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Simulated impacts and potential cost effectiveness of Communities Putting Prevention to Work: Tobacco control interventions in 21 U.S. communities, 2010–2020

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ABSTRACT

In 2010, the Centers for Disease Control and Prevention (CDC) funded communities to implement policy, systems, and environmental (PSE) changes under the Communities Putting Prevention to Work (CPPW) program to make it easier for people to make healthier choices to prevent chronic disease. Twenty-one of 50 funded communities implemented interventions intended to reduce tobacco use. To examine the potential cost-effectiveness of tobacco control changes implemented under CPPW from a healthcare system perspective, we compared program cost estimates with estimates of potential impacts. We used an existing simulation model, the Prevention Impacts Simulation Model (PRISM), to estimate the potential cumulative impact of CPPW tobacco interventions on deaths and medical costs averted through 2020. We collected data on the costs to implement CPPW tobacco interventions from 2010 to 2013. We adjusted all costs to 2010 dollars. CPPW tobacco interventions cost $130.5 million across all communities, with an average community cost of $6.2 million. We found $735 million in potentially averted medical costs cumulatively from 2010 through 2020 because of the CPPW-supported interventions. If the CPPW tobacco control PSE changes are sustained through 2020 without additional funding after 2013, we find that medical costs averted will likely exceed program costs by $604 million. Our results suggest that the medical costs averted through 2020 may more than offset the initial investment in CPPW tobacco control interventions, implying that such interventions may be cost saving, especially over the long term.

1. Introduction

Chronic diseases are among the leading causes of death and disability in the United States and impose a considerable economic burden, accounting for 86% of annual health care spending (Gerteis et al., 2014). These diseases are largely preventable through lifestyle changes, such as reducing tobacco use and obesity (National Center for Chronic Disease Prevention and Health Promotion, n.d.). However, prevention often requires action on multiple levels, including adoption of clinical interventions at the individual level and environmental changes at the population level that make it easier for individuals to pursue healthy lifestyles (Frieden, 2010).

In 2010 the U.S. Department of Health and Human Services (HHS) created a 2-year initiative, Communities Putting Prevention to Work (CPPW). This initiative, led by the Centers for Disease Control and Prevention (CDC), provided awards to 50 communities in the United States to implement policy, systems and environmental (PSE) changes. PSEs alter the environmental context to make default choices healthier (Frieden, 2010). Under CPPW, evidence-based strategies were implemented to reduce tobacco use and/or obesity (Bunnell et al., 2012). The American Recovery and Reinvestment Act of 2010 (Khavjou et al., 2014) supported 21 CPPW communities to address tobacco control.

Each CPPW awardee developed a plan to reduce tobacco use and secondhand smoke exposure through evidence-based PSE implementation. Although plans differed across awardees, most included smoke-free policies, cessation services, and mass media interventions, such as counter-advertising. Examples of interventions implemented by CPPW awardees included mass media campaigns combined with free

Abbreviations: CPPW, Communities Putting Prevention to Work; PRISM, Prevention Impacts Simulation Model

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nicotine therapy giveaways targeting light smokers; media campaigns promoting increased compliance with existing smoking-prohibition policies (Jasek et al., 2015; Jeong et al., 2015; Gibson et al., 2014; Waddell et al., 2014); and policies that required permits to sell tobacco products and restricted the portion of a retailer's windows that could be covered with tobacco signs or advertisements to 15% (Coxe et al., 2014).

Smoking is the main preventable cause of premature death in the United States (U.S. Department of Health and Human Services, 2014). Although smoking prevalence has declined over the past four decades, as of 2014, almost 500,000 annual deaths were attributable to smoking (U.S. Department of Health and Human Services, 2014). Smoking also imposes a large economic burden. The annual costs of smoking for 2009 to 2012 were approximately $300 billion, with almost half of the burden arising from direct medical costs, another half from lost productivity resulting from premature mortality, and over $5 billion from lost productivity resulting from secondhand smoke exposure (U.S. Department of Health and Human Services, 2014).

The study purpose was to estimate the potential long-term cost-effectiveness of CPPW tobacco PSE changes. Findings provide insight into the potential long-term benefits and return on investment from implementing interventions that address tobacco use and secondhand smoke exposure.

2. Methods

The CPPW evaluation included cost and modeling studies. For the cost study, we collected data on the 21 awardees' direct implementation costs for the duration of the CPPW award (Khavjou et al., 2014; Honeycutt et al., 2016). For the modeling study, we adapted an existing chronic disease system dynamics simulation model (Homer et al., 2008; Homer et al., 2010; Homer et al., 2014; Hirsch et al., 2010; Loyo et al., 2013; Honeycutt et al., 2015) to estimate the potential impacts, relative to baseline trends, of PSE changes implemented by the 21 CPPW awardees. The CPPW program and CPPW cost study have been described elsewhere (Bunnell et al., 2012; Khavjou et al., 2014; Honeycutt et al., 2016; Soler et al., 2016).

2.1. Cost data and analysis

We collected data on the costs to implement CPPW interventions via a Web-based cost instrument (Khavjou et al., 2014; Honeycutt et al., 2016). We provided each community with protected access to the instrument to report costs of their CPPW-funded activities quarterly for the award period. We obtained cost data for (i) labor, (ii) consultants, (iii) materials, travel and services, (iv) overhead activities (i.e., indirect expenditures), and (v) partner organization efforts (i.e., contracted services). In addition to costs paid from the CPPW award, we collected information on in-kind contributions from communities and their partners.

As part of CPPW, each community developed a community action plan (CAP) that included community-defined objectives designed to improve population health. Communities reported costs for each resource category (e.g., labor, consultants, and materials) and entered the percentage allocation of those costs to each CPPW objective, allowing for cost estimation at the objective level. Costs included CPPW-funded expenditures and in-kind costs of awardees and their partners, but did not include costs incurred by program participants. To estimate costs for tobacco interventions, we first linked interventions to community objectives. If multiple interventions were linked, we divided objective costs equally across the linked interventions. We collected costs for the CPPW award period (2010 − 2013) from 2011 to 2013. We conducted analyses in 2015, adjusting costs to 2010 dollars using gross domestic product price indices (Bureau of Economic Analysis, n.d.).

We estimated total CPPW tobacco intervention costs as the sum of spending on labor, materials, travel, supplies, overhead, and partners minus spending on evaluation activities plus the value of in-kind contributions. We analyzed costs for four community types: large cities, state-coordinated communities, tribes, and urban areas. Large cities had populations of more than 1 million. State-coordinated communities received an award at the state level to support work in two separate cities or rural areas of up to 500,000 people. Tribal communities were federally recognized Tribal governments, Regional Area Indian Health Boards, Urban Indian organizations, or Inter-Tribal Councils. Urban areas were those with populations of 500,000 to 1 million.

For each community type, we assessed the breakdown of total costs by objective type. Evaluators coded objectives as one of five categories: (i) implementation, (ii) change, (iii) planning, (iv) promotion, and (v) other (i.e., “training” or “dissemination/evaluation”). Objectives in the implementation category included adopting or implementing a PSE intervention to reduce tobacco use or exposure, such as restricting internet tobacco sales or limiting tobacco product placement. Change objectives involved changing an existing intervention. Planning objectives supported meetings or other efforts to plan for interventions. Promotion objectives were those with a goal of promoting or raising awareness of issues targeted by CPPW. The other category included all remaining objectives.

2.2. CPPW tobacco interventions and reach

All CPPW tobacco communities invested in counter-advertising or other media efforts and all provided quitline and other cessation services (Bunnell et al., 2012). Such efforts reached as many as 27 million people across all CPPW tobacco communities (Soler et al., 2016). For our analysis, reach was defined as the estimated fraction of people in the target population who were protected by a CPPW tobacco intervention. CDC project officers obtained reach estimates from awardees during monthly and quarterly progress reviews and cross-verified those data with community demographic data, such as U.S. Census data (Soler et al., 2016). Although all communities were asked to implement tobacco interventions in five strategic areas, including media, access, point of purchase, price, and social supports and services (Bunnell et al., 2012), the specific interventions implemented by awardees varied. For example, one awardee conducted a free nicotine replacement therapy giveaway targeting light smokers, which was promoted using a TV campaign to counter rationalizations that light smoking does not make one a smoker and educate about the health risks of any smoking (Jeong et al., 2015). Another awardee created institutional partnerships with local hospitals to improve compliance with existing smoke-free air laws (Waddell et al., 2014). Still another CPPW awardee worked with the local government to implement a policy requiring tobacco retailers to obtain an annual permit to sell tobacco. The ordinance prohibited issuance of permits to new retailers applying to operate near a school or another tobacco retailer and allowed no more than 15% of windows to be covered with tobacco advertisements (Coxe et al., 2014).

2.3. Simulation modeling analysis

We used the Prevention Impacts Simulation Model (PRISM) to model the impacts of CPPW. PRISM is an interactive decision-support tool that allows users to estimate the potential health and economic impacts of PSE changes to reduce cardiovascular disease risks (Homer et al., 2008; Homer et al., 2010; Homer et al., 2014; Hirsch et al., 2010; Loyo et al., 2013; Honeycutt et al., 2015). Strategies included in PRISM can be adjusted to explore the impacts of increasing or decreasing efforts to adopt a strategy. For example, raising the levels of “Workplace Smoking Bans” and/or “Smoking Counter-marketing” strategies reduces cigarette smoking rates in PRISM and leads to reductions in the future estimated prevalence of chronic disease and disease-related deaths and costs compared with baseline trends. Because quitting smoking does not immediately eliminate its risks, PRISM applies half of smokers' risk of CVD and the full amount of smokers' risk of non-CVD

Table 1
PRISM strategies analyzed for communities putting prevention to work (CPPW) tobacco control awardees.

PRISM strategy name	Number of awardees working on strategy, 2010–2013	Examples of CPPW interventions captured in PRISM strategy[a]
Tobacco tax rate	5	-Support increases in tobacco prices
Tobacco marketing restrictions	9	-Restrict sale of tobacco to minors -Restrict product placement -Ban free samples -Ban price discounts
Smoking counter marketing	14	-Hard hitting counter-advertising -Events or media to change behavior
Workplace smoke-free policies[b]	20	-100% smoke-free policies or 100% tobacco-free policies
Use of quit counseling and NRT by smokers	10	-Provide quitline and other cessation services -Reduce out-of-pocket costs for cessation therapies

[a] Complete list of tobacco control interventions used in CPPW is provided in Table 3 of Bunnell et al. (2012).
[b] Implemented as fraction of workplaces that allow smoking; when smoke-free policies are implemented, this fraction declines.

conditions to ex-smokers who quit within the previous 10 years. For those who quit more than 10 years earlier, PRISM applies half of smokers' risk of non-CVD conditions. We provide detailed information about PRISM in a supplementary appendix.

Five PRISM strategies related to reducing tobacco use and secondhand smoke exposure were explored in this analysis: tobacco product price increases, tobacco marketing restrictions, smoking counter-marketing, workplace smoke-free policies, and quitline and related cessation services. Table 1 shows the number of awardees with at least one intervention tied to each strategy and provides examples of the interventions implemented.

Baseline PRISM strategy levels reflect a community's public health environment before CPPW interventions were implemented. To identify baseline strategy levels for each awardee, we reviewed the published literature and data, including the American Lung Association State Legislated Actions on Tobacco Issues database and the National Worksite Health Promotion Survey, and extrapolated information for the relevant city, county and/or state level (Soler et al., 2016). Each awardee had the opportunity to review and edit their baseline levels to more accurately represent the pre-CPPW environment in their communities.

To reflect the work accomplished by CPPW awardees in PRISM, three teams of reviewer-dyads translated completed CPPW objectives and milestones into movements in PRISM strategy settings. Reviewers estimated the impact of awardees' CPPW tobacco interventions as a combination of reach, which was estimated by CDC, and intensity (Soler et al., 2016). Intensity is the degree to which people exposed to an intervention make healthier choices because of being reached. For some strategies, intensity is measurable, such as price levels for cigarettes; for others, intensity is established relative to benchmarked minimum and maximum values (e.g., from 0% to 100%). Our reviewers used an ordinal scale (e.g., 0%, 20%, 40%, 60%, 80%, and 100%) to quantify the CPPW intensity change from baseline (Bunnell et al., 2012; Soler et al., 2016). We calculated the CPPW-related change for each PRISM strategy relative to the baseline level as intensity multiplied by reach.

After translating tobacco PSE changes into PRISM, we simulated the potential benefits (i.e., premature deaths and medical costs averted) of CPPW achievements relative to baseline trends. CDC tracked objective completion status throughout the CPPW award period. Our modeling analysis included objectives that were completed by June 2013 and assumed that PSE changes were fully sustained through 2020. We used 2010 as the starting point to be consistent with the year and value of the federal CPPW investment and assumed a 2-year period was needed to phase in all interventions. Premature deaths averted included those from CVD, such as coronary heart disease and stroke, as well as other chronic diseases, such as type 2 diabetes and lung cancer. The risk factor and disease cost estimates applied in PRISM were generated by combining data from the published literature with cost analysis results from Medical Expenditure Panel Survey data from 2002 through 2008 (details in supplementary appendix). We calculated the present value of medical costs by applying a 3% annual discount rate in each year after the completion of CPPW (i.e., from 2013 through 2020). Because PRISM economic outputs are in 2008 dollars, we inflated costs to 2010 dollars using the GDP deflator (Bureau of Economic Analysis, n.d.).

To estimate the cumulative effect of CPPW for all 21 tobacco awardees, we aggregated the 2010 through 2020 community estimates across all awardees. For PRISM outcomes that were reported on a per capita basis (e.g., premature deaths averted per 1000 persons), total potential benefit was estimated using U.S. Census Bureau forecasts of the adult population in each year through 2020.

2.4. Cost-effectiveness analysis

We used the cost data to estimate total direct costs of CPPW tobacco control interventions by community type. Next, we calculated the percentage of costs that went toward implementing new or changing existing PSEs versus conducting planning, promotion, or other activities.

To assess how costs for tobacco interventions compare with potential benefits, we used PRISM estimates of potential medical costs saved, deaths averted, and life-years gained annually through 2020. We combined estimates from the cost study and PRISM to estimate the cost-effectiveness of CPPW tobacco interventions. We estimated the total net costs of CPPW compared with baseline costs as follows:

$$Total\_CPPW\_net\_cost_i = CPPW\_Cost_i + (MedCost_{CPPW,i} - MedCost_{Baseline,i}), \quad (1)$$

where $CPPW\_Cost_i$ represents tobacco program costs incurred from 2010 to 2013 from the CPPW cost study. $MedCost_{CPPW,i}$ denotes the present value of predicted medical costs from 2010 through 2020 in the CPPW tobacco communities, as estimated using PRISM. $MedCost_{Baseline,i}$ denotes the present value of medical costs from 2010 through 2020 under pre-CPPW, or baseline, conditions. All costs were in 2010 dollars; no discounting was applied to CPPW program costs. We conducted all analyses separately by community type, as represented by the subscript *i*.

We estimated cost effectiveness as follows:

$$Total\_CPPW\_net\_cost_i \div (Effectiveness_{CPPW,i} - Effectiveness_{Baseline,i}), \quad (2)$$

where total net CPPW costs were calculated as shown in Eq. (1), $Effectiveness_{CPPW,i}$ represents the simulated number of deaths or life-years from chronic disease-related causes in CPPW tobacco communities from 2010 through 2020, and $Effectiveness_{Baseline,i}$ represents the estimated number of deaths or life-years in these communities under baseline conditions. We estimated the present value of life-years, discounting to 2010 using a 3% annual discount rate; we did not discount estimates of deaths.

2.5. Scenario and sensitivity analyses

Although our base analysis assumed no additional costs were incurred after CPPW ended, maintaining PSE changes may require an ongoing investment of time and resources (McAuley et al., 2009). To explore how maintenance costs would affect results, we analyzed a scenario that included such costs from 2013 through 2020 equal to 90% of a community's average annual CPPW cost. This assumption likely reflects higher maintenance costs than would be needed for many of the tobacco interventions implemented under CPPW. Some interventions, such as campus usage bans, are expected to have negligible maintenance costs once implemented. Another sensitivity analysis examined the impact on cost per death averted of applying a 3% annual discount rate to calculate the discounted number of deaths averted between 2010 and 2020. Additionally, we conducted sensitivity analyses to account for uncertainty in the input data and assumptions. PRISM conducts probabilistic sensitivity analyses (PSAs), randomly and repeatedly selecting values for 63 model inputs from 500 model runs to create a distribution of results. In combination with the PSAs, we generated pessimistic and optimistic estimates by increasing and decreasing the CPPW-related changes by 10% of the full range of possible values for each strategy. The lower bound of reported sensitivity ranges is the 97.5th percentile of the PSA results from the pessimistic run, and the upper bound is the 2.5th percentile of the PSA results from the optimistic run.

3. Results

Table 2 shows the total and average costs of CPPW interventions for each community type. The 21 communities had $130.6 million in total costs, with an average community cost of $6.2 million. Of the four community types, the eight large cities had the highest costs, totaling $82.8 million, with an average of $10.3 million per community. The urban areas' averages were about $5.6 million. Overall, communities allocated costs by objective type as follows: 82% for implementation, 3% for change, and 10% for planning objectives. We estimated that more than 4500 premature deaths could be averted and 21,400 life-years saved for the period 2010 through 2020 if CPPW tobacco interventions are sustained (confidence range of 950 to 14,060 for deaths averted–Table 3; range of 21,200 to 21,500 for life-years saved—Table 4).

Results suggest that $735 million in medical costs may be averted from 2010 through 2020 (confidence range of $156 million to $2.37 billion), with the largest share of savings in large cities ($596.5 million [$121 million to $2.02 billion]; Table 3). We found estimated cost savings of $604.4 million to health care and program payers over the analysis time horizon ($25 million to $2.24 billion), indicating no additional costs per death averted (Table 3). Similarly, when we analyzed the incremental cost per life-year saved, we found that CPPW tobacco interventions would likely be cost saving through 2020 across all 21 communities. For state coordinated communities, the estimated incremental cost per life-year gained ranged from cost saving to $1340 per life-year gained (Table 4).

When we discounted the number of deaths from 2010 through 2020 using a 3% discount rate, we found 3750 deaths averted versus an undiscounted estimate of 4530 (results not shown); the large impact of discounting indicates that the largest share of deaths averted occur close to the end of the 11-year analysis period. For the scenario in which we assumed that 90% of average annual CPPW costs would be incurred annually to maintain CPPW interventions, we found potential cost savings of $353 million for 2010 through 2020 across the 21 CPPW tobacco awardees ($226 million in costs to $1.99 billion cost savings; Table 3). Results suggest that CPPW would remain cost saving even if maintenance costs were incurred, but the confidence range is wide, suggesting incremental cost effectiveness from cost saving to $239,300 per death averted. The confidence ranges account for uncertainty in both model input values and the impact of CPPW, and because of this are fairly wide. However, additional research is needed to better understand the costs to maintain tobacco PSE interventions and how costs compare with potential benefits.

4. Discussion

CPPW tobacco communities implemented evidence-based, high-impact tobacco control interventions, such as smoke-free policies and quitlines. Previous research, including simulation modeling of tobacco control policies implemented in the United States and other countries, has shown that such efforts can reduce tobacco use and secondhand smoke exposure, resulting in short- and long-term health and economic benefits (U.S. Department of Health and Human Services, 2014; Levy et al., 2006; Petrovic-van der Deen et al., 2018). By comparing the costs of CPPW tobacco interventions with estimated cumulative potential benefits from 2010 through 2020, we found that CPPW tobacco programs have the potential to be cost effective or save health system costs. Our estimates are conservative, because a large share of the benefits from reducing tobacco use and exposure will likely accrue more than 10 years after PSE changes are implemented. Further, when we assumed that a high proportion of the initial program investment would need to be reinvested annually to sustain CPPW tobacco interventions, results suggested that the investments would likely still be cost saving or cost effective.

Our analysis was subject to several limitations. First, cost data were self-reported by awardee staff. We verified quarterly total costs entered in the CSI against quarterly expenditures in federal financial reports; however, we could not verify the accuracy of reported cost allocations across objectives or in-kind contributions.

Second, because our analysis omitted several potential benefits of CPPW tobacco interventions, our estimates understate the potential cost savings of CPPW. For example, we did not account for smoke-free policies in private multi-unit housing units because they are not captured in PRISM. Also, although we included all costs to implement CPPW tobacco objectives, regardless of whether the objectives were

Table 2
Communities putting prevention to work, 2010–2013: Tobacco control awardee costs by community type and objective type (2010 $ and % of total costs).

	Community type				
	Large cities	State coordinated	Tribal	Urban areas	All communities
Number of communities (n)	8	5	2	6	21
Total costs (in millions, USD$)	82.75	11.10	3.34	33.35	130.55
Average cost per community (in millions, USD$)	10.34	2.22	1.67	5.56	6.22
Objective type					
Implementation	82.6%	88.4%	86.0%	77.1%	81.8%
Change	1.9%	0.0%	0.0%	8.0%	3.2%
Planning	12.7%	0.0%	8.5%	5.2%	9.6%
Promotion	0.0%	9.8%	5.5%	0.0%	1.0%
Other	3%	2%	0%	10%	4%

Table 3
Communities putting prevention to work (CPPW) tobacco control awardee deaths, costs, and cost-effectiveness, by community type.

	Primary analysis results					Scenario analysis results: Annual maintenance costs equal to 90% of initial annual investment	
Community type[a]	Potential deaths averted, 2010–2020	CPPW program Costs[b], 2010–2013	Potential medical costs averted from CPPW[b,c], 2010–2020	Total CPPW costs[b] (=Program costs − Potential medical Costs averted)	Potential cost per death averted (=Total CPPW costs ÷ potential deaths averted, in USD$)[d]	Total potential CPPW costs, 2010–2020	Potential cost per death averted[d]
Large cities	3676 [747–11,833]	82.75	596.50 [121.22–2017.11]	(513.75) [(1934.36) – (38.47)]	CS [CS - CS]	(354.27) [(1774.88) –121.01]	CS [CS - 161,940]
State coordinated	154 [32–457]	11.10	23.48 [5.10–67.45]	(12.38) [(56.35) – 6.00]	CS [CS – 186,880]	9.01 [(34.96) –27.39]	58,380 [CS - 853,170]
Tribal	54 [19–96]	3.34	8.99 [3.34–16.06]	(5.64) [(12.72) – 0.003]	CS [CS – 160]	0.80 [(6.28) – 6.45]	14,840 [CS – 335,940]
Urban areas	645 [148–1669]	33.35	106.03 [26.03–270.36]	(72.67) [(237.00) – 7.33]	CS [CS – 49,610]	(8.39) [(172.72–71.61)]	CS [CS – 484,910]
All communities	4530 [946–14,055]	130.55	734.99 [155.69–2370.98]	(604.44) [(2240.43) – (25.14)]	CS [CS – CS]	(352.84) [(1988.83) – 226.45]	CS [CS – 239,330]

CPPW – Communities Putting Prevention to Work.
CS – Cost saving.
Costs are reported in millions of USD$, except in the Potential Cost Per Death Averted Columns. Parentheses denote negative values. Numbers in brackets reflect the upper and lower bounds on deaths and medical costs from sensitivity analysis PRISM runs.

[a] Large cities had populations of more than 1 million. State-coordinated communities received an award at the state level to support work in two separate cities or rural areas of up to 500,000 people. Tribal communities were federally recognized Tribal governments, Regional Area Indian Health Boards, Urban Indian organizations, or Inter-Tribal Councils. Urban areas were those with populations of 500,000 to 1 million.

[b] CPPW program costs are for 2010–2013. All costs were adjusted to 2010 dollars using the GDP deflator. Medical costs averted were discounted to 2010 using a 3% annual discount rate, but program costs were not discounted.

[c] Potential medical costs averted calculated as simulated medical costs from 2010 through 2020 under baseline conditions less simulated medical costs from 2010 through 2020 under CPPW conditions for the 21 communities.

[d] "Cost saving" indicates that net medical costs were less than zero, or in other words, that the potential medical costs averted exceeded CPPW estimated program costs.

Table 4
Communities putting prevention to work (CPPW) tobacco control awardee life years saved, costs, and cost-effectiveness, by community type.

Community Type[a]	Life years saved, 2010 – 2020[b]	Total CPPW costs (=Program costs[c] − potential medical costs averted[d])	Potential cost per life year saved (=Total CPPW costs ÷ life years saved, in USD$)[e]
Large cities	10,046 [9926–10,067]	(513.75) [(1934.36) – (38.47)]	CS [CS - CS]
State coordinated	4513 [4467–4521]	(12.38) [(56.35) – 6.00]	CS [CS – 1340]
Tribal	660 [650–662]	(5.64) [(12.72) – 0.003]	CS [CS – 5]
Urban areas	6215 [6160–6221]	(72.67) [(237.00) – 7.33]	CS [CS – 1190]
All communities	21,434 [21,204–21,471]	(604.44) [(2240.43) – (25.14)]	CS [CS – CS]

Costs are reported in millions of US 2010$, except in the Potential Cost Per Life Year Saved Column, for which costs are reported in US 2010$. Parentheses denote negative values. Numbers in brackets reflect the 95% upper and lower confidence bounds from PRISM sensitivity analyses.
CPPW – Communities Putting Prevention to Work.
CS – Cost saving
[a] Large cities had populations of more than 1 million. State-coordinated communities received an award at the state level to support work in two separate cities or rural areas of up to 500,000 people. Tribal communities were federally recognized Tribal governments, Regional Area Indian Health Boards, Urban Indian organizations, or Inter-Tribal Councils. Urban areas were those with populations of 500,000 to 1 million.
[b] Life Years Saved were discounted to 2010 using a 3% annual discount rate.
[c] CPPW program costs are for 2010–2013. All costs were adjusted to 2010 dollars using the GDP deflator. Medical costs averted were discounted to 2010 using a 3% annual discount rate. These costs are shown by community type in Table 3.
[d] Potential medical costs averted were calculated as simulated medical costs from 2010 through 2020 under CPPW conditions less simulated medical costs from 2010 through 2020 under baseline conditions for the 21 communities. This cost component is displayed in Table 3.
[e] "Cost saving" indicates that net medical costs were less than zero; in other words, that the potential medical costs averted exceed CPPW estimated program costs.

completed, we only included the potential benefits of completed objectives. If objectives that were not completed produced benefits, those were not captured in our estimates. Additionally, our analyses did not account for non-medical costs potentially averted, such as improved labor productivity.

Third, the process of translating interventions into PRISM lever movements is inherently subjective. To ensure consistent coding, we implemented several checks on our processes, including using two coders to establish the appropriate levels for each strategy. Additionally, although our translation approach was developed independently of work by the Center for Community Health and Evaluation (CCHE), the resulting process is similar to CCHE's approach for evaluating the impact of the Community Health Initiative (Center for Community Health and Evaluation, 2012).

Fourth, we assumed that PSE changes and any resulting risk behavior changes would be sustained for the full period. Although data are not available on whether CPPW tobacco control changes have been maintained, trends show increases in the aggregate number of U.S. smoke-free municipalities from 658 in 2013 to 858 in January 2017 (http://www.no-smoke.org/goingsmokefree.php?id=519#ords, n.d.). Previous research suggests that, once implemented, smoke-free policies are typically sustained (Sanders-Jackson et al., 2013).

Our results are consistent with other economic evaluations of population-based interventions aimed at reducing or preventing tobacco use that found cost savings and large impacts on lives saved and life-years gained. The California Tobacco Control Program (TCP) included price increases, a statewide anti-tobacco media campaign, and community-based and school-based prevention efforts, and was estimated to save the state $1.5 billion in medical costs over a 90-year period (Miller et al., 2010). New York's TCP included media campaigns, telephone quitline counseling, and nicotine replacement therapy and was estimated to have a net benefit of $800 million over a 20-year period (Simpson and Nonnemaker, 2013). The American Legacy Foundation's youth-focused mass media campaign, "Truth", had estimated costs of $324 million and an estimated $1.9 billion in averted medical costs over a 27-year period (Holtgrave et al., 2009). Levy and coauthors estimated 25,000 lives saved through 2040 from Arizona's Tobacco Education and Prevention Program (Levy et al., 2006), and Petrovic-van der Deen and colleagues estimated at least 28,900 quality-adjusted life-years gained in New Zealand from achieving a smoke-free goal by 2025 (Petrovic-van der Deen et al., 2018).

Potential health outcomes and medical costs averted from CPPW interventions may not be realized until several years after PSE changes are implemented. We therefore compared program costs incurred for 2010 to 2013 to simulated program outcomes for a longer period, 2010 through 2020. Our results suggest that medical costs averted through 2020 may more than offset the initial investment in CPPW tobacco control interventions, thus highlighting the value of tobacco control interventions, especially over the long term.

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Conflicts of interest

None.

Appendix A. Supplementary materials

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ypmed.2019.01.005.

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