# Association Between Smoke-Free Legislation and Hospitalizations for Cardiac, Cerebrovascular, and Respiratory Diseases : A Meta-Analysis

Crystal E. Tan and Stanton A. Glantz

*Circulation.* 2012;126:2177-2183
doi: 10.1161/CIRCULATIONAHA.112.121301
*Circulation* is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231

Print ISSN: 0009-7322. Online ISSN: 1524-4539

# Association Between Smoke-Free Legislation and Hospitalizations for Cardiac, Cerebrovascular, and Respiratory Diseases

## A Meta-Analysis

Crystal E. Tan, MS; Stanton A. Glantz, PhD

***Background***—Secondhand smoke causes cardiovascular and respiratory disease. Smoke-free legislation is associated with a lower risk of hospitalization and death from these diseases.

***Methods and Results***—Random-effects meta-analysis was conducted by law comprehensiveness to determine the relationship between smoke-free legislation and hospital admission or death from cardiac, cerebrovascular, and respiratory diseases. Studies were identified by using a systematic search for studies published before November 30, 2011 with the use of the Science Citation Index, Google Scholar, PubMed, and Embase and references in identified articles. Change in hospital admissions (or deaths) in the presence of a smoke-free law, duration of follow-up, and law comprehensiveness (workplaces only; workplaces and restaurants; or workplaces, restaurants, and bars) were recorded. Forty-five studies of 33 smoke-free laws with median follow-up of 24 months (range, 2–57 months) were included. Comprehensive smoke-free legislation was associated with significantly lower rates of hospital admissions (or deaths) for all 4 diagnostic groups: coronary events (relative risk, 0.848; 95% confidence interval 0.816–0.881), other heart disease (relative risk, 0.610; 95% confidence interval, 0.440–0.847), cerebrovascular accidents (relative risk, 0.840; 95% confidence interval, 0.753–0.936), and respiratory disease (relative risk, 0.760; 95% confidence interval, 0.682–0.846). The difference in risk following comprehensive smoke-free laws does not change with longer follow-up. More comprehensive laws were associated with larger changes in risk.

***Conclusions***—Smoke-free legislation was associated with a lower risk of smoking-related cardiac, cerebrovascular, and respiratory diseases, with more comprehensive laws associated with greater changes in risk. **(*Circulation*. 2012;126: 2177-2183.)**

**Key Words:** myocardial infarction ■ stroke ■ lung ■ health care policy ■ tobacco ■ tobacco smoke pollution

Secondhand smoke causes cardiovascular, respiratory, and neoplastic disease in adults, adverse reproductive outcomes in women, and delayed growth and respiratory and infectious disease in children.[1–3] Smoke-free legislation, which prohibits smoking in certain settings, reduces exposure of nonsmokers to secondhand smoke and creates an environment that helps smokers cut down or quit smoking.[4,5] Because of the large and rapid effects of secondhand smoke on the cardiovascular system,[3,6] these laws would be expected to lead to reductions in acute myocardial infarctions (AMIs) and other cardiac events. Because it is impossible to conduct a randomized controlled trial of large-scale public policy interventions such as a smoke-free law, these laws are studied with the use of interrupted time series analysis, in which one estimates changes following the law, typically after accounting for preexisting time trends (often including seasonal variation) and other factors.[7] Three previous meta-analyses of the literature concluded that smoke-free laws were followed by immediate reductions in AMI[8,9] and other cardiac[10] hospitalizations and that effects grew over time. The number of studies on the effect of smoke-free laws has rapidly grown since these earlier meta-analyses to include not only AMI, but also non-AMI cardiac disease, cerebrovascular accidents, and respiratory disease. These new reports add extended follow-up periods, new study populations and locations, and smoke-free laws with varying degrees of comprehensiveness (ie, workplaces only; workplaces and restaurants only; or workplaces, restaurants, and bars). This article presents a meta-analysis of these new out-

**Continuing medical education (CME) credit is available for this article. Go to http://cme.ahajournals.org to take the quiz.**

Received May 30, 2012; accepted September 14, 2012.

From the Center for Tobacco Control Research and Education, University of California, San Francisco (C.E.T., S.A.G.); and Department of Medicine, University of California, San Francisco (S.A.G.).

**The online-only Data Supplement is available with this article at http://circ.ahajournals.org/lookup/suppl/doi:10.1161/CIRCULATIONAHA.112.121301/-/DC1.**

Correspondence to Stanton A. Glantz, PhD, Center for Tobacco Control Research and Education, University of California, San Francisco, 520 Parnassus Ave, #366, San Francisco, CA 94143. E-mail glantz@medicine.ucsf.edu



*Circulation* **is available at http://circ.ahajournals.org** **DOI: 10.1161/CIRCULATIONAHA.112.121301**

comes, including assessment of a dose–response effect of the comprehensiveness of the laws.

Clinical Perspective on p 2183

## Methods

### Study Identification

Study identification occurred from October 1, 2011 through November 30, 2011. Because there was already an identified literature in this area, we began our search for new studies by using Science Citation Index, Google Scholar, and PubMed to identify publications that cited the article that first reported a drop in AMI after implementation of a smoke-free law in Helena, Montana,[11] 3 recent meta-analyses of AMI or other cardiac outcomes,[8–10] and the first article identifying a reduction in respiratory (asthma) emergency admissions after a smoke-free law.[12] We also searched PubMed and Embase by the use of search terms "smoking ban," or "smoke-free" or "smokefree" with "legislation" or "law" or "ordinance" with "acute myocardial infarction," "heart attack," "asthma," "respiratory," "pulmonary," and "stroke." Reference lists were reviewed for all articles located, and for the Institute of Medicine report *Secondhand Smoke Exposure and Cardiovascular Effects*,[3] and the Cochrane review, "Legislative smoking bans for reducing secondhand smoke exposure, smoking prevalence and tobacco consumption,"[4] as well. Finally, we identified relevant reports written by state public health departments and independent researchers through contacts in the tobacco control network. One non-English study[13] was translated from French by using Google Translate.

We identified 47 studies: 36 peer-reviewed publications,[11,12,14–47] 7 abstracts,[48–54] 1 presentation,[13] and 3 reports by state health departments.[55–57] These studies cover 37 different smoke-free laws (10 national, 12 state, and 15 local).

We included studies examining the association between smoke-free laws and hospitalizations or deaths due to cardiovascular or respiratory disease with sufficient data to calculate the relative risk and confidence interval before and after or, in 2 studies,[27,34] localities with and without a law. Two of the 47 studies were excluded because they did not meet these inclusion criteria. One tobacco industry–supported article[41] comparing trends in AMI death rates in 6 US states that passed state laws was conducted by using nonstandard methodology that did not report or present data that permitted estimating relative risk and confidence intervals. In addition, the analysis was based on a very small number of data points, had very low power to detect changes, and did not account for the presence of a large number of comprehensive local laws in 2 states (California and New York), all of which bias the results to the null. An abstract[53] based on a Malta study was excluded because of discrepancies between the results reported in the text and the figure that could not be resolved; we contacted the authors who reported they had not completed a manuscript based on the abstract.

Three studies performed separate analyses of reductions in hospitalizations following state laws on localities with no previous law versus localities with existing laws.[18,32,35] In this situation, we used the estimates from localities without previous laws only to capture the full effect of the state law. One result for stroke from the New York State study[18] was excluded because no information was available from localities without previous laws; other results from this study were included in our analysis.

Because the risk of coronary heart disease due to smoking decreases with age,[58] in the 7 studies that stratified results on age,[14,20,21,26,32,36,50] we used the results for ≤65 years of age (or the nearest alternative) for the primary meta-analysis.

For studies that presented estimates for diseases nested within diagnostic categories (eg, AMI and unstable angina classified under acute coronary syndrome),[14,44,47] we used the most disaggregated level of data.

For studies that provide multiple estimates of the change in hospitalization rates for different time periods after law implementation,[15,17,23,28,38,42] we used the estimate from the longest follow-up period to prevent double-counting in the meta-analysis. Separately, we performed a metaregression to test whether hospitalization rates changed over time after implementation of the law; in this case, we included all available estimates from various time points. For this regression, when a law was phased in[13,29,54] (with restaurant or bar provisions typically taking effect after workplace restrictions), we used only the first implementation phase so that the postimplementation period and risk change associated with the law was measured consistently from the "no law" condition.

After screening all studies and excluding those with missing or incomplete data and those that did not meet inclusion criteria, 43 articles[11–40,42–52,54–57] were selected for meta-analysis (online-only Data Supplement Tables I through V and online-only Data Supplement Figure I). The outcomes are AMI, acute coronary syndrome (ACS), acute coronary events (ACE), ischemic heart disease (IHD), angina, coronary heart disease (CHD), sudden cardiac death (SCD), stroke, transient ischemic attack (TIA), chronic obstructive pulmonary disease (COPD), asthma, lung infections, and spontaneous pneumothorax.

Median prelegislation time was 29.5 months (range, 3–99 months); median follow-up time was 24 months (range, 2–57 months) (online-only Data Supplement Table VI). Laws were categorized based on comprehensiveness: (1) laws applying only to workplaces, (2) workplaces and restaurants, and (3) workplaces, restaurants, and bars. Because many studies looked at >1 law or >1 disease outcome or stratified results by age or sex, our review collectively yielded 86 risk estimates for the meta-analysis.

### Estimates of Risk Reductions Following Laws

Relative risks are estimated taking "no law" as the reference condition. Thirteen studies[11,13,16,29,35,37,38,44,49,51,52,55,56] reported changes in absolute number or rates of disease events rather than the relative risk following implementation of a smoke-free law. For these, we used the frequency data published in the article or obtained by contacting the authors to estimate incidence rate reduction (as an estimate of relative risk) with the use of negative binomial regressions. Models included the effect of the law and, when applicable, seasonality, or they were structured to mirror the analysis in the published study (as detailed in online-only Data Supplement Tables I through IV). Thirty-one of the 43 articles accounted for long-term secular trends, 26 by including time as a variable in the analysis and 5 by doing time-matched comparisons with control communities. Nineteen of the articles included seasonality in their models.

### Analysis

All analyses were conducted using 2-sided tests with a significance level of $\alpha=0.05$.

Q tests revealed statistically significant heterogeneity ($P<0.001$) between studies for all outcomes, with the exception of acute coronary events (2 studies[20,50] with borderline heterogeneity, $P=0.067$). To account for this heterogeneity and to use a more conservative approach, we performed a random-effects meta-analysis for each outcome, stratified by comprehensiveness of laws with the use of Stata 10.1 or 9.2 metan.

We performed a random-effects metaregression (Stata metareg) with dummy variables for the 13 disease outcomes to determine whether they were similar enough to be grouped into diagnostic categories for further analysis. The regressions (online-only Data Supplement Table VII) showed no significant differences between hospital admissions or deaths for:

- Coronary events: AMI, ACS, ACE, and IHD
- Other heart disease: angina, CHD, and out-of-hospital SCD
- Cerebrovascular accident: stroke and TIA
- Respiratory disease: COPD, asthma, lung infection, and spontaneous pneumothorax

We performed analyses for these 4 diagnostic groups and the 13 individual outcomes.

We conducted a random-effects metaregression to test whether the risk reduction following smoke-free laws increased over time, as

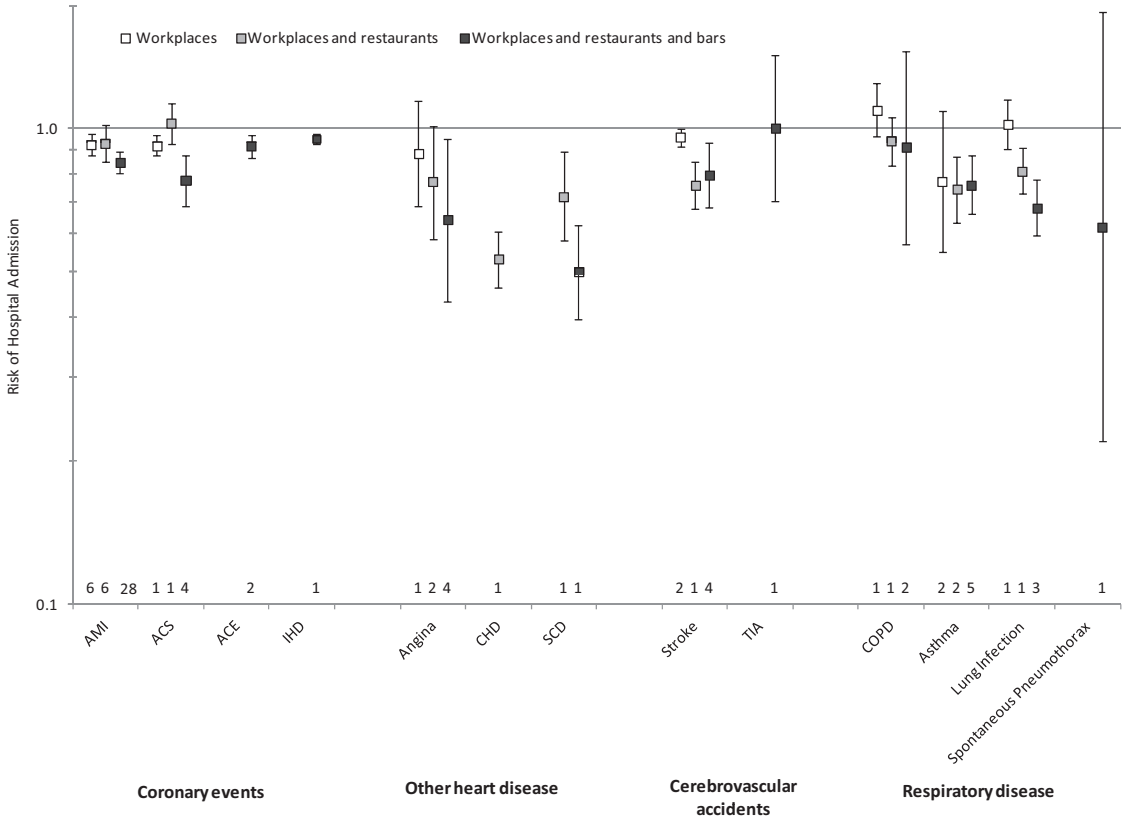



**Figure 1.** Relative risk of hospital admissions for various conditions (except sudden cardiac death [SCD], which is defined as out-of-hospital deaths) after implementation of a smoke-free law in comparison with before the law was implemented. Error bars indicate 95% confidence intervals, and numbers above the horizontal axis indicate number of studies used to compute the estimate. AMI indicates acute myocardial infarction; ACS, acute coronary syndrome; ACE, acute coronary event; IHD, ischemic heart disease; CHD, coronary heart disease; TIA, transient ischemic attack; and COPD, chronic obstructive pulmonary disease.

previously reported,[8–10] for each outcome and each diagnostic group. For each study, the duration of follow-up postlegislation was used as the time measure.

To test whether the comprehensiveness of a law was associated with greater reductions in hospital admissions (or deaths in 6 cases[14,20,24,32,50,54]), we performed a random-effects metaregression with comprehensiveness of law as an ordinal variable (0 for workplaces only; 1 for workplaces and restaurants; 2 for workplaces, restaurants, and bars) including dummy variables for different outcomes.

We conducted a separate random-effects meta-analysis for older people that were excluded from the primary meta-analysis by using the results from 6 studies[14,20,26,32,36,50] that reported the risk of coronary events in older populations (median cutoff age 70, range 60–75; online-only Data Supplement Tables I through IV).

For 10 studies[21,23–26,30,32,36,42,43] that presented results from sex-stratified analyses, we also conducted meta-analyses for females and males.

Finally, to test for the possibility of publication bias in the meta-analysis, we performed the Egger test, examined a funnel plot (using Stata metafunnel), and conducted a Duval and Tweedie[59] nonparametric trim-and-fill analysis to estimate the effects of any publication bias (with the use of Stata metatrim for a random-effects meta-analysis).

## Results

Comprehensive smoke-free laws were followed by significant reductions in hospital admissions for AMI, ACS, ACE, IHD, angina, CHD, SCD, stroke, asthma, and lung infection but not TIA, COPD, or spontaneous pneumothorax (Figure 1). Because there were only a few studies for some of these specific outcomes, we also pooled specific outcomes into 4 diagnostic groups as described in Methods to increase the number of studies in each group; comprehensive smoke-free laws were followed by significant reductions in hospital admissions for all 4 diagnostic groups (Figure 2 and online-only Data Supplement Figures II through V).

There was an overall pattern of more comprehensive laws being associated with greater reductions in hospital admissions ($P=0.001$ for individual outcomes, Figure 1, and $P=0.002$ for disease groups, Figure 2).

Contrary to previous findings,[8–10] we did not find that the AMI risk reduction associated with smoke-free laws increased with time ($P=0.537$; online-only Data Supplement Figure VI) or other disease outcomes and diagnostic groups for which there were sufficient data to conduct this analysis ($P>0.318$ for all of them).

Consistent with the fact that the relative risk of coronary heart disease due to smoking declines with age,[58] there was no significant change in risk of AMI or coronary events among older patients[14,20,26,32,36,50] following a comprehensive smoke-free law (relative risk [RR], 0.973; 95% confidence interval [CI], 0.918–1.032 and RR, 0.980; 95% CI, 0.953–1.008, respectively).

Reductions in AMI hospitalizations were similar for females (RR, 0.897; 95% CI, 0.847–0.950) and males (RR, 0.912; 95% CI, 0.872–0.955) after smoke-free laws of all degrees of comprehensiveness.

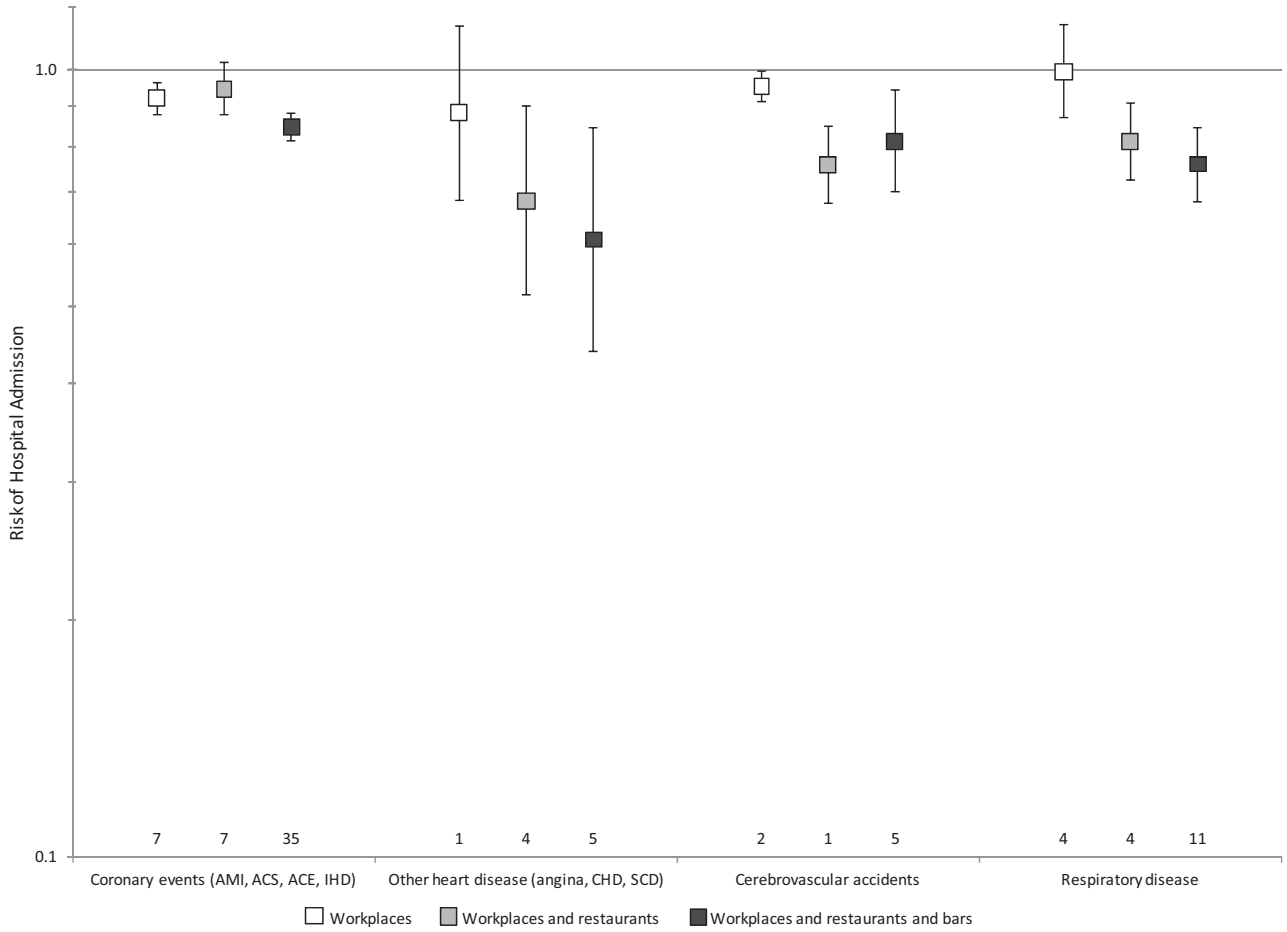



**Figure 2.** Relative risk of hospital admissions for various disease categories after implementation of a smoke-free law compared with before the law was implemented. Error bars indicate 95% confidence intervals, and numbers above the horizontal axis indicate number of studies used to compute the estimates. AMI indicates acute myocardial infarction; ACS, acute coronary syndrome; ACE, acute coronary event; IHD, ischemic heart disease; CHD, coronary heart disease; and SCD, sudden cardiac death.

Although the Egger test was statistically significant for publication bias ($P=0.007$) and the funnel plot suggested possible publication bias among the articles selected for the meta-analysis (online-only Data Supplement Figure VII), the nonparametric trim-and-fill estimate of the effects of publication bias[59] produced essentially the same results as the meta-analysis of the published studies: RR, 0.839 (95% CI, 0.818–0.861) for actual studies versus RR, 0.829 (95% CI, 0.808–0.851) from the fill-and-trim analysis for all outcomes and RR, 0.846 (95% CI, 0.803–0.890) versus RR, 0.803 (95% CI, 0.764–0.84.) for studies of AMI following comprehensive laws, suggesting that publication bias is not likely to explain our findings.

## Discussion

Given that secondhand smoke has been established to cause cardiovascular and respiratory disease,[1–3] one would expect that hospitalization for these diseases would drop when exposure to secondhand smoke is substantially reduced or eliminated. Consistent with 3 prior meta-analyses[8–10] that concluded that smoke-free laws are associated with significant decreases in AMI and other cardiac hospital admissions, we found that comprehensive smoke-free laws (covering workplaces, restaurants, and bars) were associated with a 15% decrease in AMI hospitalizations. In addition, we found that the laws were followed by decreases in hospitalizations for ACS, ACE, IHD, angina, CHD, SCD, stroke, asthma, and lung infection (Figure 1), and decreased risk of hospitalizations for coronary events, other heart disease, cerebrovascular accident, and respiratory disease, as well (Figure 2). For TIA, COPD, and spontaneous pneumothorax, which demonstrated no statistically significant association, negative findings should be interpreted cautiously because of the small numbers of studies that examined these outcomes.

Based on a much larger evidence base than previous meta-analyses,[8–10] we did not find that the reduction in risk associated with these laws increased with longer follow-up.

We also found evidence of a dose–response; more comprehensive laws were associated with larger effects (Figures 1 and 2).

Our results are consistent with an earlier meta-analysis of stroke associated with secondhand smoke exposure quantified in individuals, which showed an overall risk of 1.25 (95% CI, 1.12–1.38) and a nonlinear dose–response.[60] This overall risk is consistent with the reductions in hospital admissions for stroke that we observed following smoke-free laws (RR, 0.795; 95% CI, 0.680–0.930 [Figure 1], corresponding to risk increases associated with secondhand smoke of RR, 1.26; 95% CI, 1.08–1.47).

Several studies included in the meta-analysis documented reductions in healthcare costs associated with fewer hospitalizations for cardiovascular or respiratory diseases. Healthcare savings were reported at the city, state, and national levels, ranging from $302 000 in AMI expenses after 35 months in Starkville, Mississippi[55] to €2.6 million ($3.3 million, 9.6% decrease from baseline) in angina-related hospitalization costs and €5.3 million ($6.9 million, 20.1% decrease from baseline) AMI-related hospitalization costs during the first year after smoke-free law implementation in Germany.[46] (See online-only Data Supplement Tables I through IV for more details.)

Evidence on the association between smoke-free legislation and other health effects is emerging. A study in Ireland[61] found a drop in preterm births (odds ratio, 0.75; 95% CI, 0.59–0.96) but an increase in low birthweight (odds ratio, 1.43; 95% CI, 1.10–1.85) 1 year after the smoke-free law. Another study from Scotland[62] found significant decreases in babies small for gestational age (by 4.5%), preterm delivery (11.7%), and spontaneous preterm labor (11.4%).

Smoke-free legislation per se does not produce the effects that we observed, which are due to the associated reductions in secondhand smoke exposure and increases in smoking cessation that accompany these laws. As more places adopt smoke-free policies (whether by law in subordinate jurisdictions or voluntarily), the marginal effects of subsequent laws will be smaller, as was observed in New York and Massachusetts when those states passed comprehensive laws after many localities had.[18,32] The passage of these laws reflects changes in social norms that also affect smoking behavior; the laws both formalize and accelerate this social change and the associated health benefits.

### Limitations

The interrupted time series observational studies that form the foundation for this meta-analysis alone do not establish causation. At the same time, a randomized, controlled trial of the effects of enacting legislation is impractical or impossible. The studies included in our meta-analysis consistently meet standards for high-quality interrupted time series studies[7]; in particular, all studies used objective measures of outcomes, and most considered secular trends and seasonality. The observed reductions in hospitalizations are, however, consistent with the known biological pathways by which tobacco smoke exposure causes disease and triggers acute events. The observation that AMI admissions in Helena, Montana[11] rebounded after enforcement of its smoke-free law was suspended because of a lawsuit also supports a causal link.

Although compliance with smoke-free laws is high in general and many studies have documented drops in secondhand smoke exposure after law implementation (online-only Data Supplement Tables I through IV), we could not assume any 1 individual's level of exposure had decreased and subsequently reduced their risk of hospitalization. Few studies included in the meta-analysis measured tobacco smoke exposure or smoking status in individual cases.[16,22,38,39] Because a randomized controlled trial is impossible, an analysis measuring individual smoking and secondhand smoke exposure would offer the most valid evidence regarding the effectiveness of smoke-free laws.

We entered the ordinal variable for comprehensiveness of a law (0 for workplaces only; 1 for workplaces and restaurants; 2 for workplaces, restaurants, and bars) in the metaregression to test whether more comprehensive laws were followed by greater reductions in hospital admissions (or deaths). We treated comprehensiveness of law as an ordinal, not an interval (continuous) variable, which is why we only reported the probability value for law comprehensiveness and not an effect size. Although this is a standard approach for integrating ordinal variables into regression analyses, we investigated the use of this procedure to ensure that our conclusions were not sensitive to this technique by treating law comprehensiveness as a categorical variable (together with dummy variables for the different outcome groups, as we do in the analysis in the article that treats law comprehensiveness as an interval variable) and tried recoding the law comprehensiveness by using alternative codings (0, 1, 3) and (0, 1, 4). As described in detail in the online-only Data Supplement Text, these analyses gave essentially the same results as the main analysis, indicating that the approach we use in the article produces robust evidence for a dose–response effect of the law, treating law comprehensiveness as an ordinal variable.

Although it is not usual in epidemiological studies, we did not consider multiple testing. Readers should take into account potential inflation from multiple testing when interpreting significance levels ($\alpha$) and confidence intervals.

In one study,[47] the authors expressed concern about misclassification between different outcomes.

Publication bias is always a concern in meta-analysis (online-only Data Supplement Figure VII). The nonparametric trim-and-fill analysis, however, indicated that adjusting for publication bias had little effect on the results.

## Conclusion

This study provides evidence that smoke-free laws are followed by fewer hospitalizations and lower healthcare expenditures for a wide range of diseases and that comprehensive laws ending smoking in workplaces, restaurants, and bars are associated with greater effects. The general public, public health professionals, and policy makers should consider these positive associations as they develop smoke-free legislation and decide whether or not to include exceptions to these laws.

## Sources of Funding

This work was supported by National Cancer Institute grants CA-61021 and CA-87472. The funding agency played no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript.

## Disclosures

None.

## References

1. California Environmental Protection Agency. Proposed Identification of Environmental Tobacco Smoke as a Toxic Air Contaminant. 2005. http://www.arb.ca.gov/regact/ets2006/ets2006.htm. Accessed October 3, 2012.

2. US Department of Health and Human Services. *The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2006.
3. IOM (Institute of Medicine). *Secondhand Smoke Exposure and Cardiovascular Effects: Making Sense of the Evidence.* Washington, DC: The National Academies Press; 2010.
4. Callinan JE, Clarke A, Doherty K, Kelleher C. Legislative smoking bans for reducing secondhand smoke exposure, smoking prevalence and tobacco consumption. *Cochrane Database Syst Rev.* 2010:CD005992.
5. Naiman AB, Glazier RH, Moineddin R. Is there an impact of public smoking bans on self-reported smoking status and exposure to secondhand smoke? *BMC Public Health*. 2011;11:146.
6. Barnoya J, Glantz SA. cardiovascular effects of secondhand smoke: nearly as large as smoking. *Circulation*. 2005;111:2684–2698.
7. Ramsay CR, Matowe L, Grilli R, Grimshaw JM, Thomas RE. Interrupted time series designs in health technology assessment: lessons from two systematic reviews of behavior change strategies. *Int J Technol Assess Health Care*. 2003;19:613–623.
8. Lightwood JM, Glantz SA. Declines in acute myocardial infarction after smoke-free laws and individual risk attributable to secondhand smoke. *Circulation*. 2009;120:1373–1379.
9. Meyers DG, Neuberger JS, He J. Cardiovascular effect of bans on smoking in public places: a systematic review and meta-analysis. *J Am Coll Cardiol*. 2009;54:1249–1255.
10. Mackay DF, Irfan MO, Haw S, Pell JP. Meta-analysis of the effect of comprehensive smoke-free legislation on acute coronary events. *Heart*. 2010;96:1525–1530.
11. Sargent RP, Shepard RM, Glantz SA. Reduced incidence of admissions for myocardial infarction associated with public smoking ban: before and after study. *BMJ*. 2004;328:977–980.
12. Rayens MK, Burkhart PV, Zhang M, Lee S, Moser DK, Mannino D, Hahn EJ. Reduction in asthma-related emergency department visits after implementation of a smoke-free law. *J Allergy Clin Immunol.* 2008;122:537.e3–541.e3.
13. Dautzenberg B. Indicateurs mensuels du tabagisme passif: mesure des bénéfices de l'interdiction totale de fumer. 2008. http://www.la-croix.com/content/download/686570/20854176/2008_2_24_tabac.pdf. Accessed October 3, 2012.
14. Barone-Adesi F, Vizzini L, Merletti F, Richiardi L. Short-term effects of Italian smoking regulation on rates of hospital admission for acute myocardial infarction. *Eur Heart J*. 2006;27:2468–2472.
15. Bartecchi C, Alsever RN, Nevin-Woods C, Thomas WM, Estacio RO, Bartelson BB, Krantz MJ. Reduction in the incidence of acute myocardial infarction associated with a citywide smoking ordinance. *Circulation*. 2006;114:1490–1496.
16. Seo DC, Torabi MR. Reduced admissions for acute myocardial infarction associated with a public smoking ban: matched controlled study. *J Drug Educ*. 2007;37:217–226.
17. Khuder SA, Milz S, Jordan T, Price J, Silvestri K, Butler P. The impact of a smoking ban on hospital admissions for coronary heart disease. *Prev Med*. 2007;45:3–8.
18. Juster HR, Loomis BR, Hinman TM, Farrelly MC, Hyland A, Bauer UE, Birkhead GS. Declines in hospital admissions for acute myocardial infarction in New York State after implementation of a comprehensive smoking ban. *Am J Public Health*. 2007;97:2035–2039.
19. Lemstra M, Neudorf C, Opondo J. Implications of a public smoking ban. *Can J Public Health*. 2008;99:62–65.
20. Cesaroni G, Forastiere F, Agabiti N, Valente P, Zuccaro P, Perucci CA. Effect of the Italian smoking ban on population rates of acute coronary events. *Circulation*. 2008;117:1183–1188.
21. Vasselli S, Papini P, Gaelone D, Spizzichino L, De Campora E, Gnavi R, Saitto C, Binkin N, Laurendi G. Reduction incidence of myocardial infarction associated with a national legislative ban on smoking. *Minerva Cardioangiol*. 2008;56:197–203.
22. Pell JP, Haw S, Cobbe S, Newby DE, Pell AC, Fischbacher C, McConnachie A, Pringle S, Murdoch D, Dunn F, Oldroyd K, Macintyre P, O'Rourke B, Borland W. Smoke-free legislation and hospitalizations for acute coronary syndrome. *N Engl J Med*. 2008;359:482–491.
23. Centers for Disease Control and Prevention. Reduced hospitalizations for acute myocardial infarction after implementation of a smoke-free ordinance–city of Pueblo, Colorado, 2002–2006. *MMWR Morb Mortal Wkly Rep.* 2009;57:1373–1377.
24. Gasparrini A, Gorini G, Barchielli A. On the relationship between smoking bans and incidence of acute myocardial infarction. *Eur J Epidemiol*. 2009;24:597–602.
25. Villalbí JR, Castillo A, Cleries M, Salto E, Sanchez E, Martinez R, Tresserras R, Vela E, Barcelona G. Acute myocardial infarction hospitalization statistics: apparent decline accompanying an increase in smoke-free areas. *Rev Esp Cardiol*. 2009;62:812–815.
26. Barnett R, Pearce J, Moon G, Elliott J, Barnett P. Assessing the effects of the introduction of the New Zealand Smokefree Environment Act 2003 on acute myocardial infarction hospital admissions in Christchurch, New Zealand. *Aust N Z J Public Health*. 2009;33:515–520.
27. Shetty KD, DeLeire T, White C, Bhattacharya J. Changes in U.S. hospitalization and mortality rates following smoking bans. *J Policy Anal Manage*. 2010;30:6–28.
28. Trachsel LD, Kuhn MU, Reinhart WH, Schulzki T, Bonetti PO. Reduced incidence of acute myocardial infarction in the first year after implementation of a public smoking ban in Graubuenden, Switzerland. *Swiss Med Wkly*. 2010;140:133–138.
29. Naiman A, Glazier RH, Moineddin R. Association of anti-smoking legislation with rates of hospital admission for cardiovascular and respiratory conditions. *CMAJ*. 2010;182:761–767.
30. Sims M, Maxwell R, Bauld L, Gilmore A. Short Term impact of smoke-free legislation in England: retrospective analysis of hospital admissions for myocardial infarction. *BMJ*. 2010;340:c2161.
31. Mackay D, Haw S, Ayres JG, Fischbacher C, Pell JP. Smoke-free legislation and hospitalizations for childhood asthma. *N Engl J Med*. 2010;363:1139–1145.
32. Dove MS, Dockery DW, Mittleman MA, Schwartz J, Sullivan EM, Keithly L, Land T. The Impact of Massachusetts' smoke-free workplace laws on acute myocardial infarction deaths. *Am J Public Health*. 2010;100:2206–2212.
33. Moraros J, Bird Y, Chen S, Buckingham R, Meltzer RS, Prapasiri S, Solis LH. The impact of the 2002 Delaware smoking ordinance on heart attack and asthma. *Int J Environ Res Public Health*. 2010;7:4169–4178.
34. Dove MS, Dockery DW, Connolly GN. Smoke-free air laws and asthma prevalence, symptoms, and severity among nonsmoking youth. *Pediatrics*. 2011;127:102–109.
35. Herman PM, Walsh ME. Hospital admissions for acute myocardial infarction, angina, stroke, and asthma after implementation of Arizona's comprehensive statewide smoking ban. *Am J Public Health*. 2011;101:491–496.
36. Barone-Adesi F, Gasparrini A, Vizzini L, Merletti F, Richiardi L. Effects of Italian smoking regulation on rates of hospital admission for acute coronary events: a country-wide study. *PLoS One*. 2011;6:e17419.
37. Ferrante D, Linetzky B, Virgolini M, Schoj V, Apelberg B. Reduction in hospital admissions for acute coronary syndrome after the successful implementation of 100% smoke-free legislation in Argentina: a comparison with partial smoking restrictions. *Tob Control*. 2011;21:402–406.
38. Bonetti PO, Trachsel LD, Kuhn MU, Schulzki T, Erne P, Radovanovic D, Reinhart WH. Incidence of acute myocardial infarction after implementation of a public smoking ban in Graubünden, Switzerland: two year follow-up. *Swiss Med Wkly.* 2011;141:w13206.
39. Gupta R, Luo J, Anderson RH, Ray A. Clean indoor air regulation and incidence of hospital admissions for acute coronary syndrome in Kanawha County, West Virginia. *Prev Chronic Dis*. 2011;8:A77.
40. Bruintjes G, Bartelson BB, Hurst P, Levinson AH, Hokanson JE, Krantz MJ. Reduction in acute myocardial infarction hospitalization after implementation of a smoking ordinance. *Am J Med*. 2011;124:647–654.
41. Rodu B, Peiper N, Cole P. Acute myocardial infarction mortality before and after state-wide smoking bans. *J Community Health*. 2012;37:468–472.
42. Villalbí JR, Sanchez E, Benet J, Cabezas C, Castillo A, Guarga A, Salto E, Tresserras R, Barcelona Group for Smoking Regulation Policies E. The extension of smoke-free areas and acute myocardial infarction mortality: before and after study. *BMJ Open*. 2011;1:e000067.
43. Hahn EJ, Rayens MK, Burkhart PV, Moser DK. Smoke-free laws, gender, and reduction in hospitalizations for acute myocardial infarction. *Public Health Rep*. 2011;126:826–833.
44. Cronin EM, Kearney PM, Kearney PP, Sullivan P, Perry IJ, on behalf of the Coronary Heart Attack Ireland Registry Working G. Impact of a national smoking ban on hospital admission for acute coronary syndromes: a longitudinal study. *Clin Cardiol*. 2012;35:205–209.
45. Sebrie EM, Sandoya E, Hyland A, Bianco E, Glantz SA, Cummings KM. Hospital admissions for acute myocardial infarction before and after implementation of a comprehensive smoke-free policy in Uruguay. *Tob*

*Control.* February 15, 2012. doi:10.1136/tobaccocontrol-2011-050134. http://tobaccoccontrol.bmj.com. Accessed October 3, 2012.
46. Sargent JD, Demidenko E, Malenka DJ, Li Z, Gohlke H, Hanewinkel R. Smoking restrictions and hospitalization for acute coronary events in Germany. *Clin Res Cardiol*. 2012;101:227–235.
47. Kent BD, Sulaiman I, Nicholson TT, Lane SJ, Moloney ED. Acute pulmonary admissions following implementation of a national workplace smoking ban. *Chest.* March 1, 2012. doi:10.1378/chest.11-2757. http://journal.publications.chestnet.org. Accessed October 3, 2012.
48. Heinz J, Rasmussen CM, Johnson CJ. The effect of smoking bans on myocardial infarctions: the Boise experience. *Nicotine Tob Res*. 2007; 9:S301.
49. Gudnason T, Viktorsson T, Andersen K. A smoking ban in public places may reduce the incidence of acute coronary syndrome among non-smoking men. *Eur Heart J*. 2009;30:153.
50. Barone-Adesi F, Vizzini L, Merletti F, Richiardi L. Italian smoking regulation decreased hospital admissions for acute coronary events: effect modification by age and day of the week. *Eur Heart J*. 2009;30:148.
51. Di Valentino M, Limoni C, Rigoli A, Gallino A, Muzzarelli S, Pedrazzini G. Reduced hospitalization for acute coronary syndrome after introduction of smoking ban in public places in Canton Ticino, Southern Switzerland. *Eur Heart J*. 2010;31:680.
52. Di Valentino M, Rigoli A, Limoni C, Barazzoni F, Gallino A, Muzzarelli S, Pedrazzini G. Reduced incidence of ST-elevation myocardial infarction in the first two years after introduction of a public smoking ban in Canton Ticino, Switzerland. *Eur Heart J.* 2011;32 502.
53. Xuereb R, Calleja N, Distefano A, England K, Gatt M, Grech V. Smoking ban: the Malta paradox. *Eur Heart J*. 2011;32:379.
54. Hurt RD, Weston SA, Ebbert JO, McNallan SM, Croghan IT, Schroeder DR, Roger VL. Myocardial infarction and sudden cardiac death in Olmsted County, Minnesota, before and after smoke-free workplace laws. *Circulation*. 2011;124:21.
55. McMillen R, Hill A, Valentine N, Collins R. The Starkville and Hattiesburg Heart Attack Studies: Reductions in Heart Attack Admissions Following the Implementation of Local Smoke-Free Ordinances. October 2010. http://www.ttac.org/resources/pdfs/120810_Miss_Heart_Attack_Report.pdf. Accessed October 3, 2012.
56. Bruckman D, Bennett B. Significant Change in Statewide Rates of Hospital Discharge Data for Myocardial Infarction Due to the Enactment of Ohio's Smoke-Free Work Place Law. Analyses of the Impact of the Ohio Smoke-Free Workplace Act [Serial on the Internet]. 2011. http://www.odh.ohio.gov/ASSETS/81B904A706574FFB97271C46256E53C2/Final%20Reports.pdf. Accessed November 20, 2011.
57. The North Carolina Smoke Free Restaurants and Bars Law and Emergency Department Admissions for Acute Myocardial Infarction: A Report to the North Carolina State Health Director. 2011. http://tobaccopreventionandcontrol.ncdhhs.gov/smokefreenc/docs/TPCB-2011SFNCReport-SHD.pdf. Accessed October 3, 2012.
58. US Department of Health and Human Services. *How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health; 2010.
59. Duval S, Tweedie R. A nonparametric "trim and fill" method of accounting for publication bias in meta-analysis. *JASA*. 2000;95:89–98.
60. Oono IP, Mackay DF, Pell JP. Meta-analysis of the association between secondhand smoke exposure and stroke. *J Public Health (Oxf)*. 2011;33: 496–502.
61. Kabir Z, Clarke V, Conroy R, McNamee E, Daly S, Clancy L. Low birthweight and preterm birth rates 1 year before and after the Irish workplace smoking ban. *BJOG*. 2009;116:1782–1787.
62. Mackay DF, Nelson SM, Haw SJ, Pell JP. Impact of Scotland's smoke-free legislation on pregnancy complications: retrospective cohort study. *PLoS Med.* 2012;9:e1001175.

## CLINICAL PERSPECTIVE

Secondhand smoke causes cardiovascular and respiratory disease, and implementation of smoke-free legislation is followed by drops in hospitalizations and deaths from these diseases. This meta-analysis of 45 studies of 33 smoke-free laws found that smoke-free legislation was associated with significantly lower rates of hospital admissions (or deaths) for coronary events, other heart disease, cerebrovascular accidents, and respiratory disease. There was a dose-response relationship between the strength of the law; more comprehensive laws (including workplaces, restaurants, and bars) had the largest health benefits. This study provides strong evidence not only of the health benefits of smoke-free laws, but also of the need to enact comprehensive laws without exceptions.

**Go to http://cme.ahajournals.org to take the CME quiz for this article.**

# ASSOCIATION BETWEEN SMOKEFREE LEGISLATION AND HOSPITALIZATIONS FOR CARDIAC, CEREBROVASCULAR, AND RESPIRATORY DISEASES: A META-ANALYSIS

## SUPPLEMENTAL MATERIAL

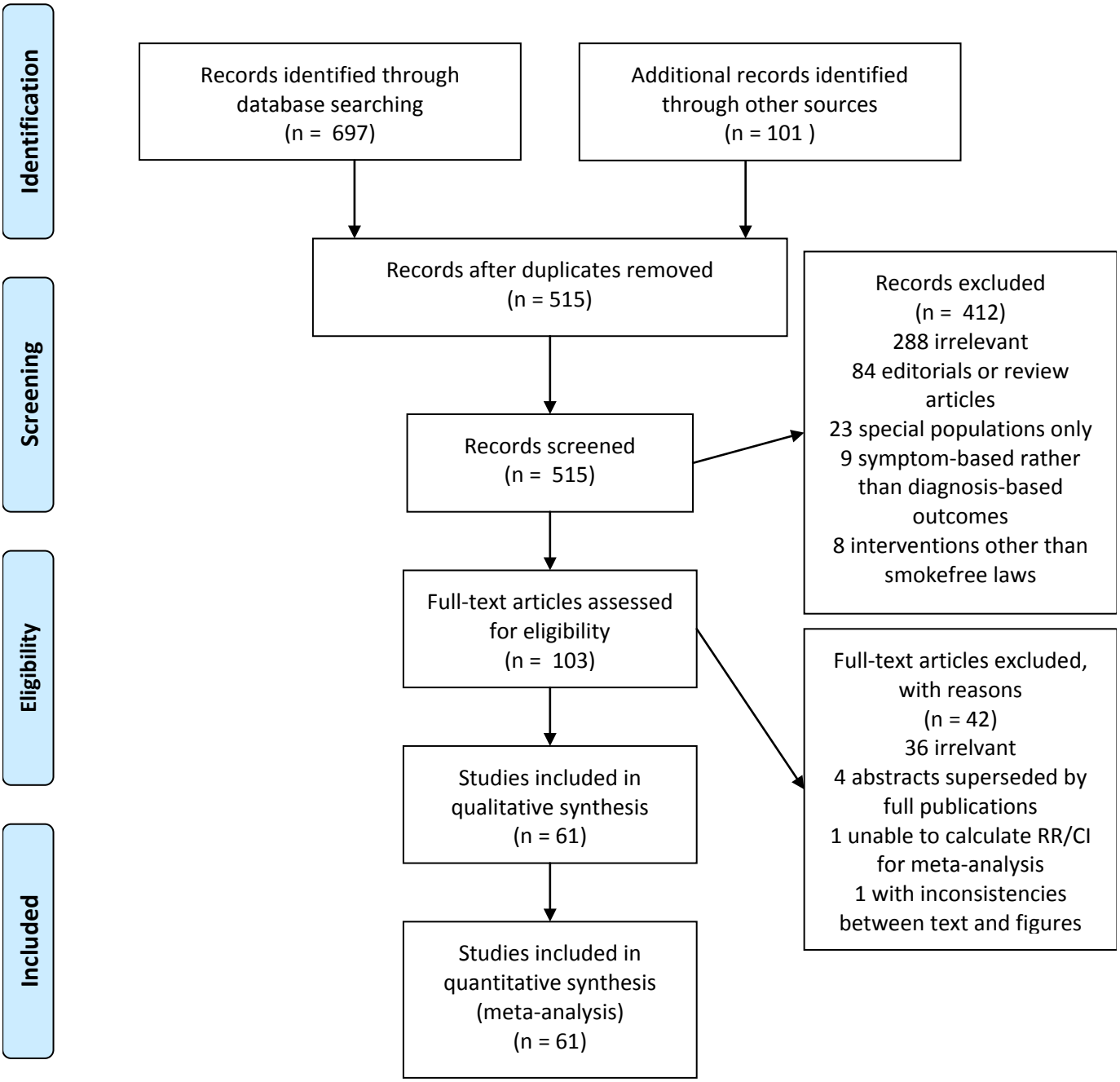
Crystal E. Tan, M.S.[1]

Stanton A. Glantz, Ph.D.[1, 2]

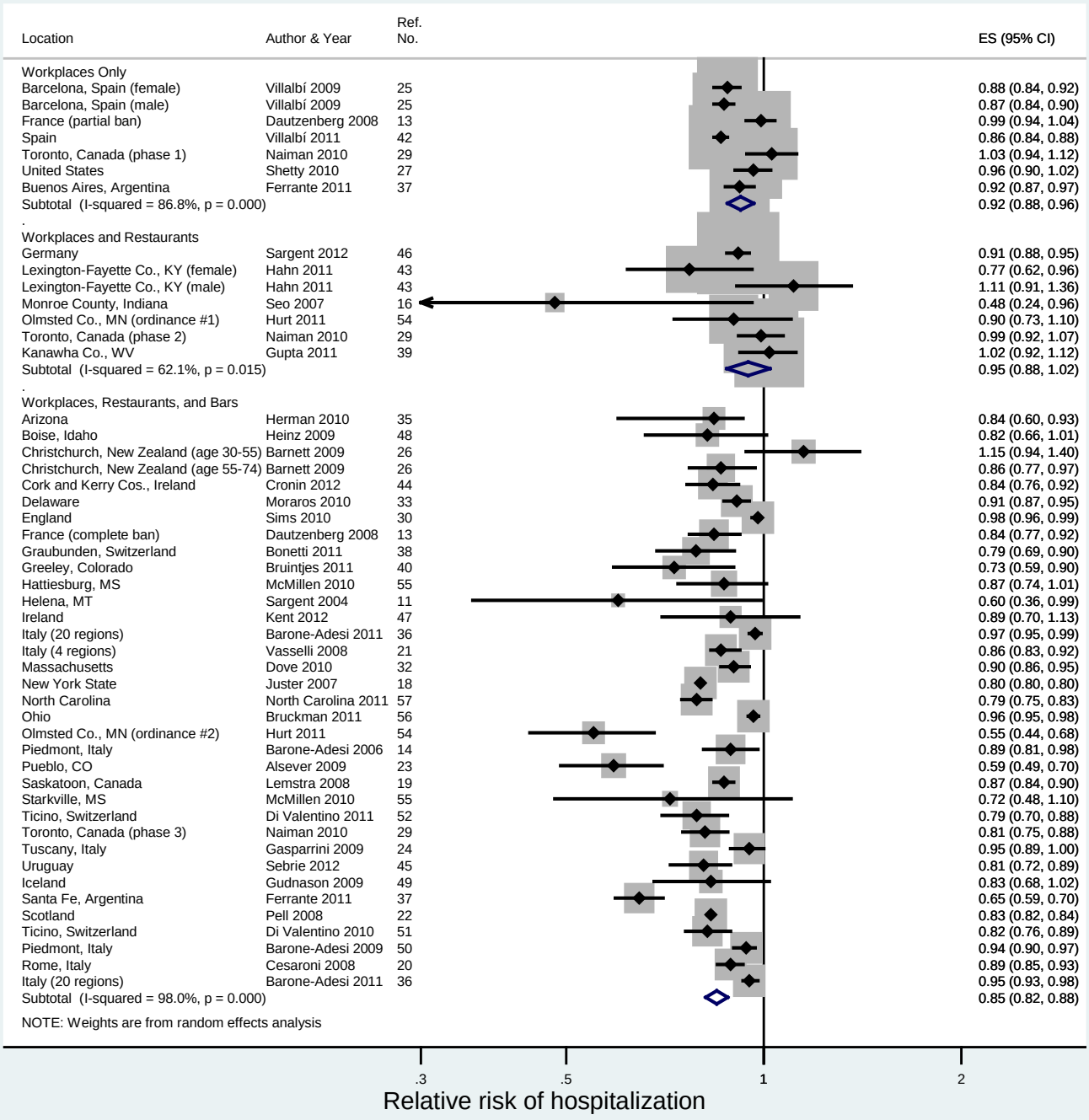
[1] Center for Tobacco Control Research and Education, University of California, San Francisco

[2] Department of Medicine, University of California, San Francisco

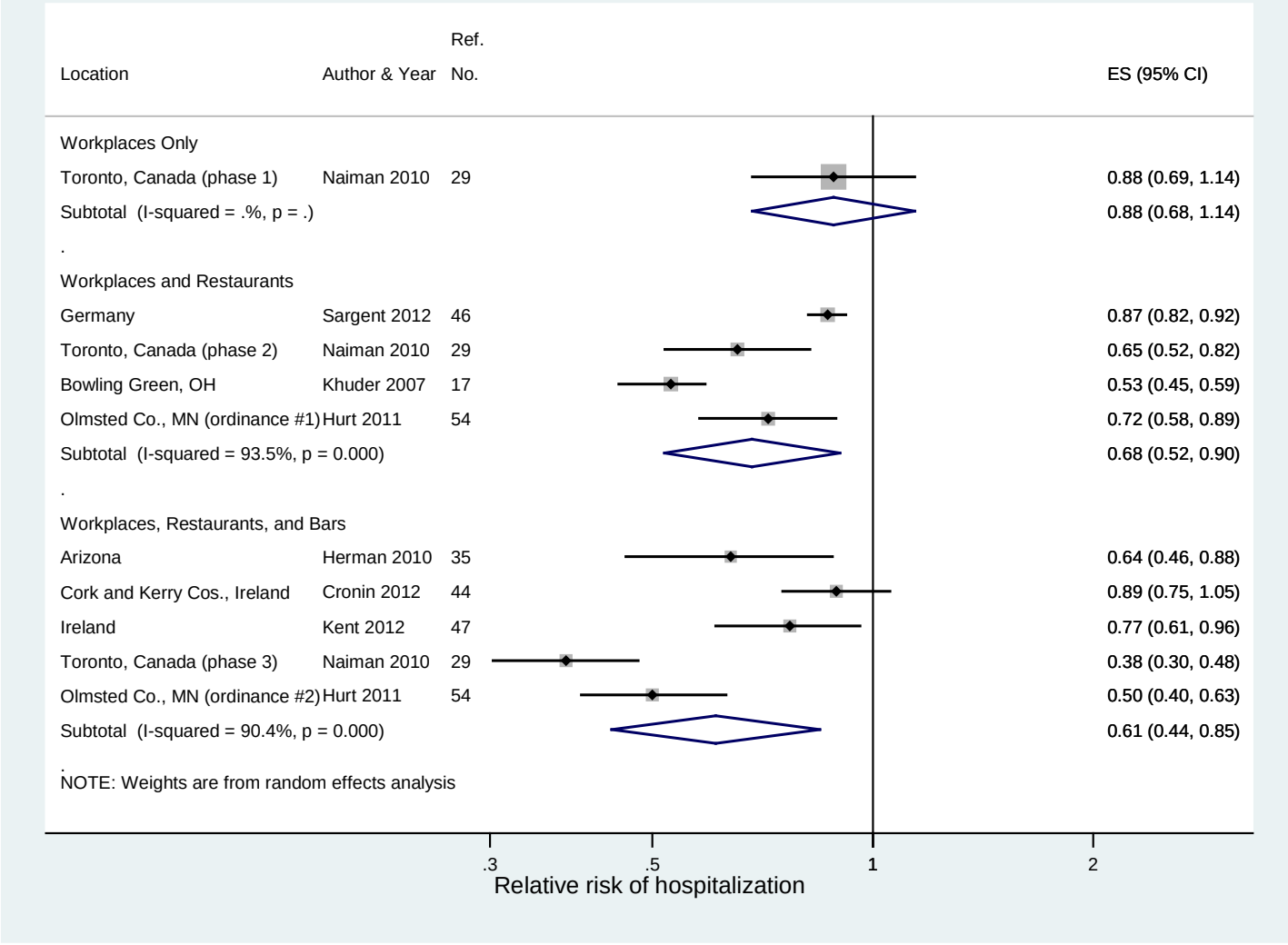
## Table of Contents



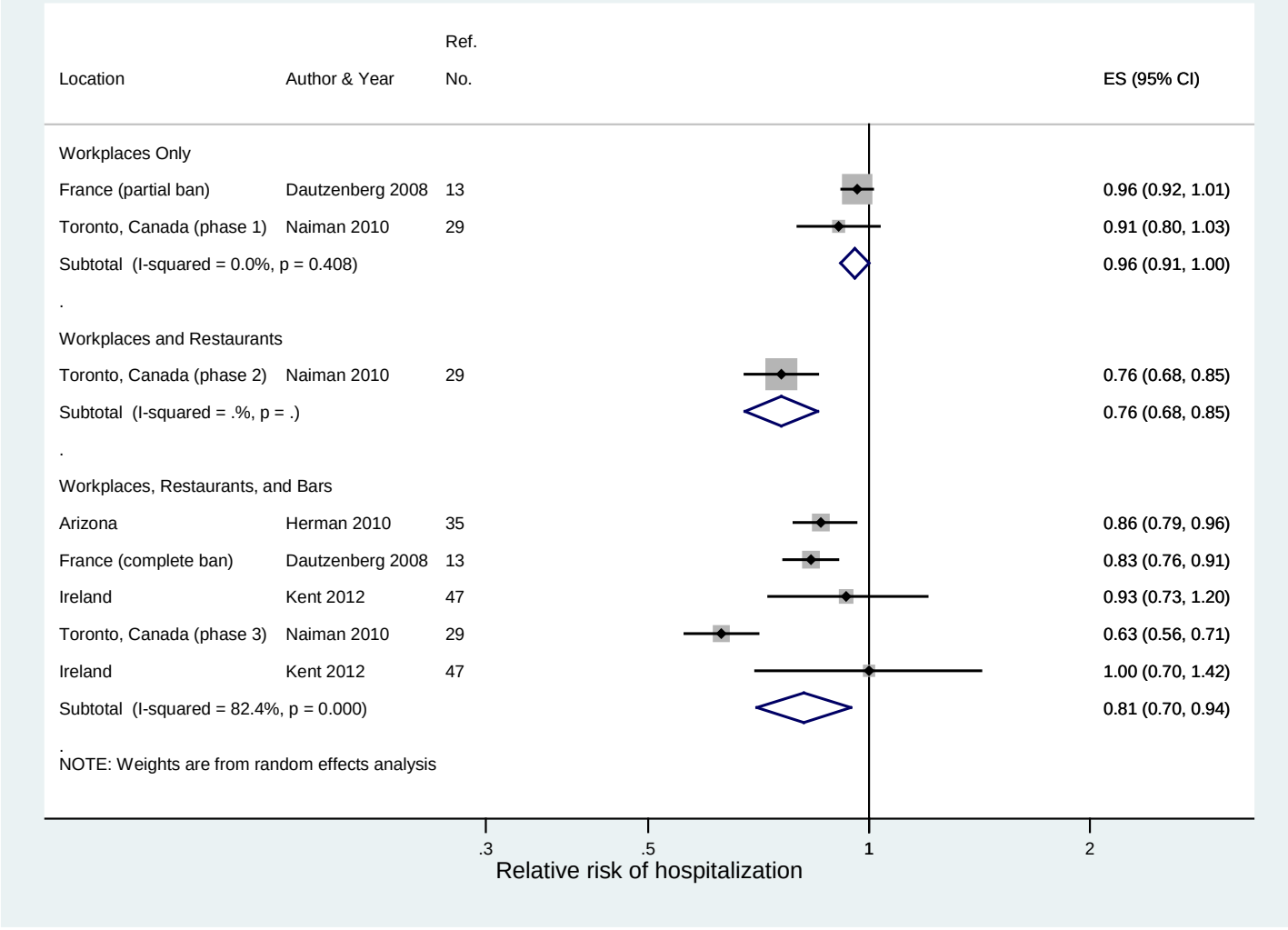

**Supplementary Figure 1.** PRISMA chart for for study selection. Note: If an individual paper presented results for two more outcomes it was counted as that number of studies



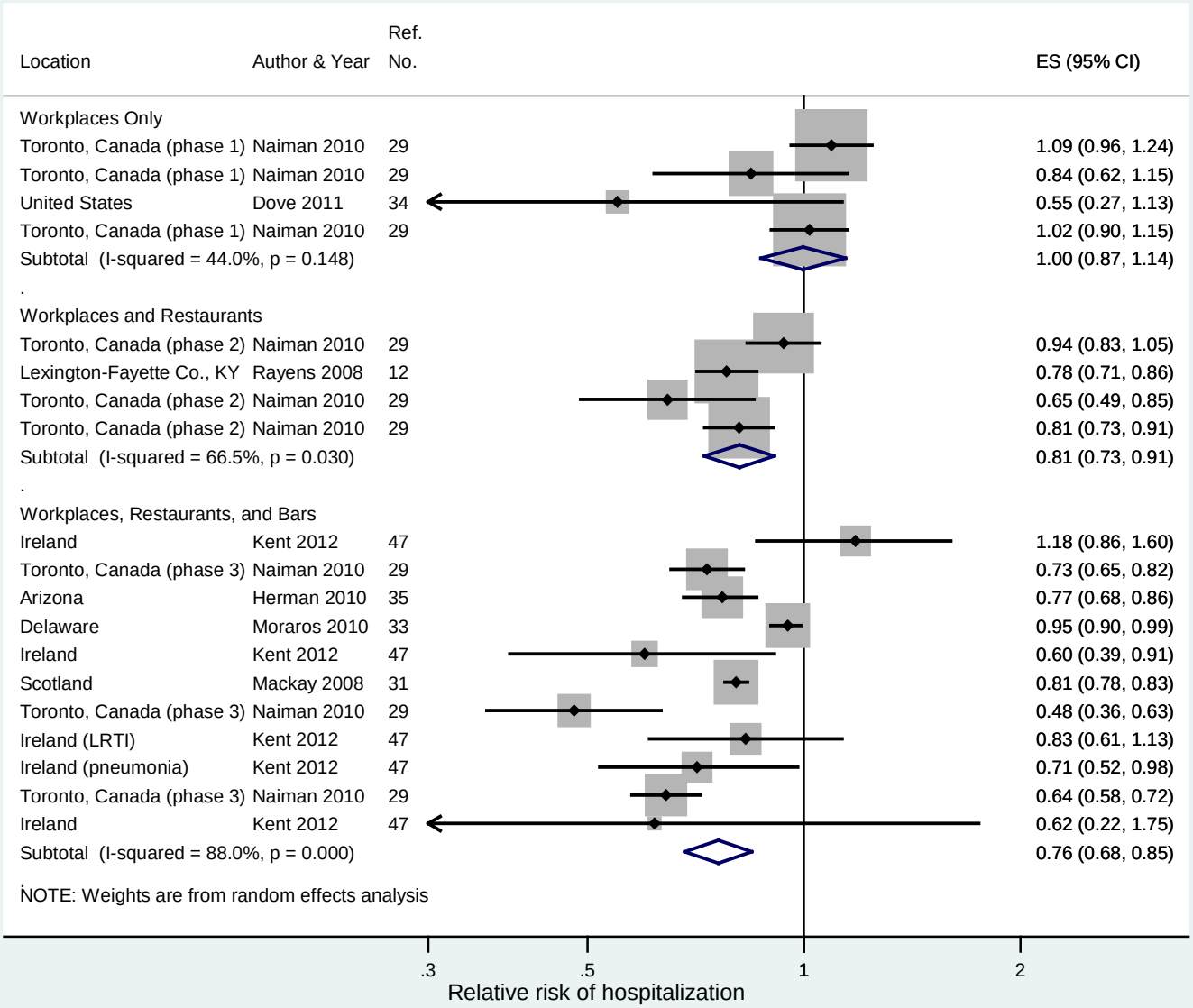

**Supplementary Figure 2.** Forest Plot for Coronary Events. ES = effect size (relative risk) and 95% confidence interval for each study. The size of the shaded area around each point is proportional to the weight in the random effects meta-analysis. Error bars indicate 95% confidence intervals for each study. Reference numbers are shown in square brackets. Refer to Tables S1-S4 for further details about each risk estimate or study.



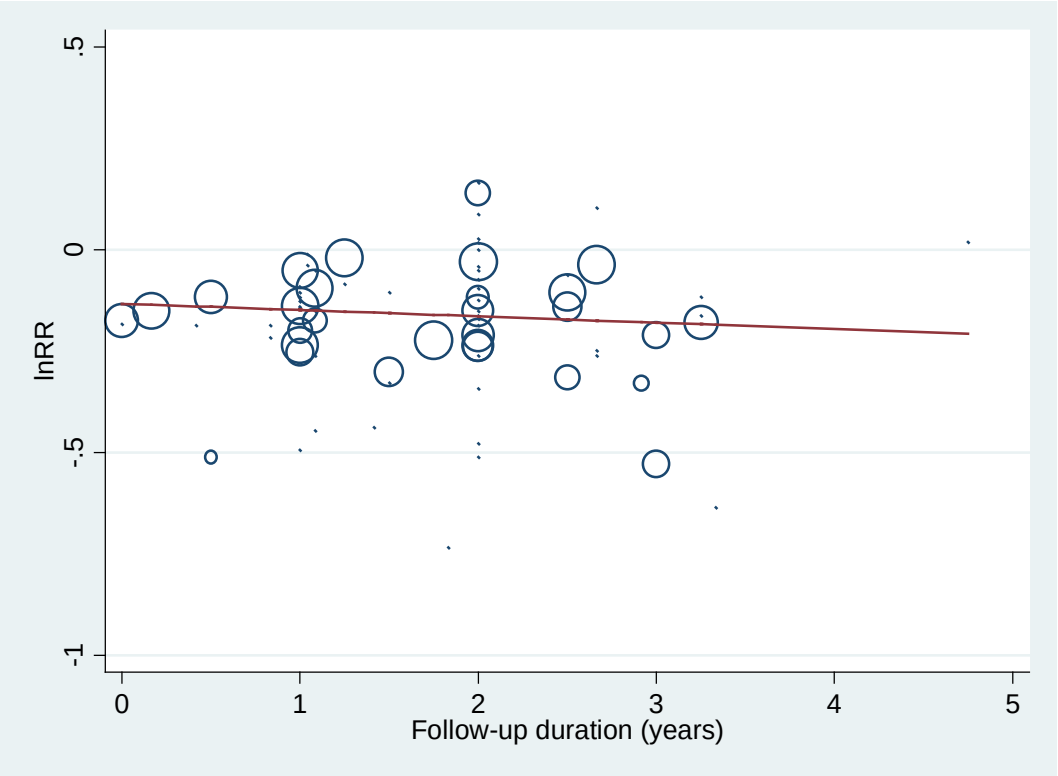

**Supplementary Figure 3.** Forest Plot for Other Heart Disease. ES = effect size (relative risk) and 95% confidence interval for each study. The size of the shaded area around each point is proportional to the weight in the random effects meta-analysis. Error bars indicate 95% confidence intervals for each study. Reference numbers are shown in square brackets. Refer to Tables S1-S4 for further details about each risk estimate or study.



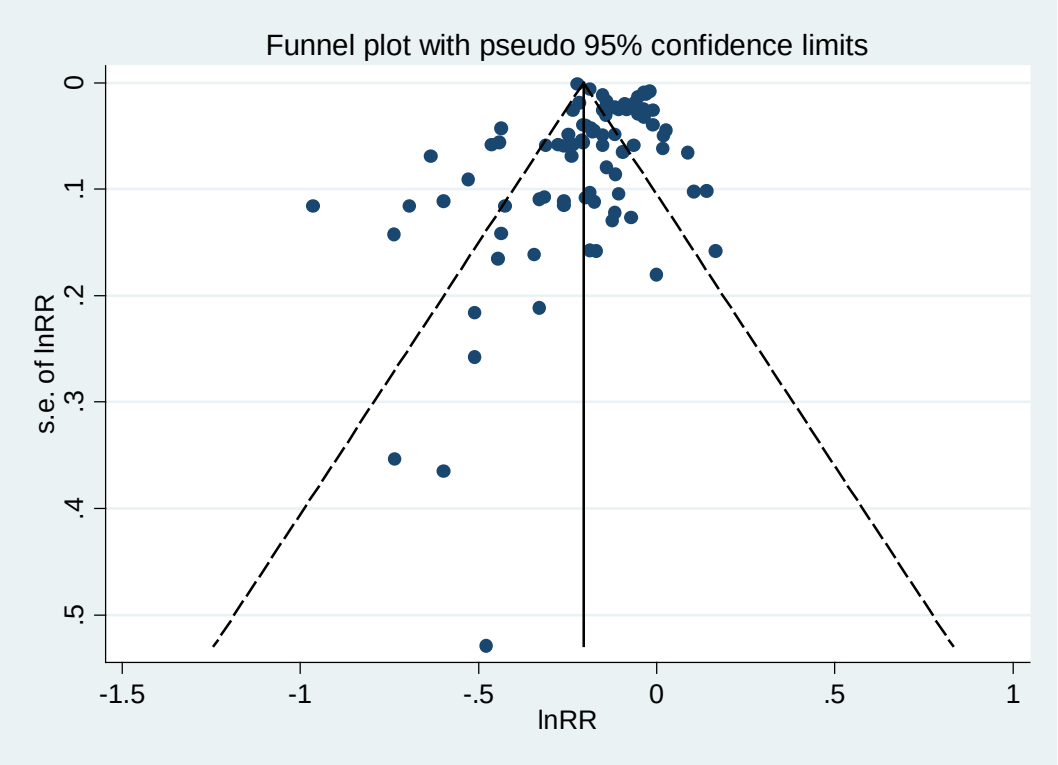

**Supplementary Figure 4.** Forest Plot for Cerebrovascular Accidents. ES = effect size (relative risk) and 95% confidence interval for each study. The size of the shaded area around each point is proportional to the weight in the random effects meta-analysis. Error bars indicate 95% confidence intervals for each study. Reference numbers are shown in square brackets. Refer to Tables S1-S4 for further details about each risk estimate or study.




**Supplementary Figure 5**. Forest Plot for Respiratory Disease. ES = effect size (relative risk) and 95% confidence interval for each study. The size of the shaded area around each point is proportional to the weight in the random effects meta-analysis. Error bars indicate 95% confidence intervals for each study. Reference numbers are shown in square brackets. Refer to Tables S1-S4 for further details about each risk estimate or study.




**Supplementary Figure 6.** Metaregression for Reduction in Risk of Hospitalization (or Death) associated with Comprehensive Laws for Acute Myocardial Infarction based on 31 Risk Estimates. The size of the points is proportional to the weight in a random effects metaregression. Each locality studied for a smokefree law was associated with one follow-up time per outcome.




**Supplementary Figure 7.** Funnel Plot for 86 Risk Estimates Used in the Meta-analysis. Solid vertical line represents the summary estimate of the effect of all ordinances on hospital admissions (assuming a fixed effects meta-analysis), and the dashed lines represent the 95% confidence interval.

## Supplementary Table 1. Detailed Description of Studies of Coronary Events

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **AMI – Workplace Only Laws** | | | | | | | | | | | |
| Villalbí 2009[25] | Barcelona, Spain | January 1, 2006 | January 2004-December 2005 vs. January 2006-December 2006 | Pre: 24<br>Post: 12 | Acute myocardial infarction (ICD-9 410.x1) | >24 | Comparison of age- and gender-specific annual hospitalization rates | Age, gender | F: .88 (.84, .92) *[a]<br>M: .87 (.84, .90) *[a]<br><br>Adjusted rates for men were 185.6 (179.2, 192.1) per 100,000 population in 2004, 175.0 (168.9, 181.2) in 2005, and 156.4 (150.6, 162.1) in 2006 post-law.<br><br>Adjusted rates for women were 81.2 (77.1, 85.3) in 2004, 75.6 (71.7, 79.6) in 2005, and 69.0 (65.3, 72.7) in 2006 post-law. | 13,317 | Law in workplaces, but not cafés, bars, restaurants, night clubs, or discotheques.<br><br>Antismoking legislation also included law on advertising and reduction in sales outlets.<br><br>In men, the decline in 2006 (-10.68%) was much greater than in 2005 (-5.69%); in women, it was only slightly greater (-8.76% vs. -6.85%). This decline is apparent in all age groups except men aged <45. |
| Dautzenberg 2008[13] | France | February 1 2007; restaurants, bars, and casinos added January 1, 2008 | January 2006-February 15, 2008 | Partial law:<br>Pre: 13<br>Post: 12.5 | Acute myocardial infarction | <65 | Rate per 100,000 admissions | | Partial law:<br>.99 (.94, 1.04) *[b] | N/A | Smoking ended in public places in February 2007, but restaurants, bars, and casinos were given exceptions until January 2008. Law permits ventilated smoking rooms under strict conditions.<br><br>Between January 2007 (before law) and January 2008 (after law), SHS exposure dropped from 57% to 14%. $PM_{2.5}$ levels also dropped.<br><br>Also report substantial drops in respiratory symptoms among hospitality workers. |
| Villalbí 2011[42] | Spain | January 1, 2006 | January 2006 – December 2007 vs. January 2004-December 2005 | Pre: 24<br>Post: 24 | Acute myocardial infarction deaths (ICD-10 CM 055) | 34+ | Comparison of age- and sex-specific mortality rates; Poisson regression to calculate annual relative risk | Age, sex | First post-law year:<br>.90 (.88, .92)<br>F: .90 (.87, .92)<br>M: .90 (.88, .93)<br><br>Second post- law year:<br>.86 (.84, .88) *<br>F: .86 (.84, .89)<br>M: .86 (.83, .88)<br><br>Significant reduction in the relative risks of AMI death in both men and | 90,382 | Law in workplaces, but not cafés, bars, restaurants, night clubs, or discotheques.<br><br>Antismoking legislation also included law on advertising and reduction in sales outlets.<br><br>A population-based surveillance system showed that the percentage of employed workers reporting smoke-free jobs rose from 54-91% after implementation. |

| Supplementary Table 1. Detailed Description of Studies of Coronary Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | | | | | | | | women. Magnitude of reduction appears greater among the elderly. | | |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 1: 24 | Acute myocardial infarction (ICD-9 410, ICD-10 I21) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 1 vs. pre-law: 1.03 (.94, 1.12) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>The largest declines were seen after the phase of the law affecting restaurants came into effect, including a 17% (14%, 19%) decrease in AMI.<br><br>Crude rates of hospital admissions decreased 39% (38%, 40%) for cardiovascular conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| Shetty 2010[27] | United States | Varies; study uses American Nonsmokers' Rights Foundation smoking law database and national health outcomes datasets to analyze effect of smokefree laws in various places. | | | Acute myocardial infarction (ICD-9 and ICD-10) | All | Region-level fixed effects multivariate linear regression model | Stratified by age. Regression model included hospital beds/person, county population, physicians/person, percent population in labor force, cigarette taxes<br><br>Compared trends in regions where smoking laws were implemented to control regions with no laws. | Deaths in 18-64: .964 (.904, 1.025) * | Nationwide inpatient sample: 673,631<br><br>Multiple cause of death dataset: 2,018,548<br><br>Medicare patients: 2,382,387 | Does not differentiate between weak and strong laws<br><br>Assumes that county-level laws apply in cities and unincorporated places (varies by county), causing significant misclassification.<br><br>No statistically significant reduction of hip fracture admissions (control condition). |
| **AMI – Workplace and Restaurant Laws** | | | | | | | | | | | |
| Sargent | Germany | Nationwide: | January 2004- | Pre: varies | Acute myocardial | 30+ | Rate of | Age, sex, | .914 (.878, .950) * | 39,224 | Legislation addressed smoking in |

| Supplementary Table 1. Detailed Description of Studies of Coronary Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| 2012[46] | | September 1, 2007<br><br>Statewide: varies | December 2008 | Post: 12 | infarction (ICD-10 I21.0-I21.9) excluding recurrent AMI within 28 days of the initial event | | hospitalization for AMI; logistic regression and interrupted time series linear regression model | occupation | In the first year after implementation, 449 AMI hospitalizations were prevented. | | federal buildings and the transportation system. Private employers were allowed to introduce a total or partial smoking law in workplaces. States were permitted to decide how to limit smoking in the hospitality sector (hotels, restaurants, bars).<br><br>Nonsignificant trend toward decreasing rate of admissions after law.<br><br>Hospitality smoking laws were passed in all states in implemented between August 1, 2007 and July 1, 2008. Most states continued to allow smoking in small bars without any food delivery and in separate rooms in large restaurants. A population-based survey revealed a significant decrease of cigarettes smoked in Germany after the law.<br><br>Hospital admissions for control condition fractures increased slightly from 65100 in 2007 to 66954 in 2009. Bronchitis cases, which might be affected by smoke-free laws, declined from 16900 in 2007 to 15391 in 2009.<br><br>Hospitalization costs for AMI decreased significantly by 20.1 (16.0, 24.2)% or about 5.2 million euros. |
| Hahn 2011[43] | Lexington-Fayette County, Kentucky | April 27, 2004 | May 2004-December 2006 vs. January 2001-April 2004 | Pre: 40<br>Post: 32 | Acute myocardial infarction (primary discharge diagnosis ICD-9 410) | 35+ | Age-adjusted rates for AMI hospitalizations; Poisson regression and first-order autoregressive time-series model | Age, gender, county-level smoking rate, secular trend, seasonal variation | F: .77 (.62, .96) *<br>M: 1.11 (.91, 1.36) * | 2692 | Smokefree enclosed public places law prohibited smoking in restaurants, bars, bowling alleys, bingo halls, convenience stores, laundry facilities, and other businesses open to the public. Buildings not open to the public, including government office buildings or workplaces, were excluded. Manufacturing facilities were also excluded.<br><br>Rates for men and women were |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | relatively stable during the 32-month post-law period.<br><br>There was a dramatic improvement in air quality in hospitality venues and immediate reduction in hair nicotine among bar and restaurant workers following implementation of the law.<br><br>Within 3 months of implementation, there was a 56% decline in hair nicotine.<br><br>Among AMI hospitalizations, there was an overrepresentation of women in the hospitality industry and a disproportionate number of men working in manufacturing facilities and government worksites on mandated by the law.<br><br>AMI prevalence and hospitalization rate for CVD showed a steady upward trend from 2001 to 2006 in Kentucky. |
| Seo 2007[16] | Monroe County, Indiana | 1 Aug 2003, bars added 1 Jan 2005 | August 2001-May 2003 vs. August 2003-May 2005 (same months selected to control for seasonality) | Pre: 22<br>Post: 22 | Acute myocardial infarction (ICD-9 410), confirmed with troponin or CPK excluding past cardiac procedures, no cardiac risk factors (e.g., hypertension or hypercholesterolemia) | All | Poisson test | Comparison with Delaware County (no law). No significant decrease in admissions observed in Delaware County. | .48 (.24, .96) *[c]<br><br>Drop in admissions in the number of nonsmoking patients from pre- to post-law period of -12 (-21.29, -2.81) from 17 to 5 cases | 37 | Public smoking law in effect for all restaurants, retail stores, and workplaces since August 2003; bar provisions only in effect since January 2005 (last 5 months of study period).<br><br>There was a 69% reduction in AMIs (16 vs. 5) among documented nonsmokers before and after the law. No significant change in number of smokers admitted.<br><br>The study is limited by unrealistically stringent exclusionary criteria and small sample size. |
| Hurt 2011[54] | Olmsted County, Minnesota | January 1, 2002 (Ordinance 1: smokefree restaurants)<br><br>October 1, 2007 | October 2007-March 2009 vs. July 2000-December 2001 | Pre ordinance 1: 18<br>Post ordinance 1: 18 | Acute myocardial infarction validated using biomarkers, cardiac pain, and Minnesota coding | All | Age and sex-adjusted rate per 100,000; adjusted hazard ratio | Age, sex | Ordinance 1 vs. no law: .90 (.73, 1.10) * | N/A | Law was initiated in two steps, smokefree restaurants in January 2002, and smokefree workplaces in 2007.<br><br>AMI rate per 100,000 dropped from 212.3 to 168.7 following the restaurant |

| Supplementary Table 1. Detailed Description of Studies of Coronary Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | (Ordinance 2: smokefree workplaces) | | | of the ECG | | | | | | law (HR .90; .73, .1.10; *p*=.30) and from 130.0 to 102.9 following the workplace law (.79; .63, .98; *p*=.04).<br><br>During this period, the prevalence of hypertension, diabetes, hypercholesterolemia, and obesity either remained constant or increased while the prevalence of smoking among the adults declined by 23%. |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 2: 36; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | Acute myocardial infarction (ICD-9 410, ICD-10 I21) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 2 vs. pre-law: .99 (.92, 1.07) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>The largest declines were seen after the phase of the law affecting restaurants came into effect, including a 17% (14%, 19%) decrease in AMI.<br><br>Crude rates of hospital admissions decreased 39% (38%, 40%) for cardiovascular conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **AMI – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Herman 2011[35] | Arizona | May 1, 2007 | May 2007-May 2008 vs. January 2004-April 2007 | Pre: 40<br>Post: 13 | Acute myocardial infarction (primary diagnosis ICD-9 410.x0) | All | Rate of admissions per 100,000 annually; Poisson regression | Seasonality, population, annual linear trend<br><br>Separate analyses for counties with pre-existing smoke-free laws vs. those without | .84 (.60, .93) *[d]<br><br>Estimated 159 fewer cases of hospital admissions (-13%) for AMI than expected for counties with no pre-existing law | 5025 (counties without previous laws) | Law ended smoking in all enclosed workplaces including bars and restaurants.<br><br>Cost-savings analysis estimates $16.8 million in savings for AMI, unstable angina, acute stroke, and acute asthma in 13 months after law in non-law counties ($7.2 million for AMI alone). |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | No change in rates of control diseases (acute appendicitis, kidney stones, acute cholecystitis, and ulcers) pre and post law. |
| Heinz 2007[48] | Boise, Idaho | July 1, 2004 | July 1, 2004-June 30, 2005 vs. July 1, 2002-June 30, 2004 | Pre: 24<br>Post: 12 | Acute myocardial infarction (primary diagnosis using ICD-9 classification) | All | Poisson test | Weather, outdoor air quality, time | All patients:<br>.82 (.66, 1.01) *[e]<br><br>Nonsmokers:<br>.68 (.53, .87) [e]<br><br>Significant 32% decrease in MI rate among nonsmokers (*p*=.002) and nonsignificant 18% decrease in MI rate among all patients (*p*=.068). | 1197 | Law on smoking in public buildings, including restaurants.<br><br>Control condition (urinary tract infection) demonstrated nonsignificant increase during study period. |
| Barnett 2009[26] | Christchurch, New Zealand | December 2004 | February 2005-December 2006 vs. February 2003-December 2004 (bimonthly intervals) | Pre: 24<br>Post: 24 | Acute myocardial infarction (principal diagnosis code ICD-10 I21.0-I22.9), excluding repeat admissions | 30+ | Poisson regression | Sex, age, smoking status, neighborhood social deprivation | .92 (.86, .99)<br><br>F: .94 (.84, 1.05)<br>M: .90 (.82, .99)<br><br>30-55: 1.15 (.94, 1.40) *<br>55-74: .86 (.77, .97) *<br>75+: .89 (.81, .98) | 3079 | 2004 law covered all workplaces, including bars and restaurants. Earlier restrictions in 1990 prohibited smoking in most workplaces, public interiors (i.e. shops), and half of seating in restaurants.<br><br>Higher rates of AMI reduction observed in affluent neighborhoods. |
| Cronin 2012[44] | Cork and Kerry Counties, Ireland | March 29, 2004 | Primary data set:<br>April 2004-March 2007 vs. March 2003-March 2004<br><br>Secondary data set:<br>July 2003-March 2004 vs. April 2004-June 2007 | Pre: 13<br>Post: 36<br><br>Pre: 9<br>Post: 39 | Acute myocardial infarction, diagnosed in hospital by physician using troponin T or I, allowing repeat admissions<br><br>Primary analysis was for overall acute coronary syndrome. | 18+ | AMI admissions and rate per 100,000; Poisson regression | Linear time trend<br><br>Sensitivity analyses were undertaken by gender, smoking status, and type of ACS.<br><br>According to mortality data, there was no change in all cause mortality and overall 6.5% decrease in deaths from circulatory | All AMI:<br>.84 (.76, .91) *[b]<br><br>NSTEMI:<br>.80 (.71, .90) [b]<br><br>STEMI:<br>.92 (.78, 1.07) [b]<br><br>Estimates derived from secondary data set. | Primary data set: 3041<br><br>Secondary data set: 3195 | See description of law in entry for Ireland.<br><br>The first year's reduction in admissions for ACS was due to fewer cases among men and current smokers. The third year's reduction in admissions for ACS was due to fewer cases among men, current smokers, and never smokers.<br><br>Increased effect on ACS over time evidenced by 12% decrease in year 1 and 13% decrease in year 3.<br><br>This paper supersedes an abstract of the same study used in the 2009 meta- |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | causes in Cork and Kerry counties, so results were not attributable to changes in coronary death patterns outside of hospital. | | | analysis. |
| Moraros 2010[33] | Delaware | Nov 1, 2002 | Jan 2003-Dec 2004 vs. Jan 1999-Sep 2002 | Pre: 45<br>Post: 24 | Acute myocardial infarction (primary discharge diagnosis ICD-9 410) | 18+ | Quarterly rates of events; Poisson regression | Seasonal effects<br><br>Compared with non-Delaware residents admitted in Delaware for AMI. AMI relative risk in non-Delaware residents was similar pre-ordinance and post-ordinance period (.98; .90, 1.08). | .91 (.87, .95) *<br><br>Estimated 169 AMI cases prevented in 2 year post-ordinance period. | 10,210 | *Delaware Clean Indoor Air Act* of 1994 became comprehensive in 2002 with an amendment to include all enclosed indoor areas accessible to the general public, including restaurants, bars, and casinos.<br><br>A model including ordinance, season, and linear trend using pre and post ordinance data showed that the linear trend is not significant ($p$=0.557)<br><br>Delaware DPH reported 99.6% compliance in bars and restaurants, and the Delaware Department of Labor reported 100% compliance in other workplaces in first year. |
| Sims 2010[30] | England | July 1, 2007 | July 2007-Sept 2008 vs. July 2002-May 2007 | Pre: 60<br>Post: 15 | Acute myocardial infarction (primary diagnosis code ICD-10 I21) excluding repeat admissions within 28 days | 18+ | Interrupted time series design with hospital episode statistics data; segmented Poisson regression | Long-term trend, temporal fluctuations (temperature, week of year, holidays), population size<br><br>Stratified by age and sex | .98 (.96, .99) *<br><br>< 60:<br>F: .98 (.92, 1.03)<br>M: .97 (.94, .99)<br>≥ 60:<br>F: .96 (.94, .99)<br>M: .96 (.95, .99)<br><br>Around 1600 emergency admissions for AMI prevented in 12 months. | 342,361 | Law affected bars and restaurants most; some of these venues went smokefree *before* July 1 in preparation for the law, which may create a less marked decrease.<br><br>No evidence of a change in the slope of the AMI trend line after the legislation.<br><br>Prior to the law, many public places and workplaces were already smokefree. In the year before implementation, 55% of employed adults already worked in smoke-free environments.<br><br>Subgroup analysis shows significant 3.07% drop in admissions in 60+ ($p$=0.001) and 3.46% drop in men <60 ($p$<0.01). |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Dautzenberg 2008[13] | France | February 1 2007; restaurants, bars, and casinos added January 1, 2008 | January 2006-February 15, 2008 | Complete law:<br>Pre: 24<br>Post: 1.5; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | Acute myocardial infarction | <65 | Rate per 100,000 admissions | | Complete law:<br>.84 (.77, .92) *[b] | N/A | Smoking ended in public places in February 2007, but restaurants, bars, and casinos were given exceptions until January 2008. Law permits ventilated smoking rooms under strict conditions.<br><br>Between January 2007 (before law) and January 2008 (after law), SHS exposure dropped from 57% to 14%. $PM_{2.5}$ levels also dropped.<br><br>Also report substantial drops in respiratory symptoms among hospitality workers. |
| Bonetti 2011[38] | Graubünden, Switzerland | March 1, 2008 | March 2006-February 2008 vs. March 2008-February 2010 | Pre: 24<br>Post: 24 | Acute myocardial infarction (defined as detectable troponin in a clinical setting consistent w/ myocardial ischemia, identified by ICD-10 codes) undergoing coronary angiography (may be viewed as representative of overall incidence in the region) | All | AMI incidence | Air quality ($PM_{10}$ and $NO_2$), sales of lipid lowering drugs<br><br>Separate analyses based on resident status, gender, smoking status, medical history<br><br>Compared to Lucerne, a nearby region without smoke-free law. AMI incidence increased in Lucerne during the post-law period in Graubünden. | .79 (.69, .90) *[b]<br><br>The number of AMI patients decreased 21% in the 2 years before vs. 2 years after law.<br><br>For each of the 4 years of the study, incidence rate of AMI was 89.4 (pre), 93.8 (pre), 69.8 (1 year post), and 68.8 (2 years post) per 100,000 residents. | 842 | Smoking law in public places, including cafes, bars, and restaurants.<br><br>Based on the large number of visitors, the population of the Canton of Graubuenden may almost double during the holiday season, hence the resident vs. nonresident analysis.<br><br>The most pronounced reduction in AMI was in patients with documented coronary artery disease.<br><br>Female AMI patients showed a more pronounced drop in the second year of the law compared to the first, while male patients experience a diminished magnitude of decrease.<br><br>Changes in outdoor air pollution or use of lipid-lowering drugs (potential confounders) did not substantially contribute to the decrease in the incidence of AMI. |
| Bruintjes 2011[40] | Greeley, Colorado | December 2003 | Jan 2004-Jun 2006 vs. Jul 2002-Nov 2003 | Pre: 17<br>Post: 30 | Acute myocardial infarction (primary diagnosis ICD-9 410) and | All | Population-adjusted monthly hospitalization | Seasonality (nonsignificant), linear trends (nonsignfiicant), | .73 (.59, .90) * | 706 | Law prohibits smoking in all places of public assembly, including restaurants, bars, bowling alleys, bingo halls, and outdoor public gathering places where |

| Supplementary Table 1. Detailed Description of Studies of Coronary Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | | | | biomarker confirmation (troponin I or CKMB) | | rates; Poisson regression | smoking status, type of MI<br><br>Compared to adjacent area immediately surrounding Greeley. A smaller, nonsignificant decreased was noted in the area immediately surrounding Greeley (0.83; 0.61, 1.14). Comparison of relative risk reductions between Greeley and the control area was not significant ($p$=.48). | | | seating is provided.<br><br>Smoking law underwent various legal challenges through November 2004, during which compliance was variable.<br><br>Significant reductions in AMI among smokers (.44; .29, .65); nonsignificant reduction among nonsmokers (.86; .67, 1.09). Smokers from control area also experienced a significant decrease (.58; .35, .97) that was not significantly different from Greeley smokers ($p$=*.38*).<br><br>Reduction in events was similar in patients with STEMI (.79; .34, 1.83) and NSTEMI (0.66; .37, 1.17).<br><br>Linear trends were tested and not significant. |
| McMillen 2010[55] | Hattiesburg, Mississippi | January 1, 2007 | January 1, 2007-June 30, 2009 vs. April 21, 2005-December 31, 2006 | Pre: 20<br>Post: 30 | Acute myocardial infarction (primary diagnosis ICD-9 410) | All | AMI admissions per day compared to standardized rate prior to implementation | Compared the number of heart attack admissions among people living outside of city limits and not protected by smoke-free ordinance. A 3.8% reduction was observed in the Hattiesburg-adjacent control region compared to a 13.4% reduction in Hattiesburg. | .87 (.74, 1.01) *[c]<br><br>There were 299 heart attack admissions compared to a standardized rate of 345 admissions before law | 1754 | Smoking law in enclosed workplaces, including restaurants and bars.<br><br>Reductions in AMI admissions resulted in cost savings of $2,367,909 in 2010 dollars. |
| Sargent 2004[11] | Helena, Montana | June 5, 2002 - December 3, 2002 | December 1997-November 2003 | Pre: same 6 months for 4 pre years and 1 year after | Acute myocardial infarction (primary and secondary diagnoses of ICD-9 | All | Number of admissions during 6 month period the law | Comparison with number of admissions from surrounding area | .60 (.36, .99) *[c]<br><br>Drop in number of admissions -16 (-31.7, - | 304 | Law prohibited smoking in public and in workplaces but was suspended by a court order after 6 months. |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | law suspended<br>Post: 6 | 410, some validated with troponin or CPK) | | was in effect compared to the average for the same 6 months in other years by Poisson test | (not covered by law). No significant change in control area outside Helena. | .03) from 40 cases to 24. | | Analysis did not consider fact that admissions were increasing with time, which biases comparison toward null. |
| Kent 2012[47] | Ireland | March 29, 2004 | April 2004-March 2006 vs. April 2002-March 2004 | Pre: 24<br>Post: 24 | Acute myocardial infarction | 20-70 | Change in emergency hospital admissions for acute myocardial infarction<br><br>Stratified by age and gender. | Population, weather, pollution, and influenza | .89 (.70, 1.13) * | N/A | March 2004 law applied to workplaces (including bars and restaurants); prior to this law, smoking had been outlawed in public buildings, hospitals, public pharmacies, schools, lawking halls, cinemas, restaurant kitchens, part of all restaurants, public transport aircraft and buses, and some trains.<br><br>Significant reduction in emergency cardiopulmonary admissions in the two years following the smoking law (RR: .87; .78, .98). |
| Barone-Adesi 2011[36] | Italy (20 regions) | January 10, 2005 | January 2005-November 2006 vs. January 2002-December 2004 | Pre: 36<br>Post: 24 | Acute myocardial infarction (ICD-9 410)<br><br>Primary analysis was for acute coronary events (AMI and other acute and sub-acute ischemic heart disease). | All | Admission rates; Poisson test with mixed effect regression models with fixed coefficients describing the national trend and random coefficients describing region-specific deviations. | Seasonality, long term trends<br><br>Separate analyses conducted based on age, gender | <70: .97 (.95, .99) *<br>F: .98 (.94, 1.02)<br>M: .97 (.95, .99)<br><br>70+: 1.01 (.99, 1.04)<br>F: 1.02 (.99, 1.04)<br>M: 1.00 (.98, 1.03) | 936,519 (all acute coronary events) | See entry for Italy (4 regions).<br><br>The observed reduction was stable over the study period, similar in different geographic areas, and stronger among young people.<br><br>No evidence of a gradual effect over time, as there was no change in the underlying trend in admissions for ACEs after law. |
| Vasselli 2008[21] | Italy (4 regions) | January 10, 2005 | January 10-March 10, 2005 (after law) vs. January-March 2001-2004 (before law) | Pre: 12 (over 4 years)<br>Post: 2 | Acute myocardial infarction (primary discharge diagnosis ICD-9 410) | 40-64 | Age-standardized rates (using European standard population)<br><br>Comparison of observed rate | Age, gender, region | .86 (.83, .92) *<br><br>F: .98 (.87, 1.11)<br>M: .85 (.81, .91)<br>40-44: .98 (.82, 1.19)<br>45-49: .77 (.68, .89)<br>50-54: .74 (.67, .85)<br>55-59: .92 (.84, 1.02)<br>60-64: .99 (.88, 1.06) | 7305 | National law prohibited smoking in all indoor public places, including cafes, bars, restaurants, and discotheques.<br><br>Effect largest among young men and people 45-54. Some regional variation.<br><br>Small decreases in smoking prevalence (30.0 to 29.3% in men and 22.5% to |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | after law with expected value based on linear secular trend for same months during the 4 years before the law went into effect. | | | | 22.1% in women) and consumption (16.7 to 16.3 cig/day for men and 13.7 to 12.4 cig/day for women) led to 7.6% decline in cigarette consumption.<br><br>Fewer than 100 violations in 6000 checks by police.<br><br>90-95% reduction in air nicotine in pubs and discos.<br><br>8.9% decline in cigarette sales in 2005. |
| Dove 2010[32] | Massachusetts | July 5, 2004 | July 2004-December 2006 vs. January 1999-June 2004 | Pre: 66<br>Post: 30 | Death due to acute myocardial infarction (ICD-10 I21) | 35+ | Daily number of deaths from AMI by city or town; Poisson regression | Long-term trend, season, air particulate matter, influenza, city/town-specific demographic data, prior local smoking law, gender, age<br><br>Separate analyses for cities and towns with vs. without prior comprehensive local laws. | No prior local law:<br>.90 (.86, .95) *<br>With prior local law:<br>1.01 (.92, 1.11)<br>Effect of local law:<br>.95 (.86, 1.05)<br><br>Overall:<br>.93 (.89, .97)<br>F: .90 (.85, .96)<br>M: .95 (.89, 1.01)<br>35-64: .92 (.82,1.04)<br>65-74: .99 (.89,1.11)<br>75+:.91 (.86,.96) | 26,982 | State law prohibited smoking in all workplaces, including restaurants and bars.<br><br>Prior to the state-wide smoking law, about 25% of the Massachusetts population was covered by a local law.<br><br>In cities and towns without prior local laws, there was a significant 9.2% decrease in AMI mortality.<br><br>Estimated 270 fewer AMI deaths per year associated with the state law.<br><br>For cities and towns with no prior local laws, AMI mortality rates decreased by 1.6% (-4.0%, 7.0%) in the first 12 months and 18.6% (13.6%, 23.3%) thereafter.<br><br>Compliance ranged from 88-96.3% in bars and restaurants.<br><br>93% reduction in environmental tobacco smoke exposure.<br><br>Study reports a BRFSS finding of a 5.2% relative reduction in smoking rate (19.1% in the year preceding law vs. 18.1% the year after). |
| Juster 2007[18] | New York State | July 24, 2003 | January 1995 - | Pre: 99 | Acute myocardial | 35+ | Multiple | Age-adjusted (NY | In absence of pre-existing | 462,396 | July 2003 law prohibited smoking in all |

| Supplementary Table 1. Detailed Description of Studies of Coronary Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | | December 2004 | Post: 21 | infarction (primary diagnosis code ICD-9 410) | | regression time series | population in 2000)<br><br>Existence of strong local ordinance, time (linear secular trend), seasonality, county<br><br>Analyzed comprehensive laws (smoking prohibited in restaurants, bars, and other hospitality venues) vs. moderate laws (smoking permitting in hospitality venues) | local laws:<br>.8004 (.7985, .8023) *[f]<br><br>In 2004, there were 3813 fewer hospital admissions for AMI than expected in the absence of the comprehensive smoking law. | | workplaces including restaurants and bars. Limited statewide restrictions since 1989 limited smoking in many public places, including schools, hospitals, public buildings, and retail stores. Local laws varied by county.<br><br>By 2002, 75% of New Yorkers were subject to strong local laws, as well as limited restrictions at the state level implemented in 1989; authors performed analysis to compare effects assuming hypothetical case of no pre-existing local laws.<br><br>No sudden change with law; rate of decline in AMI admissions increased significantly over moderate or no local laws.<br><br>Enactment of a moderate smoking restriction in a county would reduce monthly trend rate in AMI hospital admissions by 0.15 per 100,000 per month in that county, and a statewide comprehensive smoking law would reduce AMI hospitalizations by 0.32 per 100,000 per month in all counties.<br><br>After implementation of the state law, exposure to SHS declined by nearly 50%; saliva cotinine dropped from 0.078 to 0.041 ng/mL.<br><br>Direct health care cost savings of $56 million in 2004. |
| North Carolina 2011[57] | North Carolina | January 1, 2010 | January 2010-December 2010 vs. January 2008-December 2009 | Pre: 24<br>Post: 12 | Acute myocardial infarction (diagnosis code ICD-9 410.x1 to 410.x0) | 18+ | Rate of emergency visits for AMI; Poisson regression | Age, gender, Christmas holidays, time, average weekly temperature, log-transformed weekly flu rates, week of year | .79 (.75, .83) * | 24,848 | Law prohibits smoking in bars, restaurants, government buildings, and vehicles.<br><br>Projected cost savings $3.3-4.8 million from AMIs prevented. |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bruckman 2011[56] | Ohio | May 2007 | January 2005-April 2007vs. May 2007-Dec 2009 | Pre: 28<br>Post: 32 | Acute myocardial infarction (principal discharge diagnosis ICD-9 410) | All | Age- and sex-adjusted discharge rate per 1000 (converted to per 100,000); mixed linear models with a varying covariance structure to determine if rates decreased yearly; spline polynomial functions to determine inflection point in monthly rate data | Age, gender, linear trend, seasonality | .96 (.95, .98) *[b]<br><br>AMI discharge rates dropped from 198 per 100,000 in 2005 to 168 per 100,000 in 2009. | N/A | Law prohibits smoking in a public place or a place of employment.<br><br>Inflection point identified as June 2007, one month after implementation.<br><br>Average decrease in MI discharge of 7 per 100,000 each year from 2005-2009.<br><br>Conservative estimate of $737,782 in hospital stay costs in first year after law (estimate does not account for physician fees). Direct system savings of $1.1 million from 69 cases prevented by smoking law. |
| Hurt 2011[54] | Olmsted County, Minnesota | January 1, 2002 (Ordinance 1: smokefree restaurants)<br><br>October 1, 2007 (Ordinance 2: smokefree workplaces) | October 2007-March 2009 vs. July 2000-December 2001 | Pre ordinance 2: 18<br>Post ordinance 2: 18; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | Acute myocardial infarction validated using biomarkers, cardiac pain, and Minnesota coding of the ECG | All | Age and sex-adjusted rate per 100,000; adjusted hazard ratio | Age, sex | Ordinance 2 vs. no law: .55 (.44, .68) * | N/A | Though the law was initiated in two steps (smokefree restaurants in January 2002 and smokefree workplaces in 2007), this study was included in the meta-analysis because authors compared the period before any law to the period after full implementation, thus capturing the true effect of the law.<br><br>AMI rate per 100,000 dropped from 212.3 to 168.7 following the restaurant law (HR .90; .73, .1.10; *p*=.30) and from 130.0 to 102.9 following the workplace law (.79; .63, .98; *p*=.04).<br><br>During this period, the prevalence of hypertension, diabetes, hypercholesterolemia, and obesity either remained constant or increased while the prevalence of smoking among the adults declined by 23%. |
| Barone-Adesi | Piedmont, Italy | January 10, 2005 | Compared | Pre: 3 | Acute myocardial | All | Age- | Age | 1.01 (.97, 1.06) | 17,153 | See entry for Italy (4 regions). |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006[14] | | | October-December 2004 (before law) and February-June 2005 (after law) with same periods 1 year earlier | Post: 6 | infarction (primary discharge diagnosis ICD-9 410) and hospital deaths due to AMI | | standardized rates (European) | | <60: .89 (.81, .98) *<br>F: .75 (.58-.96)<br>M: .91 (.82, 1.01)<br><br>≥ 60: 1.05 (1.00, 1.11)<br>F: 1.05 (.97-1.14)<br>M: 1.03 (.96-1.11) | | No changes from one year before for pre-law period; change compared to one year earlier for post-law period.<br><br>Estimated that 1% out of the 11% reduction in AMI is attributable to reduced smoking among smokers, rather than passive smoking. |
| Alsever 2009[23] | Pueblo, Colorado | July 1, 2003 | January 2005 – June 2006 ("Phase II") vs. July 2003 – December 2004 ("Phase I") vs. January 2002 – June 2003 (pre-law) | Pre: 18<br>Post: 36 | Acute myocardial infarction (primary diagnosis code ICD-9 410) | All | Comparison of rate ratios with chi square test | Comparison with people living in surrounding Pueblo County (not covered by ordinance) and with nearly El Paso County (which did not have an ordinance). No significant change in surrounding area (1.03; .68, 1.39) or El Paso County (.95; .87, 1.03) | Phase II vs. pre-law:<br>.59 (.49, .70) *<br>F: .48 (.36, .60)<br>M: .67 (.52, .82)<br><br>Phase II vs. Phase I:<br>.81 (.67, .96) | 4954 | Municipal ordinance ended smoking in enclosed workplaces, including restaurants and bars.<br><br>Assuming all fatal AMI's reached hospital reduced risk estimate to .66 (.55, .77) from pre-law to Phase II.<br><br>Rate of AMI hospitalizations decreased from 257 per 100,000 person-years before law to 187 in Phase I and 152 in Phase II. |
| Lemstra 2008[19] | Saskatoon, Canada | July 1, 2004 | July 2004-June 2005 vs. July 2000-June 2004 | Pre: 48<br>Post: 12 | Acute myocardial infarction (ICD-10) | All | Incidence ratio and confidence interval post-law compared to pre-law.<br><br>Age-standardized AMI incidence rate | Stratification was used to test for confounding by age, gender, and previous MI in the unadjusted rates, which were then directly age-standardized to the 2001 Canadian population. | Age-adjusted:<br>.87 (.84, .90) *<br><br>Age-standardized incidence rate fell from 176.1 (165.3, 186.8) cases per 100,000 to 152.4 (135.3-169.3) cases per 100,000 | 1689 | City-wide smoking law prohibited smoking or holding lighted tobacco products in any enclosed public that is open to the public or to which the public is customarily admitted or invited; also applied to outdoor seating areas for restaurants and licensed premises. A previous bylaw prohibited smoking in enclosed government buildings only.<br><br>914 of 924 eligible businesses establishments were inspected by a public health inspector within the first 6 months of the law; only 13 required an initial warning for non-compliance. Re-inspection only required 1 citation being issued during the first year of the |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | law.<br><br>Smoking prevalence in Saskatoon fell from 24.1% in 2003 (95% CI 20.4-27.7) to 18.2% in 2005 (15.7-20.9); smoking in the rest of Saskatchewan Province (which includes Saskatoon) remained stable from 2003 to 2005 at 23.8% (22.6-25.3).<br><br>One year after implementation (July 2005), 79% responded that the "smoking law was a good idea." |
| McMillen 2010[55] | Starkville, Mississippi | May 20, 2006 | May 20, 2006-April 7, 2009 vs. July 29, 2004-May 19, 2006 | Pre: 22<br>Post: 35 | Acute myocardial infarction (primary diagnosis ICD-9 410) | All | AMI admissions per day compared to standardized rate prior to implementation | Compared the number of heart attack admissions among people living outside of city limits and not protected by smoke-free ordinance. A 14.8% reduction was observed in the Starkville-adjacent control region compared to at 27.7% reduction in Starkville. | .72 (.48, 1.10) *[c]<br><br>There were 38 heart attack admissions compared to a standardized rate of 52.57 admissions before law | 100 | Smoking law in indoor public places, including restaurants and bars.<br><br>Reductions in AMI admissions resulted in cost savings of $288,270 in 2010 dollars. |
| Di Valentino 2011[52] | Ticino, Switzerland | April 2007 | 2007-2008 vs. 2004-2006 | Pre: 36<br>Post: 24 | ST-elevation myocardial infarction (ICD-10) | All | Comparison of annual frequency of hospitalizations due to STEMI | | .79 (.70, .88) *[a]<br><br>22.4% (p<.0001) and 20.6% (P<.0002) reduction in hospitalizations during first and second post-law years, respectively. | 1272 | Smokefree public places, including restaurants, bars, and discos. Smoking rooms permitted.<br><br>This study population overlaps with that of another study[52] also conducted in Ticino examining rates of STEMI (a subset of ACS) following the law. |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 | January 1996-May 2006 | Pre: 36<br>Post phase 3: 36; not included in length of | Acute myocardial infarction (ICD-9 410, ICD-10 I21) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region | Phase 3 vs. pre:<br>.81 (.75, .88) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>The largest declines were seen after the |

| Supplementary Table 1. Detailed Description of Studies of Coronary Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | | follow-up analysis because the pre-law period did not immediately precede the post-law phase | | | hospital admission | and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | | | phase of the law affecting restaurants came into effect, including a 17% (14%, 19%) decrease in AMI.<br><br>Crude rates of hospital admissions decreased 39% (38%, 40%) for cardiovascular conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| Gasparrini 2009[24] | Tuscany, Italy | January 10, 2005 | January 2000-December 2004 vs. January 2005-December 2005 | Pre: 48<br>Post:12 | Acute myocardial infarction as principal discharge diagnosis (ICD-9 410) or principal death diagnosis (ICD-9 410-414) | 30-64 | Age-standardized rates of annual AMI episodes using European population as reference; Poisson regression analysis of the time series | Age, sex, seasonality, and long-term trend | Linear trend model:<br>.95 (.89, 1.00) *<br>F: .94 (.82, 1.09)<br>M: .95 (.89, 1.01)<br><br>Non-linear trend model:<br>1.01 (.93,1.10)<br>F:1.05 (.87-1.27)<br>M:1.01 (.92,1.10) | 13,456 | See entry for Italy (4 regions). |
| Sebrie 2012[45] | Uruguay | March 2006 | March 2006-February 2008 vs. March 2004-February 2006 | Pre: 24<br>Post: 24 | Acute myocardial infarction (primary diagnosis code ICD-10 I21.0-I21.9); non-country residents and patients with AMI after a coronary angioplasty or bypass, or as a complication of another disease (secondary diagnosis) were | All | Number of AMI hospitalizations per month; multiple linear regression and negative binomial regression | Seasonal variation, population changes, time trend<br><br>Stratified by public vs. private hospital, gender, age. | .81 (.72, .89) *<br><br>Two years after the smokefree policy adoption in enclosed public places and workplaces, hospital admissions for AMI were reduced by 22%.<br><br>Reductions in monthly AMI admissions between 15% and 22% were observed for private hospitals, men, women, | 7949 | Law prohibited smoking in all indoor public places and workplaces including restaurants and bars.<br><br>No evidence that overall effect grew or fell over time following the law. In public hospitals only, AMI trend increased before the law and decreased after the law.<br><br>Study covered 37 hospitals, capturing 79% of the Uruguay population.<br><br>Air particulate matter ($PM_{2.5}$) decreased dramatically (210 to 18 $\mu m/m^3$) and |

| Supplementary Table 1. Detailed Description of Studies of Coronary Events | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | | | | excluded | | | | and people aged 40-65 and over 65. There was a nonsignificant trend toward fewer monthly AMIs in people under 40. | | adults reported decreased exposure to SHS 1 year after implementation, suggesting a high level of compliance. |
| **ACS – Workplace Only Laws** | | | | | | | | | | | |
| Ferrante 2011[37] | Buenos Aires, Argentina | October 2006 | October 2006-December 2008 vs. January 2004-September 2006 | Pre: 33<br>Post: 15 | Acute coronary syndrome (ICD10-I20-I25) | 18+ | Monthly age-adjusted admission rates; multiple linear regression analysis using standard methods for interrupted time series analysis | Age, secular trends, seasonality | .92 (.87, .97) *[b]<br><br>5.3% reduction in admissions in year before vs. year after law.<br><br>Implementation not significantly associated with immediate change: increase of 1.74 admissions per 100,000 (-1.42, 4.92). | 3307 | Law ended smoking in workplaces but allowed for designated smoking areas up to 30% in bars and restaurants if > 100 $m^2$.<br><br>No significant change in trend after law: increase of .01 admissions per 100,000 per month (-.12, .14).<br><br>Buenos Aires served as a control for Santa Fe, to compare partial smoking laws with comprehensive smoking laws; data from Buenos Aires suggest the ineffectiveness of the implementation of partial smoke-free legislation.<br><br>Nonsignificant decrease in smoking prevalence from 27.4% 1 year before law to 26.1% 3 years after law.<br><br>Self-reported SHS exposure decreased from 52.9% to 31.7%. |
| **ACS – Workplace and Restaurant Laws** | | | | | | | | | | | |
| Gupta 2011[39] | Kanawha County, West Virginia | January 1, 2004 | January 2004-September 2008 vs. January 2000-December 2003 | Pre: 48<br>Post: 57 | Acute coronary syndrome (primary diagnostic code ICD9-410, 411.1, 411.81, 411.89, 413.0, 413.1, 413.9. An analysis performed for AMI yielded similar results but were not shown. | 18+ | Age-adjusted ACS hospital admission rates; Poisson regression | Age, gender, year, season, tobacco use, diabetes | 1.02 (.92, 1.12) *<br><br>Age-adjusted ACS hospitalization rates decreased 37% during entire study period. No additional significant change due to removal of smoking areas in restaurants after accounting for the sustainable decline of ACS hospitalizations since the 2002 revision. | 14,245 | Effective May 22, 1995, a modest smoking regulation was enacted prohibiting smoking in all enclosed public places. Restaurants were allowed to designate up to 50% of their seating capacity as smoking areas. On July 20, 2000 the law was modified to increase penalties for violations. On April 3, 2003, a revised regulation prohibited smoking in all restaurants and at most worksites. However, to come into compliance, the regulation allowed several businesses an exemption until January 1, 2004. |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Stratification showed that the observed decline was significant only among nonsmokers. | | The likelihood of hospital admissions for ACS was significantly lower among nonsmokers, people without diabetes, and women.<br><br>Incidence of hospital admissions for ACS decreased significantly by 6% per year (CI 4-8%) throughout the study; among male smokers, there was a significant decline in time trend (7%; 0.4%, 12%) in admission rates after the 2004.<br><br>Smoking rate decreased from 32% to 24% from 2002 to 2008, a nonsignificant change. In conjunction with steady tobacco sales, authors dismiss the notion that changes in ACS can be attributed to a decline in smoking. |
| **ACS – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Gudnason 2009[49] | Iceland | June 1, 2007 | June 2007-October 2007 vs. January 2007-May 2007 | Pre: 5<br>Post: 5 | Patients undergoing coronary angiography for acute coronary syndrome, defined as clinical symptoms of unstable coronary artery disease (chest pain at rest) as well as at least one of the following: 1) elevated cardiac enzymes, 2) ischemic changes on the EKG at rest, or 3) an abnormal exercise stress test during the same unstable episode | All | Comparison of ACS incidence before vs. after smoking law | | .83 (.68, 1.02) *[c]<br><br>Number of events before vs. after law, given in powerpoint presentation based on abstract: http://spo.escardio.org/eslides/view.aspx?eevtid=33&id=978<br><br>Nonsmokers demonstrated 21% reduction in ACS incidence among men ($p$<0.05) and no significant effect observed among women; in the total population, there was a trend toward a 20% reduction in ACS ($p$=0.08) | 535 | Legislation prohibited smoking in public places.<br><br>Initial analysis considered only non-smoking patients; numbers for overall population obtained by personal communication with Dr. Gudnason. |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ferrante 2011[37] | Santa Fe, Argentina | August 2006 | August 2006-December 2008 vs. January 2004-July 2006 | Pre: 31<br>Post: 17 | Acute coronary syndrome (ICD-10 I20-I25) | 18+ | Monthly age-adjusted admission rates; multiple linear regression analysis using standard methods for interrupted time series analysis | Age, secular trends, seasonality | .65 (.59, .70) *[b]<br><br>20.8% reduction in admissions in year before vs. year after law.<br><br>Implementation resulted in immediate change of -2.5 admissions per 100,000 (-4.74, -.26). | 2889 | 100% smokefree law in all enclosed public places. Law also ended tobacco ads, promotion, and sponsorship.<br><br>Persistent change after law of 0.26 fewer admissions per 100,000 per month (-.39, -.13).<br><br>Buenos Aires served as a control for Santa Fe, to compare partial smoking laws with comprehensive smoking laws; data from Buenos Aires suggest the ineffectiveness of the implementation of partial smoke-free legislation.<br><br>High levels of compliance, per National Tobacco Control Program.<br><br>Nonsignificant decrease in smoking prevalence from 27.3% 1 year before law to 26.6% 3 years after law.<br><br>Self-reported SHS exposure decreased from 51.6% to 31.7%. |
| Pell 2008[22] | Scotland | April 2006 | April 2006-March 2007 vs. June 2005-March 2006 | Pre: 10<br>Post: 10 | Acute coronary syndrome (detectable troponin after emergency admission for chest pain, ICD-10 I21) | All | Chi-square and test for trend | Stratified on gender and age (men≤55; women≤65)<br><br>Used data from England as historical control; admissions for ACS in England dropped 4% during a similar period compared to 17% in Scotland. | .83 (.82, .84) * | 5919 | Legislation prohibited smoking in all enclosed public places.<br><br>17% drop overall, 14% among smokers, 19% among former smokers, 21% among nonsmokers. 67% of the decrease in ACS involved nonsmokers.<br><br>Larger risk reductions in older people.<br><br>Decrease in monthly admissions became more pronounced over time after implementation of legislation ($p$=0.02)<br><br>Percentage of people who had never smoked who reported no exposure to secondhand smoke increased from 57% to 78% ($p$<.001); there was a reduction in geometric mean serum |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | cotinine from 0.68 to 0.56 ng/mL ($p$<.001). |
| Di Valentino 2010[51] | Ticino, Switzerland | April 2007 | 2007-2008 vs. 2005-2006 | Pre: 24<br>Post: 24 | Acute coronary syndrome (ICD-10) | All | Comparison of annual frequency of hospitalizations due to ACS | | .82 (.76, .89) *[a]<br><br>15.5% (p<.001) and 14.7% (p<.001) reduction in hospitalizations during first and second post-law years, respectively. | 2426 | Smokefree public places, including restaurants, bars, and discos. Smoking rooms permitted.<br><br>This study population overlaps with that of another study[52] also conducted in Ticino examining rates of STEMI (a subset of ACS) following the law. |
| **ACE – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Barone-Adesi 2009[50] | Piedmont, Italy | January 2005 | January 2005-June 2007 vs. January 2001-December 2004 | Pre: 48<br>Post: 30 | Acute coronary events (ICD-9 410, 411) | | Poisson regression; standard methods for interrupted time-series adopted to assess the role of immediate and gradual effects of the smokefree law | Long term trends, seasonality, age, day of the week | <70: .94 (.90, .97) *<br>≥70: 1.00 (.97, 1.03)<br><br>Weekends: .87 (.80, .93)<br>Weekdays: .96 (.92, 1.00) | N/A | See entry for Italy (4 regions).<br><br>The observed reduction in the number of admissions for acute coronary events started in the same month in which the law came into effect and remained evident for the entire study period. No change (p=.51) in the underlying trend was found.<br><br>This study population overlaps with that of another study[14] also conducted in Piedmont examining rates of AMI (a subset of ACE) following the Italian national law. |
| Cesaroni 2008[20] | Rome, Italy | January 10, 2005 | January 2005-December 2005 vs. January 2000-December 2004 | Pre: 48<br>Post: 12 | Acute coronary events, including AMI (ICD-9 410) and "other acute and subacute forms of ischemic heart disease" (ICD-9 411). Cases were included with principal diagnosis of AMI or secondary diagnosis of AMI when principal diagnosis indicated AMI complications | 35-84 | Age standardized rates (European)<br><br>Poisson regression on number of daily events after January 10, 2005 compared to before<br><br>Separate analyses done for out-of-hospital deaths and hospitalizations | Age, gender, $PM_{10}$ air pollution, flu epidemics, holidays, temperature, secular trend, all-cause hospitalizations, socioeconomic status | 35-64: .89 (.85, .93) *<br>65-74: .92 (.88, .97)<br>75-84: 1.02 (.98, 1.07)<br><br>Adjusted for time trends and all-cause hospitalization rates:<br>35-64: .94 (.88, 1.01)<br>65-74: .90 (.84, .96) | 2136 | See entry for Italy (4 regions).<br><br>No effect in 75-84 year olds.<br><br>Protective effect of law seemed stronger in low SES areas.<br><br>Prevalence of smoking decreased from 34.9% to 30.5% in men and from 20.6% to 20.4% in women. Cigarette sales decreased in Rome by 5.5% in 2005 compared to 2004.<br><br>Estimated reduction in coronary events attributable to changes in active smoking habits was <2%. |

**Supplementary Table 1. Detailed Description of Studies of Coronary Events**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | (ICD-9 427.1, 427.41, 427.42, 427.5, 428.1, 429.5, 429.6, 429.71, 429.79, 429.81, 518.4, 780.2, 785.5, 414.10, 423.0).<br><br>Out-of-hospital deaths from ischemic heart diseases (ICD-9 410-414) if no evidence of hospitalization for coronary causes in the previous 28 days or any cause in the last 2 days. | | and an analysis of incident cases only. | | | | Concentrations of urinary cotinine among non-smoking workers decreased from 17.8 to 5.5 mg/ml at 3 months post-law and 3.7 mg/mL 12 months post-law. |
| **IHD – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Barone-Adesi 2011[36] | Italy (20 regions) | January 10, 2005 | January 2005-November 2006 vs. January 2002-December 2004 | Pre: 36<br>Post: 24 | Non-AMI acute and subacute forms of ischemic heart disease (ICD-9 411)<br><br>Primary analysis was for acute coronary events (AMI and other acute and sub-acute ischemic heart disease). | All | Admission rates; Poisson test with mixed effect regression models with fixed coefficients describing the national trend and random coefficients describing region-specific deviations. | Seasonality, long term trends<br><br>Separate analyses conducted based on age, gender | <70: .95 (.93, .98) *<br>F: .92 (.88, .98)<br>M: .96 (.93, .99)<br><br>70+: .98 (.96, 1.00)<br>F: .98 (.95, 1.01)<br>M: .97 (.94, 1.01) | 936,519 (all acute coronary events) | See entry for Italy (4 regions).<br><br>The observed reduction was stable over the study period, similar in different geographic areas, and stronger among young people.<br><br>No evidence of a gradual effect of the law, as there was no change in the underlying trend in admissions for ACEs after law. |

* Estimate used in meta-analysis
[a] RR and CI calculated by Monte Carlo simulation run 100,000 times; rate ratio calculated by dividing post-law rates with mean pre-law rates
[b] RR and CI calculated using negative binomial regression with model including effect of law and seasonality (if applicable)
[c] RR and CI calculating using number of events before vs. after law
[d] RR and CI computed using Poisson regression with model described in paper for counties with no prior law
[e] CI calculated from p-value presented in paper
[f] CI obtained from communication with author of paper
Notes: Observed risk is presented as a risk ratio unless otherwise specified. If number of events is N/A, then events were recorded as rates and absolute counts are not available.

| Supplementary Table 2. Detailed Description of Studies of Other Heart Disease | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| **Angina – Workplace Only Laws** | | | | | | | | | | | |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 1: 24 | Angina (ICD9-411, 413; ICD10-I20) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 1 vs. pre-law: .88 (.69, 1.14) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 39% (38%, 40%) for cardiovascular conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **Angina – Workplace and Restaurant Laws** | | | | | | | | | | | |
| Sargent 2012[46] | Germany | Nationwide: September 1, 2007<br><br>Statewide: varies | January 2004-December 2008 | Pre: varies<br>Post: 12 | Stable or unstable angina pectoris (ICD10-I20.0-I20.9) | 30+ | Rate of hospitalization for AMI; logistic regression and interrupted time series linear regression model | Age, sex, occupation | .87 (.82, .92) *<br><br>In the first year after implementation, 1431 angina hospitalizations were prevented. | 39,224 | Legislation addressed smoking in federal buildings and the transportation system. Private employers were allowed to introduce a total or partial smoking law in workplaces. States were permitted to decide how to limit smoking in the hospitality sector (hotels, restaurants, bars).<br><br>Hospitality smoking laws were passed in all states in implemented between August 1, 2007 and July 1, 2008. Most states continued to allow smoking in small bars without any food delivery and in separate rooms in large restaurants. A population-based survey revealed a significant decrease of cigarettes smoked in Germany after the |

| Supplementary Table 2. Detailed Description of Studies of Other Heart Disease | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | | | | | | | | | | law.<br><br>After the law, there was a statistically significant downward trend, with slope resulting in a decline of 5.33 (7.18, 3.48) hospitalizations per month.<br><br>Hospital admissions for control condition fractures increased slightly from 65100 in 2007 to 66954 in 2009. Bronchitis cases, which might be affected by smoke-free laws, declined from 16900 in 2007 to 15391 in 2009.<br><br>Hospitalization costs for angina decreased significantly by 9.6 (2.5, 16.6)% or about 2.5 million euros. |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 2: 36; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | Angina (ICD9-411, 413; ICD10-I20) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 2 vs. pre-law: .65 (.52, .82) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 39% (38%, 40%) for cardiovascular conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **Angina – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Naiman 2010[29] | Arizona | May 1, 2007 | May 2007-May 2008 vs. January 2004- | Pre: 40<br>Post: 13 | Unstable angina (ICD9-411.1x) | All | Rate of admissions per 100,000 | Seasonality, population, annual linear trend | .64 (.46, .88) *[d] | 670 (counties without | Law ended smoking in all enclosed workplaces including bars and restaurants. |

**Supplementary Table 2. Detailed Description of Studies of Other Heart Disease**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | April 2007 | | | | annually; Poisson regression | Separate analyses for counties with pre-existing smoke-free laws vs. those without | | previous laws) | Cost-savings analysis estimates $16.8 million in savings for AMI, unstable angina, acute stroke, and acute asthma in 13 months after law in non-law counties ($.9 million for angina alone).<br><br>No change in rates of control diseases (acute appendicitis, kidney stones, acute cholecystitis, and ulcers) pre and post law. |
| Cronin 2012[44] | Cork and Kerry Counties, Ireland | March 29, 2004 | Primary data set: April 2004-March 2007 vs. March 2003-March 2004<br><br>Secondary data set: July 2003-March 2004 vs. April 2004-June 2007 | Pre: 13<br>Post: 36<br><br>Pre: 9<br>Post: 39 | Unstable angina, diagnosed in hospital by physician using troponin T or I, allowing repeat admissions<br><br>(Primary analysis was for overall acute coronary syndrome.) | 18+ | Unstable angina admissions and rate per 100,000; Poisson regression | Linear time trend<br><br>Sensitivity analyses were undertaken by gender, smoking status, and type of ACS.<br><br>According to mortality data, there was no change in all cause mortality and overall 6.5% decrease in deaths from circulatory causes in Cork and Kerry counties, so results were not attributable to changes in coronary death patterns outside of hospital. | .89 (.75, 1.06) *[b]<br><br>Estimates derived from secondary data set. | Primary data set: 1236<br><br>Secondary data set: 1314 | See description of law in entry for Ireland.<br><br>The first year's reduction in admissions for ACS was due to fewer cases among men and current smokers. The third year's reduction in admissions for ACS was due to fewer cases among men, current smokers, and never smokers.<br><br>Increased effect on ACS over time evidenced by 12% decrease in year 1 and 13% decrease in year 3.<br><br>This paper supersedes an abstract of the same study used in the 2009 meta-analysis. |
| Kent 2012[47] | Ireland | March 29, 2004 | April 2004-March 2006 vs. April 2002-March 2004 | Pre: 24<br>Post: 24 | Unstable angina | 20-70 | Change in emergency hospital admissions for unstable angina | Population, weather, pollution, and influenza<br><br>Stratified by age and gender. | .77 (.61, .96) * | N/A | March 2004 law applied to workplaces (including bars and restaurants); prior to this law, smoking had been outlawed in public buildings, hospitals, public pharmacies, schools, lawking halls, cinemas, restaurant kitchens, part of all restaurants, public transport aircraft and buses, and some trains. |

**Supplementary Table 2. Detailed Description of Studies of Other Heart Disease**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Significant reduction in emergency cardiopulmonary admissions in the two years following the smoking law (RR: .87; .78, .98). |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 3: 36; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | Angina (ICD9-411, 413; ICD10-I20) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 3 vs. pre-law: .38 (.30, .48) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 39% (38%, 40%) for cardiovascular conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **CHD – Workplace and Restaurant Laws** | | | | | | | | | | | |
| Khuder 2007[17] | Bowling Green, Ohio | March 2002 | January 1999-February 2002 vs. March 2002-June 2005 | Pre: 38<br>Post: 40 | Coronary heart disease (ICD-9 410-414, 428) | 18+ | Age-standardized rates<br><br>ARIMA<br><br>Ordinance effect assumed to start in Oct 2002 | Comparison with control community Kent, OH (not covered by law). No significant change in Kent. | 12 months post-law: .61 (.55, .67)<br><br>40 months post-law: .53 (.45, .59) * | N/A | Smoking was prohibited in all public places within the city, except for bars and restaurants with bars, provided that the bar area was isolated within a separate smoking room. Smoking was allowed in bars and bowling alleys at the discretion of the owners.<br><br>39% reduction in CHD in 12 months and 47% reduction in 40 months.<br><br>Projected that 17% of reduction may be due to decreased SHS exposure, while the remaining 21% is due to decreased smoking prevalence and cigarette consumption. |

| Supplementary Table 2. Detailed Description of Studies of Other Heart Disease | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | | | | | | | | | | No differences in admissions for unspecified non-smoking related conditions. |
| **SCD – Workplace and Restaurant Laws** | | | | | | | | | | | |
| Hurt 2011[54] | Olmsted County, Minnesota | January 1, 2002 (Ordinance 1: smokefree restaurants)<br><br>October 1, 2007 (Ordinance 2: smokefree workplaces) | October 2007-March 2009 vs. July 2000-December 2001 | Pre ordinance 1: 18<br>Post ordinance 1: 18 | Sudden cardiac death defined as out-of-hospital deaths assigned to coronary heart disease (ICD9-410-414) | All | Age and sex-adjusted rate per 100,000; adjusted hazard ratio | Age, sex | Ordinance 1 vs. no law, hazard ratio:<br>.72 (.58, .89) * | N/A | Though the law was initiated in two steps (smokefree restaurants in January 2002 and smokefree workplaces in 2007), this study was included in the meta-analysis because authors compared the period before any law to the period after full implementation, thus capturing the true effect of the law.<br><br>SCD rate per 100,000 dropped from 152.5 to 112.2 following the restaurant law (HR: .72, .58, .89; $p$<.01) and from 78.0 to 76.6 following the workplace law (HR: .99; .76, 1.28; $p$=.91).<br><br>During this period, the prevalence of hypertension, diabetes, hypercholesterolemia, and obesity either remained constant or increased while the prevalence of smoking among the adults declined by 23%. |
| **SCD – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Hurt 2011[54] | Olmsted County, Minnesota | January 1, 2002 (Ordinance 1: smokefree restaurants)<br><br>October 1, 2007 (Ordinance 2: smokefree workplaces) | October 2007-March 2009 vs. July 2000-December 2001 | Pre ordinance 2: 18<br>Post ordinance 2: 18; not included in length of follow-up analysis because the pre-law period did not immediately precede the | Sudden cardiac death defined as out-of-hospital deaths assigned to coronary heart disease (ICD9-410-414) | All | Age and sex-adjusted rate per 100,000; adjusted hazard ratio | Age, sex | Ordinance 2 vs. no law, hazard ratio:<br>.50 (.40, .63) * | N/A | Though the law was initiated in two steps (smokefree restaurants in January 2002 and smokefree workplaces in 2007), this study was included in the meta-analysis because authors compared the period before any law to the period after full implementation, thus capturing the true effect of the law.<br><br>SCD rate per 100,000 dropped from 152.5 to 112.2 following the restaurant law (HR: .72, .58, .89; $p$<.01) and from 78.0 to 76.6 following the workplace law (HR: .99; .76, 1.28; $p$=.91). |

**Supplementary Table 2. Detailed Description of Studies of Other Heart Disease**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | post-law phase | | | | | | | During this period, the prevalence of hypertension, diabetes, hypercholesterolemia, and obesity either remained constant or increased while the prevalence of smoking among the adults declined by 23%. |

* Estimate used in meta-analysis
[a] RR and CI calculated by Monte Carlo simulation run 100,000 times; rate ratio calculated by dividing post-law rates with mean pre-law rates
[b] RR and CI calculated using negative binomial regression with model including effect of law and seasonality (if applicable)
[c] RR and CI calculating using number of events before vs. after law
[d] RR and CI computed using Poisson regression with model described in paper for counties with no prior law
[e] CI calculated from p-value presented in paper
[f] CI obtained from communication with author of paper
Notes: Observed risk is presented as a risk ratio unless otherwise specified. If number of events is N/A, then events were recorded as rates and absolute counts are not available.

## Supplementary Table 3. Detailed Description of Studies of Cerebrovascular Accidents

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Stroke – Workplace Only Laws** | | | | | | | | | | | |
| Dautzenberg 2008[13] | France | February 1 2007; restaurants, bars, and casinos added January 1, 2008 | January 2006-February 15, 2008 | Partial law: Pre: 13 Post: 12.5 | Stroke | <66 | Rate per 100,000 admissions | | Partial law: .96 (.8, 1.03) *[b] | N/A | Smoking ended in public places in February 2007, but restaurants, bars, and casinos were given exceptions until January 2008. Law permits ventilated smoking rooms under strict conditions.<br><br>Between January 2007 (before law) and January 2008 (after law), SHS exposure dropped from 57% to 14%. $PM_{2.5}$ levels also dropped.<br><br>Also report substantial drops in respiratory symptoms among hospitality workers. |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36 Post phase 1: 24 | Stroke (ICD9-433, 434, 435, 436; ICD10-I63, I64, I65, I66, G45, G46) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 1 vs. pre-law: .91 (.80, 1.03) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 39% (38%, 40%) for cardiovascular conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **Stroke – Workplace and Restaurant Laws** | | | | | | | | | | | |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 | January 1996-May 2006 | Pre: 36 Post phase 2: 36; not included in length of | Stroke (ICD9-433, 434, 435, 436; ICD10-I63, I64, I65, I66, G45, G46) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region | Phase 2 vs. pre: .76 (.68, .85) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions |

| Supplementary Table 3. Detailed Description of Studies of Cerebrovascular Accidents | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | | follow-up analysis because the pre-law period did not immediately precede the post-law phase | | | hospital admission | and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | | | decreased 39% (38%, 40%) for cardiovascular conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **Stroke – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Herman 2011[35] | Arizona | May 1, 2007 | May 2007-May 2008 vs. January 2004-April 2007 | Pre: 40<br>Post: 13 | Acute stroke (ICD9-430-434.xx, 436.xx, 437.1x) | All | Rate of admissions per 100,000 annually; Poisson regression | Seasonality, population, annual linear trend<br><br>Separate analyses for counties with pre-existing smoke-free laws vs. those without | .86 (.79, .96) *[d] | 6018 (counties without previous laws) | Law ended smoking in all enclosed workplaces including bars and restaurants.<br><br>Cost-savings analysis estimates $16.8 million in savings for AMI, unstable angina, acute stroke, and acute asthma in 13 months after law in non-law counties ($4.9 million for acute stroke alone).<br><br>No change in rates of control diseases (acute appendicitis, kidney stones, acute cholecystitis, and ulcers) pre and post law. |
| Dautzenberg 2008[13] | France | February 1 2007; restaurants, bars, and casinos added January 1, 2008 | January 2006-February 15, 2008 | Complete law:<br>Pre: 24<br>Post: 1.5; not included in length of follow-up analysis because the pre-law | Stroke | <66 | Rate per 100,000 admissions | | Complete law:<br>.83 (.77, .91) *[b] | N/A | Smoking ended in public places in February 2007, but restaurants, bars, and casinos were given exceptions until January 2008. Law permits ventilated smoking rooms under strict conditions.<br><br>Between January 2007 (before law) and January 2008 (after law), SHS exposure dropped from 57% to 14%. $PM_{2.5}$ levels also dropped. |

| Supplementary Table 3. Detailed Description of Studies of Cerebrovascular Accidents | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | | | period did not immediately precede the post-law phase | | | | | | | Also report substantial drops in respiratory symptoms among hospitality workers. |
| Kent 2012[47] | Ireland | March 29, 2004 | April 2004-March 2006 vs. April 2002-March 2004 | Pre: 24<br>Post: 24 | Stroke | 20-70 | Change in emergency hospital admissions for stroke<br><br>Stratified by age and gender. | Population, weather, pollution, and influenza | .93 (.73, 1.20) * | N/A | March 2004 law applied to workplaces (including bars and restaurants); prior to this law, smoking had been outlawed in public buildings, hospitals, public pharmacies, schools, lawking halls, cinemas, restaurant kitchens, part of all restaurants, public transport aircraft and buses, and some trains.<br><br>Significant reduction in emergency cardiopulmonary admissions in the two years following the smoking law (RR: .87; .78, .98). |
| Juster 2007[18] | New York State | 24 Jul 2003 | January 1995-December 2004 | Post: 21<br>Pre: 99 | Stroke (primary diagnosis code ICD9-410.00-410.99) | 35+ | Multiple regression time series | Age-adjusted (NY population in 2000)<br><br>Existence of strong local ordinance, time (linear secular trend), seasonality, county<br><br>Analyzed comprehensive laws (smoking prohibited in restaurants, bars, and other hospitality venues) vs. moderate laws (smoking permitting in hospitality venues) | No significant negative association between the stroke admission rate and moderate or comprehensive restrictions on smoking.<br><br>No estimate was available for stroke rates in places without local smokefree laws prior to the state law, so this study was excluded from the analysis for stroke. | 584833 | July 2003 law prohibited smoking in all workplaces including restaurants and bars. Limited statewide restrictions since 1989 limited smoking in many public places, including schools, hospitals, public buildings, and retail stores. Local laws varied by county.<br><br>By 2002, 75% of New Yorkers were subject to strong local laws, as well as limited restrictions at the state level implemented in 1989; authors performed analysis to compare effects assuming hypothetical case of no pre-existing local laws.<br><br>Change in monthly admission trend rate not significantly different from null.<br><br>After implementation of the state law, exposure to SHS declined by nearly 50%; saliva cotinine dropped from 0.078 to 0.041 ng/mL. |
| Naiman | Toronto, | May 2006 | January 1996- | Pre: 36 | Stroke (ICD9-433, | 45+ | Autoregressive | Subgroup analyses | Phase 3 vs. pre: | N/A | Legislation required all public places |

## Supplementary Table 3. Detailed Description of Studies of Cerebrovascular Accidents

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010[29] | Canada | Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | May 2006 | Post phase 3: 36; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | 434, 435, 436; ICD10-I63, I64, I65, I66, G45, G46) | | integrated moving-average (ARIMA) on crude rates of hospital admission | by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | .63 (.56, .71) *[c] | | and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 39% (38%, 40%) for cardiovascular conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **TIA – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Kent 2012[47] | Ireland | March 29, 2004 | April 2004-March 2006 vs. April 2002-March 2004 | Pre: 24<br>Post: 24 | Transient ischemic attack | 20-70 | Change in emergency hospital admissions for transient ischemic attack<br><br>Stratified by age and gender. | Population, weather, pollution, and influenza | 1.00 (.70, 1.42) * | N/A | March 2004 law applied to workplaces (including bars and restaurants); prior to this law, smoking had been outlawed in public buildings, hospitals, public pharmacies, schools, lawking halls, cinemas, restaurant kitchens, part of all restaurants, public transport aircraft and buses, and some trains.<br><br>Significant reduction in emergency cardiopulmonary admissions in the two years following the smoking law (RR: .87; .78, .98). |

* Estimate used in meta-analysis
[a] RR and CI calculated by Monte Carlo simulation run 100,000 times; rate ratio calculated by dividing post-law rates with mean pre-law rates
[b] RR and CI calculated using negative binomial regression with model including effect of law and seasonality (if applicable)
[c] RR and CI calculating using number of events before vs. after law
[d] RR and CI computed using Poisson regression with model described in paper for counties with no prior law
[e] CI calculated from p-value presented in paper
[f] CI obtained from communication with author of paper
Notes: Observed risk is presented as a risk ratio unless otherwise specified. If number of events is N/A, then events were recorded as rates and absolute counts are not available.

## Supplementary Table 4. Detailed Description of Studies of Respiratory Disease

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **COPD – Workplace Only Laws** | | | | | | | | | | | |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 1: 24 | COPD (ICD9-490, 491, 492, 496; ICD10-J40, J41, J32, J43, J44) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 1 vs. pre-law: 1.09 (.96, 1.24) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 33% (32%, 34%) for respiratory conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **COPD – Workplace and Restaurant Laws** | | | | | | | | | | | |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks | January 1996-May 2006 | Pre: 36<br>Post phase 2: 36; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | COPD (ICD9-490, 491, 492, 496; ICD10-J40, J41, J32, J43, J44) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 2 vs. pre-law: .94 (.83, 1.05) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 33% (32%, 34%) for respiratory conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |

| Supplementary Table 4. Detailed Description of Studies of Respiratory Disease | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | except designated smoking rooms in June 2004. | | | | | | | | | |
| **COPD – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Kent 2012[47] | Ireland | March 29, 2004 | April 2004-March 2006 vs. April 2002-March 2004 | Pre: 24<br>Post: 24 | Exacerbation of chronic obstruction pulmonary disease | 20-70 | Change in emergency hospital admissions for exacerbation of COPD | Population, weather, pollution, and influenza<br><br>Stratified by age and gender. | 1.18 (.86, 1.60) * | N/A | March 2004 law applied to workplaces (including bars and restaurants); prior to this law, smoking had been outlawed in public buildings, hospitals, public pharmacies, schools, lawking halls, cinemas, restaurant kitchens, part of all restaurants, public transport aircraft and buses, and some trains.<br><br>Significant reduction in emergency cardiopulmonary admissions in the two years following the smoking law (RR: .87; .78, .98). |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 3: 36; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | COPD (ICD9-490, 491, 492, 496; ICD10-J40, J41, J32, J43, J44) | 45+ | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 3 vs. pre-law: .73 (.65, .82) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 33% (32%, 34%) for respiratory conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **Asthma – Workplace Only Laws** | | | | | | | | | | | |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free | January 1996-May 2006 | Pre: 36<br>Post phase 1: 24 | Asthma (ICD9-493; ICD10-J45, J46) | <65 | Autoregressive integrated moving-average | Subgroup analyses by age, sex. | Phase 1 vs. pre-law: .84 (.62, 1.15) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases. |

| Supplementary Table 4. Detailed Description of Studies of Respiratory Disease | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | | | | | (ARIMA) on crude rates of hospital admission | Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | | | Crude rates of hospital admissions decreased 33% (32%, 34%) for respiratory conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| Dove 2011[34] | United States | Not a pre-post study; study uses American Nonsmokers' Rights Foundation smoking law database and NHANES data to compare asthma outcomes in places with at least 1 smokefree workplace, restaurant, or bar law to those that do not from 1999-2006. | | | Emergency department visits for asthma among nonsmoking youth | 3-15 | Weighted logistic regression to calculate ORs and CIs | Age, gender, race/ethnicity, ratio of family income to poverty, 2-year survey cycle, region, household size, health insurance status, BMI, mother's age at birth, mother's smoking status during pregnancy, low birth weight<br><br>Stratified by exposure to SHS in home. | Odds ratio:<br>.55 (.27 1.13) * | N/A | Locations classified as having a smokefree law completely ended smoking and did not allow for separately ventilated smoking rooms, size exemptions, or allowed smoking in bars attached to restaurants.<br><br>Smokefree laws found to be associated with significantly lower odds of asthmatic symptoms (OR: .67; .48, .93).<br><br>Smokefree laws trended toward lower odds of ever having asthma with current symptoms (OR: .74; .53, 1.03), and asthma attacks (OR: .66; .28, 1.56).<br><br>Smokefree laws that targeted exposures to SHS outside the home had more effect on children and adolescents without concomitant exposure at home. |
| **Asthma – Workplace and Restaurant Laws** | | | | | | | | | | | |
| Rayens 2008[12] | Lexington-Fayette County, | April 27, 2004 | May 2004-December | Pre: 40<br>Post: 32 | Asthma (primary or secondary | All | Age-adjusted rates; Poisson | Age, sex, population, | .78 (.71, .86) *<br>0-19: .82(.71-.96) | 14839 | Smokefree enclosed public places law prohibited smoking in restaurants, bars, |

**Supplementary Table 4. Detailed Description of Studies of Respiratory Disease**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Kentucky | | 2006 vs. January 2001-April 2004 | | discharge diagnosis ICD9-493) | | regression and first-order autoregressive time-series model | seasonality, secular trends, demographic variables | 20+: .76 (.69-.84) | | bowling alleys, bingo halls, convenience stores, laundry facilities, and other businesses open to the public. Buildings not open to the public, including government office buildings or workplaces, were excluded. Manufacturing facilities were also excluded.<br><br>There was a dramatic improvement in air quality in hospitality venues and immediate reduction in hair nicotine among bar and restaurant workers following implementation of the law.<br><br>Within 3 months of implementation, there was a 56% decline in hair nicotine. |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 2: 36; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | Asthma (ICD9-493; ICD10-J45, J46) | <65 | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 2 vs. pre-law: .65 (.49, .85) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 33% (32%, 34%) for respiratory conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **Asthma – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Herman 2011[35] | Arizona | May 1, 2007 | May 2007-May 2008 vs. | Pre: 40<br>Post: 13 | Acute asthma (ICD9-493.xx) | All | Rate of admissions per | Seasonality, population, annual | .77 (.68, .86) *[d] | 4125 (counties | Law ended smoking in all enclosed workplaces including bars and |

| Supplementary Table 4. Detailed Description of Studies of Respiratory Disease | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | | January 2004-April 2007 | | | | 100,000 annually; Poisson regression | linear trend<br><br>Separate analyses for counties with pre-existing smoke-free laws vs. those without | | without previous laws) | restaurants.<br><br>Cost-savings analysis estimates $16.8 million in savings for AMI, unstable angina, acute stroke, and acute asthma in 13 months after law in non-law counties ($3.8 million for acute asthma alone).<br><br>No change in rates of control diseases (acute appendicitis, kidney stones, acute cholecystitis, and ulcers) pre and post law. |
| Moraros 2010[33] | Delaware | Nov 1, 2002 | Jan 2003-Dec 2004 vs. Jan 1999-Sep 2002 | Pre: 45<br>Post: 24 | Asthma (primary discharge diagnosis ICD9-493) | 18+ | Quarterly rates of events; Poisson regression | Age, seasonal effects, resident status<br><br>Compared with non-Delaware residents admitted for asthma. Asthma relative risk in non-Delaware residents increased significantly from pre-ordinance to post-ordinance (1.62; 1.41, 1.86). | .95 (.90, .99) * | 6370 | *Delaware Clean Indoor Air Act* of 1994 became comprehensive in 2002 with an amendment to include all enclosed indoor areas accessible to the general public, including restaurants, bars, and casinos.<br><br>Relative risk for linear trend is 0.95 (.92, .97), showing a 5% decrease per year after law.<br><br>Delaware DPH reported 99.6% compliance in bars and restaurants, and the Delaware Department of Labor reported 100% compliance in other workplaces in first year. |
| Kent 2012[47] | Ireland | March 29, 2004 | April 2004-March 2006 vs. April 2002-March 2004 | Pre: 24<br>Post: 24 | Asthma | 20-70 | Change in emergency hospital admissions for asthma | Population, weather, pollution, and influenza<br><br>Stratified by age and gender. | .60 (.39, .91) * | N/A | March 2004 law applied to workplaces (including bars and restaurants); prior to this law, smoking had been outlawed in public buildings, hospitals, public pharmacies, schools, lawking halls, cinemas, restaurant kitchens, part of all restaurants, public transport aircraft and buses, and some trains.<br><br>Significant reduction in emergency cardiopulmonary admissions in the two years following the smoking law (RR: .87; .78, .98). |
| Mackay | Scotland | March 26, 2006 | April 2006- | Pre: 10 | Asthma (principal | <15 | Negative | Sex, age group, | .81 (.78, .84) * | 21415 | Legislation prohibited smoking in all |

| Supplementary Table 4. Detailed Description of Studies of Respiratory Disease | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| 2010[31] | | | October 2009 vs. January 2000- March 2006 | Post: 10 | diagnosis ICD10-J45, J46) | | binomial regression model | urlaw/rural, socioeconomic status, region | | | enclosed public places.<br><br>The reduction was apparent among both preschool and school-age children. There were no significant interactions between hospital admissions for asthma and age group, sex, urlaw or rural resident, region, or socioeconomic status.<br><br>Net reduction in admissions for asthma of 15.1% per year (12.9, 17.2). |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 3: 36; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | Asthma (ICD9-493; ICD10-J45, J46) | <65 | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 3 vs. pre-law: .48 (.36, .63) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 33% (32%, 34%) for respiratory conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **Lung Infections – Workplace Only Laws** | | | | | | | | | | | |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in | January 1996-May 2006 | Pre: 36<br>Post phase 1: 24 | Pneumonia/bronchitis (ICD9-466, 480-486; ICD10-J12-J18, J20) | All | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with | Phase 1 vs. pre: 1.02 (.90, 1.15) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 33% (32%, 34%) for respiratory conditions. |

**Supplementary Table 4. Detailed Description of Studies of Respiratory Disease**

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | | | | | | no smoke-free laws. No significant reductions were observed in control cities. | | | No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **Lung Infections – Workplace and Restaurant Laws** | | | | | | | | | | | |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 2: 36; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | Pneumonia/bronchitis (ICD9-466, 480-486; ICD10-J12-J18, J20) | All | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 2 vs. pre: .81 (.73, .91) *[c] | N/A | Legislation required all public places and workplaces to be smokefree and was implemented in 3 phases.<br><br>Crude rates of hospital admissions decreased 33% (32%, 34%) for respiratory conditions.<br><br>No significant reductions were observed in number of hospital admissions attributable to control conditions (cholecystitis, appendicitis, bowel obstruction) in Toronto. |
| **Lung Infections – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Kent 2012[47] | Ireland | March 29, 2004 | April 2004-March 2006 vs. April 2002-March 2004 | Pre: 24<br>Post: 24 | Pneumonia | 20-70 | Change in emergency hospital admissions for pneumonia | Population, weather, pollution, and influenza<br><br>Stratified by age | .71 (.52, .98) * | N/A | March 2004 law applied to workplaces (including bars and restaurants); prior to this law, smoking had been outlawed in public buildings, hospitals, public pharmacies, schools, lawking halls, |

| Supplementary Table 4. Detailed Description of Studies of Respiratory Disease | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Study** | **Location** | **Effective Date** | **Study Period** | **Pre/Post Duration (months)** | **Endpoint** | **Eligible Age (years)** | **Measure / Statistical Method** | **Confounders** | **Observed Risk / 95% Confidence Interval** | **N (events)** | **Notes** |
| | | | | | | | | and gender. | | | cinemas, restaurant kitchens, part of all restaurants, public transport aircraft and buses, and some trains.<br><br>Significant reduction in emergency cardiopulmonary admissions in the two years following the smoking law (RR: .87; .78, .98). |
| Kent 2012[47] | Ireland | March 29, 2004 | April 2004-March 2006 vs. April 2002-March 2004 | Pre: 24<br>Post: 24 | Lower respiratory tract infection | 20-70 | Change in emergency hospital admissions for lower respiratory tract infection | Population, weather, pollution, and influenza<br><br>Stratified by age and gender. | .83 (.61, 1.13) * | N/A | March 2004 law applied to workplaces (including bars and restaurants); prior to this law, smoking had been outlawed in public buildings, hospitals, public pharmacies, schools, lawking halls, cinemas, restaurant kitchens, part of all restaurants, public transport aircraft and buses, and some trains.<br><br>Significant reduction in emergency cardiopulmonary admissions in the two years following the smoking law (RR: .87; .78, .98). |
| Naiman 2010[29] | Toronto, Canada | May 2006<br><br>Smoke-free legislation occurred in 3 phases: smoke-free public places and workplaces in Oct. 1999, smoke-free restaurants, dinner theaters, and bowling centers except designated smoking rooms in June 2001, smoke-free bars, billiard halls, bingo halls, casinos, racetracks except designated smoking rooms in June 2004. | January 1996-May 2006 | Pre: 36<br>Post phase 3: 36; not included in length of follow-up analysis because the pre-law period did not immediately precede the post-law phase | Pneumonia/bronchitis (ICD9-466, 480-486; ICD10-J12-J18, J20) | All | Autoregressive integrated moving-average (ARIMA) on crude rates of hospital admission | Subgroup analyses by age, sex.<br><br>Comparison with Durham Region and Thunder Bay, two Ontario municipalities with no smoke-free laws. No significant reductions were observed in control cities. | Phase 3 vs. pre: .64 (.58, .72) *[c] | N/A | March 2004 law applied to workplaces (including bars and restaurants); prior to this law, smoking had been outlawed in public buildings, hospitals, public pharmacies, schools, lawking halls, cinemas, restaurant kitchens, part of all restaurants, public transport aircraft and buses, and some trains.<br><br>Significant reduction in emergency cardiopulmonary admissions in the two years following the smoking law (RR: .87; .78, .98). |

## Supplementary Table 4. Detailed Description of Studies of Respiratory Disease

| Study | Location | Effective Date | Study Period | Pre/Post Duration (months) | Endpoint | Eligible Age (years) | Measure / Statistical Method | Confounders | Observed Risk / 95% Confidence Interval | N (events) | Notes |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Spontaneous Pneumothorax – Workplace and Restaurant and Bar Laws** | | | | | | | | | | | |
| Kent 2012[47] | Ireland | March 29, 2004 | April 2004-March 2006 vs. April 2002-March 2004 | Pre: 24<br>Post: 24 | Spontaneous pneumothorax | 20-70 | Change in emergency hospital admissions for spontaneous pneumothorax | Population, weather, pollution, and influenza<br><br>Stratified by age and gender. | .62 (.22, 1.75) * | N/A | March 2004 law applied to workplaces (including bars and restaurants); prior to this law, smoking had been outlawed in public buildings, hospitals, public pharmacies, schools, lawking halls, cinemas, restaurant kitchens, part of all restaurants, public transport aircraft and buses, and some trains.<br><br>Significant reduction in emergency cardiopulmonary admissions in the two years following the smoking law (RR: .87; .78, .98). |

* Estimate used in meta-analysis
[a] RR and CI calculated by Monte Carlo simulation run 100,000 times; rate ratio calculated by dividing post-law rates with mean pre-law rates
[b] RR and CI calculated using negative binomial regression with model including effect of law and seasonality (if applicable)
[c] RR and CI calculating using number of events before vs. after law
[d] RR and CI computed using Poisson regression with model described in paper for counties with no prior law
[e] CI calculated from p-value presented in paper
[f] CI obtained from communication with author of paper
Notes: Observed risk is presented as a risk ratio unless otherwise specified. If number of events is N/A, then events were recorded as rates and absolute counts are not available.

**Supplementary Table 5. Summary of 47 Studies Containing 94 Risk Estimates Considered for Inclusion in Meta-analysis**

| | Risk Estimates (n) | | | Studies (n) |
|---|---|---|---|---|
| **Coronary events** | 56 | | | |
| *Acute myocardial infarction* | | 46 | | |
| Workplace only | | | 12 | |
| RR published | | | 2 | 2 |
| RR calculated | | | 4 | 3 |
| Unreliable results, excluded[41] | | | 6 | 1 |
| Workplace and restaurant | | | 6 | |
| RR published | | | 4 | 3 |
| RR calculated | | | 2 | 2 |
| Workplace and restaurant and bar | | | 28 | |
| RR published | | | 16 | 15 |
| RR calculated | | | 11 | 10 |
| RR provided by author[18] | | | 1 | 1 |
| *Acute coronary syndrome* | | 7 | | |
| Workplace only | | | 1 | |
| RR calculated | | | 1 | 1 |
| Workplace and restaurant | | | 1 | |
| RR published | | | 1 | 1 |
| Workplace and restaurant and bar | | | 5 | |
| RR published | | | 1 | 1 |
| RR calculated | | | 3 | 3 |
| Data inconsistencies, excluded[53] | | | 1 | 1 |
| *Acute coronary events* | | 2 | | |
| Workplace and restaurant and bar | | | 2 | |
| RR published | | | 2 | 2 |
| *Ischemic heart disease* | | 1 | | |
| Workplace and restaurant and bar | | | 1 | |
| RR published | | | 1 | 1 |
| **Other heart disease** | 10 | | | |
| *Angina* | | 7 | | |
| Workplace only | | | 1 | |
| RR calculated | | | 1 | 1 |
| Workplace and restaurant | | | 2 | |
| RR published | | | 1 | 1 |
| RR calculated | | | 1 | 1 |
| Workplace and restaurant and bar | | | 4 | |
| RR published | | | 1 | 1 |
| RR calculated | | | 3 | 3 |
| *Coronary heart disease* | | 1 | | |
| Workplace and restaurant | | | 1 | |
| RR published | | | 1 | 1 |
| *Sudden cardiac death* | | 2 | | |
| Workplace and restaurant | | | 1 | |
| RR published | | | 1 | 1 |
| Workplace and restaurant and bar | | | 1 | |
| RR published | | | 1 | 1 |

**Supplementary Table 5. Summary of 47 Studies Containing 94 Risk Estimates Considered for Inclusion in Meta-analysis**

| | Risk Estimates (n) | | | Studies (n) |
|---|---|---|---|---|
| **Cerebrovascular accident** | 9 | | | |
| *Stroke* | | 8 | | |
| Workplace only | | | 2 | |
| RR calculated | | | | 2 |
| Workplace and restaurant | | | 1 | |
| RR calculated | | | | 1 |
| Workplace and restaurant and bar | | | 5 | |
| RR published | | | | 1 |
| RR calculated | | | | 3 |
| RR not calculable, excluded[18] | | | | 1 |
| *Transient ischemic attack* | | 1 | | |
| Workplace and restaurant and bar | | | 1 | |
| RR published | | | | 1 |
| **Respiratory Disease** | 19 | | | |
| *Chronic obstructive pulmonary disease* | | 4 | | |
| Workplace only | | | 1 | |
| RR calculated | | | | 1 |
| Workplace and restaurant | | | 1 | |
| RR calculated | | | | 1 |
| Workplace and restaurant and bar | | | 2 | |
| RR published | | | | 1 |
| RR calculated | | | | 1 |
| *Asthma* | | 9 | | |
| Workplace only | | | 2 | |
| RR published | | | | 1 |
| RR calculated | | | | 1 |
| Workplace and restaurant | | | 2 | |
| RR published | | | | 1 |
| RR calculated | | | | 1 |
| Workplace and restaurant and bar | | | 5 | |
| RR published | | | | 3 |
| RR calculated | | | | 2 |
| *Lung infections* | | 5 | | |
| Workplace only | | | 1 | |
| RR calculated | | | | 1 |
| Workplace and restaurant | | | 1 | |
| RR calculated | | | | 1 |
| Workplace and restaurant and bar | | | 3 | |
| RR published | | | | 2 |
| RR calculated | | | | 1 |
| *Spontaneous pneumothorax* | | 1 | | |
| Workplace and restaurant and bar | | | 1 | |
| RR published | | | | 1 |

| Supplementary Table 6. Follow-up Duration for All Studies Used in Meta-analysis (Months) | | | | | | |
|---|---|---|---|---|---|---|
| **Outcome** | **Workplace Law** | | **Workplace and Restaurant Law** | | **Workplace, Restaurant, and Bar Law** | |
| | **Median** | **Range** | **Median** | **Range** | **Median** | **Range** |
| AMI[11, 13-16, 18, 19, 21, 23-30, 32, 33, 35, 38, 40, 42-48, 52, 54-57] | 12.5 | 12-24 | 22 | 12-32 | 24 | 2-39 |
| ACS[22, 37, 39, 49, 51] | 15 | | 57 | | 13.5 | 5-24 |
| ACE[20, 50] | | | | | 21 | 12-30 |
| IHD[36] | | | | | 24 | |
| Angina[29, 35, 44, 46, 47] | 24 | | 12 | | 24 | 13-39 |
| CHD[17] | | | 40 | | | |
| SCD[54] | | | 18 | | 18 | |
| Stroke[13, 29, 35, 47] | 18.25 | 12.5-24 | | | 18.5 | 13-24 |
| TIA[47] | | | | | 24 | |
| COPD[29, 47] | 24 | | | | 24 | |
| Asthma[12, 29, 31, 33-35, 47] | 24 | | 32 | | 13 | 10-24 |
| Lung Infections[29, 47] | 24 | 24* | | | 24 | |
| Spontaneous Pneumothorax[47] | | | | | 24 | |

Follow-up times for Phase 2 (adding restaurants to workplaces) and Phase 3 (adding bars to restaurants and workplaces) of the Toronto, Canada law,[29] Ordinance #2 of Olmsted County, Minnesota[54] (adding workplaces to restaurants), and the comprehensive law in France[13] (adding restaurants, bars, and casinos to other public places) were not used because the post-law period did not immediate follow a time with no restrictions. Though the effect of some laws were examined at multiple time points (Bowling Green, OH,[17] Pueblo, CO.,[15, 23] Graubünden, Switzerland,[28, 38] and Spain[42]), only the latest estimate is included on this table. Due to study design, follow-up length could not be determined for the two analyses that looked at multiple smokefree laws across the United States[27, 34] These studies were excluded from the length of follow-up analysis and do not appear in this table. For number of studies in each category, see Table 1. For details, see notes in Tables S1-S4.
* Risk estimates in this category all had same follow-up duration

**Supplementary Table 7. Results of Dummy Variable Metaregressions Comparing Natural Log of Risk Ratios to Determine Grouping Order of Disease Outcomes***

| Outcome | p-value | N | Outcome | p-value | N |
|---|---|---|---|---|---|
| **Cardiac (reference = AMI)** | | 40 | **Coronary Events (reference = AMI)** | | 40 |
| ACS | .307 | 6 | ACS | .173 | 6 |
| ACE | .455 | 2 | ACE | .375 | 2 |
| IHD | .425 | 1 | IHD | .330 | 1 |
| Angina | .015 | 7 | **Other Heart Disease (reference = Angina)*** | | 7 |
| CHD | † | 1 | CHD | .378 | 1 |
| SCD | .010 | 2 | SCD | .518 | 2 |
| **Cerebrovascular Accident (reference = Stroke)** | | 7 | **Respiratory Disease (reference = COPD)** | | 4 |
| TIA | .430 | 1 | Asthma | .367 | 9 |
| | | | Lung Infections | .358 | 5 |
| | | | Spontaneous Pneumothorax | .563 | 1 |

* For all categories, estimates are calculated from studies of comprehensive smokefree laws (smokefree workplaces, restaurants, and bars) except for Other Heart Disease, which used all smokefree laws because there were not enough data points.
†Too few studies to calculate

**Sensitivity Analysis for Coding of Ordinal Variable for Comprehensiveness of Law in Metaregressions**

We treated comprehensiveness of law as an ordinal, not an interval (continuous) variable, which is why we only reported the P value for law comprehensiveness and not an effect size. While this is a standard approach for integrating ordinal variables into regression analyses, we investigated use of this procedure to ensure that our conclusions were not sensitive to this technique in two ways:

First, we conducted the analysis treating law comprehensiveness as a categorical variable (together with dummy variables for the different outcome groups, as we do in the analysis in the paper that treats law comprehensiveness as an interval variable), taking workplace only law as the reference condition. This analysis yielded

Workplace + restaurant: RR = .948 (95% CI .842, 1.068)
Workplace + restaurant + bar RR = .864 (95% CI .787, .948)

The square of the point estimate for the risk change associated with workplace + restaurant laws, 0.948, is .899, which is well within the confidence interval for the point estimate for workplace + restaurant + bar laws, .864, suggesting that the way that we coded the laws as an interval variable (0, 1, 2) is a reasonable description of the dose-response.

Doing the analysis using dummy variables for the four outcome groups comes even closer:

Workplace + restaurant: RR = .928 (95% CI .823, 1.046)
Workplace + restaurant + bar RR = .865 (95% CI .788 .951)

The square of the point estimate for the risk change associated with workplace + restaurant laws, 0.928, is .861, which is very close to the point estimate for workplace + restaurant + bar laws, .865.

Second, we tried recoding the law comprehensiveness using alternative codings (0, 1, 3) and (0, 1, 4), which effectively allowed for larger incremental changes between workplace + restaurant + bar laws than between workplace + restaurant and workplace only laws. The P values for the law comprehensiveness variable was .002 for the original coding (0, 1, 2) compared to .002 for the (0, 1, 3) and .003 for the (0, 1, 4 coding), respectively.

Based on these additional sensitivity analyses, we believe that the approach we use in the paper produces robust evidence for a dose-response effect of the law, treating law comprehensiveness as an ordinal variable

## REFERENCES

Reference numbers correspond to those in the main paper.


1. California Environmental Protection Agency. Proposed Identification of Environmental Tobacco Smoke as a Toxic Air Contaminant. 2005: Available from: http://www.arb.ca.gov/regact/ets2006/ets2006.htm.
2. U.S. Department of Health and Human Services. *The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General.* Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Presention, Coordinating Center for Health Promotion, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. 2006.
3. IOM (Institute of Medicine). *Secondhand Smoke Exposure and Cardiovascular Effects: Making Sense of the Evidence*. Washington, DC: The National Academies Press. 2010.
4. Callinan JE, Clarke A, Doherty K, Kelleher C. Legislative Smoking Bans for Reducing Secondhand Smoke Exposure, Smoking Prevalence and Tobacco Consumption. *Cochrane Database Syst Rev.* 2010:CD005992.
5. Naiman AB, Glazier RH, Moineddin R. Is There an Impact of Public Smoking Bans on Self-Reported Smoking Status and Exposure to Secondhand Smoke? *BMC Public Health.* 2011;11:146.
6. Barnoya J, Glantz SA. Cardiovascular Effects of Secondhand Smoke: Nearly as Large as Smoking. *Circulation.* 2005;111:2684-98.
7. Ramsay CR, Matowe L, Grilli R, Grimshaw JM, Thomas RE. Interrupted Time Series Designs in Health Technology Assessment: Lessons from Two Systematic Reviews of Behavior Change Strategies. *Int J Technol Assess Health Care.* 2003;19:613-23.
8. Lightwood JM, Glantz SA. Declines in Acute Myocardial Infarction after Smoke-Free Laws and Individual Risk Attributable to Secondhand Smoke. *Circulation.* 2009;120:1373-9.
9. Meyers DG, Neuberger JS, He J. Cardiovascular Effect of Bans on Smoking in Public Places: A Systematic Review and Meta-Analysis. *J Am Coll Cardiol.* 2009;54:1249-55.
10. Mackay DF, Irfan MO, Haw S, Pell JP. Meta-Analysis of the Effect of Comprehensive Smoke-Free Legislation on Acute Coronary Events. *Heart.* 2010;96:1525-30.
11. Sargent RP, Shepard RM, Glantz SA. Reduced Incidence of Admissions for Myocardial Infarction Associated with Public Smoking Ban: Before and after Study. *BMJ.* 2004;328:977-80.
12. Rayens MK, Burkhart PV, Zhang M, Lee S, Moser DK, Mannino D, Hahn EJ. Reduction in Asthma-Related Emergency Department Visits after Implementation of a Smoke-Free Law. *J Allergy Clin Immunol.* 2008;122:537-41.e3.
13. Dautzenberg B. Indicateurs Mensuels Du Tabagisme Passif: Mesure Des Bénéfices De L'interdiction Totale De Fumer. 2008: Available from: http://www.la-croix.com/content/download/686570/20854176/2008_2_24_tabac.pdf.
14. Barone-Adesi F, Vizzini L, Merletti F, Richiardi L. Short-Term Effects of Italian Smoking Regulation on Rates of Hospital Admission for Acute Myocardial Infarction. *Eur Heart J.* 2006;27:2468-72.
15. Bartecchi C, Alsever RN, Nevin-Woods C, Thomas WM, Estacio RO, Bartelson BB, Krantz MJ. Reduction in the Incidence of Acute Myocardial Infarction Associated with a Citywide Smoking Ordinance. *Circulation.* 2006;114:1490-6.
16. Seo DC, Torabi MR. Reduced Admissions for Acute Myocardial Infarction Associated with a Public Smoking Ban: Matched Controlled Study. *J Drug Educ.* 2007;37:217-26.
17. Khuder SA, Milz S, Jordan T, Price J, Silvestri K, Butler P. The Impact of a Smoking Ban on Hospital Admissions for Coronary Heart Disease. *Prev Med.* 2007;45:3-8.

18. Juster HR, Loomis BR, Hinman TM, Farrelly MC, Hyland A, Bauer UE, Birkhead GS. Declines in Hospital Admissions for Acute Myocardial Infarction in New York State after Implementation of a Comprehensive Smoking Ban. *Am J Public Health.* 2007;97:2035-9.
19. Lemstra M, Neudorf C, Opondo J. Implications of a Public Smoking Ban. *Can J Public Health.* 2008;99:62-5.
20. Cesaroni G, Forastiere F, Agabiti N, Valente P, Zuccaro P, Perucci CA. Effect of the Italian Smoking Ban on Population Rates of Acute Coronary Events. *Circulation.* 2008;117:1183-8.
21. Vasselli S, Papini P, Gaelone D, Spizzichino L, De Campora E, Gnavi R, Saitto C, Binkin N, Laurendi G. Reduction Incidence of Myocardial Infarction Associated with a National Legislative Ban on Smoking. *Minerva Cardioangiol.* 2008;56:197-203.
22. Pell JP, Haw S, Cobbe S, Newby DE, Pell AC, Fischbacher C, McConnachie A, Pringle S, Murdoch D, Dunn F, Oldroyd K, Macintyre P, O'Rourke B, Borland W. Smoke-Free Legislation and Hospitalizations for Acute Coronary Syndrome. *N Engl J Med.* 2008;359:482-91.
23. Centers for Disease C, Prevention. Reduced Hospitalizations for Acute Myocardial Infarction after Implementation of a Smoke-Free Ordinance--City of Pueblo, Colorado, 2002-2006. *MMWR Morb Mortal Wkly Rep.* 2009;57:1373-7.
24. Gasparrini A, Gorini G, Barchielli A. On the Relationship between Smoking Bans and Incidence of Acute Myocardial Infarction. *Eur J Epidemiol.* 2009;24:597-602.
25. Villalbí JR, Castillo A, Cleries M, Salto E, Sanchez E, Martinez R, Tresserras R, Vela E, Barcelona G. Acute Myocardial Infarction Hospitalization Statistics: Apparent Decline Accompanying an Increase in Smoke-Free Areas. *Rev Esp Cardiol.* 2009;62:812-5.
26. Barnett R, Pearce J, Moon G, Elliott J, Barnett P. Assessing the Effects of the Introduction of the New Zealand Smokefree Environment Act 2003 on Acute Myocardial Infarction Hospital Admissions in Christchurch, New Zealand. *Aust N Z J Public Health.* 2009;33:515-20.
27. Shetty KD, DeLeire T, White C, Bhattacharya J. Changes in U.S. Hospitalization and Mortality Rates Following Smoking Bans. *J Policy Anal Manage.* 2010;30:6-28.
28. Trachsel LD, Kuhn MU, Reinhart WH, Schulzki T, Bonetti PO. Reduced Incidence of Acute Myocardial Infarction in the First Year after Implementation of a Public Smoking Ban in Graubuenden, Switzerland. *Swiss Med Wkly.* 2010;140:133-8.
29. Naiman A, Glazier RH, Moineddin R. Association of Anti-Smoking Legislation with Rates of Hospital Admission for Cardiovascular and Respiratory Conditions. *CMAJ.* 2010;182:761-7.
30. Sims M, Maxwell R, Bauld L, Gilmore A. Short Term Impact of Smoke-Free Legislation in England: Retrospective Analysis of Hospital Admissions for Myocardial Infarction. *BMJ.* 2010;340:c2161.
31. Mackay D, Haw S, Ayres JG, Fischbacher C, Pell JP. Smoke-Free Legislation and Hospitalizations for Childhood Asthma. *N Engl J Med.* 2010;363:1139-45.
32. Dove MS, Dockery DW, Mittleman MA, Schwartz J, Sullivan EM, Keithly L, Land T. The Impact of Massachusetts' Smoke-Free Workplace Laws on Acute Myocardial Infarction Deaths. *Am J Public Health.* 2010;100:2206-12.
33. Moraros J, Bird Y, Chen S, Buckingham R, Meltzer RS, Prapasiri S, Solis LH. The Impact of the 2002 Delaware Smoking Ordinance on Heart Attack and Asthma. *Int J Environ Res Public Health.* 2010;7:4169-78.
34. Dove MS, Dockery DW, Connolly GN. Smoke-Free Air Laws and Asthma Prevalence, Symptoms, and Severity among Nonsmoking Youth. *Pediatrics.* 2011;127:102-9.
35. Herman PM, Walsh ME. Hospital Admissions for Acute Myocardial Infarction, Angina, Stroke, and Asthma after Implementation of Arizona's Comprehensive Statewide Smoking Ban. *Am J Public Health.* 2011;101:491-6.

36. Barone-Adesi F, Gasparrini A, Vizzini L, Merletti F, Richiardi L. Effects of Italian Smoking Regulation on Rates of Hospital Admission for Acute Coronary Events: A Country-Wide Study. *PLoS One.* 2011;6:e17419.
37. Ferrante D, Linetzky B, Virgolini M, Schoj V, Apelberg B. Reduction in Hospital Admissions for Acute Coronary Syndrome after the Successful Implementation of 100% Smoke-Free Legislation in Argentina: A Comparison with Partial Smoking Restrictions. *Tob Control.* 2011;21:402-6.
38. Bonetti PO, Trachsel LD, Kuhn MU, Schulzki T, Erne P, Radovanovic D, Reinhart WH. Incidence of Acute Myocardial Infarction after Implementation of a Public Smoking Ban in Graubunden, Switzerland: Two Year Follow-Up. *Swiss Med Wkly.* 2011;141:w13206.
39. Gupta R, Luo J, Anderson RH, Ray A. Clean Indoor Air Regulation and Incidence of Hospital Admissions for Acute Coronary Syndrome in Kanawha County, West Virginia. *Prev Chronic Dis.* 2011;8:A77.
40. Bruintjes G, Bartelson BB, Hurst P, Levinson AH, Hokanson JE, Krantz MJ. Reduction in Acute Myocardial Infarction Hospitalization after Implementation of a Smoking Ordinance. *Am J Med.* 2011;124:647-54.
41. Rodu B, Peiper N, Cole P. Acute Myocardial Infarction Mortality before and after State-Wide Smoking Bans. *J Community Health.* 2012;37:468-72.
42. Villalbí JR, Sanchez E, Benet J, Cabezas C, Castillo A, Guarga A, Salto E, Tresserras R, Barcelona Group for Smoking Regulation Policies E. The Extension of Smoke-Free Areas and Acute Myocardial Infarction Mortality: Before and after Study. *BMJ Open.* 2011;1:e000067.
43. Hahn EJ, Rayens MK, Burkhart PV, Moser DK. Smoke-Free Laws, Gender, and Reduction in Hospitalizations for Acute Myocardial Infarction. *Public Health Rep.* 2011;126:826-33.
44. Cronin EM, Kearney PM, Kearney PP, Sullivan P, Perry IJ, on behalf of the Coronary Heart Attack Ireland Registry Working G. Impact of a National Smoking Ban on Hospital Admission for Acute Coronary Syndromes: A Longitudinal Study. *Clin Cardiol.* 2012;35:205-9.
45. Sebrie EM, Sandoya E, Hyland A, Bianco E, Glantz SA, Cummings KM. Hospital Admissions for Acute Myocardial Infarction before and after Implementation of a Comprehensive Smoke-Free Policy in Uruguay. *Tob Control.* 2012:PMID 22337557 [Epub ahead of print].
46. Sargent JD, Demidenko E, Malenka DJ, Li Z, Gohlke H, Hanewinkel R. Smoking Restrictions and Hospitalization for Acute Coronary Events in Germany. *Clin Res Cardiol.* 2012;101:227-35.
47. Kent BD, Sulaiman I, Nicholson TT, Lane SJ, Moloney ED. Acute Pulmonary Admissions Following Implementation of a National Workplace Smoking Ban. *Chest.* 2012:PMID 22383660 [Epub ahead of print].
48. Heinz J, Rasmussen CM, Johnson CJ. The Effect of Smoking Bans on Myocardial Infarctions: The Boise Experience. *Nicotine Tob Res.* 2007;9:S301.
49. Gudnason T, Viktorsson T, Andersen K. A Smoking Ban in Public Places May Reduce the Incidence of Acute Coronary Syndrome among Non-Smoking Men. *Eur Heart J.* 2009;30:153.
50. Barone-Adesi F, Vizzini L, Merletti F, Richiardi L. Italian Smoking Regulation Decreased Hospital Admissions for Acute Coronary Events:Effect Modification by Age and Day of the Week. *Eur Heart J.* 2009;30:148.
51. Di Valentino M, Limoni C, Rigoli A, Gallino A, Muzzarelli S, Pedrazzini G. Reduced Hospitalization for Acute Coronary Syndrome after Introduction of Smoking Ban in Public Places in Canton Ticino, Southern Switzerland. *Eur Heart J.* 2010;31:680.
52. Di Valentino M, Rigoli A, Limoni C, Barazzoni F, Gallino A, Muzzarelli S, Pedrazzini G. Reduced Incidence of St-Elevation Myocardial Infarction in the First Two Years after Introduction of a Public Smoking Ban in Canton Ticino, Switzerland. *Eur Heart J.* 2011;32 502.
53. Xuereb R, Calleja N, Distefano A, England K, Gatt M, Grech V. Smoking Ban: The Malta Paradox. *Eur Heart J.* 2011;32:379.

54. Hurt RD, Weston SA, Ebbert JO, McNallan SM, Croghan IT, Schroeder DR, Roger VL. Myocardial Infarction and Sudden Cardiac Death in Olmsted County, Minnesota, before and after Smoke-Free Workplace Laws. *Circulation.* 2011;124:21.
55. McMillen R, Hill A, Valentine N, Collins R. The Starkville and Hattiesburg Heart Attack Studies: Reductions in Heart Attack Admissions Following the Implementation of Local Smoke-Free Ordinances. 2010: Available from: http://www.ttac.org/resources/pdfs/120810_Miss_Heart_Attack_Report.pdf.
56. Bruckman D, Bennett B. Significant Change in Statewide Rates of Hospital Discharge Data for Myocardial Infarction Due to the Enactment of Ohio's Smoke-Free Work Place Law. Analyses of the Impact of the Ohio Smoke-Free Workplace Act [serial on the Internet]. 2011: Available from: http://www.odh.ohio.gov/ASSETS/81B904A706574FFB97271C46256E53C2/Final%20Reports.pdf.
57. The North Carolina Smoke Free Restaurants and Bars Law and Emergency Department Admissions for Acute Myocardial Infarction: A Report to the North Carolina State Health Director. 2011: Available from: http://tobaccopreventionandcontrol.ncdhhs.gov/smokefreenc/docs/TPCB-2011SFNCReport-SHD.pdf