The Effect of 100% Smoke-Free Medical Campus Policies on Community and Employee Health: A Systematic Literature Review

Mary A. McQuilkin

Johns Hopkins University School of Nursing

"On my honor, I pledge that I have neither given nor received any unauthorized assistance on this assignment."

- Mary Allison McQuilkin

Abstract

The objective of this literature review was to gather existing evidence comparing the impact of 100% smoke-free policies with partial smoking bans on health outcomes. A PICO framework (Population, Intervention, Comparison, Outcomes) was defined to guide the search of four databases since 1990. Articles that assessed the effect of 100% smoke-free policy implemented on the community level, rather than the institutional level, were included because little research has assessed health outcomes resulting from 100% smoke-free medical campus policy implementation within a community without a total smoking ban. Of 589 references identified, 73 articles were eligible for inclusion. The outcomes assessed were rates of hospital employee smoking cessation, acute myocardial infarction (AMI), acute coronary syndrome (ACS), and asthma. Based on the literature, 100% smoke-free medical campus policies decrease staff smoking, increase nicotine replacement therapy (NRT) use by patients, and do not have an adverse fiscal impact on hospitals. Smoke-free policies implemented on the community level decrease rates of ACS, AMI, and asthma. Community-level 100% smoke-free policies are more effective in improving health outcomes than partial smoking bans, and provide a greater reduction in secondhand smoke exposure. Research is needed to assess whether the health effects of 100% smoke-free medical campus policy implementation in a city without a smoke-free ordinance are comparable to effects seen with broader policy implementation.

keywords: 100% smoke-free medical campus policy, tobacco control, smoking ban

The Effect of 100% Smoke-Free Medical Campus Policies on Community and Employee Health: A Systematic Literature Review

Tobacco is the leading preventable cause of premature death in the U.S., contributing to one in five deaths (United States Department of Health and Human Services [HHS], 2010). Second-hand smoke (SHS) contains more than 7000 chemicals, at least 69 of which are known carcinogens (HHS, 2010). SHS contributes to respiratory and cardiovascular disease, including atherosclerosis, coronary artery disease, myocardial infarction, chronic obstructive pulmonary disease, and lung and other cancers (United States Centers for Disease Control and Prevention [CDC], 2008). SHS is a known cause of sudden infant death syndrome, ear infections, and asthma in infants and children (HHS, 2010). Air quality studies have found that the exposure to SHS outdoors within a few feet of a smoker is comparable to SHS levels inside the home of a smoker (Repace, 2008). Concentrations of tobacco smoke respirable particles on city sidewalks and outside public buildings can be comparable to SHS indoors (Repace, 2008). There is no safe level of SHS, and evidence has shown that creating 100% smoke-free environments is the only effective way to protect communities from harmful health effects (Global Smokefree Partnership, 2009).

Every year, smoking causes $96.8 billion in productivity losses for U.S. businesses (CDC, 2008). If all workplaces in the U.S. implemented 100% smoke-free policies, the reduction in myocardial infarction incidence would save $49 million in the first year, with the savings expected to increase over time (Americans for Nonsmokers’ Rights, 2008). Compared to non-smokers, workers who smoke cost their employer about $5,324 annually due to lost time at work, increased healthcare costs, and productivity lost to smoke breaks (Northeastern Vermont Regional Hospital, 2008). These data demonstrate that implementing a smoke-free campus policy is not only good for the health of the community, it is also good business.

A campus is considered 100% smoke-free when all indoor and outdoor areas, including adjacent sidewalks, parking lots, and vehicles on property owned or leased by the institution are smoke-free, and there are no designated smoking areas on the premises (Northeastern Vermont Regional Hospital, 2008). In 2008, 45% of hospitals in the U.S. had implemented 100% smoke-free campus policies as part of a rising trend (Ponkshe, 2009). As of 2013, 3,697 hospitals, healthcare systems, and clinics have implemented 100% smoke-free campus grounds (American Nonsmokers' Rights Foundation, 2013).

Very few studies have measured the impact of 100% smoke-free medical campuses on health outcomes. There is substantial data correlating negative health effects with exposure to SHS, and air quality studies correlating 100% smoke-free policies to decreased SHS exposure. Because there is a wealth of data indicating that tobacco smoke is harmful, it follows that a decrease in smoking prevalence would likely improve health outcomes. The purpose of this paper is to gather existing evidence comparing the impact of 100% smoke-free policies with partial smoking bans on health outcomes. The outcomes targeted by this review are hospital employee smoking rates and emergency department admissions for acute myocardial infarction (AMI), acute coronary syndrome (ACS), and asthma. While the focus of this paper is on smoke-free medical campuses, studies assessing the three health outcomes were based on broad implementation of smoke-free policy, rather than policy restricted to a medical campus. No data on health outcomes resulting from smoke-free medical campus policy implementation in the context of a community without a total smoking ban could be found.

If there is evidence that 100% smoke-free medical campuses improve community and employee health, nurses and other health professionals have a moral obligation to advocate for smoke-free policy implementation. Medical centers play an important role in the health of patients, staff, and the community. They portray an image of health, provide health advice, and staff may be viewed as role models of healthy behavior. The patient population accessing medical centers is likely to be especially vulnerable to the negative health effects of tobacco smoke due to pre-existing conditions.

Despite consistently being ranked as one of the best hospitals in the U.S. (U.S. News & World Report, 2014), Johns Hopkins is not among the more than 45% of hospitals that have implemented 100% smoke-free campus policies. The following literature review is intended to provide evidence in support of a change to the current Johns Hopkins Medical Institutions tobacco policy. My hope is that bringing attention to existing data on this topic will lead to the current partial smoking ban on the Johns Hopkins Medical Campus being changed to a 100% smoke-free policy. If Johns Hopkins University is truly committed to implementing evidence-based solutions to improve the health of the East Baltimore community, patients, students, and staff, it will invest resources to create and maintain a 100% smoke-free medical campus.

Methods

This literature review was conducted to answer the research question: Do 100% smoke-free medical campus policies result in decreased community rates of AMI, ACS, and asthma, compared to partial smoking bans? A PICO (Population, Intervention, Comparison, Outcome) was defined to structure the literature search (Figure 1A). The outcomes “decreased admissions for AMI, ACS, and asthma” and “decreased self-reported secondhand smoke exposure among non-smokers” pertain to people residing in 100% smoke-free communities, while “increased employee participation in smoking cessation programs” and “decreased prevalence of tobacco use by hospital employees” are specific to medical campus smoke-free policy implementation. The databases PubMed, Cochrane Library, Embase, and CINAHL were searched from March 10, 1990 to March 10, 2014, using the search terms ‘smoke-free policy’, ‘smoking ban’, ‘law’, ‘ordinance’, ‘legislation’, ‘prevention’, ‘cessation’, ‘tobacco prevention and control’, ‘smoking statistics and numerical data', 'hospital', 'medical center', 'hospitalization', 'myocardial infarction', 'ami', 'asthma', and 'acute coronary syndrome'. Reference lists of articles were scrutinized for additional references. The search was not restricted to the past five years because much of the literature on tobacco control policy is greater than five years old. Articles that were not available electronically or in English were excluded.

The search yielded 547 articles after 42 duplicates were removed (Figure 2A). Each abstract was reviewed for relevance to the PICO using the inclusion criteria of implementation of a 100% smoke-free policy or law, data collected from a medical campus or entire community implementing a smoking ban, comparison between pre-smoking ban and post-ban of employee smoking prevalence and cessation, SHS exposure, and health outcomes of asthma, AMI, or ACS. Abstracts on smoke-free medical campuses that focused on how hospital staff and patients feel about such policies, the history of tobacco use on hospital grounds, the prevalence of 100% smoke-free medical campuses, or implementation strategies for 100% smoke-free policy were excluded because they did not assess the outcomes defined in the PICO. Studies pertaining only to indoor environmental tobacco smoke were also excluded. After evaluating the remaining 122 articles, another 58 articles were excluded based on the content of the full text manuscript, leaving 73 articles that met the PICO criteria. Publications from the same study were linked to avoid including data from the same study more than once, which accounts for many of the articles excluded at this stage. The remaining articles were categorized based on the main health outcome studied, with 31 for MI, 9 for ACS, 9 for asthma, 10 with a combination of the previous three outcomes, and 14 for employee smoking cessation or decreased SHS exposure. The articles in each of the five health outcome categories (MI, ACS, asthma, and employee smoking cessation or decreased SHS exposure) were reviewed and 12 articles total were selected to represent the 73 articles that met the inclusion and exclusion criteria for the PICO. ACS was grouped with MI for article selection because ACS encompasses MI and unstable angina (Ferrante et al., 2012). The decision of which articles to evaluate further was based on the quality and strength of the evidence, how significant the findings were to the literature on the specific topic studied, and whether the conclusions were congruent with similar studies on the topic, with the objective of including studies that utilized a variety of research methods and represented a range of geographic locations (see Appendix A for more information on the study selection process). The strength of the twelve studies and quality of the evidence was graded according to the Johns Hopkins Nursing Evidence Based Practice Rating Scheme (Table B2) (Newhouse, Dearholt, Poe, Pugh, & White, 2007). Data was summarized (Table B1) using a variation on the individual evidence summary format developed by Sigma Theta Tau International (See Appendix B for a summary of individual studies) (Newhouse et al., 2007).

Discussion

This literature review is unique in its focus on health outcomes resulting from implementation of 100% smoke-free medical campus policy. Previous studies that were specific to medical campuses primarily assessed non-clinical outcomes such as staff opinion of the smoke-free policy. Most previous research that did address health outcomes studied policy implementation at the city, county, or national level rather than implementation at the institutional level. While many researchers have assessed the effectiveness of specific interventions for implementing 100% smoke-free medical campus policies, no previous studies were found specifically investigating whether there is evidence to support these interventions based on health outcomes such as decreased rates of asthma, AMI, or ACS.

Summary of Findings

Myocardial infarction and acute coronary syndrome. Six studies were selected to summarize the literature on the effects of 100% smoke-free policies on cardiovascular outcomes.

Two meta-analyses of quasi-experimental studies were included, one by Meyers, Neuberger, and Jianghua (2009) and another by Lightwood, Stanton, and Glantz (2009). While both studies were published in the same year, Meyers et al. (2009) conducted a systematic review and included a narrative summary of data in addition to a meta-analysis, while Lightwood et al. (2009) used a strictly quantitative approach. Meyers et al. (2009) found smoking bans decreased risk of AMI by 17%, with the greatest reduction in younger individuals and non-smokers. After smoke-free policy implementation, Lightwood et al., (2009) reported a monthly decrease in the relative risk of AMI of 0.0113 and Meyers et al. (2009) reported an annual decrease in incidence rate ratio of AMI of 26%. Both meta-analyses found evidence to support implementation of smoke-free policies to decrease AMI rates, and both found more significant decreases in the risk of AMI when policies are enforced over several years (Meyers et al., 2009; Lightwood et al., 2009).

Ferrante, Linetsky, Virgolini, Schoj, and Apelberg (2012) and Gasparini, Gorini, and Barchielli (2009) both conducted a time series analysis. Ferrante et al. (2012) compared hospital admissions for ACS among the 660,000 adults covered by public hospitals in Santa Fe, Argentina with the 700,000 adults covered by public hospitals in Buenos Aires, Argentina. The study allowed for comparison between a 100% smoke-free policy implemented in Santa Fe, and a partial smoking ban that allowed smoking in designated areas, implemented in Buenos Aires. The 100% smoke-free policy resulted in an immediate 13% reduction in hospital admissions for ACS, followed by a sustained monthly reduction of 0.26 per 100,000. The study found that the 100% smoke-free policy was more effective than a partial smoking ban in reducing hospital admissions for ACS (Ferrante et al., 2012).

Gasparini et al. (2009) were skeptical of the declines in AMI reported by other studies on smoke-free policies. They used time series analysis to evaluate short-term effects of the Italian smoke-free ordinance on AMI incidence rates, with a focus on the consequences of an incorrect specification of the time trend effect. Tuscany AMI admissions were analyzed to assess the plausibility and consistency of the decline in AMI after smoking ban implementation that has been reported by many studies. Based on a Poisson regression model, Gasparini et al. (2009) concluded the smoke-free ordinance had no significant effect on AMI incidence during the first year after the ban. The authors speculated that previous studies may be substantially biased due to incorrect specification of the time trend, so smoke-free policies are not as effective at reducing AMI rates as has been reported by other researchers (Gasparini et al., 2009). While this skeptical view of smoke-free policies adds interesting contrast to the consensus of other articles, Gasparini et al. (2009) used a smaller sample size than many of the studies they criticized and failed to identify any limitations of their own study.

A study by Seo and Torabi (2007) was unique in that it used a retrospective matched control group design. They compared AMI admissions at two hospitals, one in a county that had just implemented a smoke-free ordinance and a similar county without a smoke-free policy. A chart review was conducted over a 44 month period to compare AMI rates in the two counties to assess the health effect on nonsmoking patients. They found a decrease in AMI hospital admissions of nonsmokers in the county implementing the smoke-free policy, and concluded that a public smoking ban may decrease AMI rates. Seo and Torabi (2007) suggested the change in AMI rate after smoke-free policy implementation likely results primarily from decreased SHS exposure of nonsmokers, rather than smokers quitting or reducing their tobacco consumption. This is an interesting assertion taken together with data comparing 100% smoke-free policies to partial smoking bans because it would support 100% smoke-free policies on account of their superior protection of nonsmokers from SHS exposure.

Johnson and Beal (2012) used a before and after ecological study design to assess the impact of implementing a smoke-free law on MI incidence where a partial smoking ban was already in place. The study was set at a rural hospital, using the community around the hospital as its own comparison group. Based on electronic medical records of MI patients admitted four months prior to, and four months following implementation of the smoke-free ordinance, MI rate decreased 30.6%, number of MIs decreased 24.1%, and overall mortality rate decreased from 2.5% to 1.8% (Johnson & Beal, 2012). These decreases in AMI rates are remarkable, especially when considering the short follow-up time and pre-existing partial smoking ban. The observed decline in MI incidence is presumably an improvement above and beyond the protection provided by the partial ban.

With the exception of the assertion by Gasparini et al. (2009) that decreases in AMI rates after smoke-free policy implementation are over-reported due to poor use of statistical methods, the data on cardiovascular outcomes support smoke-free policy. The two meta-analyses from 2009 provide solid quantitative evidence indicating that 100% smoke-free policies improve cardiovascular outcomes. Despite differences in study design and whether the outcome was AMI or ACS, the majority of evidence to date suggests that 100% smoke-free policies do improve community cardiovascular outcomes.

Asthma. Rayens et al. (2008) examined the association between implementation of a smoke-free policy and emergency department (ED) visits for asthma. ED visits for asthma at four hospitals in Kentucky were analyzed before and after passage of a 100% smoke-free policy using Poisson regression and time series analysis. A prediction curve was calculated to show ED visits for asthma if the smoke-free policy had not been implemented. A 22% decline in ED visits for asthma was found, with a 24% decline for adults over age 20 and an 18% decline for those 19 and younger (Rayens et al., 2008).

Dove, Dockery, and Connolly (2011) assessed the effect of smoke-free laws on asthma in nonsmoking youth using a retrospective cross-sectional survey. A secondary analysis of National

Health and Nutrition Examination Survey (NHANES) data from 1999-2006 was performed and locations were categorized as having or not having at least one smoke-free workplace, restaurant, or bar law at the county or state level that covered the entire population. Youth in smoke-free counties had fewer asthmatic symptoms, lower odds of asthma symptoms, lower odds of having an asthma attack, and lower odds of going to the ED for asthma compared to youth residing in counties without smoke-free laws. The authors concluded that smoke-free laws reduce asthma symptoms including persistent wheeze, chronic night cough, and wheeze-medication use in nonsmoking youth (Dove et al., 2011).

The studies by Rayens et al. (2008) and Dove et al. (2011) both found improvements in community asthma rates after implementation of a 100% smoke-free policy. While the study by Rayens et al. (2008) did not include a comparison group and the method used to classify counties as smoke-free used by Dove et al. (2011) likely does not accurately capture individual SHS exposure, their conclusions were consistent with the findings of other studies. The evidence suggests smoke-free policies implemented on the community level improve respiratory outcomes in both adults and children (Rayens et al., 2008; Dove et al., 2011).

Respiratory and cardiovascular health outcomes studies included in the analysis were representative of a range of geographic locations and medical center sizes. Smoke-free policy implementation at a large campus with geographic separation from the city (Stave & Jackson, 1991), a large medical campus in the middle of a dense urban area (Offord et al., 1992), and small rural hospitals (Johnson & Beal, 2012) were all studied, with similar effects reported on health outcomes. This indicates that decreases in SHS exposure are likely not significantly impacted by the facility size or setting, so long as a 100% smoke-free campus policy is enforced rather than a partial smoking ban.

Employee smoking cessation. Three studies were specific to 100% smoke-free policy implementation on medical campuses and included hospital staff smoking cessation as an outcome. The studies by Gadomski, Stayton, Krupa, and Jenkins (2010) and Offord, Hurt, Berge, Frusti, and Schmidt (1992) both used a time series design with one hospital serving as its own comparison group. Stave and Jackson (1991) performed a randomized, cross-sectional survey and used a separate campus without a smoke-free policy as a comparison. Gadomski et al. (2010) found the staff's smoking rate decreased from 14.3% to 9% after the ban. The study by Stave and Jackson (1991) used exhaled carbon monoxide testing to validate smoking cessation with an objective measure, while the other two studies relied on self-reporting to measure smoking cessation rates. Mean cigarette consumption was also reported to decline during the workday after policy implementation (Stave & Jackson, 1991). Offord et al. (1992) and Stave and Jackson (1991) both found that the hospital staff who continued to smoke after policy implementation were more likely to attempt to quit compared to before the policy. All three studies found increased smoking cessation rates among hospital staff after the implementation of a 100% smoke-free campus policy (Gadomski et al., 2010; Offord et al., 1992; Stave & Jackson, 1991).

Gadomski et al. (2010) also made important contributions to the data on smoke-free medical campus policy by specifically investigating the reasons most commonly cited for not implementing such a policy. In addition to monitoring staff smoking behaviors, Gadomski et al. (2010) tracked inpatient volume, percentage of inpatients who smoke, nicotine replacement therapy (NRT) orders, and number of patients who left against medical advice (AMA). The year before the smoking ban, 150 staff participated in a smoking cessation program. The percentage of inpatient smokers and number of patients leaving AMA did not change after the smoke-free medical campus policy went into effect. After the ban, NRT use by patients tripled (Gadomski et al., 2010). Nearly all hospital staff, including smokers, supported the policy and no exit interviews mentioned the smoke-free policy as a reason for leaving (Offord et al., 1992). These studies help dispel commonly cited reasons for not implementing 100% smoke-free medical campus policies and provide evidence of benefits in addition to increased employee smoking cessation rates (Offord et al., 1992).

Decreased secondhand smoke exposure. Hahn (2010) conducted a literature review to summarize smoke-free legislation health and economic outcomes research. A total of 880 local, 35 state, and 44 national smoke-free policies were found. Of these, 405 local, 22 state, and 18 national laws covered workplaces, restaurants, and bars, while other regulations were less comprehensive. Hahn (2010) found that disparities in protection from SHS exposure remain in subpopulations, and outcomes vary by race, gender, socioeconomic status, and age. The author concluded that smoke-free legislation is a powerful public health intervention and has the potential to contribute lasting reductions in the health and economic burden from tobacco use by decreasing SHS exposure (Hahn, 2010).

The study by Ferrante et al. (2012) discussed previously found that both a 100% smoke-free policy and partial smoking ban reduce SHS exposure, with less exposure reported with the 100% smoke-free policy. Nagle, Schofield, and Redman (1996) made behavioral observations of smokers before and after implementation of a 100% smoke-free medical campus policy. Secret observers found that 90% of the smokers on hospital grounds were staff or visitors rather than patients based on 4451 observations at a hospital becoming smoke-free and 2497 at a comparison hospital. A 4% decrease in prevalence of smoking around the hospital was attributed to putting up no smoking signs (Nagle et al., 1996). While Nagle et al. (1996) did not directly address the outcomes specified in the PICO, the observation that 90% of smokers on hospital grounds were staff or visitors is worth noting because, combined with the evidence that 100% smoke-free medical campus policy decreases staff smoking rates, policy implementation is likely to significantly decrease the total number of smokers on a medical campus.

Another study that contributes relevant data despite not specifically addressing the outcomes of the PICO is a qualitative cross-sectional survey by Wheeler et al. (2007). Patient volume, patient satisfaction, employee attitudes, recruitment, and retention were monitored to assess the validity of common reasons for not implementing a 100% smoke-free medical campus policy. Before implementation, 83.3% of employees supported the smoke-free policy and 89.8% were in support after implementation. Similar to the findings of Offord et al. (1992), there was no evidence of increased employee separations or decreased hiring after policy implementation. Bed occupancy, mean daily census, and patient satisfaction remained unchanged at both facilities. Wheeler et al. (2007) found that creating a 100% smoke-free medical campus did not have a detrimental effect on employee or patient attitudes and behaviors.

The studies by Gadomski et al. (2010), Offord et al. (1992), and Wheeler et al. (2007) dispel common negative assumptions about the impacts of 100% smoke-free medical campus policy, while highlighting benefits. Existing data indicate that 100% smoke-free medical campus policies increase rates of employee smoking cessation, and those who continue to smoke make more quit attempts and smoke fewer cigarettes during the workday (Gadomski et al., 2010; Stave & Jackson, 1991). Fewer hospital staff smoking will likely translate to a significant reduction in SHS on medical grounds and decreased SHS exposure for nonsmokers (Ferrante et al., 2012; Nagle et al., 1996).

Limitations

No experimental studies could be found related to health outcomes from 100% smoke-free policy implementation, likely due to the ethical barrier of needing to assign people to be exposed to SHS for such a study. No studies that assessed health outcomes were based on implementation of smoke-free policy at the institutional level. While the evidence indicates implementation of 100% smoke-free policies is associated with declines in hospital admissions for ACS, AMI, and ED visits for asthma, the public health impact would likely be less dramatic for a policy confined to medical campus grounds. Changes in health outcomes seen with broad smoke-free policy implementation likely cannot be extrapolated to medical campuses within a community that is not 100% smoke-free, so it is difficult to estimate health effects of medical campus policies based on the existing literature.

Limitations of articles. The most common limitation of the studies reviewed was the use of only one or two hospitals or communities as samples, which may threaten external validity. This was the case for the studies by Ferrante et al. (2012), Gasparini et al. (2009), Johnson and Beal (2012), Stave and Jackson (1991), Seo and Torabi (2007), Rayens et al. (2008), Gadomski et al. (2010), and Offord et al. (1992). Despite the use of only one or two communities, several of these studies achieved large sample sizes such as the comparison of Santa Fe, Argentina, population 660,000, and Buenos Aires, population 700,000 by Ferrante et al. (2012). With the exceptions of Stave and Jackson (1991), Offord et al. (1992), and Lightwood et al. (2009), power analysis was not specifically described.

The quasi-experimental studies were at an increased risk for confounding due to lack of randomization, which authors used various approaches to address. Stave and Jackson (1991) introduced an element of randomization by randomly selecting staff for phone interviews, although it would not have been feasible to randomly assign staff to work at the Medical Campus or University Campus, so the risk of confounding was not completely eliminated. Most of the studies made attempts to account for potential confounding variables using multivariate statistical modeling. Some of the threat to internal validity was also minimized by the use of communities as their own comparison group in the majority of studies that assessed health outcomes (Grove, Burns, & Gray, 2013). None of the study designs were blinded, with the exception of Seo and Torabi (2007), which had hospital staff, rather than researchers, access patient charts to minimize bias in case selection.

A limitation of the Johnson and Beal (2012) study was the follow-up period of four months after implementation of the smoke-free ordinance. Based on the findings of other studies that assessed AMI rates, it seems unlikely that the full effect of the ban would be reflected in community health outcomes in such a short time. This makes their finding of a 30.6% decrease in AMI rate following the smoking ban questionable (Johnson & Beal, 2012).

The study by Hahn (2010) was of poor quality and was primarily included in this review to add variety to the level and type of evidence reviewed. Only the MEDLINE database was searched, the strategy for deciding which articles to review was not discussed, and no quantitative analysis was performed. While the article does provide a narrative overview of the topic, the design flaws make it unlikely that all existing literature was reviewed (Hahn, 2010).

The conclusion reached by Gasparini et al. (2009) that no decrease in AMI rates occurred after smoke-free policy implementation may have been affected by type II error (Grove et al., 2013). Only 2,190 AMI cases occurred after the ban during the Gasparini et al. (2009) study, compared with 215,524 AMI cases included in the meta-analysis by Meyers et al. (2009). Gasparini et al. (2009) may have failed to find a difference in AMI rates because the study was inadequately powered. Despite extensive statistical modeling, and assertions that authors of previous studies on the topic made mathematical errors, no power analysis was described (Gasparini et al., 2009).

Literature review limitations. This literature review is limited in that no meta-analysis could be performed to pool data. Combining the results of existing quantitative studies was complicated by variable definitions of smoke-free, variable case definitions, lack of objectively validated smoking cessation data, lack of SHS exposure information, and lack of a standardized method for calculating incidence rates. Some researchers used the total population as the denominator when calculating incidence rates, while others used total hospital admissions.

None of the articles included in the review perfectly matched the PICO because each article was either not specific to medical campuses or did not assess health outcomes. Hospital staff smoking cessation and smoking behavior were the closest outcome measures that could be found in the existing literature specific to medical campuses. Because of the lack of data that met the PICO criteria, and the age of the bulk of tobacco control research in general, studies were included in the analysis that were greater than five years old.

Inter-rater reliability was not established because the review was completed individually, which is a potential limitation to the study selection process. Doubt about how evidence should be graded or whether a study should be included was resolved by returning to the question at a later time, rather than having another researcher review the decision. This review is also limited by the exclusion of articles that did not have a full text available electronically and in English. No print sources or unpublished studies were reviewed.

Conclusion

A systematic literature review was conducted to answer the research question: Do 100% smoke-free medical campus policies result in decreased community rates of AMI, ACS, and asthma, compared to partial smoking bans? The twelve articles selected for review out of the 73 that met the PICO criteria included two systematic reviews and meta-analyses of quasi-experimental studies, one literature review, eight quasi-experimental studies, and one retrospective cross-sectional survey. Of these, three studies were rated IIA, four IIB, three IIC and two were rated IIIC (Table B1).

Based on the literature, 100% smoke-free medical campus policies increase staff participation in smoking cessation programs, decrease the prevalence of cigarette smoking among staff, and increase NRT use by patients (Gadomski et al., 2010). Such policies do not increase the number of patients leaving AMA to smoke, decrease bed occupancy or mean daily census, decrease patient satisfaction, decrease hiring of new staff, or cause staff to seek employment elsewhere (Gadomski et al., 2010; Wheeler et al., 2007).

When 100% smoke-free policies are implemented on the community level or more broadly, there is an associated decrease in hospital admissions for ACS and AMI, with the impact becoming more significant if the policy is enforced for several years (Ferrante et al., 2012; Meyers et al., 2009). A significant decline in ED admissions for asthma is also seen (Rayens et al., 2008). Community-level 100% smoke-free policies are more effective in improving health outcomes than partial smoking bans, and provide a greater reduction in SHS exposure (Ferrante et al., 2012). The decline in risk of AMI with smoking bans has the greatest impact on youth and non-smokers (Meyers et al., 2009).

No studies were found that directly assessed the effects of 100% smoke-free medical campus policies on the health outcomes of AMI, ACS, or asthma. Based on studies of community implementation, and the decreased staff smoking rates seen with medical campus implementation, it is likely that 100% smoke free medical campus policy implementation would improve health outcomes for staff, patients, and the community.

Implications for Practice and Further Research

For public health nurses and other professionals with an interest in occupational and environmental health, the findings of this literature review indicate an area in need of further study. Research should be undertaken to study whether the health effects of 100% smoke-free medical campus policy implementation in a city without a smoke-free ordinance are comparable to effects seen with broader policy implementation. This intervention is likely to decrease SHS exposure of community members, patients, staff, and visitors to medical campuses and subsequently improve respiratory and cardiovascular health outcomes. Studies of broad smoke-free policy implementation stress the importance of sustaining the policy with continued enforcement over several years to produce continued improvements in health outcomes. Therefore, smoke-free medical campus policy research focused on health outcomes should be of long duration and ensure that the institution is invested in enforcing the policy in the long-term.

The evidence that decreased SHS exposure improves health is well-established, and the existing research specific to medical campuses demonstrates that smoking on and around campus decreases with 100% smoke-free policy implementation. It is logical that decreased smoking prevalence and decreased SHS exposure will improve the health of hospital staff, patients, and the surrounding community, but this cannot be known definitively without conducting more specific research on this topic.

Appendix A

P (Patient, population, or problem):

The community members, patients, staff, and visitors to medical campuses

I (Intervention):

Implementation of 100% smoke-free policy

C (Comparison with usual or routine care):

Partial smoking bans

O (Outcomes):

One year after 100% smoke-free policy implementation:

- Increased employee participation in smoking cessation programs
- Decreased prevalence of tobacco use by hospital employees
- Decreased admissions for AMI, ACS, and asthma
- Decreased self-reported secondhand smoke exposure among non-smokers

Research question: Do 100% smoke-free medical campus policies result in decreased community rates of AMI, ACS, and asthma, compared to partial smoking bans?

Figure 1A. PICO search criteria.

Table A1

Search Strategy Used in Pubmed

("Smoke-Free Policy"[Mesh] OR "smoking ban" OR "smoke-free policy" OR "smoke-free law" OR "smoke-free ordinance" OR "smoke-free laws" OR "smoke-free legislation") OR "Tobacco Smoke Pollution/prevention and control"[Mesh]) OR "Smoking/legislation and jurisprudence"[Mesh] OR "Smoking/prevention and control"[Mesh] OR "Smoking/statistics and numerical data"[Mesh] OR "Smoking/trends"[Mesh]) OR "Smoking Cessation/organization and administration"[Mesh]))) AND ("Hospitals"[Mesh] OR hospital* [tw] OR "medical center" [tiab] OR "medical centers" [tiab] OR hospitalization [mh]) AND (myocardial infarction [mh] OR ami [tiab] OR asthma [mh] OR asthma [tiab] OR "acute coronary syndrome")

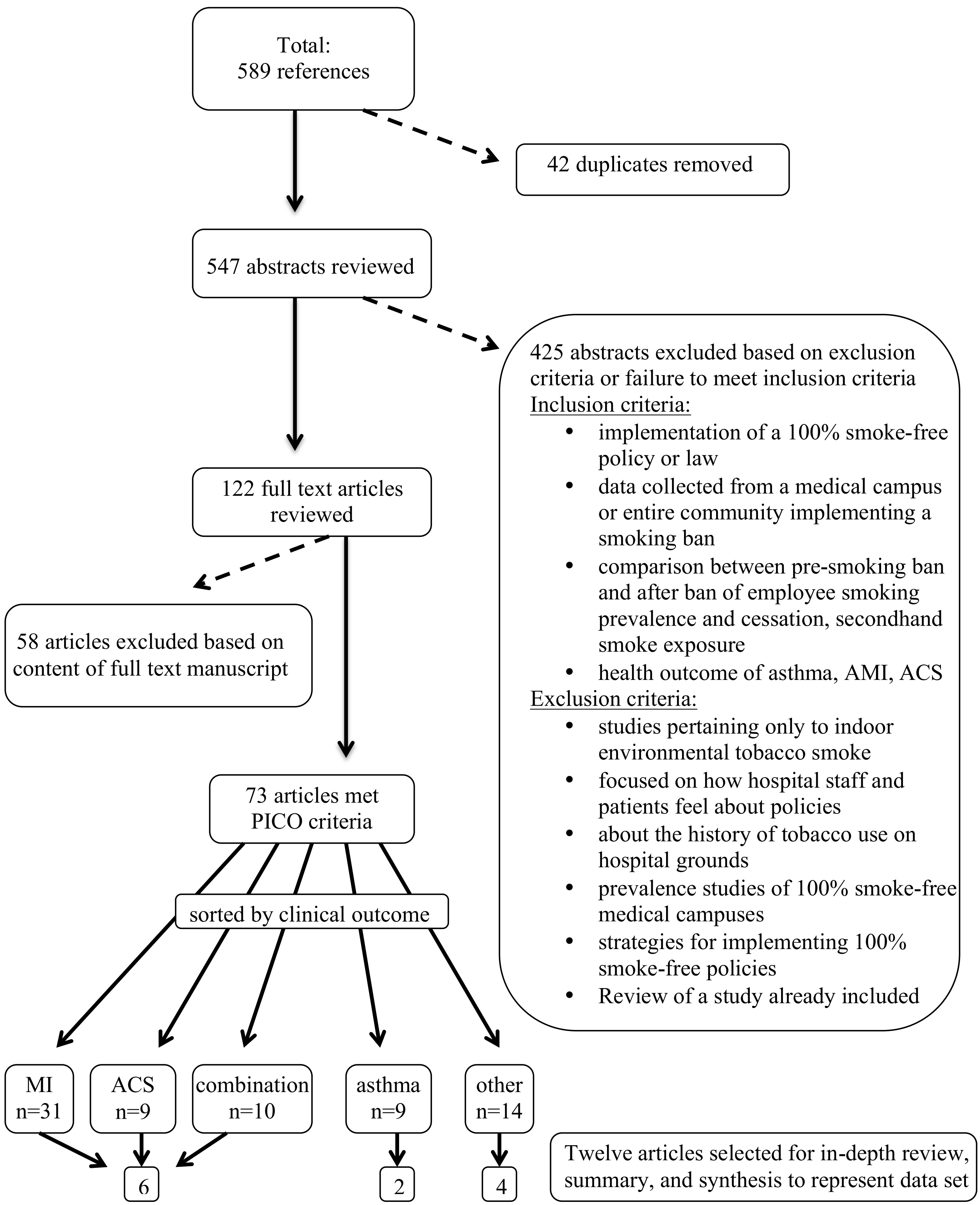

Figure 2A. Flow chart of the study selection process.

Appendix B

Table B1

Individual Evidence Summary

<table>
<tr><td colspan="4">Myocardial Infarction and Acute Coronary Syndrome</td></tr>
<tr><td>Study Design</td><td>Sample Size, Composition, & Setting</td><td>Results / Recommendations</td><td>Limitations</td></tr>
<tr><td colspan="2">#1 1st Author, Year: Meyers, 2009</td><td colspan="2">Strength/Quality: II / A</td></tr>
<tr><td><u>Design:</u>
• Systematic review and meta-analysis of quasi-experimental studies.
<u>Control:</u>
• Communities served as their own comparison group.
<u>Intervention:</u>
• Pubmed, EMBASE, and Google Scholar databases were searched from January 1, 2004 through April 30, 2009 using the search terms “smoking ban” and “heart” or “myocardial infarct.”
<u>Outcome / objective:</u>
• Study objective was to determine the association between public smoking bans and risk for hospital admission for acute myocardial infarction (AMI).
<u>Statistical methods:</u>
• Incidence rates of AMI per 100,000 person-years before and after implementation of smoking bans and incidence rate ratios (IRR) with 95% confidence intervals (CI) were calculated.
• Random effects meta-analyses estimated the overall effect of smoking bans. Heterogeneity among studies was assessed using funnel plot and meta-regression</td><td><u>Sample size:</u>
• Total of 24 million people with 215,524 cardiac events from 11 reports.
<u>Composition:</u>
• Cases of AMI, from all age groups.
<u>Setting:</u>
• 10 locations in the U.S., Canada, and Europe.</td><td>• Smoking bans decreased overall risk of AMI by 17% (IRR 0.83, 95% CI 0.75 to 0.92).
• The greatest effects were seen in non-smokers, youth, and institutions that enforced the policy for several years. IRR decreased 26% each year after ban implementation.
• All studies showed a decrease in AMI rates after smoking bans, with largest reductions seen in the U.S.
• 6 months after the ban in Helena, Montana was suspended, a return of AMI rates to pre-ban levels was observed, which lends evidence to a causal relationship.
• Based on the meta-analysis findings and the 920,000 incident MIs annually in the U.S., the authors predict a national smoking ban would prevent up to 156,400 MIs annually.</td><td>• The studies included in the analysis assessed workplace and public smoking bans, and were not specific to hospital grounds or medical centers.
• Local smoking bans in New York were in place before the statewide ban, so the analysis may only capture the additive effect of the statewide ban, rather than the cumulative effect of the local and state laws together.
• The 11 studies were all ecological in design, which are primarily for generating hypotheses.
• Studies varied in case definition, secondhand smoke (SHS) exposure information, smoking prevalence data, and case confirmation.
• The limited number of studies did not allow the authors to determine whether</td></tr>
</table>

(*p*<0.001). Studies were weighed by person-years to consider both population size and duration of observation. • Power analysis was not specifically described.			the IRR changes post-ban followed a nonlinear pattern like the nonlinear dose-response relationship of SHS and AMI.
#2 **1st Author, Year:** Ferrante, 2012		**Strength/Quality:** II/B	
Design: • Time series analysis, quasi-experimental design. Control: • Communities were used as their own comparison group. Intervention: • Age-standardized Acute Coronary Syndrome (ACS) admission rates were compared before and after policy implementation in two cities to compare a 100% smoke-free policy to a partial smoking ban. • Diagnoses were divided by the population denominator for each district to estimate ACS rates, which were then standardized by age and sex using the 2000 Argentine standard population. • SHS exposure and legislation compliance were measured using National Risk Factor Survey Data from 2005 (pre-law) and 2009 (post-law). Outcome / objective: • ACS admission rates, smoking prevalence, policy compliance, and SHS exposure were compared in both cities. Statistical methods: • Multiple linear regression analysis estimated the effect of laws on admission rates. • Rate ratios and their 95% CIs were estimated to compare ACS admission rates	Sample size: • 660,000 for 100% smoke-free population, 700,000 for partial smoking ban population. Composition: • Adults over age 18 covered by public sector hospitals. Setting: • Santa Fe, Argentina (100% smoke-free), and Buenos Aires, Argentina (partial ban).	• The 100% smoke-free policy immediately resulted in a 13% reduction in hospital admissions for ACS, (-2.5 admissions per 100,000, 95% CI -0.39 to -4.74, p=0.03), and there was a persistent decrease in ACS admissions (-0.26 per 100,000 per month, 95% CI -0.39 to -0.13, p<0.001). • The partial ban resulted in no change in ACS hospital admissions (increase of 1.74 admissions per 100,000, 95% CI -1.43 to 4.92, p=0.28). • There was a slight but not statistically significant decrease in smoking prevalence in both districts. In 2005, Buenos Aires smoking prevalence was 27.4% (95% CI 24.4%-30.6%) and 27.3% (95% CI 24.3%-30.5%) in Santa Fe (p=0.95). In 2009, Buenos Aires smoking prevalence was 26.2% (95% CI 22.8%-29.7%) and 26.6% (95% CI 25.5%-27.8%) in Santa Fe (p=0.84). • More smokers attempted to quit during	• No information was collected about the individuals admitted for ACS such as smoking status or SHS exposure. • It cannot be known whether the decrease in ACS admissions was because people quit smoking or because non-smokers weren't exposed to as much SHS. • The study took place in Argentina, which has a different socioeconomic, legal, and cultural setting than the U.S., so findings may not be generalizable to a U.S. population. • The study was not specific to smoke-free policy on medical campuses, but instead included entire cities enforcing tobacco control policies.

between Santa Fe and Buenos Aires before and after the law. • X^2 tests were used to compare self-reported SHS exposure and smoking prevalence. Significance criterion < 0.05 was used. • Power analysis was not specifically described.		the year after the ban in Santa Fe compared to Buenos Aires (53%, 95% CI 42.5%-63.6% vs. 44.4% CI 34.3%-55.0%, p=0.045). • Both policies were followed by a decrease in reported SHS exposure, with the largest decrease seen in Santa Fe. • 100% smoke-free policy was more effective than a partial restriction in reducing admissions for ACS. • Smoke-free laws can also be effective at decreasing ACS in developing countries.	
#3 **1st Author, Year:** Lightwood, 2009		**Strength/Quality:** II/A	
Design: • Meta-analysis of quasi-experimental studies. Control: • In some studies analyzed the community served as its own comparison group, while in some a similar community was used as a comparison during the same time period. Intervention: • Declines in AMI rates after smoke-free law passage were compared mathematically. • SHS exposure scenarios were assessed using serum cotinine level from population data. Outcome / objective: • To determine the consistency of estimates of reductions in AMI rates resulting from smoking restriction laws. • Outcome measure was the	Sample size: • The article did not specify the cumulative number of individuals included in the studies analyzed. Composition: • 12 studies. Setting: • U.S., Canada, Italy, Scotland, and Ireland.	• Pooled random-effects estimate of the rate of acute MI hospitalization 12 months after smoking ban implementation was 0.83 (95% CI 0.80-0.87), and the benefit grew with time. RR of AMI decreased 0.0113/month of follow-up, standard error (SE) 0.002, p<0.0005. • 76% of heterogeneity in AMI declines after smoke-free law passage was primarily due to differences in duration of follow-up after law implementation. • Authors concluded that passage of strong smoke-free legislation results in rapid and substantial declines in	• The meta-analysis was limited by the lack of biomarker-based levels of SHS exposure in populations before and after laws went into effect. Self-reported SHS exposure tends to be underreported. The lack of accurate SHS exposure data limits the ability to evaluate health effects of the laws on the populations. • The studies also lacked accurate data on smoking status at the time of admission for AMI. • The parameters used in the mathematical models

ratio of AMI rates after dividing by the rate before implementation of a smoking restriction law. Statistical methods: • Simple random-effects meta-analysis and meta-regression estimated decline in AMI rate as a function of time since ban implementation. 4 distributions of individual relative risk (RR) of AMI associated with SHS were modeled. Simulation estimates of RR or AMI were calculated for 48 combinations of parameters. Significance criterion < 0.05. • Effect size was calculated for the models and sensitivity analysis was performed to determine the robustness of the results to changes in the sample and statistical method. • Funnel plot and Begg test were used to assess whether publication bias contributed to heterogeneity of results.		AMI rates, and the benefits increase over time.	were treated as independent, but some may covary such as current smoking and exposure to SHS. • The parameter distributions were derived from observational studies, which may have introduced bias. • The authors did not account for the effect of lower SHS exposure among people who quit smoking or decreased cigarette consumption after law implementation, which may lead to an underestimate of the law's effect.
#4 **1st Author, Year:** Gasparrini, 2009		**Strength/Quality:** II/C	
Design: • Time series analysis, quasi-experimental design. Control: • The community served as its own comparison group. Intervention: • Assessed the short-term effects of the Italian smoke-free ordinance on AMI incidence rates, with a focus on the consequences of an incorrect specification of the time trend effect. • Data consisted of monthly number of AMIs stratified by age and sex, excluding multiple events in the same	Sample size: • Population of 3,550,000 with 13,456 total cases of AMI. 2,190 AMI cases post-ban. • Comparison was 10 previously published studies. Composition: • 30-64 year olds. Setting: • Tuscany,	• The linear time trend model estimated a decrease of 5.4% (RR 0.95, 95% CI 0.89-1.00), but the effect disappeared when the linearity assumption was relaxed (RR 1.01, 95% CI 0.93-1.10). The non-linear model showed a significantly improved fit (p=0.01). • Bias may be substantial in previously published studies due to incorrect specification of the time trend. • In the present study, no	• The authors did not admit that their study had any limitations. • The authors point out that only 3 of the 10 published studies considered the effect of the temporal trend in their statistical analysis, but this is only a problem if this individual study is correct and all previous studies are incorrect, which seems presumptuous. • The present study included a total of

patient within 28 days. Outcome / objective: • To assess the plausibility and consistency of the decline in AMI after smoking ban implementation that has been reported by many studies. Statistical methods: • A Poisson model of the monthly time-series adjusted for seasonality was compared to different models with linear and non-linear trends. • The model's goodness of fit was assessed by Pearson test. • RR and CIs were computed for all estimates. Significance criterion < 0.05 was used. • Power analysis was not specifically described.	Italy.	significant effect was found on AMI incidence during the first year after the ban.	13,456 cases of AMI, which is smaller than some of the studies on the same topic the authors are criticizing. • There was no discussion of a formal power analysis to determine the sample size needed for the present study. • The study was not specific to smoke-free policy on medical campuses.
#5 **1st Author, Year:** Johnson, 2012		**Strength/Quality:** II/C	
Design: • Retrospective, before and after ecological, quasi-experimental design. Control: • Community served as its own comparison group. Intervention: • Implementation of a smoke-free ordinance in a community with an existing partial smoking ban. • Electronic medical records of AMI patients admitted 4 months prior to and 4 months following implementation of a comprehensive smoke-free ordinance were compared. Outcome / objective: • Determine whether a relationship exists between implementation of a smoke-free ordinance and community rate of AMI. • AMI rate was calculated by	Sample size: • 55,600, with 35,215 AMI admissions during the study period. Composition: • 92% white, 40.4% male, rural residents. Only patients who made it to the hospital alive were included. Average age 48.3±19.6. Setting: • One rural hospital in Grand Forks, ND.	• AMI rate pre-ban was 0.5% (83/16702). • AMI rate post-ban was 0.3% (63/18513) p=0.023. • AMI rate decreased 30.6%, number of AMIs decreased 24.1% from 83 to 63. • Implementing the comprehensive smoke-free law was associated with a 30.6% decrease in the rate of AMI. • The mortality rate decreased from 2.5% before the ban to 1.8% after (p<0.001).	• Sample was from an individual rural hospital, which may limit external validity. • A partial smoking ban was already in place when the smoke-free ordinance was implemented, which may have minimized the effect of the legislation on rate of AMI. • Only 4 months of follow-up were done, which may not be a long enough duration to assess the health effects of the law. • AMI rate was calculated using total patients admitted to the hospital as the denominator, rather

dividing number of heart attacks by total admissions for the given time period. Statistical methods: • Frequencies and relative percentages were computed for each categorical variable. X^2 tests were performed to determine which categories were significantly different, and *t*-tests were used to compare continuous variables. • Significance criterion < 0.05 and all *p* values were two-sided. No power analysis was described.			than community population as in other studies. • A before and after ecological design was used, so cause and effect cannot be determined, only association. • Study did not measure individual smoking habits or SHS exposure.
#6 1st **Author, Year:** Seo, 2007		**Strength/Quality:** II/B	
Design: • Retrospective quasi-experimental design with a matched control group. Control: Delaware County, Indiana, (without a smoking ban). Intervention: • A chart review at 2 hospitals over a 44 month period to compare AMI rates in the 2 counties. • A degree of blinding was introduced by having hospital employees rather than the researchers access patient charts, to decrease bias in patient selection for inclusion in the data set. Outcome / objective: • To investigate a link between public smoking bans and reduced AMI rate among nonsmoking patients. • Compared number of smoking-patient hospital admissions and non-smoking patient admissions. • Outcome measure was number of nonsmoking AMI	Sample size: • 35,482 admissions for all causes in Monroe county and 41,640 in Delaware County. Composition: •Bloomington Hospital in Monroe County and Ball Memorial Hospital in Delaware County. Setting: • Monroe County, IN (smoking ban), and Delaware County, IN (no ban).	• In Monroe County, there was a significant drop in nonsmoker AMI admissions after the smoking ban (17 to 5 admissions, 95% CI -21.19 to -2.81). • In Delaware County there was a nonsignificant drop (18 admissions to 16, 95% CI -13.43-9.43). • A public smoking ban may decrease AMI rates, and the change likely results primarily from decreased SHS exposure of nonsmokers rather than smokers quitting or reducing their tobacco consumption.	• Delaware County was selected as a control for Monroe county based on variables the researchers deemed important such as size, geographic location, and MI mortality, but there may be other confounders that differ between the 2 populations. • The decreased AMI rate seen in the study may have been underestimated due to a population increase of 0.4% in Monroe County and an increase of 0.8% in Delaware County. • The number of admissions analyzed was small, and the duration of follow-up was limited to 22 months. • Public awareness of

patients admitted with no past cardiac history, no hypertension (HTN), or high cholesterol for the two 22 month periods. Statistical methods: • Poisson regression was used to model a probability distribution for MIs occurring within the 2 time periods. • 95% CIs were calculated on all measures and significance criterion < 0.05 was used. No power analysis was described.			the dangers of ETS exposure in Delaware county was increased during the study due to a local political debate on the topic, which may have biased the results, but this bias would lend strength to the study if it exists.
Asthma			
Study Design	**Sample Size, Composition, & Setting**	**Results / Recommendations**	**Limitations**
#7 **1st Author, Year:** Rayens, 2008		**Strength/Quality:** II/C	
Design: • Retrospective quasi-experimental time series analysis. Control: • There was not a matched control or community without a smoke-free law, although the authors included a control for changes in case frequency over time using rates from U.S. Census data. Intervention: • Asthma-related emergency department (ED) visits were assessed before and after smoke-free legislation implementation. Outcome / objective: • Objective was to evaluate the effects of a smoke-free law on rate of ED admissions for asthma. Statistical methods: • Monthly asthma ED visit rates over the 6-year period were modeled using Poisson regression analysis and a	Sample size: • 14,839 ED visits for asthma (7763 pre-law, 7076 post-law). Composition: • 5 hospitals. Pre-law cohort averaged 29.5 years of age (SD = 21.6) and was 63% female. Post-law cohort averaged 29.7 years of age (SD = 21.3) and was 63% female. Setting: • Lexington-Fayette County, KY.	• The smoke-free law reduced ED visits for asthma by 22% ($p<0.0001$, 95% CI 14%-29%). There was a 24% decline in adult asthma visits ($p<0.0001$) and a 18% decline in pediatric visits ($p=0.01$). • When examining data from 2002-2006 instead of the full 2001-2006 study period, the model for pediatric cases did not have a significant decrease (RR = 0.99, 95% CI 0.85-1.16, $X^2 < 0.1$, $p = 0.9$), but the adult model did (RR = 0.85, 95% CI 0.76-0.95, $X^2 = 8.1$, $p = 0.004$). • Overall, the decline in ED visits was greater for adults than pediatrics. • The smoke-free law was associated with a significant reduction in ED visits for asthma.	• The study design did not allow causation to be established. • A population without a smoke-free law was not monitored as a comparison group. • Asthma incidence may have been affected by the migration of workers in and out of Lexington because there is a large agricultural worker population. • County residents who visited an ED outside of the county were not recorded. • Actual exposure of individuals to SHS was not measured. • Lexington's law did not ban smoking in all places of

time-series analysis was performed using a first-order autoregressive model. • Rates were adjusted for seasonality, secular trends over time, and differences among demographic subgroups. A second prediction curve was generated to show projected rates if the law had not been implemented for comparison. • Significance criterion was < 0.05. Power analysis was not specifically described.			employment, so the reported decline may be an underestimate. • The study was not specific to smoke-free policy on medical campuses.
#8 **1st Author, Year:** Dove, 2011		**Strength/Quality:** III/C	
Design: • Retrospective cross-sectional survey, secondary analysis. Control: • Youth residing in areas classified as not having any smoke-free laws were used as a comparison group. Intervention: • National Health and Nutrition Examination Survey (NHANES) data from 1999-2006 was reviewed. • Asthma was assessed by self-report. • Locations were categorized as having or not having at least 1 smoke-free workplace, restaurant, or bar law at the county or state level that covered the entire population. Outcome / objective: • To examine the association between smoke-free laws and asthma prevalence, symptoms, and severity in nonsmoking youth. Ear infection was assessed as a fourth outcome. Statistical methods: • Examination sample weights	Sample size: • From the NHANES 1999-2006 sample of 50,939 people, this study sampled 8800 youth aged 3-15 with cotinine levels <15.0 ng/mL. Composition: • Nonsmoking 3-15 year olds • NHANES selects participants using a complex, multistage, probability cluster design with oversampling of minorities to improve reliability and precision of estimates for	• 10.0% of youth not living in smoke-free counties reported current asthma vs. 9.7% in smoke-free counties, OR 1.03, 95% CI 0.81-1.30. • Youth in smoke-free counties had 0.66 (95% CI 0.28-1.56) times the odds of having an asthma attack and 0.55 (95% CI 0.27-1.13) times the odds of going to the ED for asthma. • Smoke-free laws were significantly associated with lower odds of asthma symptoms, OR 0.67, 95% CI 0.48 to 0.93. • Smoke-free laws were associated with lower odds of asthma attacks, OR 0.66, 95% CI 0.28-1.56, and ED visits for asthma, OR 0.55, 95% CI 0.27-1.13, although these results were not statistically significant. • Youth in smoke-free	• Locations were categorized as smoke-free if they had at least one workplace, restaurant, or bar law at the county or state level, but this does not meet the standard definition of smoke-free. For example, a county with smoke-free workplaces that still allows smoking in restaurants and bars would have been labeled smoke-free by this method, and such a community would likely still have a high rate of SHS exposure. • County smoke-free laws may not accurately capture individual SHS exposure. • Self-reported asthma presence and symptom data may be unreliable because

were used to account for differential probabilities of selection and for nonresponse. Variance estimates were calculated with Taylor linearization-with-replacement. Differences in proportions were evaluated with a t-test using a significance level of $p<0.05$. • Weighted logistic regression was used to calculate odds ratios (ORs) and 95% CIs for the association between smoke-free laws and prevalent asthma, asthma symptoms, ear infection, and asthma severity. Effect modification by home SHS exposure and age was assessed using an interaction term in the adjusted model. • Power analysis was not specifically described.	low income people, the elderly, Mexican Americans, and African Americans. • NHANES used a household interview and standardized physical exam conducted in a mobile examination center. Setting: • U.S.	counties had fewer asthmatic symptoms (8.4%) compared to (12.1%) without smoke-free laws, OR 0.67, 95% CI 0.48 to 0.93. • No significant association was found between smoke-free laws and current asthma. • The authors concluded that smoke-free laws reduce asthma symptoms including persistent wheeze, chronic night cough, and wheeze-medication use in nonsmoking youth.	asthmatics, especially young children, may not be able to reliably self-assess their symptoms. Data were not validated by clinical evaluation or objective measures. • The study's definition of asthma symptoms as being different from an asthma attack is also questionable because in many cases symptomatic asthma is defined as an asthma attack, thus these categories are not exclusive.
Employee Smoking Cessation and Decreased Secondhand Smoke Exposure			
Study Design	**Sample Size, Composition, & Setting**	**Results / Recommendations**	**Limitations**
#9 **1st Author, Year:** Gadomski, 2010		**Strength/Quality:** II/B	
Design: • Quasi-experimental, prospective time series. Control: • Hospital served as its own comparison group. Intervention: • A smoke-free medical campus policy, staff smoking cessation program, and inpatient smoking cessation service were implemented. • Inpatient volume, percentage of inpatients who smoke, nicotine replacement therapy (NRT) orders from EMRs, and employee tobacco-use rates from annual occupational health	Sample size: • 1 hospital. 489 staff responded in 2005 and 2007. 959-988 patients were admitted to the hospital per month. Composition: • Employees and patients of a 180-bed acute care facility. Setting: • Small town	• 150 staff participated in a smoking cessation program during the year before the ban, which decreased staff self-reported smoking from 14.3% to 9% ($p<0.0002$). • NRT orders tripled after the ban. • There was no increase in patient leaving AMA. Leaving to smoke was cited as the reason by 13.8% of patients leaving AMA 6 months pre-ban and 13.6% of patients 6 months post-ban.	• The study was at one hospital, so results may not be generalizable. • Individual smoke-free plan components were not evaluated because the medical campus smoking ban, inpatient cessation program, and hospital staff education occurred simultaneously. • Self-reported smoking status was used without biochemical validation, so

assessments were compared pre-ban and post-ban. Outcome / objective: • To investigate reasons commonly cited for not implementing a smoke-free medical campus policy, including decrease in patient volume, particularly patients who smoke, and increase in patients leaving against medical advice (AMA). • The study also assessed the impact of starting an inpatient smoking cessation service and the effects of a smoking ban on hospital staff smoking rates beyond one year of policy implementation. • Interventions were guided by the University of Michigan Smoke-Free Hospital Implementation Plan. Statistical methods: • Significance criterion < 0.05 was used. Chow test was used to assess the trend in inpatient NRT orders before and after the ban. No power analysis was described.	in upstate NY.	• Fears of declining inpatient volume after implementation of a 100% smoke-free medical campus policy were unfounded, although the policy did result in a significant decrease in employee smoking rates and increased NRT use by patients. • The authors concluded that prohibiting smoking in outdoor areas near the hospital and providing employees with smoking cassation assistance is an effective policy for decreasing hospital employee tobacco use beyond benefits seen with partial smoking bans.	smoking could have been underreported due to social desirability bias. • Only one part-time staff was employed to visit patients who smoke to provide smoking cessation counseling, and she was not able to visit many patients, so it is possible more patients might have quit smoking if more smoking cessation specialists were on staff.
#10 1st **Author, Year:** Offord, 1992		**Strength/Quality:** II/B	
Design: • Time series, quasi-experimental survey. Control: • Medical center served as its own comparison group. Intervention: • Implementation of a smoke-free medical campus policy. • Staff smoking, use of smoking-cessation services, and opinions of the policy were assessed using an anonymous, self-administered 27 question written survey given to all medical center	Sample size: • Combined bed capacity was ≈1,800, with 286,000 patients during the year of policy implementation, and 15,966 staff. • 10,579 staff questionnaires were returned with usable information.	• The survey response rate was 66.3%, with the lowest response rate (56%) from the hospital staff group, and the highest (77.6%) from the physician group. • Staff smoking prevalence decreased from 16.7% to 13.8% (95% CI 13.1-14.5%, $p<0.001$), with a smoking cessation rate of 22.5% (95% CI 20.4-24.6%) among regular smokers over the 2.5	• Although the surveys were anonymous, self-report of smoking still could have been underreported due to social desirability bias. If smokers thought reporting disapproval of the ban had the potential to reverse the policy, this also could have introduced bias. • The staff survey response rate was

staff. Three time points were assessed: at the time of the policy announcement, at the time of policy implementation, and 6 months post-implementation. • Staff were divided into 3 groups: physicians, scientists, & senior admin (n=990), secretaries, students, lab techs (n=8,698), and nurses & support staff (n=6,278). Outcome / objective: • To assess the effect of smoke-free medical campus policy implementation on hospital staff smoking prevalence, cessation rates, job productivity, and policy approval. Statistical methods: • Confidence intervals and X^2 tests were used to compare proportions, logistic regression analysis modeled and tested associations between categorical outcomes and potential predictor variables. • A two-tail $p \leq 0.05$ was considered a difference not attributable to chance and power was 0.80.	Composition: • Large urban medical center with 37 buildings occupying 13 city blocks. Setting: • The Mayo Medical Center in Rochester, MN.	year period after the policy was announced. • 119 of 352 staff who reported not smoking (33.8% or 7.6% of the total 1,562) reported quitting as a result of the policy. • Gender was the only staff variable significantly related to smoking status, with more females than males smoking ($p<0.001$). • After 2 years, the policy was widely endorsed by staff, although the staff who continued to smoke viewed it less favorably. • Many staff who continued to smoke after policy implementation were in the action stage of cessation (37.1% made a serious quit attempt, 20.7% used NRT, and 13.8% attended a formal cessation program). • No staff reported leaving because of the policy in exit interviews. • The smoke-free medical center policy made a significant contribution to creating a healthful work environment and encouraging nonsmoking behavior.	only 66.3%, and this could have biased the results if smokers were more likely than nonsmokers to fail to return the survey. • External forces related to the trend of decreasing social acceptability of smoking may have influenced the study. Specifically, a state-wide law went into effect following the study that generally prohibited smoking in any area of a hospital, health-care clinic, physician's office, or other health care facility. Laws prohibiting smoking at day care centers and schools also received local media attention around the time of the study. • Data on smoking status from the first time point assessed, at the time of the policy announcement, may have been subject to recall bias because the survey was being filled out after this time.
#11 **1st Author, Year:** Hahn		**Strength/Quality:** III/C	
Design: • Literature review. Control: n/a. Intervention:	Sample size: • A total of 880 local, 35 state, and 44	• There is an abundance of smoke-free policy outcomes research showing health and	• Only one database was searched, and a comprehensive search methodology was not

• MEDLINE was searched from 2000 to 2010 using the terms: smoking, smoking cessation, smoking/legislation, and jurisprudence, smoking cessation/legislation and jurisprudence, and health policy. Outcome / objective: • To review health and economic outcomes research on smoke-free legislation and summarize policy interventions over the last 10 years. Statistical methods: • No quantitative analysis was performed.	national smoke-free policies were found, of which 405 local, 22 state, and 18 national laws cover workplaces, restaurants, and bars, while other regulations were less comprehensive. Sample sizes of the studies were not included. Composition: • Not specified. Setting: • Global.	economic impacts, but observed effects may be more related to implementation effectiveness than adoption. • Disparities in protection from SHS exposure remain in subpopulations and outcomes vary by race, gender, socioeconomic status (SES), and age. • The author concluded that smoke-free legislation is a powerful public health intervention and has the potential to contribute lasting reductions in the health and economic burden from tobacco use.	used, so it is likely that not all literature on the topic was retrieved. • While the search terms used were provided, inclusion and exclusion criteria were not specified, and no further description of the search strategy was included. • A quantitative analysis was not performed, rather data were summarized in narrative form. • The study was not specific to smoke-free policy on medical campuses.
#12 **1st Author, Year:** Stave, 1991		**Strength/Quality:** II/A	
Design: • Randomized cross-sectional survey, quasi-experimental. Control: Duke University, which did not implement a smoke-free policy when the Duke Medical Center campus did. Intervention: • Implementation of a smoke-free medical campus policy. • 3 months after policy implementation, a telephone survey was conducted on 400 staff randomly selected from each campus. Staff were asked about current and previous smoking and their opinion on the smoking ban. • 6 months after the initial survey, a follow-up survey	Sample size: • 800 staff, 400 from each campus. The first survey had a 91.25% response rate and the second had a 97% response rate. Composition: • 1 medical campus and 1 university campus. Baseline smoking prevalence was 23.6% among staff at	• 3 months after the ban, smoking cessation rates were 12.6% at the Medical Center and 6.9% at the University ($p<0.10$). Mean cigarette consumption during the work day declined from 8.1±6.8 (mean ±SD) to 4.3±4.4 at the Medical Center but showed little change at the University Campus (9.3±7.5 vs. 8.7±8.0). • Carbon monoxide validated quit rates were 9.2% at the Medical Center and 1.4% at the University ($p<0.02$; one-sided test). • The follow-up survey	• Using the University Campus as a comparison group for the Medical Campus could have introduced bias. While the distribution of race, age, education level, and marital status were similar between the two groups of staff, the Medical Center staff was 33% male, while the University staff was 49% male. • No single occupation was represented disproportionately in those who quit

was conducted on self-identified smokers or recent ex-smokers from the first survey. • Self-reported smoking cessation was validated with exhaled carbon monoxide measurements. Outcome / objective: • To assess the effects of a smoke-free medical campus policy on staff smoking behavior and attitudes. Statistical methods: • Multiple regression analysis and differences between proportions were examined to compare the two samples. • Fleiss' method was used to determine the sample size needed to detect a 20% difference in quit rates. Smokers were expected to make up at least 20% of the population, so the number of subjects needed per group was 5 times the number of smokers required, so a sample size of 400 /group was used. • Significance criterion was 0.05 and power was 0.80.	the Medical Center, compared to 20.3% at the University. Setting: • Duke University Medical Center in Durham, NC.	on those who identified as smokers revealed a smoking cessation rate of 22.5% in Medical Center staff and 6.9% in University staff in the 15 months since the policy announcement ($p<0.01$). • 32% of smokers at the Medical Center vs. 13% at the University who attempted to quit agreed that the smoke-free policy affected their decision to quit. • On the follow-up survey, 50% of smokers at the Medical Center reported at least one quit attempt in the past 12 months vs. 45.8% on the University Campus. • A smoking ban was favored by the majority of staff and resulted in a decrease in cigarette consumption and increased smoking cessation rates.	smoking, but the study lacked power to evaluate occupation-specific cassation rates.

Table B2

Johns Hopkins Nursing Evidence Based Practice Rating Scheme

Strength of research evidence rating scheme	
Level	Type of evidence
I	Evidence obtained from an experimental study/randomized controlled trial (RCT) or meta-analysis of RCTs
II	Evidence obtained from a quasi-experimental study
III	Evidence obtained from a non-experimental study, qualitative study, or meta-synthesis
Quality rating scheme for research evidence	
Grade	Research evidence
A: High	Consistent results with sufficient sample, adequate control, and definitive conclusions; consistent recommendations based on extensive literature review that includes thoughtful reference to scientific evidence
B: Good	Reasonably consistent results; sufficient sample, some control, with fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive review that includes some reference to scientific evidence
C: Low / Major flaw	Little evidence with inconsistent results; insufficient sample size; conclusions cannot be drawn.

(Newhouse et al., 2007)

References

Americans for Nonsmokers' Rights Foundation. (2008). *Business costs in smoke-filled environments*. Retrieved from www.no-smoke.org

American Nonsmokers' Rights Foundation. (2013, April 5). *100% Smokefree U.S. hospitals and psychiatric facilities*. Retrieved from http://www.no-smoke.org/goingsmokefree.php?id=519

Centers for Disease Control and Prevention. (2008). Annual smoking-attributable mortality, years of potential life lost, and productivity losses: United States, 2000-2004. *Morbidity and Mortality Weekly Report, 57*(45), 1226-1228. Retrieved from http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5745a3.htm

Dove, M. S., Douglas, W. D., & Connolly, G. N. (2011). Smoke-free air laws and asthma prevalence, symptoms, and severity among nonsmoking youth. *Pediatrics, 127*(1), 102-110. doi:10.1542/peds.2010-1532

Ferrante, D., Linetzky, B., Virolini, M., Schoj, V., & Apelberg, B. (2012). 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. *Tobacco Control, 21*(4), 402-406. doi:10.1136/tc.2010.042325

Gadomski, A. M., Stayton, M., Krupa, N., & Jenkins, P. (2010). Implementing a smoke-free medical campus: Impact on inpatient and employee outcomes. *Journal of Hospital Medicine, 5*(1), 51-54. doi:10.1002/jhm.473

Gasparrini, A., Gorini, G., & Barchielli, A. (2009). On the relationship between smoking bans and incidence of acute myocardial infarction. *European Journal of Epidemiology, 24*(10), 597-602. doi:10.1007/s 10654-009-9377-0

Global Smokefree Partnership. (2009). *The trend toward smokefree outdoor areas*. Retrieved from www.globalsmokefreepartnership.org/resources/.../SF_Outdoors.pdf

Grove, S. K., Burns, N., & Gray, J. R. (2013). *The practice of nursing research: Appraisal, synthesis, and generation of evidence* (7th ed.). St. Louis, MO: Elsevier.

Hahn, E. J. (2010). Smokefree legislation: A review of health and economic outcomes research. *American Journal of Preventive Medicine, 39*(6S1), 66-76. doi:10.1016/j.amepre.2010.08.013

Johnson, E. L. & Beal, J. R. (2012). Impact of a comprehensive smoke-free law following a partial smoke-free law on incidence of heart attacks at a rural community hospital. *Nicotine & Tobacco Research, 15*(3), 745-747. doi:10.1093/ntr/nts216

Meyers, D. G., Neuberger, J. S., & He, J. (2009). Cardiovascular effect of bans on smoking in public places: A systemic review and meta-analysis. *Journal of the American College of Cardiology, 54*(14), 1249-1255. doi:10.1016/j.jacc.2009.07.022

Nagle, A. L., Schofield, M. J., & Redman, S. (1996). Smoking on hospital grounds and the impact of outdoor smoke-free zones. *Tobacco Control, 5*(3), 199-204. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9035354

Newhouse, R, Dearholt, S., Poe, S., Pugh, L., & White, K. (2007). *Johns Hopkins Nursing Evidence-Based Practice Model and Guidelines*. Sigma Theta Tau International. Retrieved from http://www.nursingsociety.org/Media/Pages/JohnsHopkins2nd.aspx

Northeastern Vermont Regional Hospital. (2008). *Tobacco-free environment resource guide*. Retrieved from www.nvrh.org/uploads/1235745955.pdf

Offord, K. P., Hurt, R. D., Berge, K. G., Frusti, D. K., & Schmidt, L. (1992). Effects of the implementation of a smoke-free policy in a medical center. *CHEST Journal, 102*(5), 1531-1536. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/1424878

Ponkshe, P. (2009, August 20). *Majority of US hospitals will have smoke-free campuses by end of year*. Retrieved from http://www.eurekalert.org/pub_releases/2009-08/bc-mou081709.php

Rayens, M. K., Burkhart, P. V., Zhang, M., Lee, S., Moser, D. K., Mannino, D., & Hahn, E. J. (2008). Reduction in asthma-related emergency department visits after implementation of a smoke-free law. *Journal of Clinical Immunology, 122*(3), 537-541. doi:10.1016/j.jaci.2008.06.029

Repace, J. L. (2008). Benefits of smoke-free regulation in outdoor settings: beaches, golf courses, parks, patios, and in motor vehicles. *William Mitchell Law Review, 34*(4), 1621-1638. Retrieved from tclconline.org/documents/wmcl-law-review-symposium.pdf

Seo, D. C. & Torabi, M. R. (2007). Reduced admission for acute myocardial infarction associated with a public smoking ban: Matched controlled study. *Journal of Drug Education, 37*(3), 217-226. doi:10.2190/DE.37.3.a

Stave, G. M. & Jackson, G. W. (1991). Effect of a total work-site smoking ban on employee smoking and attitudes. *Journal of Occupational Medicine, 33*(8), 884-890. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1508862/

U.S. Department of Health and Human Services. (2010). *How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General.* Atlanta, GA: U.S. 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.

U.S. News & World Report. (2014). *U.S. news best hospitals 2013-14*. Retrieved from http://health.usnews.com/best-hospitals/rankings

Wheeler, J. G., Pulley, L., Felix, H. C., Bursac, Z., Siddiqui, N. J., Stewart, M. K., … Gauss, C.

H. (2007). Impact of a smoke-free hospital campus policy on employee and consumer behavior. *Public Health Reports,122*(6), 744-752. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/18051667