

# Smokefree Policies to Reduce Tobacco Use

## A Systematic Review

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**Abstract:** In 2001, a systematic review for the *Guide to Community Preventive Services* identified strong evidence of effectiveness of smoking bans and restrictions in reducing exposure to environmental (secondhand) tobacco smoke. As follow-up to that earlier review, the focus here was on the evidence on effectiveness of smokefree policies in reducing tobacco use. Smokefree policies implemented by worksites or communities prohibit smoking in workplaces and designated public areas. The conceptual approach was modified for this review; an updated search for evidence was conducted; and the available evidence was evaluated. Published articles that met quality criteria and evaluated changes in tobacco-use prevalence or cessation were included in the review. A total of 57 studies were identified in the period 1976 through June 2005 that met criteria to be candidates for review; of these, 37 met study design and quality of execution criteria to qualify for final assessment. Twenty-one studies measured absolute differences in tobacco-use prevalence with a median effect of -3.4 percentage points (interquartile interval: -6.3 to -1.4 percentage points). Eleven studies measured differences in tobacco-use cessation among tobacco users exposed to a smokefree policy compared with tobacco users not exposed to a smokefree policy. The median absolute change was an increase in cessation of 6.4 percentage points (interquartile interval: 1.3 to 7.9 percentage points). The qualifying studies provided sufficient evidence that smokefree policies reduce tobacco use among workers when implemented in worksites or by communities. Finally, a systematic economic review identified four studies that, overall, demonstrated economic benefits from a smokefree workplace policy. Additional research is needed to more fully evaluate the total economic effects of these policies.

(Am J Prev Med 2010;38(2S):S275-S289) Published by Elsevier Inc. on behalf of American Journal of Preventive Medicine

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### Introduction

Involuntary exposure to environmental tobacco smoke, or secondhand smoke, contributes to morbidity and mortality in nonsmokers, including an estimated 35,000 deaths due to cardiovascular disease and 3000 deaths due to lung cancer every year.<sup>1-3</sup> Smoking in workplaces and indoor public areas represents an important source of secondhand smoke exposure for nonsmoking adults.<sup>4-7</sup> Increasingly, communities and workplaces have adopted smokefree policies, which prohibit the smoking of tobacco products in the workplace

and in public areas,<sup>8-10</sup> with the primary intent of providing the best possible protection for employees and patrons from repeated, extended exposures to secondhand tobacco smoke.<sup>2,7,11</sup>

In 2001, the Task Force on Community Preventive Services (Task Force) published the results of a systematic review for the *Guide to Community Preventive Services (Community Guide)* of the evidence on effectiveness of smoking bans and restrictions for reducing exposure to environmental tobacco smoke.<sup>12,13</sup> For that review, the Task Force examined ten studies<sup>14-23</sup> published prior to June 2000 that met quality criteria for study design and execution, and found strong evidence that these interventions reduced exposure to secondhand smoke in a variety of worksite and community settings.<sup>13</sup>

In the original review, the Task Force examined smoking bans and restrictions on tobacco use, but found insuf-

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0749-3797/00/\$17.00

doi: 10.1016/j.amepre.2009.10.029

ficient evidence to draw a conclusion on the effect.<sup>12,13</sup> Fifty studies were evaluated, almost all of which measured tobacco use among workers exposed to worksite-based policies or to community regulations affecting workplaces. The Task Force noted that several qualifying studies observed substantial reductions in daily consumption of cigarettes by workers exposed to a smoking ban or restriction. In addition, some of the qualifying studies evaluating smoking bans observed increases in tobacco-use cessation and reductions in tobacco-use prevalence in their study populations.<sup>13</sup>

As part of the current Task Force review of interventions appropriate for worksite health promotion efforts, smokefree policies were selected for inclusion as an important intervention option for consideration by many worksites and communities. This report complements the previously completed *Community Guide* review<sup>12</sup> by focusing on: (1) policies that prohibit smoking in designated venues (i.e., smokefree policies); and (2) the evidence that smokefree policies reduce tobacco use.

## Definition

Smokefree policies include private-sector rules and public-sector regulations that prohibit smoking in indoor workspaces and designated public areas. Private-sector smokefree policies may establish a complete ban on tobacco use on worksite property or restrict smoking to designated outdoor locations. Community smokefree ordinances establish smokefree standards for all or for designated indoor workplaces and public areas.

A worksite may adopt a smokefree policy alone or in combination with additional interventions to support tobacco-using employees who might seek assistance in quitting. These additional interventions include tobacco cessation groups, client educational materials or activities, telephone-based cessation support, counseling and assistance from healthcare providers, and access to pharmacologic therapies.

A community may adopt a smokefree policy as part of a focused or comprehensive effort to reduce tobacco use and exposure to secondhand tobacco smoke. Studies evaluating the impact of community smokefree policies have noted, and in several cases attempted to control for, the presence of concurrent interventions such as state tobacco excise tax increases, mass media campaigns, community-wide educational activities, and telephone cessation support services.

## Background

For this update, the Task Force elected to focus on smokefree policies, as opposed to policies that restrict smoking

to designated indoor areas, for both practical and conceptual reasons. First, smokefree policies provide the best possible protection for nonsmokers from exposure to secondhand tobacco smoke.<sup>2</sup> Second, a review of the evidence on effectiveness of smokefree policies is more appropriate to current efforts to reduce exposure to secondhand smoke in the U.S. (smoking restrictions in indoor settings were more commonly adopted in the 1970s and 1980s). Third, the potential effects on tobacco consumption and cessation are conceptually stronger for efforts that prohibit smoking than for restrictions that permit smoking in a designated indoor area.

This review does not revisit the finding from the earlier review of strong evidence of the effectiveness of smoking bans and restrictions in reducing exposure to secondhand tobacco smoke. These policies remain as intervention options, recommended by the Task Force, for use in worksites and community-wide as part of a strategy to reduce exposure to secondhand tobacco smoke. In this report, the review team (the team) examines the available evidence about the impact of smokefree policies in reducing the prevalence of tobacco use among workers when measured as a change in cessation by workers who smoked prior to adoption of the policy.

In addition to the findings from the earlier *Community Guide* review, information about the impact of smokefree policies on tobacco use is available from narrative and systematic reviews by other agencies. This is discussed in greater detail (see Results from Other Reviews).

**Guide to Community Preventive Services.** The systematic reviews in this report present the findings of the independent, nonfederal Task Force on Community Preventive Services. The Task Force is developing the *Community Guide* with the support of the USDHHS in collaboration with public and private partners. The CDC provides staff support to the Task Force for development of the *Community Guide*. The book, *The Guide to Community Preventive Services: What Works to Promote Health?*<sup>24</sup> (also available online at [www.thecommunityguide.org](http://www.thecommunityguide.org)) presents the background and the methods used in developing the *Community Guide*.

**Healthy People 2010 goals and objectives.** The interventions reviewed here may be useful in reaching several objectives specified in Healthy People 2010.<sup>25</sup> These objectives include:

27-1 Adult tobacco use: reduce cigarette smoking prevalence from 24% (1998, age adjusted to year 2000 standard population) to 12%

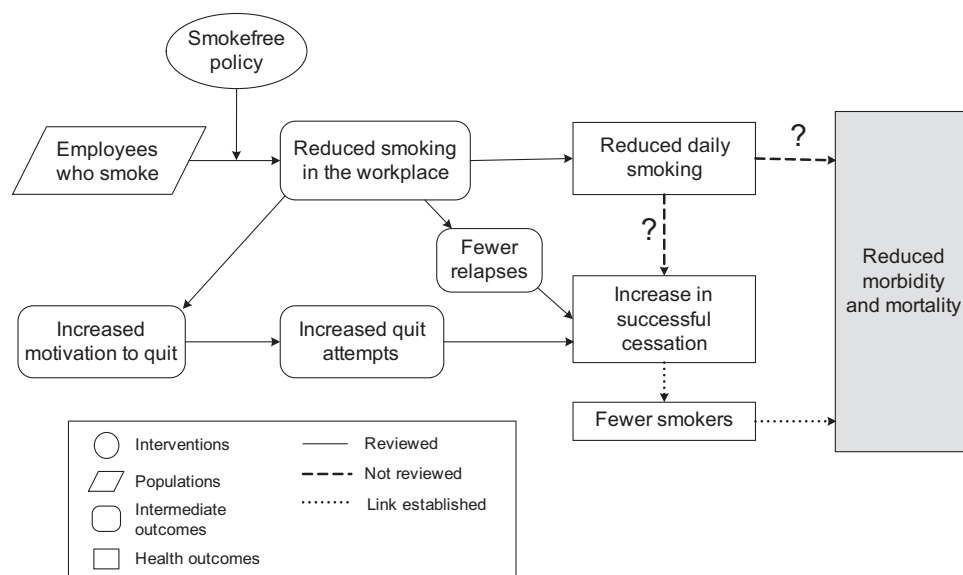
27-5 Smoking cessation by adults: increase the percentage of adult smokers stopping smoking for 1 day or longer from 41% (1998, age adjusted to year 2000 standard population) to 75%

## Methods

This review was conducted according to the methods developed for the *Community Guide*, which have been described in detail elsewhere.<sup>26,27</sup> To be included in this review, a study had to: (1) be primary research published in a peer-reviewed journal; (2) be published in English in the period January 1980 through June 2005; (3) meet the minimum research quality criteria for study design and execution<sup>27</sup>; and (4) evaluate the effects of smokefree policies on the outcomes of interest.

## Conceptual Approach

Figure 1 shows the conceptual approach that guided the update. Smokefree policies, by reducing smoking in the workplace, have already been demonstrated to be effective in reducing exposures to secondhand tobacco smoke.<sup>12</sup> The focus of this update is on the evidence that these policies also reduce tobacco use in the affected population. Smokefree policies might provide a motivation for tobacco users to initiate a cessation effort. By reducing opportunities to smoke, these policies might reduce relapses and increase the success rate for cessation attempts. More quit attempts and higher rates of success will translate into more successful quitters and fewer continuing smokers. As a result, in addition to reducing the adverse health effects associated with exposure to secondhand smoke, smokefree policies would directly reduce current and future morbidity and mortality associated with tobacco use by individuals.



**Figure 1.** Analytic framework showing the hypothesized pathways through which smokefree policy interventions are hypothesized to affect intermediate and health outcomes; ? indicates that there is neither an established understanding from the broader literature of the health effects of reduced but continued daily smoking, nor an established understanding of the sequential relationship (if any) between reduced daily smoking and future successful smoking cessation.

## Search Strategy

The articles to be reviewed were obtained from systematic searches of multiple databases, reviews of bibliographic reference lists, and consultations with experts in the field. The original search for evidence included the period 1980–2000. This updated search examined the period January 1999 through June 2005. The following databases were searched: MEDLINE, PsycINFO, EMBASE, and the database of the Office on Smoking and Health. Keywords used in this search were: work, workplace, occupational health, smoke, tobacco, policies, bans, restrictions, laws, legislation, smokefree, control.

## Evaluating and Summarizing the Studies

Using the standardized *Community Guide* abstraction form<sup>27</sup> (also available at [www.thecommunityguide.org/methods/abstractionform.pdf](http://www.thecommunityguide.org/methods/abstractionform.pdf)) a team of abstractors evaluated each study that met the inclusion criteria for the suitability of the study design and execution. They rated the suitability of each study design as greatest, moderate, or least, depending on the degree to which the design protected against threats to internal and external validity. They rated the execution of each study as good, fair, or limited, based on several predetermined factors that could potentially limit a study's utility for assessing intervention effectiveness. All studies were reviewed by at least two trained researchers. Concerns about ratings of study design and execution were discussed and resolved by team consensus. The team included studies of greatest, moderate, or least suitable design and good or fair execution (as defined by *Community Guide* methods) in the final assessment of the evidence in this review. For qualifying studies, effect estimates were then calculated for the study outcomes for which sufficient information was available to do so.

## Outcomes Evaluated

The primary outcomes examined in this review were: (1) self-reported tobacco use prevalence within the worksite population or study population; and (2) self-reported abstinence from tobacco use (with or without biochemical verification). Measurements of change in individual consumption (for example, cigarettes smoked per day) were reported in some studies, and the team sum-

marized the results. The Task Force previously examined changes in consumption,<sup>12</sup> but the link between individual consumption change and subsequent cessation (or health benefit) remains incompletely quantified.<sup>8,28</sup>

**Calculation of effect estimates.** Effect estimates were reported in a variety of ways. The team examined the subset of studies reporting change in the prevalence of tobacco use separately from the subset of studies that reported change in tobacco-use cessation, and attempted to calculate absolute percentage point change and relative percentage change for each study. Several studies provided a measurement for both and each was included in the appropriate category (prevalence or cessation), except for cases in which prevalence outcomes included both “current tobacco user” and “former tobacco user” categories. In these cases, the team selected the prevalence rates for current users.

Several studies provided unadjusted data on change in tobacco use among baseline users (cessation) and OR estimates that adjusted for a variety of demographic and setting-specific characteristics. Although these outcomes are related, both estimates are reported in the appropriate section of this review of the evidence. When studies provided multiple measurements over time, the team used the “pre” measurement closest to the start of the intervention, and the most distal “post” measurement reported. The formulas used to generate absolute and relative change estimates are provided in the following sections.

**Absolute change.** Absolute changes (differences described as “percentage point changes”) were calculated using the following formula, where  $I_{post}$  is the post-test measure for the group receiving the intervention,  $I_{pre}$  is the pretest measure for the group receiving the intervention,  $C_{post}$  is the post-test measure for the comparison group, and  $C_{pre}$  is the pretest measure for the comparison group:

$$(I_{post} - I_{pre}) - (C_{post} - C_{pre})$$

When studies did not include a comparison group, the team calculated the net intervention effect using measurements from the intervention group:

$$I_{post} - I_{pre}$$

When studies had a comparison group but no baseline measurements, the team calculated the net intervention effect as:

$$I_{post} - C_{post}$$

**Relative change.** For continuous variables (result is described as “percentage changes”), the team calculated relative percentage changes in the outcomes of interest according to the following formulas:

$$\left( \left[ \frac{I_{post}/I_{pre}}{C_{post}/C_{pre}} \right] - 1 \right) \times 100 \%$$

The team calculated the relative intervention effect for studies without a comparison group as

$$\left( \frac{I_{post} - I_{pre}}{I_{pre}} \right) \times 100 \%,$$

and studies without baseline measurements as

$$\left( \frac{I_{post} - C_{post}}{C_{post}} \right) \times 100 \%.$$

In the study of comparisons of changes in tobacco-use cessation, participants were tobacco users at baseline ( $I_{pre}=0\%$ ).

Where appropriate, results based on cross-sectional comparisons (described as “differences”) are distinguished from results in studies with concurrent comparisons over time or before-and-after assessments of a single group (described as “changes”).

The team summarized results across studies by calculating median absolute and relative percentage changes, as well as interquartile intervals or simple ranges. Some studies reported their results as ORs, which could not be converted to either absolute or relative percentage change. Results from this subset of studies are summarized by presenting the range of effect estimates and a narrative assessment.

## Searching for and Retrieving Economic Evidence

The team’s general search for evidence identified some studies with economic information. The economics evaluation team (economics team) also performed a focused economic search of the effectiveness literature using economic-specific keywords including cost analysis, cost-effectiveness analysis, cost-benefit analysis, and cost-utility analysis combined with MeSH headings. Two additional databases relevant to economics, EconLit and the Social Sciences Citation Index, were searched. As in the reviews of effectiveness, the economics team considered studies referred by experts and reviewed references from retrieved articles.

Before proceeding with abstraction, the economics team made sure that studies met general inclusion criteria and satisfied two additional requirements of economic studies: use of one or more of the four analytic methods—cost, cost-benefit, cost effectiveness, or cost-utility analysis—and provision of sufficient detail to enable use and adjustment of the study’s data and results. For this review, the economics evaluation team identified some studies that reported cost of illness averted but did not provide any information on program cost. Because they provide data that are crucial in determining any potential cost saving from the intervention, the economics team decided to keep these studies for economic review but did not rate them with a quality score. Further details about the abstraction process and assessment of quality are available at [www.thecommunityguide.org/econ/](http://www.thecommunityguide.org/econ/).

## Results

### Review of Evidence: Smokefree Policies to Reduce Tobacco Use

**Effectiveness.** Fifty-seven studies were identified in 55 reports evaluating the impact of smokefree policies on one or more outcomes of interest.<sup>8,14,18,21–23,29–77</sup> Twenty studies with limited quality of execution<sup>36,37,43–46,48,51–53,57,59,62–68,76</sup> were not included in the final body of evidence. Eight articles<sup>78–85</sup> provided additional information on studies already included in the review. In addition, the team identified seven studies described in six articles that examined the impact of smoking restrictions, but not of smokefree policies.<sup>17,19,86–89</sup> Details of the 37 studies in 35 reports that qualified for review<sup>8,14,18,21–23,29–35,38–42,47,49,50,54–56,58,60,61,69–75,77</sup> are available at [www.thecommunityguide.org/worksite/](http://www.thecommunityguide.org/worksite/).

**Study design and evaluation characteristics.** Of the 37 qualifying studies of smokefree policies, eight<sup>38,42,50,55,61,71,73,75</sup> employed designs of greatest suitability. These studies included a concurrent unexposed or less-exposed comparison population or examined a cohort of subjects over the study period. Seven studies in six reports<sup>18,21,33,35,50,61</sup> were rated as moderate in study design suitability, using time-series or retrospective cohort frameworks. The study designs employed in 23 of the qualifying studies<sup>8,14,22,23,29–31,34,39,40,41,47,49,54,56,58,60,69,70,72,74,77</sup> were assessed as least suitable. These included 13 studies<sup>8,31,34,39–41,54,58,70,72,74,77</sup> that used cross-sectional comparisons and ten studies<sup>14,22,23,29,30,47,49,56,60,69</sup> that used single group before-and-after comparisons.

Studies included in this review were conducted using two basic formats. In 19 studies,<sup>14,18,21–23,29,32,35,38,47,49,50,56,60,69,71,73,77</sup> the settings were specific worksites or companies that implemented smokefree policies (voluntarily or in response to a community smokefree ordinance). In 18 studies,<sup>8,30,31,33,34,39–42,54,55,58,61,70,72,74,75</sup> workers were identified (typically as part of a telephone-based survey) and provided both information on smoking status and information on their workplace smoking policy.

All of the studies included in this review examined differences or changes in cigarette smoking. In ten studies,<sup>18,22,23,29,30,33,47,49,55,69</sup> the presence of other concurrent interventions to reduce tobacco use were described.

**Outcomes related to self-reported changes in prevalence of tobacco use.** Twenty-one studies in 19 reports<sup>14,18,21–23,30,31,35,40,47,54,56,58,61,69,72–74,77</sup> included 22 study arms evaluating differences or change in the prevalence of self-reported tobacco use. The absolute percentage point differences or change from each

study are plotted in Figure 2. The median result was a reduction in tobacco use of 3.4 percentage points (interquartile interval: –6.3 to –1.4 percentage points). In ten studies,<sup>22,30,35,40,47,54,58,72,74,77</sup> the absolute percentage point differences were reported as significant.

Twenty studies in 18 reports<sup>14,18,21–23,30,31,35,47,54,56,58,61,69,72–74,77</sup> provided sufficient information to permit a calculation of relative percentage difference or change in the prevalence of tobacco use. The median relative percentage difference or change in the prevalence of tobacco use was a reduction of 14% (interquartile interval: –28% to –6.8%).

We examined the evidence when stratified by study design suitability (Figure 2). The median absolute percentage change in six studies in five reports<sup>18,21,35,61,73</sup> with greatest or moderate suitability of design was –1.4 percentage points (interquartile interval: –3.4 to +0.6 percentage points). The median absolute percentage change in 15 studies with least suitable designs was –5.5 percentage points (interquartile interval: –8.2 to –2.4 percentage points).<sup>14,22,23,30,31,40,47,54,56,58,69,72,74,77</sup>

Thirteen studies in 12 reports<sup>14,18,21–23,30,35,47,56,61,69,73</sup> evaluated changes in tobacco-use prevalence over a period of time following implementation; the median period was 15 months (range: 6 months to 3 years). The median absolute percentage point change in tobacco-use prevalence for these studies was –2.0 percentage points (interquartile interval: –3.2 to –0.6 percentage points). The median absolute change for the seven studies in six reports<sup>14,18,21–23,56</sup> with observation periods of ≤12 months was slightly smaller (–1.5 percentage points) than that for the six studies<sup>30,35,47,61,69,73</sup> with observation periods of 18–36 months (median: –2.6 percentage points).

Six studies provided additional information comparing differences in tobacco use between workers in smoke-free settings and workers in settings in which smoking was restricted, but not prohibited.<sup>31,40,54,72,74</sup> In this subset of study comparisons, the median absolute percentage difference in the prevalence of tobacco use was –7.3 percentage points (interquartile interval: –9.2 to –2.2 percentage points) and the median relative percentage difference was –32%.

**Outcomes related to self-reported changes in tobacco-use cessation.** Twenty-three studies in 22 reports<sup>22,23,29–34,38,39,41,42,47,49,50,55,60,61,71,72,74,75</sup> evaluated the impact of smokefree policies on tobacco-use cessation among workers. Results from 18 studies<sup>22,23,29,31,34,38,39,41,42,47,49,50,60,61,71,72,75</sup> are plotted in Figure 3, stratified by the presence or absence of a concurrent comparison group.

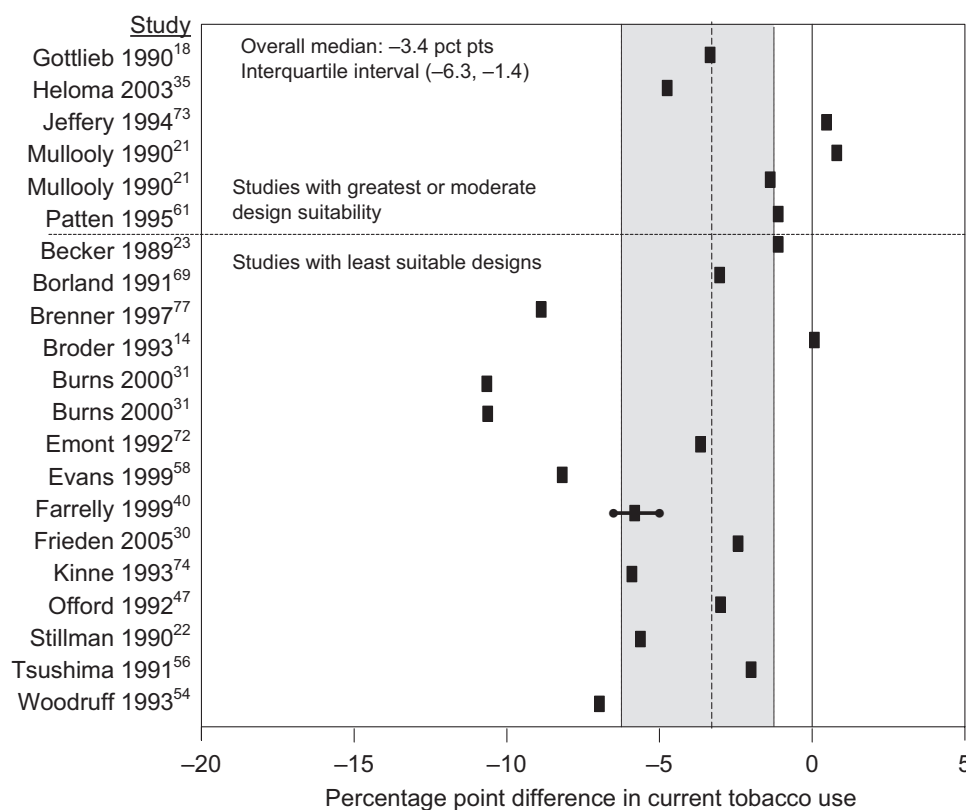
The overall difference or change in cessation among workers who used tobacco was a median improvement of

6.4 percentage points (interquartile interval: +2.0 to +9.7 percentage points). One additional study<sup>74</sup> did not provide measurement details, but reported that the observed differences were not significant. Results from eight studies were reported as significant.<sup>29,34,38,39,47,50,72,75</sup> Fifteen studies provided sufficient information to determine the relative percentage change or difference in tobacco-use cessation among workers exposed to smokefree policy.<sup>23,29,31,34,38,39,41,42,50,60,61,71,72,75</sup> The median finding was an improvement of 32% (interquartile interval: 14% to 52%).

Sixteen studies provided sufficient information to determine the cessation rate for tobacco-using workers who were exposed to a smokefree policy.<sup>22,23,29,31,34,38,39,41,42,49,50,60,61,71,75</sup> The median study finding was a quit rate of 13.2% (interquartile interval: 7.2%–21.6%) with a median follow-up or observation window of 1 year (range: 4 weeks to 8 years).

Eleven studies<sup>31,34,38,39,41,42,50,61,71,75</sup> reported measurements of differences in tobacco cessation between subjects exposed to a smokefree policy and subjects not exposed to a smokefree policy. The median absolute percentage difference or change in self-reported tobacco-use cessation was 6.4 percentage points (interquartile interval: 1.3–7.9 percentage points) and the median relative percentage change was 45% (interquartile interval: 29%–57%). An additional study<sup>74</sup> did not report measurements, but did note that differences were not significant. Only two studies<sup>50,71</sup> attempted biochemical validation of self-reported smoking status, and only three studies<sup>31,34,41</sup> evaluated self-reported cessation of  $\geq 3$  months' duration. Five of the study comparisons were cross-sectional<sup>31,39,41,74</sup> and the median observation period in the remaining seven studies<sup>34,38,42,50,61,71,75</sup> was 2 years (range: 4 weeks to 8 years).

In seven studies, change in tobacco cessation was measured in a single group before-and-after implementation

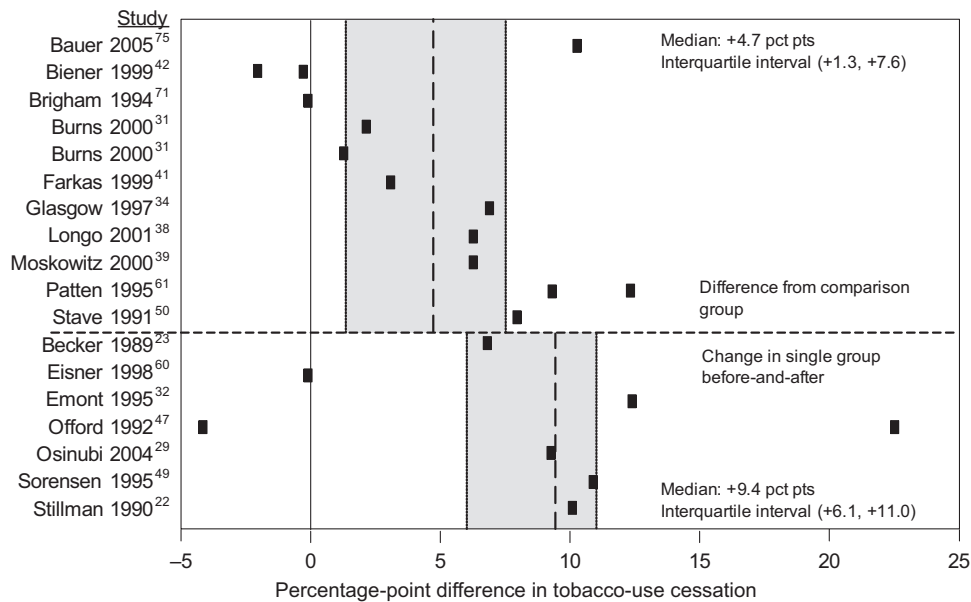


**Figure 2.** Effects of smokefree policies in workplaces and communities on tobacco use among workers, stratified by design suitability of studies. Some studies have multiple study arms so are repeated.

of smokefree policy.<sup>22,23,29,47,49,60,72</sup> The median absolute percentage change in self-reported tobacco-use cessation was 9.4 percentage points (interquartile interval: 6.1–11.0 percentage points). None of these studies attempted biochemical verification of smoking status. The median study period was 6 months (range: 1–18 months).

Eight studies in seven reports<sup>31,34,38,39,41,42,75</sup> provided, in addition to data on quit rates, comparisons of tobacco-use cessation in the form of ORs that were adjusted for a variety of demographic and worksite characteristics. Estimates in individual studies adjusted for different variables, and overall, the OR estimates for cessation demonstrated a significant effect from exposure to a worksite or community smokefree policy. Adjusted OR estimates ranged from 1.21 (95% CI=1.00, 1.45)<sup>41</sup> for cessation of  $\geq 6$  months' duration among workers surveyed in California, to 1.92 (95% CI=1.1, 1.3)<sup>75</sup> among long-term participants within the 22 COMMIT (Community Intervention Trial for Smoking Cessation) study communities in the U.S. and Canada.

Five studies<sup>30,33,54,55,70</sup> provided different measurements related to tobacco-use cessation that could not be combined with other study results. Two of these studies<sup>30,33</sup> examined smokefree policies as an identified mo-



**Figure 3.** Effects of smokefree policies in workplaces and communities on tobacco use among workers, stratified by comparison methods in studies. Some studies have multiple study arms so are repeated.

tivator among recent quitters. In the first study,<sup>33</sup> conducted in a community in Canada, 40% of former smokers reported the local smokefree ordinance as motivation to quit. This reflects an absolute percentage increase of 17 percentage points compared to the previous year when the local ordinance restricted, but did not prohibit, workplace smoking. The second study<sup>30</sup> examined the impact of a multicomponent community-wide cessation program in New York City following adoption of a smokefree ordinance in 2003. In a telephone survey of people self-identified as smokers in the year prior to the survey, 2.2% (95% CI=1.6, 3.0) (an estimated 28,000 residents) attributed their recent cessation to the workplace smoking ban.

The three remaining studies<sup>54,55,70</sup> each examined cessation activity in different ways. The first study,<sup>70</sup> from Germany, compared quit ratios (former smokers/current and former smokers) in workplaces with different smoking policies. The authors observed ratios significantly higher for women and slightly, but not significantly higher for men in worksites that did not allow smoking. The second study<sup>55</sup> compared responses to California Tobacco Surveys in 1990 and 1992, and observed that more smokers exposed to a smokefree worksite reported progression on a quitting continuum scale (adjusted OR 1.6; 95% CI=1.0, 2.6). Finally, investigators comparing responses in the 1990 California Tobacco Survey calculated an OR of 1.3 ( $p<0.05$ ) for being a smoker based on exposure to policies that did not establish a smokefree worksite environment.<sup>54</sup>

The team also examined differences in tobacco-use cessation in six studies<sup>31,34,39,41,75</sup> that provided additional data comparing change among workers in smokefree settings with workers in settings in which smoking was restricted, but not prohibited. Although similar in direction, the magnitude of change was smaller, with a median absolute percentage difference of 2.5 percentage points (interquartile interval: 1.8–4.2 percentage points) and a median relative percentage difference of 20% (interquartile interval: 7%–49%).

#### Other outcomes related

**to tobacco use.** Ten qualifying studies<sup>18,30,32,34,41,49,50,70,73,75</sup> evaluated changes or differences in self-reported attempts to quit smoking. In six studies<sup>18,34,41,50,73,75</sup> with sufficient information, the median absolute percentage change was an increase of 4.1 percentage points (interquartile interval: -0.7 to +6.8 percentage points), and the median relative percentage change was an increase of 7.4% (interquartile interval: -3.5% to +12.8%) in efforts to quit smoking. In three studies,<sup>30,32,49</sup> participating smokers exposed to a smokefree policy self-reported cessation attempts over the period of study. In two of these studies, 12.5%<sup>32</sup> and 58%<sup>49</sup> of smokers self-reported a cessation attempt in the study period following implementation of a workplace smokefree policy. In the third study,<sup>30</sup> 2.0% (95% CI=1.4, 2.8) of smokers (an estimated 26,000 smokers) attributed a recent cessation attempt to the smokefree workplace ordinance adopted by New York City.

Thirty-one studies in 29 reports<sup>8,14,18,21–23,29–32,34,35,40,41,49,50,54,56,58,60,61,69–75,77</sup> evaluated the impact of smokefree policies on self-reported tobacco consumption. In 18 studies,<sup>8,14,22,23,29,34,35,40,50,58,60,61,69,70,73–75,77</sup> differences or changes in the quantity of tobacco use were reported (or could be calculated based on the available data) as an outcome in the form of cigarettes per day. The median estimate in this subset of studies was a reduction of 2.2 cigarettes smoked per day (interquartile interval: -1.7 to -3.3 cigarettes/day). Four studies<sup>18,31,32,56</sup> reported changes in the proportion of self-identified “heavy smok-

ers" (25 or more cigarettes per day). All four studies observed reductions in the proportion of smokers in this category with a median estimate of -5.2 percentage points (range: -2.7 to -13.2 percentage points).

### Applicability

The qualifying studies evaluated the relationship between smokefree policies and tobacco use in a variety of settings. Seven studies<sup>30,33,35,39,60,72,74</sup> specifically examined the impact of state or local smokefree ordinances. Twenty-eight studies<sup>8,14,18,21-23,29,31,32,34,38,40-42,47,49,50,54,56,58,61,69-71,73,75,77,90</sup> examined the impact of individual worksite or company-wide smokefree policies whether adopted voluntarily or in response to a community ordinance or regulatory policy. Population-based studies included in this review<sup>8,31,33,34,39-42,54,55,58,61,70,72,74,75</sup> evaluated responses from workers in a wide range of both public- and private-sector indoor worksites. Several studies examined specific workplaces such as healthcare settings,<sup>21-23,38,47,50,56,71</sup> telecommunications companies,<sup>49,69</sup> and government worksites.<sup>14,18,32</sup> Almost all of the qualifying studies were conducted in the U.S.<sup>8,18,21-23,29-32,34,35,38-42,47,49,50,54-56,58,60,61,71-75</sup> or Canada.<sup>14,33,34,75</sup> The remaining studies were conducted in Germany,<sup>70,77</sup> Australia,<sup>69</sup> and Finland.<sup>35</sup> Six studies evaluated the impact of smokefree policies on tobacco use among workers in California during the time when the state developed and implemented a comprehensive, multicomponent tobacco control program.<sup>8,39,54,55,60,61</sup> Only one study<sup>29</sup> evaluated the effectiveness of a smokefree grounds policy prohibiting smoking on all company property. Overall, the range of populations, communities, and individual worksites evaluated in these studies suggests that the findings on tobacco use among workers should be applicable to most worksites in the U.S. and elsewhere.

### Other Positive or Negative Effects

In a previous review,<sup>12</sup> the Task Force recommended smokefree policies for reducing exposure to secondhand tobacco smoke. Additional postulated benefits of smokefree policies include reduced workplace cleaning costs and reduced risk for fires.<sup>91</sup>

### Economic Efficiency

The economic review team identified five economic evaluation studies<sup>91-95</sup> falling within the scope of the effectiveness review: one cost-effectiveness analysis, one cost-benefit analysis, and three studies that report benefits in terms of costs averted. For convenience of comparability, summary measures were adjusted to 2003 U.S. dollars using the all-item Consumer Price Index (CPI)<sup>96</sup> or the Medical Care component of the CPI,<sup>97</sup> depending on

whether a majority of cost items could be attributed to nonmedical or medical care goods and services. For international studies, purchasing power parity rates from World Development Indicators<sup>98</sup> were used to convert foreign currency to U.S. dollars. Details of the included studies are available at [www.thecommunityguide.org/worksite/](http://www.thecommunityguide.org/worksite/).

Ong and Glantz<sup>94</sup> conducted a cost-effectiveness analysis comparing free nicotine replacement therapy to a statewide smokefree workplace policy. This study was classified as very good based on the criteria for quality assessment of economic data used in the *Community Guide*.<sup>99,100</sup> Costs include enactment and enforcement costs for the smokefree workplace policy, as well as cost of products for the free nicotine replacement therapy program. Benefits included number of individuals who quit smoking, as well as quality-adjusted life years (QALY) gained. After 1 year the smokefree workplace policy generated 10,400 quitters at a cost of \$809 per quitter, compared to the free nicotine replacement therapy that generated 18,500 quitters at a cost of \$7294 per quitter. Thus, a smokefree workplace policy is about nine times more cost effective per smoker than the free nicotine replacement therapy program. The economic review of smokefree workplace policies found a cost of \$526 per QALY compared to a cost of \$4613 per QALY for the free nicotine replacement therapy program. Both interventions appear to be cost effective by conventional standards as the cost-effectiveness ratios fall well below \$50,000 per QALY, the commonly used threshold to reflect society's willingness to pay for health benefits based on Medicare's decision in the 1970s to cover dialysis for patients with chronic renal failure.<sup>101</sup>

Mudarri<sup>91</sup> performed a cost-benefit analysis to determine the expected net benefit of a smokefree workplace policy. This study was classified as very good based on the criteria for quality assessment of economic data used in the *Community Guide*.<sup>99,100</sup> Costs include construction and maintenance of smoking lounges as well as enforcement costs. Benefits included savings in operation and maintenance of buildings, reduced absenteeism, smoking-related fires, on-the-job productivity improvements, and benefits from reduced exposure to environmental tobacco smoke, including medical costs averted by reducing heart disease and premature deaths, valued by willingness-to-pay methods. The study estimated collective net benefits from the policy ranging from \$48 billion to \$89 billion per year in the U.S. This range is based on high and low estimates of benefits and costs. In general, these findings suggest substantial net benefits from implementing a smokefree workplace policy.

Three studies<sup>92,93,95</sup> reported benefits in terms of costs averted. These studies are difficult to categorize under



existing economic classifications. Since the studies do not report the costs of program intervention and data on actual program costs form the basis of any cost analysis, the team could not categorize these as cost analysis studies. Instead, these studies were categorized as cost-of-illness-averted studies. These studies assess cost of illness averted based on modeling and estimates available in the literature.

Ong and Glantz<sup>92</sup> considered only benefits from preventing cardiovascular disease. The study found that, in 1 year, a smokefree workplace policy could prevent about 1500 myocardial infarctions and 350 strokes, which would result in approximately \$55 million in direct medical cost savings. Parrot<sup>93</sup> discusses the potential costs to the employer averted by implementing a smokefree workplace policy in Scotland. Based on estimates in other published studies, the study found that employee smoking results in annual costs of \$858 million in lost productivity, of \$77 million in absenteeism, and of \$8 million in fire damage. Benefits to the employer include averted costs from reduced productivity losses, absenteeism, and fire damage. Weis<sup>95</sup> finds the annual costs for an employer per smoker are \$489 for absenteeism, \$511 for medical care, discounted potential lost earnings of \$1700 due to premature death or illness, insurance costs of \$200, on-the-job time loss of \$4044, property damage and depreciation of \$1111, maintenance costs of \$1111, and involuntary smoking costs of \$1080. Thus, the study finds that the employer could potentially save \$10,246 per year for every smoker who quits due to a smokefree workplace policy.

## Caveats

This systematic review of the economic efficiency of smokefree policies found two strong economic evaluations which assess both the lifetime costs and benefits of smokefree workplace policies. Although Ong and Glantz<sup>94</sup> provided a final outcome measure, the benefits of quitting were converted into QALYs based on existing literature estimates rather than on results from the intervention. It is important to note that, because the policies address health risk factors and outcomes that may take long periods of time to develop, it is difficult to calculate lifetime costs and benefits resulting from the intervention. This explains the paucity of evidence in the literature about final outcomes related to smoking cessation programs. Additionally, when economic outcomes are presented, because the opportunity to conduct RCTs is limited in this context, the studies determine benefits using modeling or published literature estimates. Thus, estimates of economic effectiveness are based on several assumptions and on extrapolations from secondary data.

## Economic Conclusions

These findings should be generally applicable to indoor workers but do not capture the impact of the smoking ban policies on smoking behavior and practices outside of the workplace. These studies also do not consider the differences in benefits for implementing a smokefree workplace policy among white-collar workers and blue-collar workers. Because smoking prevalence may be higher in blue-collar workplaces, one may see substantially higher benefits from implementing the policy in blue-collar workplaces compared to white-collar workplaces.<sup>2</sup>

Overall, the findings from this economic review indicate that smokefree policies could provide substantial savings to an employer, as well as health benefits for the former tobacco users. Based on one study with an estimated cost of \$526 per QALY (substantially lower than the conventional cost-effectiveness threshold), a smokefree workplace is very cost effective. As indicated in a second study, smokefree policies could provide a net benefit to society ranging from \$48 billion to \$89 billion per year if implemented throughout the U.S. Finally, results from the remaining three studies (that considered only benefits and did not report intervention costs) demonstrated major averted costs including averted health-care costs and productivity losses due to the intervention. A statewide smokefree workplace policy is an appealing, population-based intervention and is likely to be more cost effective than smoking cessation programs targeted to individuals. However, the specific economic findings are based on a small number of studies, and additional research is indicated to more fully evaluate the total economic effects of these policies.

## Barriers to Intervention Implementation

Preemption—the passage or presence of a preemptive state law with weaker smoking restrictions (typically exempting some worksite locations such as bars)—remains the major barrier to efforts by local governments to adopt smokefree policies.<sup>102–104</sup> Eliminating preemption statutes is one of the tobacco objectives of *Healthy People 2010*.<sup>25</sup> Political opposition by smokers, businesses concerned about potential changes in revenue, and tobacco industry-sponsored groups can be a barrier to community, state, and national efforts to adopt smokefree policies.<sup>105–110</sup>

## Summary and Discussion of Effectiveness

The qualifying studies evaluating the impact on tobacco use of smokefree policies employed a range of evaluation designs. This body of evidence includes outcomes from trials conducted in specific worksites and outcomes from state and national cross-sectional comparisons. The stud-

ies identified in this review include a wide range of community and workplace settings and study populations. Although the summary effect estimates should be interpreted with caution, the primary concern of this review was to evaluate the strength and consistency of the available evidence and the trends in tobacco use reflected there. In this case, studies with very different designs and conduct provide relatively consistent evidence of reductions in tobacco use in populations exposed to smokefree policies. Estimates from the subset of studies that measured prevalence rates for tobacco use, for example, are supported by estimates from the subset of studies that observed increases in tobacco-use cessation. Measurements of differences in tobacco use reported in cross-sectional comparisons are supported by similar estimates of change from studies with before-and-after comparisons. The other outcomes reported in the qualifying studies provide supporting evidence on the effectiveness of these policies. Workers who smoke and who were exposed to smokefree policies self-reported more cessation attempts and lower levels of daily cigarette consumption than did workers who smoke but were not exposed to these policies.

There are at least five major limitations in interpreting the findings of this report. First, this review included studies in which outcomes were derived from two or more cross-sectional differences at a single point in time. Most of these studies obtained measurements from multiple jurisdictions and included analyses that attempted to control for potential demographic and community differences. These studies were included in this review but not in our previous evaluation of the relationship between smoking bans and restrictions and SHS exposure, in which they represented a smaller proportion of the available evidence. Although, in general, the qualifying studies attempted to control for a number of potential confounders, these comparisons alone do not clearly demonstrate a causal association. Second, almost all of the included studies depended on self-reports of tobacco use, and workers exposed to smokefree policies might misreport their status at a different rate than workers not exposed to a smokefree policy. Third, the majority of the studies did not attempt to quantify the duration of self-reported tobacco cessation. Since duration of cessation beyond 6–12 months is a more accurate reflection of ultimate success, study differences based on smoking status at point of interview might overestimate the true change or difference in cessation.<sup>111</sup> On the other hand, the period of observation was relatively short across this body of evidence, and findings may underestimate the true long-term impact of a permanent change in worksite or community policy. Fourth, a number of studies in this review were conducted in settings that included additional interventions (such as worksite-based cessation

support groups or community-wide mass media campaigns) and results attributed to smokefree policy include the impact of these other efforts. Finally, bias in the submission, acceptance, and publication of some, but not all evaluations of the impact of smokefree policies on tobacco use among workers might have influenced the findings of this review.

## Results from Other Reviews

Several narrative reviews<sup>2,112–114</sup> have examined the available evidence and drawn similar conclusions about the impact of smokefree policies on tobacco use. However, two systematic reviews<sup>115,116</sup> provide findings about the evidence on effectiveness that differ from one another.

The first systematic review<sup>115</sup> included 26 studies described in 24 reports and employed a random-effects meta-analysis on outcome measurements of daily cigarette consumption and smoking prevalence. The authors calculated summary effect measurements and concluded that totally smokefree workplaces are associated with reductions in prevalence of smoking of –3.8 percentage points (95% CI= –2.8 to –4.7 percentage points) and reductions in consumption of 3.1 cigarettes per day (95% CI= –2.4 to –3.8 cigarettes per day) by continuing smokers. Overall, the authors estimate a relative percentage reduction in tobacco use of 29% in workers exposed to smokefree policies.

Workplace tobacco control policies and bans were among the interventions examined in a Cochrane review of workplace interventions for smoking cessation.<sup>116</sup> The authors included studies of workplace bans and restrictions, excluded cessation studies with less than 6 months of follow-up, and did not consider the included evidence (14 studies) suitable for a meta-analytic summary because of the heterogeneity of the study designs. Based on a narrative review of the included studies, the authors concluded that the results were inconsistent for all of the tobacco-use outcomes evaluated (daily tobacco consumption, tobacco-use prevalence, and cessation).

The *Community Guide's* inclusion criteria, summary estimates, and conclusions are similar to those provided in the review by Fichtenberg,<sup>115</sup> but they also noted the differences in outcomes presented when comparing studies organized by design suitability or type of comparison. In general, the studies with concurrent comparison groups and longer follow-up observed smaller changes in both prevalence and cessation than did studies that measured differences in cross-sectional comparisons or single-group changes over time. Despite the heterogeneity the team identified in these results, they provide generally consistent evidence that smokefree policies are effective in reducing tobacco use.

## Conclusion

According to the *Community Guide*'s rules of evidence,<sup>26</sup> the reviewed studies provided sufficient evidence that smokefree policies reduce tobacco use when implemented in worksites and communities. The reductions in tobacco use were observed in a variety of working populations indicating wide applicability. The evidence on effectiveness includes both studies that evaluated smokefree policies implemented by individual worksites and studies that evaluated community standards requiring worksites to be smokefree.

In addition to previously described evidence of effectiveness of smokefree policies in reducing exposure to secondhand smoke,<sup>12</sup> the results of this review suggest that smokefree policies reduce consumption by continuing smokers, increase smoking cessation attempts, increase the number of smokers who successfully quit, and reduce the prevalence of tobacco use among workers. Smokefree policies implemented by worksites and adopted by communities to protect patrons and employees are also an effective option to promote cessation among smoking employees.

## Research Agenda

The effectiveness of smokefree policies in protecting non-smokers from exposure to secondhand smoke is already established. This report also finds evidence of effectiveness of these policies in reducing tobacco use among workers. Some important areas for future research remain.

Future research might be able to quantify both the independent and synergistic effects of smokefree policies. The impact of smokefree policies might differ when voluntarily adopted in isolation (in a single workplace) or when adopted in response to community-wide smokefree ordinances (affecting all workplaces in the community). Smokefree policies in the workplace might be more effective when implemented in combination with other worksite-based cessation support interventions or when implemented community-wide with other population-based tobacco prevention efforts.

Future research should also determine the impact of smokefree policies on different populations of workers who smoke. Research to date has primarily focused on identifying disparities in the adoption of smokefree policies by location, setting, and occupation.<sup>117–120</sup> It is unclear if disparities exist in the impact of smokefree policies on reductions in tobacco use. Future research should investigate ways to reduce disparities in both implementation and response, so that workers receive both the protections and the benefits of these policies.

Some economic questions about smokefree policies remain, as well. The current systematic review of economic

data found evidence that smokefree workplace interventions could result in substantial cost savings based on averted healthcare costs, reductions in productivity losses, and outcomes not related to health, such as fire damages. The only cost-effectiveness study that reports cost per QALY<sup>94</sup> also demonstrates very good value of the intervention in terms of conventional benchmarks. The problem with these studies is that primary information on program costs relies on model- or literature-based estimates of benefits to compute an economic summary measure. A follow-up of intervention participants over a longer time period could directly measure health benefits and averted cost of illness from the intervention itself.

The cost-effectiveness ratio of a smokefree intervention in a particular workplace depends on a variety of factors including prevailing smoking status of employees, current smoking regulations in place, size of the workplace, and other relationships among employees, work, and tobacco use. Further research is needed to incorporate and conclusively document all of the economic returns from investment in smokefree worksite policies.

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We thank the following individuals for their contributions to this review: Randy Elder for his scientific direction; Reba Norman, research librarian; Kate W. Harris and Tony Pearson-Clarke, editors; the Coordination Team—Nico Pronk, PhD, Health Partners, Minneapolis MN; Ron Goetzel, PhD, ThompsonReuters; Dennis Richling, MD, CorSolutions, Chicago IL; Deborah R. Bauer, RN, MPH, McKing Consulting, Atlanta GA; Andrew Walker, Private Consultant, Atlanta GA; Abby Rosenthal, MPH, Office on Smoking and Health, CDC, Atlanta GA; Curtis S. Florence II, PhD, Emory University, Atlanta GA; Dee Edington, HMRC, Ann Arbor MI; and Deborah MacLean, The Coca-Cola Company, Atlanta GA; and the staff of the *Guide to Community Preventive Services* for their advice and support throughout the review process.

Points of view are those of the authors and do not necessarily reflect those of the CDC.

The names and affiliations of the Task Force members are listed in the front of this supplement and at [www.thecommunityguide.org](http://www.thecommunityguide.org).

No financial disclosures were reported by the authors of this paper.

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