactivity and healthcare expenditures.[34] The three studies each attribute a certain share of healthcare expenditures to physical inactivity. The risk factor weights used in these studies are based on the general adult population, which may be different for California given the state's unique demographic mix. These weights may also have changed on account of the data that has emerged since the early and mid-2000s, when these studies were first published. Second, the disease costs caused by physical inactivity may be understated, given that some of the studies do not include the costs from diseases which can't easily be attributable to physical inactivity. For example, the PAR model used by Colditz did not include dyslipidemia, anxiety or depression, all of which have frequently been associated with physical inactivity

Third, we have not encountered randomized control trial evidence that directly links a specific physical activity intervention with a specific reduction in either the incidence of certain diseases or overall healthcare expenditures. Instead, existing studies link specific interventions to decreases in physical inactivity levels, or, at best, to changes in risk factors such as blood pressure. Establishing the direct link between a physical inactivity intervention and disease incidence requires sustained longitudinal study.

It is also important to note that although our analysis focuses on the healthcare expenditures attributed to inactivity, the separate challenge of obesity is intimately related. The Chenoweth study[35] attributes a separate share of healthcare expenditures directly to obesity, in addition to the share due to inactivity. This implies is that our modeling estimates may be conservative. Any successful initiative that decreases inactivity may also have positive impacts on obesity and may potentially decrease other risk factors, thus decreasing healthcare expenditures.

A final limitation of our study is that we have not modeled the initiative's impact on mortality and morbidity, which may result in increased healthcare expenditures in the long-term. A large body of literature exists on the quality of life and longevity benefits of physical activity. Lee, et al. used a population attributable risk (PAR) method to suggest that eliminating physical inactivity in the United States could add 0.78 years to national life expectancy.[36] Other studies have concluded that the additional life years gained by improvements in obesity (and by extension, physical activity) may lead to additional healthcare spending that could exceed whatever reductions are attained from improved health in earlier years. Van Baal et al. used a simulation model to estimate healthcare expenditures for obese non-smokers, non-obese smokers, and non-obese non-smokers ("healthy") in the Netherlands. Somewhat surprisingly, the "healthy" cohort had the highest lifetime healthcare expenditures, followed by the obese non-smokers and finally, the non-obese smokers. Their simulation concluded that any obesity-related reduction in healthcare expenditures might be offset, over the course of 20 years, by the extra medical expenses incurred by residents during their longer life spans.[37] However, while the Dutch

[34] Chenoweth (2005); Colditz (1999); Katzmarzyk, et al. (2004).
[35] Chenoweth (2005).
[36] Lee, et al. (2012).
[37] van Baal, et al. (2008).

study suggested that decreasing obesity and smoking might not reduce costs, it also concluded that the additional life-years came at a relatively low cost, in terms of quality-adjusted life years.

In the case of the Forum's proposed initiative, much of the additional longevity created by decreased physical inactivity may not take effect within the 10 years that are modeled. Therefore, we assume that the increased healthcare expenditures due to additional longevity in newly active people would not significantly impact our projected expenditure reductions. In the long run, added longevity may reduce our expenditure reduction estimates; however, the goal aligns well with the spirit of the Forum Vision of improving the overall health of California's population.

Another body of evidence suggests that healthy lifestyles can shorten the period of disability often experienced at the end of life. This evidence runs counter to van Baal et al., in that it suggests that physical activity in earlier years may in fact decrease healthcare costs in the last few years of life. Between 1986 and 1998, Hubert et al. conducted an observational study of lifestyle-related risk factors (including physical activity) for disability prior to death in a group of older individuals. He found that group members without any significant risk factors showed average disability scores near zero at 10-12 years before their deaths, with relatively little decrease in function as death approached. By comparison, those in the group with two or more risk factors experienced a greater level of disability and more marked decline in functionality over the same period.[38] Another longitudinal study, comparing female runners and non-runners over age 50, found reductions in morbidity duration and longer life spans of those in the first group.[39]

Overall, we expect that decreased physical inactivity will significantly reduce healthcare expenditures over the coming 10 years, while offering major benefits to the health status and quality of life for all Californians, everywhere in the state.

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[38] Hubert, et al. (2002).
[39] Fries (1996).

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