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A Rural Tobacco Smoke Pollution Study

Kelly Buettner-Schmidt

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A RURAL TOBACCO SMOKE POLLUTION STUDY

by

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B.S.N., Nursing, University of North Dakota, 1983

M.S., Nursing, University of North Dakota, 1996

DISSERTATION

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Doctor of Philosophy

Nursing

The University of New Mexico
Albuquerque, New Mexico

May, 2013

DEDICATION

This dissertation is dedicated to those most influential in my life: my family, my nursing colleagues, and my tobacco control advocate colleagues. Family is always first, and so...

My deepest thanks go to my family. Thanks to my husband, Joe, who likely felt I was married to my computers at times, and who is the love of my life and ever supportive. Thank you for being a confident person and a great guy; you are my rock. Thanks to each of my three beautiful daughters, Megan Catherine, Marlee Jo, and Josie Anne. Over the past years of my journey to a Ph.D., you each have literally grown into adulthood and I am proud of and love each of you. My hope is that by observing this process, you not only gained an understanding of the importance of education and the dedication it takes to succeed, but also that you also understand that each of you and the family is my top priority - *always*.

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ABSTRACT

The purpose of this study was to determine whether the location of hospitality venues considering; rurality, presence of local ordinances, and socioeconomic status, influenced the quantity of tobacco smoke pollution in a predominantly rural state. The study built on current scientific literature in four aspects. First, it was the first U.S. statewide study on tobacco smoke pollution levels in hospitality venues. Second, it quantified indoor tobacco smoke pollution specifically in rural areas. Third, it used random sampling, a method rarely used in studying indoor tobacco smoke pollution. Fourth, it analyzed tobacco smoke exposure as a function of socioeconomic status.

A stratified random sample of 136 restaurant and bars were assessed, using a modification Roswell Cancer Park Institute's method, for the indoor air quality indicator of particulate matter that was 2.5 μm aerodynamic diameter or smaller ($\text{PM}_{2.5}$). A unique partial mediation model found 69.1% of smoke-free policy's impact on tobacco smoke pollution was mediated by observed smoking and 30.9% was the direct impact of policy on tobacco smoke pollution levels. A significant association (Welch's $F(2, 43.63) = 9.55$, $p < .001$) between rurality and tobacco smoke pollution in bars was also observed. A significant association ($R^2=0.51$, $F(3,131)=70.47$, $p < .001$) between local smoke-free laws and tobacco smoke pollution depended upon the venue type. Compliance was

significantly lower in venues in communities without local ordinances (Fisher's Exact Test, $p < .01$, 2-tailed) and in co-located venues (Fisher's Exact Test, $p < .01$, 2-tailed).

In conclusion, smoke-free laws had an indirect and direct impact on tobacco smoke pollution. As rurality increased tobacco smoke pollution in bars significantly increased. The impact of local ordinances on tobacco smoke pollution levels depended on the venue type. Compliance with laws increased significantly in communities with a local ordinance and decreased significantly in co-located venues. Continued recognition of the disparities in exposure to tobacco smoke pollution in rural areas is needed. Future studies should determine if the mediation model can be replicated. Additional studies of tobacco smoke exposure and policy impact in rural areas are needed. Further research of poverty influences on tobacco smoke pollution levels in hospitality venues is recommended.

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CHAPTER 1

Significance of Study

Regulation of tobacco use in public places and workplaces is growing globally. Several countries (World Health Organization [WHO], 2011a), along with 39 states and more than 3,000 communities within the United States, have smoke-free regulations (Americans for Nonsmokers' Rights [ANR], 2011). Twenty-six states have comprehensive statewide laws that prohibit smoking in three venues: indoor areas of worksites, restaurants, and bars (Centers for Disease Control and Prevention [CDC], 2011). Other states have enacted weaker laws, including exemptions, such as smoking in designated areas or rooms. These weaker laws and exemptions are ineffective in protecting people from secondhand smoke (SHS; CDC, 2011). The primary impetus for this increase in smoke-free regulation was the scientific evidence of the immediate and long-term health effects caused by SHS, including cancer, cardiovascular disease, and respiratory disease (Institute of Medicine, 2010; U.S. Department of Health and Human Services [USDHHS], 2006, 2011a; WHO, 2011a).

Particulate matter (PM) is composed of the solid particles or liquid droplets that are suspended in the atmosphere and is one valid atmospheric marker used to measure SHS levels (IARC, 2009). Most PM in SHS is less than 2.5 μm in diameter (Klepeis, Apte, Gundel, Sextro, & Nazaroff, 2003) and is released in large quantities from burning cigarettes (Travers, 2010); therefore, $\text{PM}_{2.5}$ is the standard size measured for SHS (IARC, 2009; Lee et al., 2011). Negative health outcomes occur when "fine particles" such as $\text{PM}_{2.5}$ are inhaled and are able to move deeply into the lungs due to their small size (Pope & Dockery, 2006; Travers, 2010). Pope and Dockery (2006) reviewed six lines of

research conducted since 1997 on the health effects of fine-particle air pollution, concluding that the effects of PM on health are dependent on the length and concentrations of exposure and include cardiovascular mortality, lung injury, atherosclerosis, and stroke mortality. In a comparison between PM_{2.5} and nicotine as measures of SHS, PM_{2.5} was shown to be highly sensitive to tobacco smoke and to have a high correlation with nicotine measurements, with training protocols readily available (Avila-Tang et al., 2010)

The U.S. Environmental Protection Agency (EPA, 2012b) sets the PM_{2.5} 24-hour and annual standards. The current EPA's National Ambient Air Quality Standards for PM_{2.5} are under review, with a decision on new proposed limits expected December 14, 2012 (Esworthy, 2012). Table 1 shows the current and proposed Air Quality Index (AQI) PM_{2.5} µg/m³ breakpoints (EPA, 2012a). The proposed revision's upper limit is 500 µg/m³, a significant harm level for PM_{2.5} above 500 µg/m³ has been discussed (EPA, 2009), and although not included in the 2012 revisions, it may have implications for this study. Table 2 shows a modified proposed AQI with the related health advisory.

Protecting people from SHS and banning smoking in public places are considered two of the "best buys" in reducing deaths, disease, and costs associated with noncommunicable diseases. Noncommunicable diseases account for 63% of total global deaths (WHO, 2010, p. 4). Because there is no safe level of exposure to SHS (USDHHS, 2006), numerous organizations, such as the WHO (2007), the CDC (USDHHS, 2010b), and Healthy People 2020 (USDHHS, 2010a), recommend passage of laws protecting people against SHS exposure. The only method that fully protects people from SHS is the prohibition of smoking in all indoor areas without exemptions (USDHHS, 2006).

Travers et al. (2004) reported an average 90% reduction ($412 \mu\text{g}/\text{m}^3$ to $27 \mu\text{g}/\text{m}^3$; $p < .001$) in $\text{PM}_{2.5}$ levels in 14 restaurants and bars after passage of New York's smoke-free air law.

Table 1. *EPA Current and Proposed $\text{PM}_{2.5}$ Air Quality Index*

AQI Category	Index Values	Existing Breakpoints (1999 AQI) ($\mu\text{g}/\text{m}^3$, 24-hour average)	Proposed Breakpoints (2012) ($\mu\text{g}/\text{m}^3$, 24-hour average)
Good	0-50	0.0 - 15.0	0.0 - (12.0 - 13.0)
Moderate	51 - 100	>15.0 - 40	(12.1 - 13.1) - 35.4
Unhealthy for Sensitive Groups	101 - 150	>40 - 65	35.4 - 55.4
Unhealthy	151 - 200	>65 - 150	55.5 - 150.4
Very Unhealthy	201 - 300	>150 - 250	150.5 - 250.4
Hazardous	301 - 400	>250 - 350	250.5 - 350.4
	401 - 500	>350 - 500	350.5 - 500

Note. AQI = U.S. Environmental Protection Agency's Air Quality Index; parentheses indicates a range. Adapted from "The national ambient air quality standards for particulate pollution. Summary of proposed improvements to the air quality standards for particle pollution and updates to the air quality index (AQI)." U.S. Environmental Protection Agency. (2012a).

Table 2. *Modified EPA PM_{2.5} Air Quality Index With Health Advisory*

AQI Category	Index Values	Proposed Breakpoints ($\mu\text{g}/\text{m}^3$, 24-hour average)	Health Advisory
Good	0-50	0 to (12.0-13.0)	None.
Moderate	51-100	(12.1-13.1) to 35.4	Unusually sensitive people should consider reducing prolonged or heavy exertion.
Unhealthy for Sensitive Groups	101-150	35.4-55.4	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.
Unhealthy	151-200	55.5-150.4	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
Very Unhealthy	201-300	150.5-250.4	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.
Hazardous	301-400	250.5-350.4	People with heart or lung disease, older adults, and children should remain indoors and keep activity levels low. Everyone else should avoid all physical activity outdoors.
Very Hazardous	401-500	350.5-500	People with heart or lung disease, older adults, and children should remain indoors and keep activity levels low. Everyone else should avoid all physical activity outdoors.
Significant Harm Level	>500	>500	Imminent and substantial endangerment to public health

Note. AQI = U.S. Environmental Protection Agency's Air Quality Index. Parentheses indicate a range. Good through Very Hazardous categories are the proposed AQI PM_{2.5} $\mu\text{g}/\text{m}^3$ breakpoints (EPA, 2012a), with the term "Very Hazardous" added by this author to differentiate between the two levels of Hazardous. The Significant Harm Level (EPA, 2009) is not included in the 2012 proposed revisions but has implications for this study. Adapted from "The national ambient air quality standards for particulate pollution. Summary of proposed improvements to the air quality standards for particle pollution and updates to the air quality index (AQI)." U.S. Environmental Protection Agency. (2012a) and "Fact sheet. Proposed revisions to air quality index reporting and significant harm level for fine particulate matter." U.S. Environmental Protection Agency. (2009).

High-risk populations that are impacted disproportionately by tobacco use include people living in rural communities. Smoking prevalence is higher outside of metropolitan statistical areas (USDHHS, 2010c). Interestingly, with more than 80% of both rural (80.9%) and urban (82.0%) residents agreeing that there is no safe level of SHS, significantly more rural homes allow smoking than do urban homes; public support for smoke-free work policies in rural areas is significantly less than in urban areas, and rural areas have fewer workplace policies against smoking (American Academy of Pediatrics Julius B. Richmond Center of Excellence [AAP], 2008). Although once a workplace smoke-free policy is in place, there is no significant difference in compliance between rural and urban areas (AAP, 2008). Also, rural children's exposure to SHS is higher due to the higher smoking rates (USDHHS, 2011b).

People with lower socioeconomic status constitute a second high-risk population, with 28.9% of those below poverty level being current smokers compared with 18.3% of people at or above poverty level (USDHHS, 2011c); this results in increased negative health and economic effects of tobacco use. Additionally, the socioeconomic environment increases the negative effects of tobacco use (American Legacy Foundation, 2010).

Purpose of the Study

The purpose of this study was to determine whether the location of hospitality venues, in terms of rurality, presence of local ordinances, and socioeconomic status, influences the quantity of tobacco smoke pollution in North Dakota. The study built on the current scientific literature in four aspects. First, it was the first U.S. statewide study on tobacco smoke pollution levels in hospitality venues. Second, it addressed a gap in

the global literature of quantifying indoor tobacco smoke pollution in rural areas (see Appendix A for the 2010 Census Profile for North Dakota). Third, this study used random selection, a sampling method infrequently used in the United States and globally in studying indoor tobacco use. Fourth, the study analyzed tobacco smoke exposure as a function of socioeconomic status.

Examination of the Literature

An examination of the literature focused on studies measuring indoor tobacco smoke pollution (also known as indoor air quality studies), studies conducted in rural areas, and studies using random selection sampling methods. This section discusses two recent comprehensive literature reviews on smoke-free policies: a Cochran Review (Callinan, Doherty, & Kelleher, 2010) and a review by the WHO (International Agency for Research on Cancer [IARC], 2009). This section also discusses the results of a literature search of PubMed and the CDC's Smoking and Health Resource Library. Appendix B contains an examination of the literature table.

Cochrane Review

The Cochrane Review article (Callinan et al., 2010) examined the literature published through July 1, 2009, and identified eight studies that met the review's inclusion criteria of reported legislative smoking bans and restrictions for populations with the ban explicitly in the study and with six months minimum follow up for measures of smoking behavior measures; and included atmospheric measures of air quality associated with legislative smoking bans or restrictions. This author reviewed each study for rural analyses or random selection sampling methods.

According to Callinan et al.'s (2010) analysis of the study designs, one study (Mulcahy, Evans, Hammond, Repace, & Byrne, 2005) used random sampling. A second study (Semple, Maccalman, et al., 2007) used mixed sampling methods, including random sampling; however, convenience sampling was used for the atmospheric measurements. Six studies used convenience sampling: one study each in Norway (Ellingsen et al., 2006), Finland (Heloma & Jaakkola, 2003), Ireland (Goodman, Agnew, McCaffrey, Paul, & Clancy, 2007), Sweden (Larsson, Boethius, Axelsson, Montgomery, 2008), England (Gotz et al., 2008), and Italy (Cesaroni et al., 2008).

Of the eight studies, two (Gotz et al., 2008; Semple, Maccalman, et al., 2007) included a limited number of rural sampling. Gotz et al.'s (2008) nationwide study in England included measurements from one rural venue at baseline and two rural venues at follow-up, representing 2% and 5%, respectively, of the total samples ($n = 41$ at baseline; $n = 43$ at follow-up); the results did not include analysis by rural location. Semple, Maccalman et al. (2007) used a random selection sample of bars to recruit bar employees ($n = 371$) to measure SHS exposure; although it included a subsample of rural bar employees ($n = 6$, 1.6%), the number of venues for these bar employees was not identified, and the results were not analyzed by rurality. Thus, of the eight studies included in the Cochrane Review (Callinan et al., 2010), one study used random selection for atmospheric measurements (Mulcahy et al., 2005) and two studies included a limited number of rural venues (Gotz et al, 2008; Semple, Maccalman, et al., 2007), although neither conducted an analysis by rurality.

Four studies that did not meet inclusion criteria for the Cochrane Review (Callinan et al., 2010) conducted atmospheric measures of air quality: one study each in

the United States, Italy and Australia, Spain, and Scotland (Akbar-Khanzadeh, Milz, Ames, Spino, & Tex, 2004; Gorini et al., 2008; Nebot et al., 2009; Semple, Creely, Naji, Miller, & Ayres, 2007). None of the studies included a rural analysis. Two studies used random selection methods: Semple, Creely et al. (2007) and Akbar-Khanzadeh et al. (2004). In Akbar-Khanzadeh et al.'s study, only two venues, one that was smoke-free and one that allowed smoking, in each of two communities were studied ($n = 4$); along with a control of a smoke-free office building.

World Health Organization

The WHO (IARC, 2009) literature review also examined SHS exposure reduction due to legislative smoke-free policies from 1990 to 2007. Six studies (Alpert, Carpenter, Travers, & Connolly, 2007; Heloma, Jaakkola, Kahkonen, & Reijula, 2001; Johnsson et al., 2006; Lee, Hahn, Riker, Head, & Seithers, 2007; Repace, 2004; Valente et al., 2007) included atmospheric measures conducted in hospitality venues that were not included in the Cochrane Review (Callinan et al., 2010). Random selection method was only used in one study (Valente et al., 2007). Although rural analysis was not the focus of the study, Lee et al.'s (2007) study was conducted in a rural town with a population of 22,071 in 2009 (US Census Bureau [USCB], n.d.).

Other Literature Sources

A broad literature search of PubMed and CDC's Smoking and Health Resource Library (CDC, n.d.) resulted in 245 articles. In addition to the WHO (IARC, 2009) review and the Cochrane Review (Callinan et al., 2010), which included studies through 2007 and July 1, 2009, respectively, this search included articles from PubMed from August 2008 through August 2011 and from CDC's Smoking and Health Resource

Library (CDC, n.d.) from January 2008 through July 31, 2011. A review of the titles showed that 115 articles potentially included air quality studies that contained atmospheric measures in public places and workplaces; 113 abstracts or full articles were obtained. Forty-six articles included atmospheric measures of air quality in a variety of workplaces and public places. Additional studies were identified by review of selected studies' reference lists. This author reviewed each study for rural analyses or random selection sampling methods.

None of the studies included a rural analysis; some studies discussed rurality in the sampling frames, such as Semple et al. (2010); however, analysis was not based on rural versus urban location. Six studies have been conducted in rural areas in the United States; however, assessing air quality in rural areas was not stated as the purpose of the studies nor was the sample frame discussed in terms of rurality, and all the studies involved convenience samples. Travers led one rural study in North Dakota (Travers & Vogl, 2010) and three in ND metropolitan areas (Travers, 2010a; Travers & Dobson, 2008; Travers & Vogl, 2011). Four studies led by Hahn (Hahn, Lee, Robertson, Cole, & Whitten, 2009; Hahn, Lee, Vogel, & Whitten, 2008; Hahn, Lee, Vogel, Whitten, & Robertson, 2009; Hahn, Lee, Whitten, & Robertson, 2009) and one study by Jones et al. (2006) were conducted in rural Kentucky.

Only one study within the United States (Bohac et al., 2010) used random selection. Seven studies outside the United States used random selection methods (Daly, Schmid, & Riediker, 2010; Goniewicz, et al., 2009; Halios et al., 2009; Lai, et al., 2011; Marin & Diaz-Toro, 2010; Rosen, Zucker, Rosen, & Connolly, 2011; Semple et al.,

2010). Thus, none of the studies found in the examination of the literature included both random sampling and rural analysis.

North Dakota

Five tobacco smoke pollution studies have been conducted in North Dakota, one in the rural city of Minot (Travers & Vogl, 2010) and four in the non-rural cities of Fargo (Travers & Dobson, 2008), Grand Forks (Travers & Vogl, 2011), and Bismarck (Repace, Hughes, Benowitz, 2006; Travers, 2010a). The Minot (Travers & Vogl, 2010; $n = 5$) and Bismarck (Travers, 2010a; $n = 11$) PM_{2.5} studies were baseline convenience studies. All of Minot's venues allowed smoking, and the mean PM_{2.5} level was 495 $\mu\text{g}/\text{m}^3$. The mean PM_{2.5} level in Bismarck's two smoke-free bars was 8 $\mu\text{g}/\text{m}^3$, compared with a mean of 345 $\mu\text{g}/\text{m}^3$ for the five bars that allowed smoking, a significant difference ($p < 0.01$). A Bismarck urine cotinine study (Repace, Hughes, & Benowitz, 2006) of eight patrons in three bars showed increased mean cotinine levels that corresponded to SHS respirable particle (RSP) levels of 246 $\mu\text{g}/\text{m}^3$, 396 $\mu\text{g}/\text{m}^3$, and 549 $\mu\text{g}/\text{m}^3$, respectively, all considered unhealthy levels.

The Fargo random sample bar surveys included the same 10 venues pre- and post-law and were also compared with six smoke-free venues across a river in Moorhead, MN. Both comparisons were statistically significant. The Fargo venues' mean PM_{2.5} level was 272 $\mu\text{g}/\text{m}^3$ pre-law, compared with 5 $\mu\text{g}/\text{m}^3$ post-law ($t(9)=13.1$, $p < 0.001$) and compared with 6 $\mu\text{g}/\text{m}^3$ in Moorhead ($t(14)=9.02$, $p < 0.001$, $r = 0.92$). In Grand Forks, although the pre-law venues ($n = 8$) and the post-law venues ($n = 8$) compared only five of the same venues, a 92% reduction of PM_{2.5} levels occurred with a pre-law PM_{2.5} mean of 85 $\mu\text{g}/\text{m}^3$ and post-law mean of 7 $\mu\text{g}/\text{m}^3$ for a statistical difference ($U = 0.00$, $p = 0.00$,

$r = .847$). Therefore, the two pre- and post-law studies in North Dakota showed significant improvements in $PM_{2.5}$ levels.

Examination of the Literature Summary

This examination of the literature included two previous reviews (Callinan et al., 2010; IARC, 2009). It also included a search of PubMed and the CDC's Smoking and Health Resource Library. Lastly, a review of studies conducted in North Dakota was discussed. Appendix B contains details of each study, including author, year of publication, rurality, random sampling, venues, sample size, exposure measurement substance, pre- and post-legislation SHS exposure levels, results, policy implications, and notes.

The most common substance measured was $PM_{2.5}$, and the second most common was nicotine. Significant reductions of exposure to $PM_{2.5}$, along with the other harmful substances from SHS exposure, were found in studies of pre- and post-legislation of enforced comprehensive laws. Pre-legislation levels of $PM_{2.5}$ reached as high as $436 \mu\text{g}/\text{m}^3$ in Israeli bars (Rosen et al., 2010), with some levels decreasing post-implementation to below $3.5 \mu\text{g}/\text{m}^3$ (Bohac et al., 2010; Marin & Díaz-Toro, 2010) in hospitality venues, including drinking places, restaurants, and discos. The studies reported $PM_{2.5}$ decreases of up to 98.6% in drinking places (Bohac et al., 2010). However, laws with only partial bans or laws lacking enforcement did not experience these levels of reductions (Akba-Khanzadeh, et al., 2004; Johnsson et al, 2006; Nebot et al., 2009; Rosen, et al., 2011). With Repace (2004) reporting that SHS was responsible for 90% to 95% of RSP air particles, these results were not surprising.

The strengths of the studies that include PM and nicotine measures was that these measures were highly correlated with SHS exposure (Avila-Tang, Travers, & Navas-Acien, 2010) and that the majority of studies were conducted discreetly so as not to alter the behaviors of the venue's patrons. Limitations include limited generalizability due the difficulty of randomization of the samples, the lack of multiple measures at different times in the same venue to assure accurate average exposure levels (Bohac et al., 2010), and, for some studies, the lack of pre- and post-legislation sampling.

For this study, the examined literature revealed nine studies conducted in rural communities. However, the assessment of air quality in rural areas was not stated as the purpose of the studies, nor was the sample frame discussed in terms of rurality, and all were convenience sample. Additionally, only 12 studies globally have used random selection, with only the Bohac et al. (2010) study taking place within the United States. Finally, there have not been any statewide random selection studies within the United States.

Background

In 2005, the North Dakota Century Code (NDCC), *Chapter 23-12: Public Health, Miscellaneous Provisions*, was amended to include NDCC §23-12-09 - §23-12-11, *Smoking in Public Places and Places of Employment*, requiring workplaces and public places to be smoke free, with certain exemptions (Appendix C). The primary exemptions include bars and separately enclosed bar areas within hotels, bowling centers, and restaurants. Other indoor public places and workplace exemptions include: (a) separately enclosed areas in truckstops, which were accessible only to adults; (b) retail tobacco stores, provided that smoke from these places does not infiltrate into areas where

smoking was prohibited under this section; (c) hotel and motel rooms and other places of lodging that were rented to guests and were designated as smoking rooms; (d) any area that was not commonly accessible to the public and which was part of an owner-operated business having no employee other than the owner-operator; and (e) any place of public access rented or leased for private functions from which the general public and children are excluded and arrangements for the function were under the control of the function sponsor.

Since 2005, seven ND communities enacted local ordinances strengthening the statewide smoke-free law by decreasing the number of exemptions. These communities and their enactment dates were Fargo (July 1, 2008), West Fargo (July 1, 2008), Grand Forks (April 2010), Napoleon (August 8, 2010), Pembina (February 1, 2011), Bismarck (April 2011), and Devils Lake (July 1, 2011). Four convenience-sample air-quality studies have been conducted in ND hospitality establishments, three in metropolitan areas (Travers, 2010a; Travers & Dobson, 2008; Travers & Vogl, 2011) and one in a rural community (Travers & Vogl, 2010).

Research Question

The research question for this study was: Did location of hospitality venues, in terms of rurality, presence of local ordinances, and socioeconomic status, influence the quantity of tobacco smoke pollution in North Dakota?

Specific Aims and Hypotheses

The specific aims of the study were as follows:

Aim 1: To describe a baseline of the quantity of tobacco smoke pollution and the impact of specific factors on tobacco smoke pollution in hospitality venues statewide in

North Dakota. These factors include: presence of a law (local or state) to be smoke-free, venue type, venue size, occupant density, smoke density, and observed smoking.

Hypothesis 1: The quantity of tobacco smoke pollution in hospitality venues will alter depending upon specific factors.

Aim 2: To compare the quantity of tobacco smoke pollution in hospitality venues in completely rural, semi-rural/urban, and non-rural locations statewide in North Dakota.

Hypothesis 2: In hospitality venues, the quantity of tobacco smoke pollution will increase as the county population decreases.

Aim 3: To compare the quantity of tobacco smoke pollution in hospitality venues located within and outside of communities with a local ordinance statewide in North Dakota.

Hypothesis 3a: The quantity of tobacco smoke pollution will be lower in hospitality venues located *within* communities with an ordinance more stringent than state law than in those located *outside* of communities with an ordinance more stringent than state law.

Hypothesis 3b: Compliance with smoke-free laws will be higher in hospitality venues located *within* communities with an ordinance more stringent than state law than in those located *outside* of communities with an ordinance more stringent than state law.

Aim 4: To determine the influence of socioeconomic status of the venue location on the quantity of tobacco smoke pollution and how it moderates the impact of the presence of an ordinance and venue type on the quantity of tobacco smoke pollution in hospitality venues statewide in North Dakota.

Eliminating Nonsmokers' Exposure to Secondhand Smoke

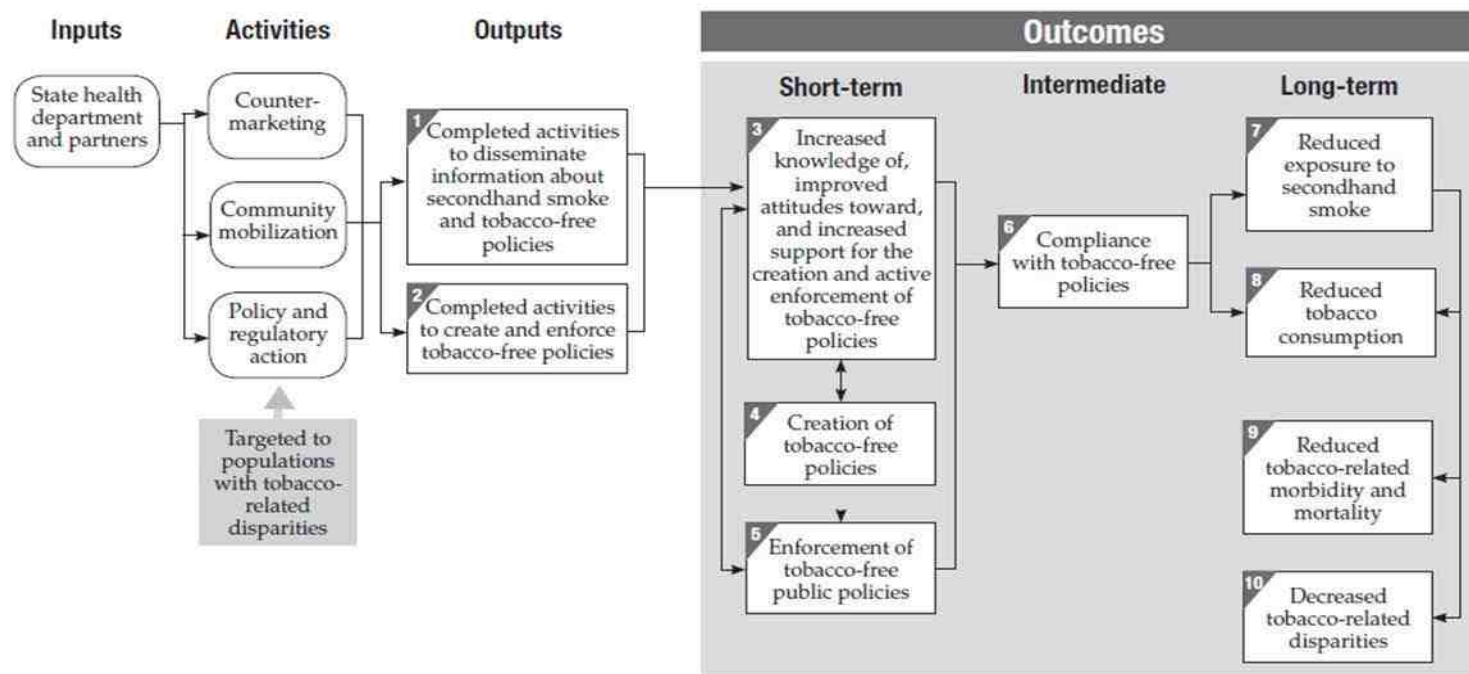


Figure 1. A logic model for Eliminating Nonsmokers' Exposure to Secondhand Smoke by G. Starr, T. Rogers, M. Schooley, S. Porter, E. Wiesen, and N. Jamison, 2005, *Key outcome indicators for evaluating comprehensive tobacco control programs*, p. 123. Atlanta, GA: Centers for Disease Control and Prevention. Reprinted.

Hypothesis 4: The quantity of tobacco smoke pollution will increase as the socioeconomic status of the venue locations decreases in hospitality venues in North Dakota.

Theoretical Framework

Tobacco control programs were encouraged to use the CDC's logic models, shown in *Key Outcome Indicators for Evaluating Comprehensive Tobacco Control Programs* (Starr et al., 2005). This study was focused on: Eliminating nonsmokers' exposure to SHS and will be guided by the corresponding logic model (see Figure 1). The study will measure two outcomes: (1) the intermediate outcome of compliance with tobacco-free policies and (2) the long-term outcomes, specifically, reduced exposure to SHS.

Assumptions

This research was based on the following assumptions:

1. Tobacco smoke pollution occurs in hospitality venues regardless of laws.
2. Tobacco smoke pollution was accurately measured by the instruments used in this study.
3. Rurality in North Dakota has similarities to other rural areas.

Definitions of Terms

Active smoke density. *Active smoke density* (ASD) was the average number of burning cigarettes per 100 m³; operationally, ASD was the average number of burning cigarettes in the hospitality venue being sampled per 100 m³.

Compliance. Conceptually, the *Oxford English Dictionary* defines *compliance* as “in harmony, agreement, or accordance with; in submission or active obedience to”

(“Compliance,” 2012). Operationally, compliance will be defined as following NDCC § 23-12-10, *Smoking restrictions - Exceptions - Retaliation - Application*. Specifically, NDCC § 23-12-10 prohibits smoking in all enclosed areas of public places and places of employment with certain exceptions. This study addresses the exception of bars, including those located within a hotel, bowling center, or restaurant, that were not licensed primarily or exclusively to sell alcoholic beverages if the bars were in a separately enclosed area (NDCC § 23-12-09.1; NDCC § 23-12-10.2.f). A full definition of *bars* was included in the definition of hospitality venues below. *Enclosed area* was defined as “all space between a floor and ceiling that was enclosed on all sides by solid walls or windows, exclusive of doorways, which extend from the floor to the ceiling (NDCC § 23-12-09.5).

Compliance was measured by observational assessment of hospitality venues’ indoor areas. Indicators of compliance were:

1. Burning cigarettes (Yes = noncompliant, No = compliant).
2. Presence of ashtrays, cigarette butts, or odor (Yes = noncompliant, No = compliant).
3. Enclosed area completely enclosed (Yes = compliant, No = noncompliant).
4. Enclosed area door shut unless a person was moving through the door (Yes = compliant, No = noncompliant).

The indicators were collapsed into a dichotomous variable of compliant and noncompliant. Noncompliance on any one indicator resulted in the venue being considered noncompliant.

Community. Conceptually, *community* was an “aspect of collective and individual identity,” such as family, friends, geographic areas, and ethnic groups (Israel, Schulz, Parker, & Becker, 1998, p. 178). Operationally, community will be defined in geographic borders, including towns, cities, counties, census tracts, and metropolitan statistical areas.

Hospitality venues. *Hospitality venues* may be defined conceptually as venues that “prepare meals, snacks, and beverages to customer order for immediate on-premises and off-premises consumption” and include “full-service restaurants; limited-service eating places; special food services, such as food service contractors, caterers, and mobile food services; and drinking places” (U.S. Census Bureau, 2011, para. 1). The NDCC provides a definition of some hospitality venues.

NDCC § Chapter 23-09, *Lodging Establishments and Assisted Living Facilities*, defines food establishment, restaurant, and limited restaurant. A *food establishment* was “any fixed restaurant, limited restaurant, coffee shop, cafeteria, short-order cafe, luncheonette, grill, tearoom, sandwich shop, soda fountain, tavern, bar, catering kitchen, delicatessen, bakery, grocery store, meat market, food processing plant, school, child care, or similar place in which food or drink is prepared for sale or service to the public on the premises or elsewhere with or without charge” (NDCC § 23-09-01.5). A *restaurant* was defined as “every building or other structure, or any part thereof, and all buildings in connection therewith, that are permanently kept, used, maintained, advertised, or held out to the public as a place where meals or lunches are served, but where sleeping accommodations are not furnished. The term includes a limited restaurant restricted to a specified menu” (NDCC§ 23-09-01.12). A *limited restaurant* was defined

as “a food service establishment that is restricted to a specific menu as determined by the department or an establishment serving only prepackaged foods, such as frozen pizza and sandwiches, which receive no more than heat treatment and are served directly in the package or on single-serve articles” (NDCC § 23-09-01.7).

The NDCC § 23-12-09, *Smoking in Public Places and Place of Employment*, provides definitions of restaurant, bar, enclosed area, and truckstop. A restaurant was defined as “every building or other structure, or any part thereof, and all buildings in connection therewith that are kept, used, maintained, advertised, or held out to the public as a place where food is served, including coffee shops, cafeterias, private and public school cafeterias, kitchens, and catering facilities in which food is prepared on the premises for serving elsewhere, and a bar area within a restaurant” (NDCC § 23-12-09.11).

A *bar* was defined as “a retail alcoholic beverage establishment licensed under chapter 5-02 that is devoted to the serving of alcoholic beverages for consumption by guests on the premises and in which the serving of food is only incidental to the consumption of those beverages. The term included a bar located within a hotel, bowling center, or restaurant that was not licensed primarily or exclusively to sell alcoholic beverages if the bar was in a separately enclosed area” (NDCC § 23-12-09.1).

The operational definitions of hospitality venues, restaurants, and bars included in this study were defined by modifications of NDCC § 23-12-09.11 and NDCC § 23-09.7. A restaurant was defined as every building or other structure, or any part thereof, and all buildings in connection therewith that were kept, used, maintained, advertised, or held out to the public as a place where food was served, including a bar area within a

restaurant. Excluded from this definition of restaurants were limited restaurants as defined by NDCC § 23-09.7, *Lodging Establishments and Assisted Living Facilities*, and other venues per the exclusion criteria identified in the Methods section. The definitions of bar followed the NDCC § 23-12-09.1 and 23-12-09.5.

Initially, truckstops and retail tobacco stores were envisioned as part of this study. However, with only one truckstop and two retail tobacco stores identified as operating within North Dakota, it was not possible to keep the identities of these venues anonymous and, therefore, they were not included in this study. The one truckstop did operate a restaurant and was included in the population as such.

Occupant density. Occupant density was the average number of occupants in an area per 100 m³; operationally, the occupant density was the average number of occupants in the hospitality venue sampled per 100 m³.

Particulate matter. Particulate matter was described in the introduction section of this paper. Operationally, PM_{2.5} was the air sample as measured by the *TSI SidePak AM510 Personal Aerosol Monitor* (Appendices E-F).

Poverty. Conceptually, the *Oxford English Dictionary* defined poverty as destitution or deficiency (“Poverty,” 2012). Operationally, this study followed the U.S. Census Bureau’s (2011) categorization of poverty, which defined *poverty areas* as census tracts with poverty rates of 20% or more and split into four categories. Category I included census tracts with poverty rates of less than 13.8%, Category II included poverty rates of 13.8% to 19.9%, Category III included poverty rates of 20.0% to 39.9%, and Category IV included poverty rates of 40.0% or more.

Rurality. Conceptually, the *Oxford English Dictionary* defines rurality as (a) “the quality, state, or fact of being rural; ruralness” and (b) “something characteristic or suggestive of the country; a rural object, feature, or area.” (“Rurality,” 2012, para. 2-3). The Institute of Medicine (2005) stated that a rural area was one that generally had low population density. Determination of rural was complex both by definition and by current ND population trends. The governmental definitions of “rural” varied. Conceptually, commonly used U.S. definitions of rural have been developed by the USCB, the Office of Management and Budget (OMB, 2010), and the U.S. Department of Agriculture’s (USDA) Economic Research Service (ERS; ND State Data Center, 2011b). Additionally,

Table 3

Advantages and Disadvantages of Geographical Units for Developing Rural Definitions

Counties	<p>Advantages: Most commonly used; simple to understand, boundaries were stable, used in many national health data sets, represented political jurisdictions</p> <p>Disadvantages: Larger counties contained both urban and rural areas; often based on OMB’s metro-nonmetro that was not developed to define rural</p>
Zip Code Areas	<p>Advantages: Finer level of precision than counties</p> <p>Disadvantage: Codes can change yearly, little or no relationship to city or county boundaries or to political boundaries</p>
Census Geography	<p>Advantages: Smallest and most precise unit, more stable than zip codes, more consistent with county geography</p> <p>Disadvantage: Hard to implement, was not used by programs and payers</p>

Note. Adapted from “Issue Brief #2. Choosing rural definitions: Implications for health policy,” by A. F. Coburn, A. C. MacKinney, T. D. McBride, K. J. Mueller, R. T. Slifkin, and M. K. Wakefield, 2007, Retrieved from <http://www.rupri.org/Forms/RuralDefinitionsBrief.pdf>

the ND Department of Health (NDDoH, 2009) and the Center for Rural Health in North Dakota (2011) developed varying definitions. Table 3 presents the advantages and the disadvantages of the three geographical units (counties, zip code areas, and census tracts) used to develop rural definitions.

Robert M Groves (2011), Director of the U.S. Census Bureau, stated that there was not a perfect classification scheme for important statistics and that a good statistic was one that has an appropriate fit for its use. The American Legacy Foundation's (2009) "Tobacco Control in Rural America" discussed defining rural for tobacco control. The American Legacy Foundation (2012) was a nonprofit public health organization formed in 1999 as a result of the Master Settlement Agreement between the tobacco industry and state governments. Although the American Legacy Foundation (2009) stated that a "one-size-fit-all" definition for rural may not be possible (p. 4), it used the USDHHS (2006a) Substance Abuse and Mental Health Services Administration's rural-urban definition based upon the USDA ERS Rural/Urban Continuum Codes (RUCC) classification scheme.

The 2003 RUCC were based on OMB's June 2003 dichotomous definition of metropolitan and nonmetropolitan counties; these definitions changed from previous censuses and included worker commuter criteria and functional adjacency (USDA, 2004). The RUCC classification scheme provided a 9-level categorization of counties by the degree of urbanization and adjacency to a metropolitan area (USDA, 2011). Using the 2003 RUCC and the 2000 Census, the USDA ERS was applied the RUCC classification scheme to each county in North Dakota. The USDA ERS will analyze the 2010 Census in

terms of RUCC classification in 2013 (T. Parker, personal communication, January 3, 2012).

Table 4

RUCC Classification Scheme, Counties per 2010 Census, and Venue Count

Code	Description	Counties, <i>n</i> (%)	Bars, <i>n</i>	Combo, <i>n</i>	Restaurants, <i>n</i>	Total Venues, <i>n</i> (%)
Metro counties:						
1	Counties in metro areas of 1 million population or more	0	0	0	0	0
2	Counties in metro areas of 250,000 to 1 million population	0	0	0	0	0
3	Counties in metro areas of fewer than 250,000 population	4 (7.55)	131	15	378	524 (36.82)
Nonmetro counties:						
4	Urban population of 20,000 or more, adjacent to a metro area	0	0	0	0	0
5	Urban population of 20,000 or more, not adjacent to a metro area	2 (3.77)	46	4	100	150 (10.54)
6	Urban population of 2,500 to 19,999, adjacent to a metro area	4 (7.55)	48	0	72	120 (8.43%)
7	Urban population of 2,500 to 19,999, not adjacent to a metro area	4 (7.55)	47	3	84	134 (9.42)
8	Completely rural or less than 2,500 urban population, adjacent to a	10 (18.87)	56	3	76	135 (9.49%)

	metro area					
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area	29 (54.72)	120	15	225	360 (25.30)
	Total	53	448	40	935	1423

Therefore, this author compared the 2000 Census (U.S. Census Bureau, 2009) with the 2010 Census (U.S. Census Bureau, 2010d) to identify population changes that may have influenced RUCC; although it was important to note that other factors affected RUCC classification as discussed previously. This author’s analysis found only one county, Williams, whose population change may have resulted in a RUCC reclassification (see Appendices G, H, & I). The 2010 Census identified three ND metropolitan statistical areas. Two included a portion of the metro area population residing in Minnesota (U.S. Census Bureau, 2010e). The three areas were: Bismarck, ND MetroSA (population 108,779); Fargo, ND-MN MetroSA (total metro population of 208,777 and ND part population of 149,778); and Grand Forks, ND-MN MetroSA (total metropolitan population 98,461, with ND part population of 66,862; U.S. Census Bureau 2010a; 2010b, 2010c, 2010e). See Appendix D for a figure of the ND MetroSAs. Table 4 provided the RUCC classification scheme (USDA, 2004), with the number of counties and a preliminary venue count per application of the 2003 classification scheme to the 2010 Census.

Current ND population trends increased the complexity of determining rural areas due to the intense oil recovery that was occurring in western North Dakota. The ND State Data Center (2011a) reported the 2010 ND Census population of 672,591 was 5% higher

than the 2000 Census. The 2010 population was the second highest in the state since the 1930 Census (ND State Data Center, 2011a).

For this study, the operationalization of rural used the RUCC classification scheme divided into three categories. *Completely rural* was defined as counties with RUCCs of 8 to 9; *semi-rural/urban* was defined as counties with RUCCs of 4 to 7; and *non-rural* was defined as RUCCs of 1 to 3. The latest population source, the 2010 Census, was applied to the RUCC classification scheme.

Summary and Overview of the Manuscripts

Chapter 1 provided an introduction to this tobacco smoke pollution study, with the goal of building on the current literature in four distinct ways. The examination of the literature, including a Cochrane Review (Callinan et al., 2010), clarified the need to study high-risk populations in rural areas, to use random sampling methods, and to consider the impact of socioeconomic status. The framework for the study depicted the ultimate outcome of tobacco control as decreased tobacco-related morbidity and mortality and decreased tobacco-related disparities.

Three manuscripts were produced as part of this non-traditional dissertation proposal. The first manuscript, presented in Chapter 2, was a published concept analysis of social justice (Buettner-Schmidt & Lobo, 2011). Tobacco prevention and control has been identified as a social justice issue (Buettner-Schmidt, 2005, 2006; Heaton & Nelson, 2004). By studying the influences of rurality and socioeconomic status on exposure to SHS, this manuscript addressed the social justice attributes of fairness, just policies, equity in human rights, and sufficiency of well-being (Buettner-Schmidt & Lobo, 2011).

The second manuscript focused on community-based participatory research (CBPR) and policy action, with application to tobacco prevention and control (Buettner-Schmidt, 2012). This manuscript fit within this dissertation as the study introduction and highlighted the fact that tobacco regulation through policy has increased globally to the extent that protecting people from SHS and banning smoking in public places were considered two of the “best buys” in reducing deaths, disease, and costs associated with 63% of the total global deaths (WHO, 2010, p. 4). The third manuscript presented the findings of this study and included policy-related statements to inform public health professionals and policymakers on factors that impact exposure to SHS.

CHAPTER 2

MANUSCRIPT 1

SOCIAL JUSTICE: A CONCEPT ANALYSIS

Abstract

Aim. This article is a report of an analysis of the concept of social justice.

Background. Nursing's involvement in social justice has waned in the recent past. A resurgence of interest in nurses' roles about social justice requires a clear understanding of the concept.

Data sources. Literature for this concept analysis included English language articles from CINAHL, PubMed, and broad multidisciplinary literature databases, within and outside of health-related literature, for the years 1968–2010. Two books and appropriate websites were also reviewed. The reference lists of the identified sources were reviewed for additional sources.

Review methods. The authors used Wilsonian methods of concept analysis as a guide.

Results. An efficient, synthesized definition of social justice was developed, based on the identification of its attributes, antecedents and consequences that provides clarification of the concept. Social justice was defined as full participation in society and the balancing of benefits and burdens by all citizens, resulting in equitable living and a just ordering of society. Its attributes included: (1) fairness; (2) equity in the distribution of power, resources, and processes that affect the sufficiency of the social determinants of health; (3) just institutions, systems, structures, policies, and

processes; (4) equity in human development, rights, and sustainability; and (5) sufficiency of well-being.

Conclusion. Nurses can have an important influence on the health of people globally by reinvesting in social justice. Implications for research, education, practice and policy, such as development of a social justice framework and educational competencies are presented.

Keywords: concept analysis, health promotion, nurse roles, politics, public health nursing, public policy, social justice

What is already known about this topic?

- Florence Nightingale and Lillian Wald actively addressed social injustices.
- The term *social justice* is used in documents guiding practice for nurses.
- Some nurses, specifically public health nurses, recognize their role in working towards social justice; however, there is no clear understanding of what social justice is.

What this paper adds

- Social justice is defined as full participation in society and the balancing of benefits and burdens by all citizens, resulting in equitable living and a just ordering of society.
- Attributes of social justice include: (1) fairness; (2) equity in the distribution of power, resources, and processes that affect the sufficiency of the social determinants of health; (3) just institutions, systems, structures, policies, and processes; (4) equity in human development, rights, and sustainability; and (5) sufficiency of well-being.
- Consequences of social justice are peace, liberty, equity, the just ordering of society, sufficiency of social determinants of health, and health, safety and security for all of society's members.

Implications for practice and/or policy

- This concept analysis provides a synthesized definition of social justice for nursing assisting nursing to proactively use social justice throughout nursing research, education, practice and policy.
- Future development of a social justice framework and educational competencies by which all nurses can influence social justice globally is essential.

- Nurses need to gain a clearer understanding of social justice, thereby allowing nursing to begin to reclaim its role in addressing global social injustices, with the ultimate goal of a just and fair society, reflected as peace, health and well-being for all.

‘Social justice is a matter of life and death’.

Commission on Social Determinants of Health
(CSDH 2008, p. 3)

Introduction

Nursing has a long history of involvement in social justice, although interest in it has waned in the recent past. Nightingale (Watson 2008) and Lillian Wald (Sklar 2003; Anderson 2007) were social justice advocates. Nightingale’s political efforts in social and economic issues ‘kindled the light of justice’ (Boykin & Dunphy 2002, p. 14). Fitzpatrick (2003) questioned at what point nursing left the path of having social justice principles and respect at its core. Leuning (2001) stated, “The question of ‘Who suffers and why?’ should always be in the foreground of our scholarly discussions and in our practice” (p. 300). Appeals for nursing to have a multidisciplinary social justice language (Boutain 2005) and to reinvest in social justice (Drevdahl *et al.* 2001) have occurred. Social justice has been identified as the broadest outcome in a conceptual model for nursing and health policy (Fawcett & Russell 2001; Russell & Fawcett 2005).

The primary aim of this concept analysis is to identify social justice’s attributes, antecedents and consequences and to develop a synthesized definition through the use of Wilsonian concept analysis methods based on a multidisciplinary literature review (Wilson 1963, Hupcey *et al.* 1996, Rodgers & Knafl 2000). A secondary aim is to determine whether or not involvement in social justice issues is appropriate for the nursing profession and whether or not nursing has reinvested in social justice, thereby reclaiming its role in addressing global social injustices.

Background

Social justice took a back seat when the perspective of nurses changed from viewing health as a social mandate to viewing it as an individual responsibility (Boutain 2005); however, there is a resurgence of interest in nursing's role in social justice issues. Watson (2008) questioned 'a world that is spending close to \$600 billion for a war on terrorism and little or nothing to combat poverty and provide basic child health care for its citizens' (p. 54). She identified poverty, mortality rates, disease, and suffering as the 'outer manifests of social injustice', stating that bioethics frames this 'as issues of race, ethnicity, and power' (Watson 2008, p. 55).

The American Nurses Association (ANA) incorporated social justice into its *Code of Ethics* (2001), *Social Policy Statement* (2003), *Nursing Scope and Standards of Practice* (2004) and *Public Health Nursing: Scope and Standards of Practice* (2007). Social justice concepts are included in some nursing undergraduate curricula (i.e. Boutain 2005, 2008, Beaty 2008, Vickers 2008). Of the nursing specialties, public health nursing is most attuned to social justice as a cornerstone of public health (Minnesota Department of Health [MDH] 2010.)

However, do nurses currently embrace their history and role in advocating for social justice? Do they understand social justice, apply nursing knowledge to rectify injustices and view advocacy beyond individual clients to include social justice advocacy? Do the ANA and other organizations provide a social justice framework empowering nurses to apply social justice in practice? Does social justice need to be explicitly addressed by the profession so that nurses can once again be a force for addressing social injustices?

This article provides an analysis of the social justice concept guided by Wilsonian methods of concept analysis (Wilson 1963, Hupcey *et al.* 1996, Rodgers & Knafelz 2000). Using Wilsonian methods requires explicating the following iterative steps: Step 1 – isolating the questions of the concept; Step 2 – developing the right answers; Step 3 – identifying uses of the concept; Step 4 – answering the questions of the concepts; Step 5 – reanalyzing the initial concept for current relevance in nursing; and Step 6 – identifying potential uses of social justice for nurses.

Wilson (1963) described the questions of concepts as potentially questions of fact, value and concept. This analysis isolated four questions of concept (Step 1): (1) a question of fact: What is social justice and how is it defined; (2) a question of value: Is social justice appropriate for the nursing profession; and two questions of concept: (3) What are the attributes, antecedents and consequences of social justice; and (4) Has nursing reinvested in social justice?

Data sources

To develop the right answers (Wilsonian Step 2), the boundaries of the analysis must first be determined (Hupcey *et al.* 1996), which for this analysis are defined by data sources, search terms and other limits. Second, all the uses of social justice within the boundaries need to be identified. Then, the right answers can be developed.

A CINAHL database search for articles published from 1994 to 2010 was conducted using the term “social justice” without selection of a specific field, resulting in 2245 articles; this was refined by limiting the results to full-text articles, leaving 830 articles. Further refinement with ‘social justice’ in the Title field resulted

in 80 articles; the term ‘nurs*’ reduced the list to 29 articles, which were then reviewed.

A PubMed database search for articles published from 1968 to 2010 was conducted for the term ‘social justice’, resulting in 10,663 citations; limiting the results to humans, English language and full-text availability left 1029 articles. Further refinement of articles with ‘social justice’ in the Title field resulted in 25 articles, 9 of which were included in the public health related and 3 were in the nursing related and 2 were not pertinent, leaving 11 medical-related articles reviewed. Additional sources were identified through broad searches of the literature in numerous disciplines. Two social justice books were reviewed, and relevant websites were searched. The reference lists of identified sources were appraised for additional sources. Only English language sources were used.

Results

This section continues with Wilsonian Steps 3 and 4 and includes the findings of the multidisciplinary literature review, developing the right answers, provision of cases and a discussion of uses and contexts. A synthesized definition is provided along with attributes, antecedents and consequences.

All uses of social justice within the identified boundaries

No social justice definitions were found in commonly used dictionaries and thesauri; this was not surprising, as Hayek (n.d., as cited in Novak 2000) stated that entire books and treatises have been written on this topic without defining it. A recent community health concept analysis discussed social justice without providing a

definition (Baisch 2009). Searches of discipline-specific references and reviews of literature in discipline-specific databases revealed lengthy explanations.

Health: nursing

Although social justice was previously considered a critical value for all nurses (Fahrenwald *et al.* 2007), Liaschenko (1999) found that justice as a central moral concept lacked attention in the literature and argued for Young's (1990) view of justice inclusive of action and enabling full social participation. Drevdahl *et al.* (2001) found that when nurses did address social justice, a social justice framework was not used. A specific social justice framework does not exist; however, several nursing frameworks include social justice (Fawcett & Russell 2001, MDH 2001, Boykin & Dunphy 2002, Boutain 2005, 2008, Russell & Fawcett 2005, Schim, *et al.* 2007, Pacquia 2008, Watson 2008). Boutain (2005, 2008) called for a more complex view to assist nurses to participate in social justice, and Schim *et al.* (2007) placed social justice at the center of the nursing paradigm. Reimer Kirkham and Anderson (2002) stated that 'postcolonial nursing scholarship will permit more thoughtful attention to the issues of equity and social justice within health and health care that fall within the mandate of nursing' (p. 16). Educating nurses on social justice has been discussed in recent literature (e.g. Boutain 2008, Cohen & Gregory 2009). The need to find and use nursing's political will to address equity issues globally was stressed (Drevdahl *et al.* 2001, Ervin & Bell 2004) through organizational and individual action (Liaschenko 1999).

Varying opinions exist as to the adequacy of ANA guidance on social justice, with some authors expressing support for ANA's guidance (Fahrenwald *et al.* 2007,

Boutain 2008, Manthey 2008) and others finding it lacking (Bekemeier & Butterfield 2005). Two of the five strategic priorities of the Public Health Nursing Section of the American Public Health Association (Anderson 2007) are ensuring social justice and eliminating health disparities. Ervin and Bell (2004) added concerns related to international threats to the common good as further priorities.

The American Association of Colleges of Nursing's (AACN 2008) *Essentials of Baccalaureate Education for Professional Nursing Practice* identified social justice as a core nursing value and defined it as 'acting in accordance with fair treatment regardless of economic status, race, ethnicity, age, citizenship, disability, or sexual orientation' (p. 28). Previously, in examining the 1998 *Essentials*, Fahrenwald *et al.* (2007) found AACN's focus narrow and not inclusive of the broad issues of health and determinants of health. The 2008 *Essentials* does discuss determinants of health, vulnerable populations and health disparities, although its primary focus remains on individuals and healthcare systems.

The Canadian Nurses Association's (CNA's 2008) *Code of Ethics for Registered Nurses* lists "Promoting Justice" (p. 17) as one of seven values and responsibilities and provides explicit practice recommendations to address social justice. The Code includes terminology such as rights, equity, fairness, allocation of resources, system and structural changes, social determinants of health and global health. The Code's focus is inclusive of individuals, groups, communities, programs, policies, legislation, regulations, systems and structures. Supporting information File S1 in the online version of the article in Wiley Online Library includes additional nursing articles defining and describing social justice (Pangman & Seguire 2000,

Drevdahl 2002, Redman & Clark 2002, Fitzpatrick 2003, Jackson 2003, Reimer Kirkham *et al.* 2005, Davison *et al.* 2006, McGee 2007, Browne & Tarlier 2008, Foley 2009, Weisz 2009, Dysart-Gale 2010).

Health: public health

The foundation of public health is social justice (Powers & Faden 2006, National Association of County and City Health Officials 2010), with equity and social justice frequently interchangeable (Levy & Sidel 2006, CSDH 2008).

Beauchamp's (1976) "Public Health as Social Justice" defined justice as the fair and equitable distribution of society's benefits and burdens. Braveman and Gruskin (2003) clarified that equities focused on distribution of resources and other processes that drive health inequality, and Stanley (2002) called for "rigorous science to improve public health and social justice" (p. 44).

Providing international leadership, the World Health Organization developed the CSDH (2008), which determined that health inequities were impacted by political, social and economic forces and recommended influencing the social determinants of health to improve health equity. Achieving health equity to ensure social justice was described using the terms rights; fairness; distribution of power, income, goods and services; unequal distribution of health-damaging experiences; economic arrangements; politics; distribution of healthcare; society; social stratification; and living conditions. Other public health social justice language included the terms disadvantaged (van den Bergh *et al.* 2009); disenfranchised and political rights (Perez & Martinez 2008); financing of healthcare, prestige, deprivation, marginalization, equal opportunities, freedom to participate fully in one's society and social structures

(Braveman & Gruskin 2003); and caring, dignity and collective health (Krieger & Birn 1998).

A book by Powers and Faden (2006) focused on people in social communities or groups, social institutions such as governments and markets, inequalities, politics and the means of allocation. They identified social justice concerns as “worries about subordination and stigma, lack of respect, lack of institutions, and social practices that adequately support capacities for attachment and self-determination” (p. 6). Powers and Faden stated that their primary concern was the ends to be achieved through social justice, although they also stated that public health should be concerned about the distribution of resources and outcomes of social justice. They identified six essential dimensions of well-being to be achieved at a sufficient level for all: health, reasoning, self-determination, attachment, personal security and respect. These dimensions related to disadvantage and privilege.

Levy and Sidel’s (2006) book focused on social injustices, defined as “the denial or violations of...rights of specific...groups...based on the perception of their inferiority by those with more power or influence” and “policies or actions that adversely affect the societal conditions in which people can be healthy” (p. 6); also that social justice is grounded in distributive justice. Root causes were identified as poverty, the income gap between people, unequal distribution of resources, discrimination, the lack of human rights protection and political disenfranchisement. Social injustice was considered a principle cause and consequence of war and terrorism (Levy & Sidel 2006).

As the leading cause of death worldwide, tobacco use has been identified as a social justice issue, with calls to action for healthcare providers and others to address the related injustices (Healton & Nelson 2004, Buettner-Schmidt 2005, 2006).

Associated terminology includes disparities, exploitation, basic human rights of good health, education, fair and equal treatment, disenfranchisement, well-being and health promotion (Healton & Nelson 2004). A full listing of public health references reviewed can be found in supporting information File S2 in the online version of the article in Wiley Online Library.

Health: medicine

The Online Medical Dictionary “Social justice” (1998) defined social justice as, “An interactive process whereby members of a community are concerned for the equality and rights of all” (¶ 1). Thirteen articles on social justice from medical journals were reviewed, 11 from the initial search and 2 identified from the readings. Nineteen social justice-related terms were identified within the articles; see supporting information Tables S1 and S2 in the online version of the article in Wiley Online Library for matrices linking terms to articles. Lee and Cubbin (2009) hypothesized that social injustices can lead to poor health outcomes and called for equitable opportunities for all to be healthy. Van Roosendaal (2006) described physicians’ ethical conflicts as a struggle between the doctor–patient relationship requirements and social justice responsibilities and recommended that physicians have “a broader sense of community responsibility in their practice of medicine” (p. 1525). Aesop and Rennie (2010) argued that medical individualism has led to ‘[a]

moral vacuum, exaggeration of human agency, and a thin...conception of justice' (p. 1).

Philosophy

Rawls (1971, 1999, 2001) stated, "Justice is the first virtue of social institutions" (Rawls 1999, p. 3). Rawls clarified that justice and fairness are not the same concepts and that equality is a hypothetical concept to begin the development of the justice concept.

According to Wenar's (2008) interpretation of Rawl's social justice philosophy, a just society has "free citizens holding basic equal rights cooperating within an egalitarian system" (§ 1) institutions included the political constitution, legal system, economy and organizations that "distribute the main benefits and burdens of social life", including rights, opportunities, work, recognition, distributions of income and wealth and more (4 .1 The Basic Structure section, ¶ 1). Wenar found that Rawls' theory of justice related to citizens' good, collective good, reciprocal advantage of all, fair equal opportunity of all, economic equality, political equality, equal basic rights, self-respect and affirmation of self.

Law

The American Bar Association (ABA) does not have a legal definition for social justice, although representatives of the organization have made statements about their duty to "bring social justice to the world" (Rand 2006, p. 461). The ABA Center for Racial and Ethnic Diversity promotes social justice in the justice system (ABA n.d.). Current legal social justice issues include racism, sexism, the environment and the "relations between rich nations and poor nations, to the first world and the rest of

the world” (Kennedy 2005, p. 93). Rand provides descriptions of social justice: “empowerment of under- represented minority groups” (Solorzano & Yosso 2001, as cited in Rand 2006, p. 460) and the process of remedying oppression” (Edwards & Vance 2001, as cited in Rand 2006).

Psychology, sociology and social work

Psychological social justice definitions were influenced by authority, power and peer pressure, which affect how others are treated (Hatfield & Rapson 2005).

Oppression was recognized as the domination and control of others through institutional systems and policies, with social justice described as full and equal participation of all of society’s groups, equal distribution of resources, physical and psychological safety, security of all and included the processes and institutional context (Morgan & Vera 2006).

The sociological literature differentiated social justice from legal, political and economic justice (Alwin 2001) and discussed social and economic inequalities and the allocation of goods (Marshall 1998). “Distributive justice” was an alternate term for social justice (Marshall 1998, Alwin 2001). Alwin (2001) defined social justice as “the realm of status, respect and the sense of worth given and received in social interaction or in relation to society” (p. 2696).

The *Code of Ethics* of the National Association of Social Workers (2008) deems social justice to be a value and an ethical principle. “Social workers challenge social injustice” and “pursue social change, particularly with and on behalf of vulnerable and oppressed individuals and groups of people.... focused primarily on issues of poverty, unemployment, discrimination.... [They] strive to ensure

access...equality of opportunity; and meaningful participation in decision making for all people” (Ethical Principles section, ¶ 3).

Geography

Geographical social justice definitions included, “The distribution of society’s benefits and burdens, and how this comes about” (“Social justice” 2000, Social Justice section, ¶ 1) and a sharing of resources and power (Ross & Rosati 2006), with questions related to spatial access to resources and exposure to environmental hazards.

Economics

The World Bank (2005) focused on social justice as inequalities in opportunity and stated that a reduction in inequities was consistent with and may be necessary to obtain long-term greater efficiency and prosperity. The ABA (n.d.) Center for Economic and Social Justice (n.d.) included economic justice in their social justice definition, stating that social justice is a guiding virtue in the creation of institutions, just social institutions give access to what is good, and peace follows justice. Brinkman and Brinkman’s (2005) social justice conception focused on: equality of opportunity and fairness as it relates to income distribution; the struggle for power; institutional, social and political structures; distributive justice; disparities; social, political, legal and economic institutions; social order; liberty; and equality of economic opportunity.

Nitsch (2005), a self-identified Catholic social economist, explained that social justice is “inextricably connected” (p. 556) to the common good and that distributive justice requires that “the allocation of income, wealth, and power in

society be evaluated in light of its effects on persons whose basic material needs are unmet” (p. 556). Contributive justice means that “persons have an obligation to be active and productive participants in the life of society and that society has a duty to enable them to participate in this way” (p. 557). Nitsch concluded that social justice consists of “every one’s rights to share/participate in the common good in accordance with her/his needs, coupled with his/her obligations to contribute thereto in accordance with his/her ability” (p. 562).

Religion

The term “social justice” was first used in Roman Catholic writings in 1840 and was defined as “the virtue that ordains all human acts toward the common good” (Calvez & Massaro 2003, p. 242). Pope Paul VI (1967) created the Justice and Peace Commission to address international social justice obligations, stating, “Extreme disparity between nations in economic, social and educational levels provokes jealousy and discord, often putting peace in jeopardy” (p. 76) and those wealthier nations have a duty to aid developing nations and an obligation to social justice. Manship (2005) stated that the secular and religious origins of social justice can augment each other, and he identified shared concepts as human equality, distributive justice, rights, the common good and the “fair distribution of resources by social structures and institutions” (p. 42).

Developing the right answers (Step 2)

The exploration of literature revealed differences among and within the various disciplines about the uses of social justice. However, the goal of obtaining social justice, that is, attaining fairness and equity, appeared to be similar in each discipline.

A pertinent question was whether social justice should be viewed through a religious or secular viewpoint. Manship (2005) found that the views had similar concepts. For the remainder of this article, the focus of the concept will be on social justice as it relates to health.

Uses, cases and contexts of the social justice concept (Steps 2 and 3)

Model case. A model case can be found in a recent tobacco control advocacy in North Dakota. The 1998 U.S. Tobacco Master Settlement will result in payment of more than \$246 billion over 25 years to the majority of US states. Adding in tobacco taxes, total state tobacco revenues will be \$25.1 billion in 2010 alone; however, states spend only 2 - 3% of this revenue on tobacco prevention, cessation and control. The Centers for Disease Control and Prevention (CDC) provides recommended funding levels for each state; currently, nine states fund at 50% or more of the recommended level, and 31 states fund at <25% (Campaign for Tobacco Free Kids, 2009). After several years of unsuccessful efforts by advocates requesting the North Dakota Legislature to fund tobacco prevention, cessation and control efforts according to recommended levels; a voter initiative was placed on the November 2008 election ballot. The voters supported the recommended level of funding, resulting in North Dakota being the only state funded at the CDC-recommended level. This is an example of social justice because the tobacco companies, who profited from selling an addictive product that causes statistically significant morbidity and mortality, are now paying to prevent the initiation of new smokers and to assist in the cessation efforts of current smokers.

Contrary case. A hospital-based clinic in Seattle increased access to physicians to 24 hours per day and provided same- day service, lengthier appointments, advocacy with insurance companies and increased privacy in client areas to clients who paid \$3000 to \$6000 per year above the regular premium (Drevdahl *et al.* 2001). The clients were given the physicians' email addresses and cell phone numbers for immediate access. This clinic demonstrates that justice can be bought (Drevdahl *et al.* 2001).

Related case. A teenage shoplifter was sent to juvenile court and sentenced to 30 hours of community service. This was a related case in that legal justice was served; however, it was not related to social justice in a healthcare context.

Social context

Social contexts change concepts (Rodgers & Knafl 2000). For example, in religion, social justice was described as a virtue, a moral duty and an obligation. In philosophy, it was also considered a virtue but related to equality and fairness. The legal profession considered social justice as empowerment, a just ordering of society and remedying of oppression. Surprisingly, in the field of geography, social justice is discussed in terms of power and the distribution of society's benefits and burdens and the processes of distribution. Nursing, public health and medicine focused primarily on equity, health outcomes, participation, well- being and social determinants of health. The World Health Organization (CSDH 2008) focused on daily living conditions; the inequitable distribution of power, money and resources; and the impact of action, including the role of civil society.

Emotive context

The underlying emotive context of social justice was characterized by intensity and deep emotions related to the social injustices and whether or how to resolve the injustices. Neutrality on the concept was not perceived by the authors. The terms rights, duty, values and justice are in themselves associated with emotion. Although the popular literature was not included in this analysis, the current debate on health system reform in the United States can be informative with regard to the range and depth of emotions related to social justice.

Practical results

Practical results should arise from the analysis of a concept (Wilson 1963). The results of this social justice concept analysis include informing the nursing profession about the definition of social justice; identifying its antecedents, consequences and attributes; determining the appropriateness and role of nursing in social justice issues.

Results in language

Although a concept could have several meanings, it is important to choose one that “works most efficiently” without being too restrictive (Wilson 1963, p. 63). The synthesized definition of social justice developed by the authors is: full participation in society and the balancing of benefits and burdens by all citizens, resulting in equitable living and a just ordering of society.

Attributes

Attribute development is challenging because organizations and entities view social justice differently. Also, social justice, being both a process and a product

(discussed later), contributes to difficulty in separating the attributes, antecedents and outcomes. The attributes are: (1) fairness; (2) equity in the distribution of power, resources and processes that affect the sufficiency of the social determinants of health; (3) just institutions, systems, structures, policies and processes; (4) equity in human development, rights and sustainability; and (5) sufficiency of well-being.

Antecedents

The antecedents of social justice are society, respect, political will and popular support, justness and equity. Society is inclusive of people and groups of people; legal, social, economic, political institutions and systems; and governments and markets. Respect includes respect for others, for members of groups and for self. Political will and popular support are necessary to assure equitable processes. Justness is inclusive of procedures, contributions, distributions, just institutions and just social and political structures. Equity from the start (CSDH 2008), that is, from prenatal development, is essential in all dimensions of life, for example, opportunities and access, full participation in decision-making, social determinants of health, representation, rights and justness.

Consequences

The consequences of social just are peace, liberty, equity, the just ordering of society, sufficiency of social determinants of health and health, safety and security for all of society's members.

Discussion

Study limitations

This study was limited to only English language articles and by the availability of full text articles, which may have resulted in the omission of some relevant articles.

Answering the questions of concepts (Step 4)

Four conceptual questions were posed. The first – What is social justice? – was answered by the development of a synthesized definition and was expanded on in the attributes section.

The answer to the second question – Is social justice appropriate for the nursing profession as a whole? – is an emphatic yes; it is appropriate, and it is nursing's duty and obligation to address social justice.

Social justice has been central to the nursing profession since Florence Nightingale (Boykin & Dunphy 2002, Watson 2008). Lillian Wald demonstrated social justice numerous times throughout her life (Sklar 2003, Anderson 2007). A review of the US guiding documents for the nursing profession included language about social justice (ANA 2001, 2003, 2004, 2007). Furthermore, several nursing articles have been published on how the nursing profession has addressed social justice (e.g. Reimer Kirkham & Anderson 2002, Boutain 2008, Cohen & Gregory 2009).

The third question – What are the defining attributes, antecedents and consequences of social justice? – was addressed previously. The answer to the fourth question – Has nursing reinvested in social justice? – is nebulous. Concern exists that although language regarding social justice is incorporated into ANA's publications, it

was primarily a historical context, focused on individual client care and not populations, and was without recommendations for currently addressing social justice (Fahrenwald et al. 2007). An in-depth review of the ANA's documents showed a lack of clarity and lack of a guiding social justice framework (Bekemeier & Butterfield 2005). The CNA's *Code of Ethics* was found to more appropriately include social justice ("Social Justice: A Means to an End" 2006).

A review of the nursing literature revealed social justice applications among numerous issues and populations, for example, among people with dementia (Barnes & Brannelly, 2008); people experiencing violence in the workplace (McMurray 2006); workers' rights (Harre' 2005); the homeless population (Ervin & Bell 2004); and tobacco use (Buettner-Schmidt 2005, 2006). Although public health nurses are expected to be involved in social justice issues, several authors call for all nurses to be responsible for social justice (e.g. Boutain 2005, Anderson 2007, Manthey 2008, Watson 2008). Therefore, the answer to whether or not there is a reinvestment in social justice by nursing may be yes formally; however, more needs to be accomplished.

Conclusions

Reanalyzing social justice for current relevance in nursing (Step 5)

Nursing and other disciplines lack a common definition of social justice; this concept analysis resulted in the development of a synthesized definition for the discipline of nursing. The reanalysis of social justice illuminates the need to study social justice as having two dimensions: a process and a product. A CNA article ("Social Justice: A Means to an End" 2006) discussed social justice as both the means

to an end and the end in itself. Both dimensions are often used without clarifying whether or not the discussion involves social justices' processes or products. One research implication is to analyze each dimension as two parts of the whole with separate, yet related, attributes, antecedents and consequences. This would give clarity of understanding to increase the effectiveness of social justice actions and advocates.

Potential usages of social justice in nursing (Step 6)

The final concept analysis step is to identify potential uses (implications) of the concept in nursing. Of the nursing profession's guiding documents analyzed, there was inadequate conceptualization of and an inadequate framework for the application of social justice in nursing (Bekemeier & Butterfield 2005, Fahrenwald et al. 2007). A recommendation for further work is to analyze the recently released 2010 ANA guiding documents. Because nurses can have an important influence on the determinants of health for all people, the development of a social justice framework by which all nurses can affect social justice is essential. Thus, a second research implication is to develop and test frameworks specific to social justice in nursing. Ethical frame-works provide a start; however, specifically elucidating a social justice framework could further guide the reinvestment in social justice by nursing. Schim *et al.* (2007) placement of social justice within nursing's metaparadigm presents an interesting framework worthy of further exploration.

As social justice is beginning to be integrated into under-graduate nursing curricula, implications for practice and research include development of social justice educational competencies, incorporation of social justice into clinical application and curricular analysis of social justice at the program level. Nurses' strong history as

social justice advocates was diminished with the rise of the medical model and with the majority of nurses providing inpatient care. By developing a framework and educational competencies to reinvest in social justice for nursing, along with the expanding knowledge and acceptance of the social and behavioral determinants of health, nursing may once again become a strong influential force for social justice globally, thereby, advocating for just and fair societies, reflected as peace, health and well-being for all.

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Conflict of interest

No conflict of interest has been declared by the authors.

Author contributions

KBS and MLL were responsible for the study conception and design, performed the data analysis and made critical revisions to the article for important intellectual content. KBS performed the data collection and was responsible for the drafting of the manuscript. MLL obtained funding.

Supporting Information Online

Additional Supporting Information may be found in the online version of this article:

File S1. Annotated bibliography of a review of literature identifying nursing's definitions and descriptions of social justice.

File S2. A listing of public health references reviewed for the article.

Table S1. A matrix of social-justice-related terms cited six or more times within the medical articles reviewed.

Table S2. A matrix of social-justice-related terms cited five or fewer times within the medical articles reviewed.

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Young I.M. (1990) *Justice and the Politics of Difference*. Princeton University Press,
Princeton, NJ.

Supporting Information File 1: Annotated Bibliography of a Review of Literature Identifying Nursing's Definitions and Descriptions of Social Justice

Anderson D. G. (2007) *Chair's message. Public Health Nursing Section Newsletter*. Retrieved from http://www.apha.org/membergroups/newsletters/sectionnewsletters/public_nur/winter07/default.htm#{B0C71FD6-72E3-46A2-AD9C-C46F66481C52} on 1 October 2010.

Social justice was described in terms of rights, social determinants of health, global poverty, populations, income, health care, education, control, policy, disenfranchisement, and empowerment.

Barnes M., & Brannelly T. (2008). Achieving care and social justice for people with dementia. *Nursing Ethics*, 15(3), 384-395.

Barnes & Brannelly (2008 p. 398) defined social justices as: "being based on the belief that all individuals are of equal worth and are thus entitled to be able to meet their basic human needs, experience equality of opportunity and be protected from unjustifiable inequalities."

Beaty B. (2008) A summit of sages exploring social justice and nursing: An interview with Marie Manthey and Joanne Disch. *Creative Nursing*, 14(2), 82-89.

The University of Minnesota held a Summit of Sages with Joanne Disch, defining social justice as "a situation in which individuals are able to achieve basic human rights—the right to access health care, the right to dignity and respect, and the right to earn a decent wage. There is always an aspect of equity and justice" (Beaty 2008, p. 83).

Bekemeier B., & Butterfield P. (2005). Unreconciled inconsistencies: A critical review of the concept of social justice in three national nursing documents. *Advances in Nursing Science*, 28(2), 152-162.

Bekemeier and Butterfield (2005, p. 154) defined social justice as "one's ability to have what others have, to be able to access the 'goods of social life' within the context of institutional conditions that are needed to develop and exercise individual capacities." Bekemeier and Butterfield cited Young (1990) and quoted "goods of social life" (Liaschenko 1999, p. 37).

Selected citations from Bekemeier and Butterfield (2005):

Liaschenko J. (1999). Can justice coexist with the supremacy of personal values in nursing practice? *Western Journal of Nursing Research*, 21(1), 35-50.

Young I. (1990). *Justice and the Politics of Difference*. Princeton, NJ: Princeton University Press.

Boutain D. M. (2005). Social justice as a framework for professional nursing. *Journal of Nursing Education*, 44(9), 404-408.

Discussed several social justice theorists, such as Drevdahl (1999, 2002), Lebacqz (1986), Liaschenko (1999), Whitehead (1992), and Young (1990). Boutain (2005, p. 404) stated, "Nurses who are supportive of a social justice agenda highlight the need to balance benefits and burdens in society, to promote equal living and health conditions (Boutain 2004, Redman & Clark 2002)."

Boutain (2005) included the following terms related to SJ: social attitudes, social institutions, respect, unequal benefits and burdens, society, vulnerable groups, privileged groups, social relationships of power and privilege, economic considerations, fairness, oppression, nondiscrimination, and equality.

Selected citations from Boutain (2005):

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- Drevdahl, D. (1999) Sailing beyond: Nursing theory and the person. *Advances in Nursing Science*, 21(4), 1-13.
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Boutain D. M. (2008). Social justice as a framework for undergraduate community health clinical experiences in the United States. *International Journal of Nursing Education Scholarship*, 5(1), 1-12.

Boutain (2008, p. 2) defined social justice as “equalizing the balance of societal burdens and benefits” citing Beauchamp (1986), Drevdahl, *et al*, (2001), and Whitehead (1992). Boutain (2008, p. 2) stated that the definition criticizes the distributive justice paradigm and “ensures everyone practice reasonableness and moderation when exercising rights (Whitehead, 1992).” Boutain (2008, p. 4) also stated some definitions of SJ included the concepts of “power, equity, and communal need for action.”

Selected citations from Boutain (2008):

Beauchamp, D. (1986). Public health as social justice. In T. Mappes & J. Zembaty (Eds.), *Biomedical ethics* (pp. 585-593). New York, NY: McGraw-Hill.

Drevdahl D., Kneipp S., Canales M., & Dorcy K. (2001). Reinvesting in social justice: a capital idea for public health nursing. *Advances in Nursing Science*, 24(2), 19-31.

Whitehead, M. (1992). The concepts and principles of equity and health. *International Journal of Health Services*, 22, 429-445.

Boykin A., & Dunphy L. (2002). Justice-making: Nursing’s call. *Policy, Politics, & Nursing Practice*, 3(1), 14-19.

Boykin and Dunphy (2002) described the actions and writings of Florence Nightingale as being related to the making of justice and used the terms compassion, caring, all (all people), health, “always advancing the ‘good’” (p. 16), impartial reason, moral judgments, universal rules and principles, and actions.

Browne A. J., & Tarlier D. S. (2008). Examining the potential of nurse practitioners from a critical social justice perspective. *Nursing Inquiry*, 15(2), 83-93.

Browne and Tarlier (2008, p. 84) described “critical social justice” as addressing “equity vs. equality; conceptualizing health as a human right; explicitly challenge neoliberal policies; draw attention to racialization, cultural devaluing and discrimination...prioritize collectivism vs individualism.”

Cohen B. E., & Gregory D. (2009). Community health clinical education in Canada: Part 2 – developing competencies to address social justice, equity, and the social determinants of health. *International Journal of Nursing Education Scholarship*, 6(1), 1-15.

Cohen and Gregory (2009) defined social justice by quoting Smith, Jacobson, and Yiu (2008, p. 112): “the degree of equality of opportunity for health made available by the political, social, and economic structures and values of a society.”

Selected citation from Cohen and Gregory (2009):

Smith, D., Jacobson, L., & Yiu, L. (2008). Primary health care. In L. Stamler & L. Yiu (Eds.), *Community health nursing: A Canadian perspective* (2nd ed., pp. 11-124). Toronto, Canada: Pearson Prentice Hall.

Davison C. M., Edwards N., Webber J., & Robinson S. (2006). Development of a social justice gauge and its use to review the Canadian Nurses Association's code of ethics for registered nurses. *Advances in Nursing Science*, 29(4), E13-E26.

Analyzed the Canadian Nurses Association's *Code of Ethics for Registered Nurses* and identified the following attributes of SJ: equity, human rights, democracy and civil rights, capacity building, just institutions, enabling environments, ethical practice, advocacy, and partnerships.

Drevdahl D. (2002). Social justice or market justice? The paradoxes of public health partnerships with managed care. *Public Health Nursing*, 19(3), 161-169.

Drevdahl (2002) stated, “Social justice postulates that important social factors (e.g. gender, age, or income) disadvantage some and limit the fair distribution of goods and hardships. Collective action (particularly by the government) is therefore required to reduce the effects of these factors.... valuing of collectivism over individualism” (pp. 162-163).

Drevdahl D., Kneipp S. M., Canales M. K., & Dorcy K.S. (2001). Reinvesting in social justice: A capital idea for public health nursing? *Advances in Nursing Science*, 24(2), 19-31.

Drevdahl *et al.* (2001, p. 23) stated: “Social justice pertains to a form of justice within which there is an equitable bearing of burdens and reaping of benefits in society” (Beauchamp 1986), and “It parallels the concept of ‘distributive’ justice, which is defined as an equitable distribution of goods consistent with egalitarian principles.” Drevdahl *et al.* (2001) also addressed the need to go beyond distribution of health care services to address social determinants of health, including the social and economic structures of education, workplace environment, and others. The authors also stated that economic inequity was not benign and that there was an inverse relationship between income inequities and public health indicators, disease incidence and prevalence, social cohesion, and violence.

Drevdahl *et al.* (2001) discussed equity and equality, stating that they not only impacted health but also that inequalities were “ethically and morally wrong” (p. 20) and that nursing must find the “political will and strength to participate in national (and global) conversations about inequalities and inequities” (p. 28).

Selected citations from Drevdahl *et al.* (2001):

Beachamp, D. E. (1986). Public health as social justice. In T. A. Mappes & J. S. Zembaty (Eds.), *Biomedical ethics* (2nd ed., pp. 585-593). New York, NY: McGraw-Hill.

Dysart-Gale D. (2010). Social justice and social determinants of health: Lesbian, gay, bisexual, transgendered, intersexed, and queer youth in Canada. *Journal of Child and Adolescent Psychiatric Nursing*, 23(1), 23-28.

Dysart-Gale (2010, p. 23) described “the nursing value of ‘social justice,’ understood as the professional obligation to fight disparities in health care that result from social bias or inequity.”

Ervin N. E., & Bell S. E. (2004). Social justice issues related to uneven distribution of resources. *Journal of the New York State Nurses Association*, 35(1), 8-13.

Discussed justice theorists, such as Lebacqz (1986), Nozick (1974), and Rawls (1971), with particular focus on Rawls’ (1971) principle of “justice as fairness,” based on the system of distribution and not the outcome of distribution. Evin and Bell (2004) stated that the language of inequities currently is focused on resources rather than on “the lack of political will for change that would enhance the common good at the risk of individual sacrifice” (p. 8).

Selected citations from Evin and Bell’s (2004):

Lebacqz, K. (1986) *Six theories of justice*. Minneapolis, MN: Augsburg Publishing House.

Nozick, R. (1974) *Anarchy, state, and utopia*. New York, NY: Basic Books.

Rawls J. (1971). *A Theory of Justice*. Cambridge, MA: Harvard University Press.

Fahrenwald N. L., Taylor J. Y., Kneipp S. M., & Canales M. K. (2007). Academic freedom and academic duty to teach social justice: a perspective and pedagogy for public health nursing faculty. *Public Health Nursing*, 24(2), 190-197.

Fahrenwald *et al.* (2007) quoted Levy and Sidel’s (2006, p. 9) definition of social justice: “an ethical concept grounded in principles of distributive justice. Equity in health can be defined as the absence of socially unjust or unfair health disparities.”

Selected citation from Fahrenwald *et al.* (2007):

Levy, B.S., & Sidel, V.W. (2006). The nature of social injustice and its impact on public health. In B. S. Levy & E. Sidel (Eds.), *Social injustice and public health* (pp. 5-21). New York, NY: Oxford University Press.

Fitzpatrick J. J. (2003). Social justice, human rights, and nursing education. *Nursing Education Perspectives*, 24(2), 65-65.

Fitzpatrick (2003) discussed social justice primarily in terms of respect and rights.

Foley E. (2009). Advocating for social justice. *Australian Nursing Journal*, 17(3), 21.

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McMurray (2006, p. x) stated, "Only when all people have a right to speak for themselves, a right to dignity, a right to work safely, in equitable conditions will we be able to declare ours a socially just society."

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Supporting Information Table 1 A matrix of social-justice–related terms cited six or more times within the medical articles reviewed.

Author(s)	Advantage/ Disadvantage	Access	Discrim- ination	Distributive Justice or Ethic	Equity/ Equitable/ Inequity/ Inequitable	Institutions/ Institutionalizing	Oppor- tunities	Rights/ Human Rights	Society	Systems/ Systematic
"Addressin g the" (2008)				x	x				x	
Azetsop & Rennie (2010)	x	x	x	x	x	x	x	x	x	x
Bal (2005)	x	x	x	x	x	x	x	x	x	x
Brown, McDonald, & Calma (2007)	x									
Cole (2007)		x	x		x	x		x		x
DeWitt (2003)					x		x	x		x
Friedenber g (2000)				x	x				x	x
Heath (1997)	x	x			x				x	
Lee & Cubbin (2009)	x	x	x		x	x	x		x	x
McGary (1999)		x	x	x	x	x	x	x	x	x

Muula (2007)	x	x	x	x	x			x	x	
Rennie & Mupenda (2008)		x	x		x	x	x	x	x	x
Van Rosendaal (2006)	x	x			x	x				x
Total of 13	7	8	7	6	12	7	6	7	9	9

Supporting Information Table 2 A matrix of social-justice–related terms cited five or fewer times within the medical articles reviewed

Author(s)	Allocation	Engagement	Fairness	Free/ Freedom	Harmony	Oppression	Primary Goods	Power/ Empowerment	Social Determinants
"Addressing the" (2008)								x	x
Azetsop & Rennie (2010)		x		x		x		x	
Bal (2005)	x		x	x	x				
Brown, McDonald, & Calma (2007)									x
Cole (2007)				x					
DeWitt (2003)									x
Friedenberg (2000)				x				x	
Heath (1997)				x					
Lee & Cubbin (2009)			x			x		x	x
McGary (1999)	x		x			x	x		
Muula (2007)		x	x						
Rennie & Mupenda (2008)						x			
Van Rosendaal (2006)									
Total out of 13	2	2	4	5	1	4	1	4	4

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CHAPTER 3
MANUSCRIPT 2
COMMUNITY-BASED PARTICIPATORY RESEARCH AND
TOBACCO CONTROL POLICY

ABSTRACT

Community-based participatory research (CBPR) can contribute to advocacy efforts for tobacco control policy. This article reviews four CBPR models, presents the results of a literature review on CBPR and tobacco control policy development, and analyzes a well-known tobacco control policy advocacy model in relation to CBPR principles. The author suggests that CBPR has the potential to facilitate successful tobacco policy advocacy.

INTRODUCTION

Tobacco use is the leading cause of death, disease, and impoverishment in the world, resulting in the death of 6 million people annually and exposing more than 600,000 nonsmokers to the harmful effects of secondhand smoke.[1] Several tobacco prevention and control guiding documents identify policy strategies and legislation as important and effective public health tools to reduce tobacco-related morbidity and mortality.[2-6] Passage of policy and legislation frequently requires building and maintaining public knowledge, engagement, and support; community-based participatory research (CBPR) characteristics coincide with these policy advocacy attributes, thereby assisting tobacco policy advocates to advance policy efforts in conjunction with the community. The purpose of this article is to review current CBPR models, critique the current use of CBPR in tobacco control policy development, and analyze a tobacco control policy advocacy model in relation to CBPR principles.

BACKGROUND

CBPR is one term for research strategies that involve a partnership between the investigators and the participants and include action to benefit the partners.[7, 8] Philosophically, CBPR developed as the operational component of critical social theory, which is fundamentally a scientific, critical, and practical critique of ideology and power,[9, 10] with varied origins in Europe and the Americas.[11-14] Implementation of CBPR stems from two traditions: Northern and Southern.[8] Begun in the 1940s, the Northern Tradition is also known as *action research*, indicating collaborative research for practical systems improvement.[8] The Southern Tradition, begun in the 1970s, is frequently associated with Paulo Freire's writings and has a more emancipatory

philosophy.[8] Currently, CBPR incorporates both traditions.[8] The Institute of Medicine recently identified CBPR as one of eight content areas and competencies needed to address health challenges.[15] It is important to understand that CBPR is not a research method; rather, it is an orientation to research and an applied approach intended to influence change in community health, systems, programs, or policies (Wallerstein N, Summer Institute in Community-Based Participatory Research for Health, University of New Mexico, Albuquerque; 2010).

The CBPR approach to research is unique in its commitment to action for change[16] and its involvement of the community. Characteristics or principles of CBPR were first developed by Israel and colleagues,[7, 17] with items 10 and 11 below added by Minkler and Wallerstein[18]:

1. recognizes the community as a unit of identity;
2. builds on strengths and resources within the community;
3. facilitates collaborative, equitable partnerships in all phases of research, involving an empowerment and power-sharing process that attends to social inequalities;
4. fosters co-learning and capacity building among all partners;
5. integrates and achieves a balance between knowledge generation and intervention for the mutual benefit of all partners;
6. focuses on the local relevance of public health problems and on ecological perspectives that attend to the multiple determinants;
7. involves systems development through a cyclical and iterative process;
8. disseminates results to all partners and involves them in the wider dissemination of results;

9. involves a long-term process and commitment to sustainability;
10. openly addresses issues of race, ethnicity, racism, and social class, and embodies “cultural humility”; and
11. works to ensure research rigor and validity but also seeks to “broaden the bandwidth of validity” with respect to research relevance.

CBPR in the field of health has been defined as:

a collaborative approach to research that equitably involves all partners in the research process and recognizes the unique strengths that each brings. CBPR begins with a research topic of importance to the community and has the aim of combining knowledge with action and achieving social change to improve community health outcomes and eliminate health disparities.[19 (para2)]

CBPR FRAMEWORKS

Four CBPR frameworks relevant to public policy advocacy are discussed next.[16, 20-22] First, Themba-Nixon and colleagues’ framework, which lends itself readily to CBPR methods comprises (1) defining and framing a policy goal; (2) selecting a policy approach; (3) identifying a target; (4) support, power, and opposition; and (5) policy process stages and CBPR opportunities.[22]

The second framework is Wallerstein and colleagues’[21] conceptual logic model. This framework identifies the dimensions of CBPR as contexts, group dynamics/equitable partnerships, interventions, and outcomes, including system and capacity outcomes, such as increased policies leading to improved health and disparities outcomes.

Third, Minkler and colleagues' [16] multimethod case study of CBPR projects, with a strong policy focus along with other criteria, identified six factors contributing to successful outcomes, six common challenges, and 13 recommendations for effectiveness (see table 1 and Web only file). [16] To develop this framework, the authors conducted a literature review and sent notices to 24 Internet listservs identifying 80 CBPR case studies in existence through 2005, with 10 meeting inclusion criteria. Examples of the issues addressed by the chosen policy projects with policy outcomes include diesel bus pollution, disability rights, food insecurity, creation of community walking and biking trails, and smoke-free policies. Most of the projects analyzed had partnerships between an academic institution and community organizations; however, others had health departments or other research entities as partners rather than academia. The study showed that although CBPR often contributes to policy success, it is difficult to single out the role that the partnerships play in the successes. Minkler and colleagues' [16] multi-case study was chosen as the framework for the following critique of the current use of CBPR in tobacco control policy development because it focuses strongly on policy and provides explicit information that serves as criteria for the critique.

Table 1 Factors contributing to successful outcomes, common challenges, and recommendations for effectiveness in community-based participatory research[16]

Factors Contributing to Successful Outcomes	Common Challenges	Recommendations for Effectiveness
1. The presence of a strong, autonomous community partner organization prior to the development of the partnership.	1. Differences in the research timetable of the community and academic partners, with the former often eager for quicker data analysis and release of findings in the interest of using them to promote change.	1. Build leadership and base of support for research and action by being genuinely community driven. Start where people are by having the community partner and its base determines the “hot button issue” to be studied—an issue the community partner is committed to help research and mobilize around.
2. A high level of mutual respect and trust among the partners and an appreciation of the complementary skills and resources that each partner brought.	2. Different perspectives on policy work held by academic/health department and community partners, with the latter often more clear from the outset about the policy goals and objectives they wished to achieve.	2. Use a mix of research methods: People’s stories (captured in qualitative data) as well as the facts and statistics that emerge from quantitative approaches are needed to move policymakers and reach the media. Different forms of data also may be needed to reach different audiences.
3. Appreciation by all partners of the need for solid scientific data as a prerequisite for making the case for policy action.	3. Funding constraints and/or termination of funding or changes in sources of project support, which in turn delayed or changed the emphasis of research and action.	3. Produce high-quality research that can stand up to careful scrutiny, but make results easily accessible and highlight their policy relevance: Policy briefs, short reports, and “talking points,” and liberal use of pie charts and other graphics to help translate the findings will help policymakers and the media, as will “quotable quotes” from your interviews and other data sources.
4. Commitment to “doing your homework”—finding out what other communities have done, who holds decision-making authority, key leverage points, etc.	4. Perceptions among partnership members that they lacked sufficient understanding of policymaking processes and avenues for systems change.	4. Use approaches and processes that reflect the local community culture and ways of doing things (even if it slows down the process).
5. Facility for and commitment to building strong collaborations and alliances with numerous and diverse stakeholders beyond the formal partnership.	5. Difficulty talking in terms of policy goals and activities because of real or perceived prohibitions and constraints due to tax-exempt status or funder concerns.	5. Remember that research includes not only the partnership’s original investigation but also subsequent study of the policy considerations involved. Community partners should be

		helped to research whether the policy level is the best route for achieving the change they seek; who has the power to make the change(s) being sought; what sorts of policy-relevant data need to be collected, from whom and how (this is all part of “data collection”).
6. Knowledge of and facility for attending to a variety of “steps” in the policy process, whether or not the language of policy was spoken.	6. Difficulty measuring the longer-term impacts of project or policy change: who follows up when the money runs out?	6. Make sure all partners, including academics, understand that advocacy is different from “lobbying”: Gain an understanding of the different types of advocacy activities allowed of nonprofit organizations, including universities and community organizations; the activities are often more plentiful than partners believe.
		7. Decide on a policy goal and identify the relevant policy targets and change strategies, but always have at least one “Plan B” and be open to compromise.
		8. Build strong linkages with organizational allies and other stakeholders, but be strategic in your choice of partners: In policy work, as in community organizing, there are “no permanent enemies, no permanent allies.”
		9. Through trainings, Web-based tools, and other resources, increase partners’ understanding of policymaking and, as appropriate, of legal processes and issues. If possible, link early on with a “policy mentor” willing and able to help partners, including academic partners, to understand and better navigate the policy process.
		10. Offer solutions to policymakers and decision makers, not just complaints: Have relevant research readily available to show them why your solution is on target, practical, and affordable; include in your research some information on the “wallet angle” to show cost effectiveness of your proposed solution; and provide them with the community support they need to advocate for change, e.g., helping to ensure strong

		community turnout at city council meetings, hearings, and other venues.
		11. Plan for sustainability by seeking new funding streams, including those (e.g., some foundations) that actively support and encourage community-partnered research and action at the policy level, directed at promoting health equity.
		12. Take advantage of the university or health department partner's media office: It can help draft and widely disseminate press releases. Making sure that community partners participate in decisions about content and timely use change (and ensuring that a new measure or policy is in fact implemented) is likely to mean developing of such media, and that any media advocacy is a well-thought-out part of a bigger plan and campaign.
		13. Recognize that policy change takes a long time, and commit to staying involved over the long haul: Achieving policy change (and ensuring that a new measure or policy is in fact implemented) is likely to mean developing and implementing several strategies and working well beyond any funded grant period.

Finally, a model by Cacari-Stone and colleagues focuses directly on policy and includes the dimensions of contexts, CBPR processes, policy strategies, and outcomes (figure 1). This model divides policy change into five categories: policy environment, policies, public voice, procedural justice, and distributive justice. This newest framework seems to hold the most promise to guide future tobacco control policy development because of its intense focus on policy strategies and the outcomes of CBPR processes.

REVIEW OF THE LITERATURE AND A COMPARISON

A review of the literature searching for tobacco policy projects using CBPR methods since Minkler and colleagues' [16] earlier 2008 literature review was conducted. Of note is that three of the 10 previously analyzed case studies by Minkler and colleagues [16] included tobacco-related policy case studies.

The purpose of the current review was to determine the potential of CBPR to contribute to tobacco policy change. Criteria for inclusion of articles followed Minkler and colleagues' criteria, [16] which was that the study "either showed evidence of having contributed to a policy change or showed promise to do so in the near future" [16 (p62)]; additionally, tobacco policy change needed to be a primary purpose of the research. Search engines included PubMed and CINAHL, with two searches using the same set of terms in each engine. The first set of terms included *community-based participatory research, tobacco, and polic**; the second set of terms included *community-based participatory research, smok**, and *polic**; (the asterisk indicates that all words containing those letters were searched), with a date limit of 2006 to August 2012. Twenty articles were identified by the search or included from this author's existing sources. [22-41] The searches identified studies using CBPR or closely related processes influencing tobacco control policies. Four articles discussed policy change or potential for change in the near future. [28,31,33,41] Another search, using the term *cooperative behavior* (this term was used because CBPR was not included as a MeSH term until 2009), in place of the term *community based participatory research* resulted in additional articles; however, none met the inclusion criteria. The four articles that discussed policy change [28,31,33,41] were chosen for a comparison with Minkler and colleagues'

previously noted framework and were analyzed in terms of success factors, common challenges, and recommendations for effectiveness[16] (see table 1 and Web only file).

In the first of the four articles, Fletcher and colleagues[28] reported on a study that used participatory action research methods, from which CBPR emerged.[8] The policy action also included a culturally appropriate concept of “yarning,” whereby open conversation occurs without direct questioning. The policy goal of this research was to pass an internal smoke-free workplace policy within an Aboriginal Controlled Community Health Organisation located in Victoria, Australia. A smoke-free workplace policy was developed and adopted.

In the second comparison study, Mendenhall and colleagues[31] used CBPR in a joint effort between the University of Minnesota and personnel and students at a Job Corps Center in St. Paul, Minnesota, USA. The goal of the project was to address tobacco use at the Center. The outcomes included campus-wide interventions to improve students’ health and well-being. Policy-specific outcomes included moving a designated smoking area and prohibiting staff from smoking with students.

In the third comparison study, Plagerson and Mathee[33] used the theoretical underpinnings of CBPR for a community research translation health promotion initiative in Riverlea Extension 1, a suburb of Johannesburg, South Africa. Addressing tobacco use was one of five initiatives described; specifically, hookah pipe smoking was identified by the community as an area requiring intervention. The outcomes of this initiative may lead to a policy because: (1) hookah pipe smoking was included in the World Health Organization Collaborating Centre for Urban Health study of living conditions and health

status of this and four other targeted communities; and (2) The South African National Council Against Smoking agreed to review legislation in relation to hookah pipe use.

In the fourth comparison study, Wynn and colleagues[41] specifically used CBPR approaches for policy change in Alabama, USA, at local and state levels. The tobacco control policy outcomes included successfully preventing a weakening of a local tobacco control ordinance and, although unsuccessful, it influenced efforts to pass a statewide smoke-free law. After tobacco policy efforts concluded, the coalition moved into breast and cervical cancer policy efforts, which were successful.

Table 1 identifies the six success factors, six challenges, and 13 recommendations for success against which the four articles were compared.[16] A detailed analysis can be found in the Web only file. Discussed next are notable findings from that review.

Of the six success factors identified by Minkler and colleagues'[16], the majority were either in place or not specifically discussed within the articles (see the Web only file). Three of the success factors were clearly present in each of the four comparison studies. Success factor 1 is the presence of a strong, autonomous community partner organization that was in place before the development of the partnership; interestingly, the only project that did not have this in place slowed down its pace to develop a new autonomous formally legal organization prior to continuing its policy change efforts.[41] Success factors 2 (a high level of mutual respect and trust) and 5 (building strong collaborations and alliances) were strongly present in all four projects. Wynn and colleagues went beyond trust and mutual respect by discussing “equitable involvement”[41 (pS104)], “balance of power,”[41 (pS112)] and “transparency”[41 (pS112)].

Of the six challenges described by Minkler and colleagues,[16] many were either not specifically addressed within the publications or were not applicable due to two of the projects being policy processes internal to the organization as opposed to public policy. Although not always specifically discussed, challenge 2 (different perspectives on policy work between academics or health departments and community partners) and challenge 4 (partners' lack of understanding of policymaking processes) are perhaps taken into account during the project planning phases. All the projects seemed either to have joint goals or time was provided by the academics/health departments to allow partners to determine or agree to policy goals. Additionally, all partners appeared highly involved in policy development. Two examples include staff contributing to development of the final policy language[28] and a description that noted that “partners...emerged as powerful role players in...policy development.”[33 (p341)]

A review of the 13 recommendations for effectiveness[16] showed strong evidence of incorporation of five of the recommendations, as exemplified in the project by Wynn and colleagues.[41] The development of the Riverlea Development Trust by the community (recommendation 1: genuinely community driven) required slowing down the process (recommendation 4: reflective of the community culture) to respect the local community's desire to create the Trust. The Trust's board of trustees included community members, a local councilor, and a representative from a medical research council (recommendation 8: build strong linkages). Recommendations 11 and 13 include planning for sustainability directed at health equity and a long-term commitment to stay involved, respectively; these were addressed by development of the Trust. The Trust provided required oversight of fundraising and a mechanism for a “commitment to

change as a long term process.”[33 (p342)] Finally, this project addressed a “disjuncture between the equal rights of every citizen...and...actualization” [33 (p340)] (sustainability directed at health equity).

Three recommendations for effectiveness[16] are only weakly included in the four projects. Although high-quality research was used (recommendation 3), mixed methods (recommendation 2) was only strongly evident through Fletcher and colleagues’[28] yarning concept, although Mendenhall and colleagues[31] mentioned the use of focus groups. Differentiating lobbying from advocacy (recommendation 6) was not discussed in the articles that included legislative processes.[31, 41] Cost-effectiveness, part of recommendation 10, was not discussed in any of the four articles.

Wynn and colleagues directly described the effect of CBPR on tobacco policy change at a legislative level and included an excellent table of the coalition’s application of CBPR principles.[41, (pS104)] Additionally, they provided evidence that the application of CBPR for successful tobacco policy change is warranted. Furthermore, results suggested that CBPR can set the groundwork for other health policy efforts, as the coalition discussed being “ready to tackle other issues of interest to the health and well-being of their community.”[41 (pS111)] Finally, CBPR allowed the community to learn of the “power of their collective voices” as they developed a philosophy to “never say that something cannot be accomplished.”[41 (pS113)] In sum, this literature review and analysis supports the potential of CBPR to facilitate tobacco control policy advocacy efforts and other health related policy issues.

ANALYSIS OF A TOBACCO CONTROL POLICY ADVOCACY MODEL

Clearing the Air: A Guide to Passing Clean Indoor Air Ordinances provides a tobacco policy advocacy model for communities advocating for local smoke-free policies.[42] This booklet has been used by tobacco control policy advocates since its publication in 1996. In the last 5 years, at least 48 agencies purchased 2,596 copies of this guide, with additional copies being donated (A. Tegen, personal communication, June 28, 2010). *Clearing the Air* identifies four major components for local smoke-free policy campaigns: (1) planning and building a campaign, (2) running the campaign, (3) what to do as the hearing day approaches, and (4) life after enactment.[42]

An analysis of the major components of *Clearing the Air*[42] was conducted to identify the CBPR principles[5, 6] that are present either explicitly or implicitly. It is important to recognize that it is not expected that all CBPR principles will be present in any one project and that the principles exist on a continuum.[11]

The first CBPR principle[7, 17] of having the community as the unit of identity is inherent throughout *Clearing the Air*. [42] In local tobacco policy campaigns, the community is typically a geographical area under the regulation of a local city council, city commission, county commission, or similar organization. Tribal communities, American Indians and Alaska Natives, are specifically included on a separate page as sovereign nations with unique policy processes.[42 (p3)]

The second CBPR principle of building on the community's strengths and resources is present,[7, 17] as *Clearing the Air* recommends the steps of coalition building, such as identifying individuals for the coalition with knowledge of inside

politics, identifying a credible health expert, and strategically choosing community organizations to join the coalition.[42]

Having equitable, collaborative partnerships in all research phases, including empowering and power sharing, is the third CBPR principle.[7, 17] As *Clearing the Air* is focused on policy advocacy and not necessarily research,[42] the third principle is analyzed in terms of the partnerships. Although *Clearing the Air* does not explicitly address equity or power sharing, it does briefly discuss potential coalition structures to consider. Empowering is discussed in relation to empowering a steering committee for decision making. Collaboration, although not specified in *Clearing the Air*,[42] is inherent in successful coalitions. This third principle is present; however, explicit language on equitable and collaborative partnerships, partner empowerment, and power sharing by coalition members may increase the success of coalitions' advocacy efforts.

The fourth CBPR principle, co-learning and capacity building of partners,[7, 17] is present in *Clearing the Air*'s recommendation to "educate yourself on the issues,"[42 (p9)] understood to mean education of the coalition. Having educational and outreach materials in languages other than English, as appropriate to the community, is emphasized.[42 (p10)] Tribal culture is specifically addressed regarding the need to potentially reference sacred tobacco use in the policies.[42 (p30)] Capacity building is alluded to in "training the next generation of activists"[42 (p8)] and in the planning of "who will say what." [42 (p17)] Capacity building is present throughout the policy process, although this should be explicitly stated to include building partners' capacities. Integrating and achieving balance between research and action, the fifth principle, does

not apply in this analysis due to the policy advocacy focus, not the research nature, of *Clearing the Air*.^[42]

The sixth principle, an emphasis on the local relevance of public health problems and ecological perspectives, is described as “striving to achieve broad-scale social changes aimed at eliminating health disparities.” [17 (p51)] The goal of *Clearing the Air*^[42] is to assist communities in passing and enacting smoke-free policies in all workplaces and public places, thereby realizing broad social change for all people.

The seventh principle discusses the multiple competencies partnerships that may develop through a cyclical and iterative process.^[7, 17] This principle overlaps with *Clearing the Air*'s recognition of policy development being cyclical and iterative, for example, the recommendation to “return to education and grassroots efforts”^[42 (p14)] if policy maker opposition is high.

The eighth principle^[7, 17] relates to dissemination of research and findings. *Clearing the Air*^[42] discusses holding press conferences, organizing media events, disseminating poll results to elected officials and the media, holding community forums, using social networking, and making presentations to a variety of community groups. Long-term commitment and sustainability, the ninth and final principle, is addressed in the *Life after Enactment* component.^[42] Life after Enactment describes challenges to newly enacted ordinances and enforcement of the ordinances, implying a commitment beyond policy passage.

Evident from this analysis is that the CBPR principles do pertain to and facilitate tobacco control policy advocacy, and this highly regarded *Clearing the Air* model^[42] for policy action includes many principles of CBPR.^[7, 17] A review and revision of

Clearing the Air could easily include CBPR language and principles to be more empowering, increase power-sharing, increase the likelihood of capacity building, and increase sustainability. As an example, the language of the model's booklet is written to speak to individuals instead of to coalitions or partnerships. Simple language changes could be made, such as changing "Check with your coalition to find out who knows the council members and have them make a personal appeal for support" to "Coalition members should identify who knows each city council member and have the coalition member make a personal appeal for support to the council member." [42 (p19)] In addition to CBPR facilitating tobacco control policy advocacy, tobacco control policy advocacy can also inform the development and application of CBPR. An example is *Clearing the Air's* primary focus on policy advocacy; with modification to other specific public health issues, *Clearing the Air* could serve to guide other policy action at the local level. Thus, tobacco control policy informs CBPR.

CONCLUSION

The use of CBPR presents an opportunity for those interested in strengthening tobacco control policy advocacy, although Malone and colleagues describe tensions between institutional review boards and conducting CBPR. [29] Because competency in CBPR is considered important to addressing health challenges [15] and because tobacco is a leading public health issue worldwide, [1] this article sought to determine whether CBPR has the potential to facilitate tobacco policy advocacy efforts. The findings of this analysis strongly suggest it does.

- Minkler and colleagues' multimethod case-study analysis of CBPR policy projects provided a basis for analysis of recently published tobacco control policy

advocacy in terms of the similarities in success factors, challenges, and recommendations.[16] A subsequent review of the literature and comparison provided support for the potential of CBPR to facilitate tobacco control policy advocacy efforts.

- The results of a second analysis of *Clearing the Air*,[42] a well-known tobacco policy advocacy model, for inclusion of CBPR principles[7, 17] found several principles present, explicitly or implicitly, thus providing support for the potential of CBPR to facilitate tobacco control policy advocacy efforts

This literature review can be strengthened by expanding the terms in the CBPR and tobacco control policy search to include other participatory action research terms, such as *action research* and *participatory evaluation*. Future analysis and studies of tobacco control policy process or guidance documents could be conducted upon publication of the newest CBPR policy focused model (figure 1). In turn, CBPR researchers and proponents can look to tobacco control policy advocacy to determine potential CBPR policy action processes; this would increase the immediacy and usefulness of CBPR research. In sum, CBPR has the potential to facilitate successful tobacco policy advocacy, thereby reducing the worldwide epidemic of tobacco use.

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CBPR Contexts, Processes, Policy Strategies & Outcomes

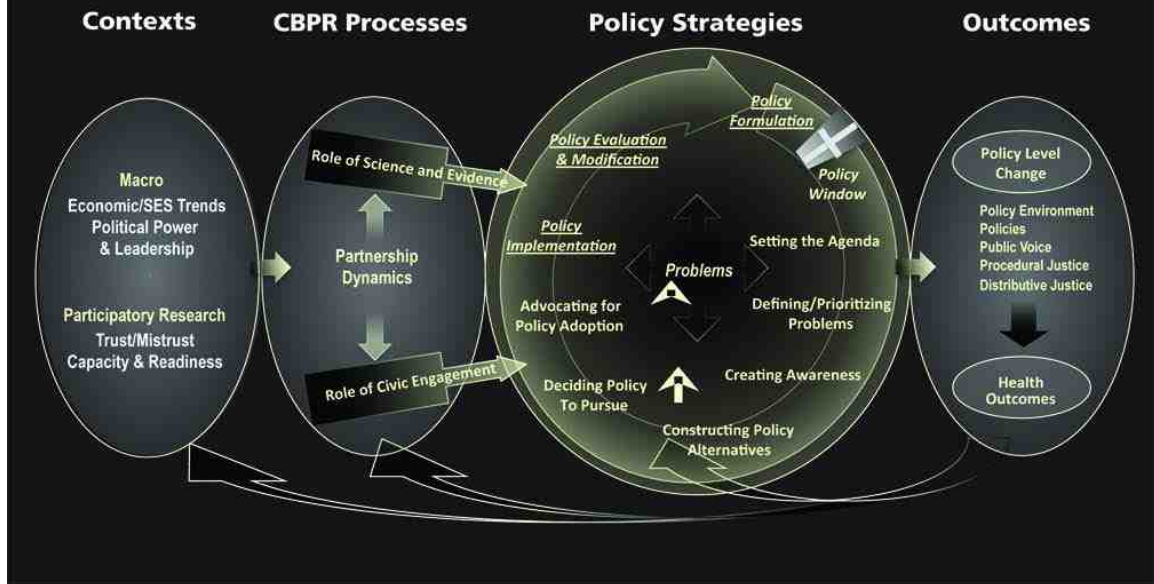


Figure 1 Community-based participatory research contexts, processes, policy strategies, and outcomes. Cacari-Stone, L., Garcia, A.P., Wallerstein, N. and Minkler, M. (in preparation). Promoting Place-Based Local Health Policy Through Community-Based Participatory Research: A Conceptual Model and Case Study Analysis.

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Web Only File

Comparison of the Four Articles Based on Minkler et al's Success Factors, Challenges, and Recommendations for Effectiveness in Community-Based Participatory Research

Minkler et al[16]	Fletcher et al[28]	Mendenhall et al[31]	Plagerson & Mathee[33]	Wynn et al[41]
Success Factors				
1. The presence of a strong, autonomous community partner organization prior to the development of the partnership.	1. Yes: Although autonomy was not addressed, the Victorian Aboriginal Controlled Community Health Organization was a strong organization representing 24 ACCHOs.	1. Yes: Job Corps and University of Minnesota.	1. No: However, a strong, autonomous, formally legal organization, the Riverlea Development Trust (Trust), developed during this initiative.	1. Yes: SCC.
2. A high level of mutual respect and trust among the partners and an appreciation of the complementary skills and resources that each partner brought.	2. Yes: Built upon participatory action research proven to be acceptable to Aboriginal communities. Also, indirectly discussed respect and trust through the creation of a culture where smoking could be discussed without fear of friction or of offending others.	2. Yes: "shared sense of trust" (p227).	2. Yes: Discussed trust and legitimacy as specific roles for select community members who were considered the intermediaries and communicators; "legitimacy" (p341).	2. Yes: "built upon mutual respect; trust; and open communication" (pS102); "responsibilities were shared...unique strengths and contributions at the grassroots level and public and private sectors were valued" (pS103); "Collaborative, equitable

				involvement" (pS104), "balance of power" (pS112), "transparency" (pS112).
3. Appreciation by all partners of the need for solid scientific data as a prerequisite for making the case for policy action.	3. Yes: Although not explicitly stated as a prerequisite; an all-staff survey was conducted, and solid science was included in the rationale for a policy.	3. Yes: Conducted surveys and focus groups.	3. Yes: Community members acted as intermediaries "in the process of translation of research into action" (p341).	3. Yes: Used evidence-based data to support policy.
4. Commitment to "doing your homework"—finding out what other communities have done, who holds decision-making authority, key leverage points, etc.	4. Yes: A comparison of policies by other ACCHOs.	4. Not specifically discussed.	4. Not specifically discussed.	4. Yes: Phase II included 1 month for development of an action plan.
5. Facility for and commitment to building strong collaborations and alliances with numerous and diverse stakeholders beyond the formal partnership.	5. Yes: As this was an internal workplace policy, efforts to build collaborative relationships focused on all staff.	5. Yes: As this was an internal policy change, efforts resulted in strong collaborations among students, staff, and researchers.	5. Yes: Two individual intermediaries assisted in discussions between key community individuals and in the formation of a new legal entity, the Trust. The Trust had its own constitution and board of trustees.	5. Yes: Community health advisors, community-based organizations, businesses, churches, health care facilities, and academic institutions joined together to form an

				independent coalition—SCC.
6. Knowledge of and facility for attending to a variety of “steps” in the policy process, whether or not the language of policy was spoken.	6. Yes: "this article is an indication of what can be achieved when a flexible, responsive and culturally appropriate process to policy development is adopted" (p97).	6. Yes: Researchers appeared to have guided the steps for this policy process.	6. Yes: Developed an "agenda for action" (p340).	6. Yes: Phase I was a 2-month capacity building and training on policy change processes and activities, including political assessments, communications, and advocacy.
Challenges				
1. Differences in the research timetable of the community and academic partners, with the former often eager for quicker data analysis and release of findings in the interests of using them to promote change.	1. Not applicable, as academic partners were not involved.	1. Not specifically discussed.	1. Challenge addressed: The Trust assists in "Challenging inclinations toward 'quick' translation" (p342).	1. Not specifically discussed.

<p>2. Different perspectives on policy work held by academic/health department and community partners, with the latter often more clear from the outset about the policy goals and objectives they wished to achieve.</p>	<p>2. Not specifically discussed: It appears entities involved had joint goals.</p>	<p>2. Challenge addressed: The academic partners wanted to address tobacco use, the staff and students were involved in early discussions to decide if they also wanted to address tobacco use.</p>	<p>2. Challenge addressed: The WHOCCUH wanted to advance policy action. The local community members were informed of the study and with two influential community members involved, the community-driven initiatives were developed.</p>	<p>2. Not specifically discussed: It appears the entities involved had joint goals.</p>
<p>3. Funding constraints and/or termination of funding or changes in sources of project support, which in turn delayed or changed the emphasis of research and action.</p>	<p>3. Not specifically discussed.</p>	<p>3. Challenges addressed: Challenge of students graduating in 6-12 months was identified and strategies were implemented to address this.</p>	<p>3. Not specifically discussed.</p>	<p>3. Not specifically discussed.</p>
<p>4. Perceptions among partnership members that they lacked sufficient understanding of policymaking processes and avenues for systems change.</p>	<p>4. Not specifically discussed: Although partners (staff) contributed to development of the final policy language.</p>	<p>4. Challenge addressed: Students expressed feelings of empowerment.</p>	<p>4. Not specifically discussed: Although partners (community members) "immediately engaged...emerged as powerful role players in post research action and policy development" (p341).</p>	<p>4. Challenge addressed: The coalition members and partners had previous training on policy processes.</p>

5. Difficulty talking in terms of policy goals and activities because of real or perceived prohibitions and constraints due to tax exempt status or funder concerns.	5. Not applicable: This was an internal policy, not legislative policy.	5. Not applicable: This was an internal policy, not legislative policy.	5. Not specifically discussed.	5. Not specifically discussed.
6. Difficulty measuring the longer-term impacts of project or policy change: who follows up when the money runs out?	6. Not specifically discussed.	6. Challenge addressed: Plans in place for ongoing data collection and analysis and to expand into other Job Corps sites.	6. Challenge addressed: The Trust was developed.	6. Not specifically discussed.
Recommendations				
1. Build leadership and base of support for research and action by being genuinely community driven. Start where people are by having the community partner and its base determines the “hot button issue” to be studied—an issue the community partner is committed to help	1. Yes: A culturally appropriate concept of "yarning" was used; yarning includes open conversations occurring without direct questioning as much as possible.	1. Yes: This was student and other Job Corps personnel driven.	1. Yes: Yearly feedback sessions on research to community reps have fostered ongoing relationships. The sessions defined issues to be addressed collectively. Moreover, the Trust provided ongoing community driven action.	1. Yes: The newly developed SCC rose from previous cancer-related training. A collective agreement determined a mission to impact tobacco-related policies.

research and mobilize around.				
2. Use a mix of research methods: People’s stories (captured in qualitative data) as well as the facts and statistics that emerge from quantitative approaches are needed to move policymakers and reach the media. Different forms of data also may be needed to reach different audiences.	2. Yes: Extensive incorporation of people's stories and an all-staff survey was conducted.	2. Yes: Surveys and focused groups were used.	2. Not enough information to determine.	2. At least partially: Data appears to be used; unable to determine if stories were used.
3. Produce high-quality research that can stand up to careful scrutiny, but make results easily accessible and highlight their policy relevance: Policy briefs, short reports, and “talking points,” and liberal use of pie charts and other graphics to help	3. Yes: High-quality research occurred with results shared. There is not enough information to determine products developed.	3. Yes: Internal focus groups and surveys conducted. Campus-wide newsletter developed to share results.	3. Yes: A panel study by the WHOCCUH and development of a glossy brochure; press statements released.	3. Yes: High-quality research used, talking points developed, PSAs used, and media stories released.

translate the findings will help policymakers and the media, as will “quotable quotes” from your interviews and other data sources.				
4. Use approaches and processes that reflect the local community culture and ways of doing things (even if it slows down the process).	4. Yes: Informal and formal "yarning" technique is reflective of local culture.	4. Yes: The local Job Corps culture was discussed and respected.	4. Yes: Development of the Trust delayed the immediate outcomes; however, it was recognized that the process was more important than the outcome.	4. Yes: SCC used a model (Direct Action Organizing Model) to empower people towards "collective action on their own behalf" (p.S103).
5. Remember that research includes not only the partnership’s original investigation but also subsequent study of the policy considerations involved. Community partners should be helped to research whether the policy level is the best route for achieving the change they seek; who has the power to make the change(s) being sought; what sorts of	5. Yes: Policy options were gathered, discussed, and the policy was written based upon staff language recommendations.	5. Yes: Consideration was given to a variety of possible policy solutions.	5. Yes: Based upon presentations, the community members identified that hookah pipe smoking needed to be addressed legislatively.	5. Yes: Included in Phase II development of an Action Plan. A political assessment was included.

policy-relevant data need to be collected, from whom and how (this is all part of “data collection”).				
6. Make sure all partners, including academics, understand that advocacy is different from “lobbying”: Gain an understanding of the different types of advocacy activities allowed of nonprofit organizations, including universities and community organizations; the activities are often more plentiful than partners believe.	6. Not applicable, as not legislative policy.	6. Not applicable, as not legislative policy.	6. Not specifically discussed.	6. Not specifically discussed.
7. Decide on a policy goal and identify the relevant policy targets and change strategies, but always have at least one “Plan B” and be open to compromise.	7. At least partially: A smoke-free workplace policy was the goal.	7. At least partially: A policy related to designated smoking areas and a prohibition on staff smoking with students was developed.	7. At least partially: Legislation addressing hookah pipe use was identified.	7. Yes: The goal was to preventing weakening of an existing law and expansion of the law.

<p>8. Build strong linkages with organizational allies and other stakeholders, but be strategic in your choice of partners: In policy work, as in community organizing, there are “no permanent enemies, no permanent allies.”</p>	<p>8. Yes: As this was an internal policy process, internal stakeholders were identified and linkages formed with staff.</p>	<p>8. Yes: As this was an internal policy process, internal stakeholders were identified and linkages formed with staff.</p>	<p>8. Yes: The Trust had its own constitution and board of trustees, including the local community representatives, the two individual intermediaries, and others. Also, the article discussed "crucial" relationships (p341).</p>	<p>8. Yes: Linkages were built with the city council members, mayor's office, city attorney, minority business leaders, and others.</p>
<p>9. Through trainings, Web-based tools, and other resources, increase partners’ understanding of policymaking and, as appropriate, of legal processes and issues. If possible, link early on with a “policy mentor” willing and able to help partners, including academic partners, to understand and better navigate the policy process.</p>	<p>9. Yes: As evidenced by ACCHO's role to "build the capacity of its membership and to advocate" (format secondary citation? (p93).</p>	<p>9. Not specifically discussed.</p>	<p>9. Not specifically discussed.</p>	<p>9. Yes: Intense education and high-level skill-building training occurred. Additionally, policy mentors and a policy analyst were available.</p>

<p>10. Offer solutions to policymakers and decision makers, not just complaints: Have relevant research readily available to show them why your solution is on target, practical, and affordable; include in your research some information on the “wallet angle” to show cost-effectiveness of your proposed solution; and provide them with the community support they need to advocate for change, e.g., helping to ensure strong community turnout at city council meetings, hearings, and other venues.</p>	<p>10. At least partially: A variety of policy options for staff to consider were offered. This recommendation is not as pertinent to internal policy processes.</p>	<p>10. At least partially: Solutions offered and support from students was evident. This recommendation is not as pertinent to internal policy processes.</p>	<p>10: At least partially: Provided brochure on study results.</p>	<p>10. At least partially: Policy solutions were offered, evidence-based data were used, and community support was visible.</p>
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<p>11. Plan for sustainability by seeking new funding streams, including those (e.g., some foundations) that actively support and encourage community-partnered research and action at the policy level, directed at promoting health equity.</p>	<p>1. Not specifically discussed.</p>	<p>11. Yes: Sustainability addressed from onset of project.</p>	<p>11. Yes: Fundraising discussed. Health equity discussion in the introduction: "disjuncture between the equal rights of every citizen...and...actualization" (p340); "findings suggested real engagement with the community's felt needs..." (p343).</p>	<p>11. Yes: Phase IV included planning for sustainability.</p>
<p>12. Take advantage of the university or health department partner's media office: It can help draft and widely disseminate press releases. Making sure that community partners participate in decisions about content and timely use change (and ensuring that a new measure or policy is in fact implemented) is likely to mean developing of such media, and that any media advocacy is</p>	<p>12. Not specifically discussed: Although the culturally appropriate "yarning" was the primary method for education.</p>	<p>12. At least partially: As an internal policy process, newsletters, posters, advertisements, etc., were developed; however, the role of the partner's media office was not discussed.</p>	<p>12. Yes: A glossy brochure designed by WHOCCUH summarized the study findings. It later was used to assist in development of an action plan, encouraged community participation "to lobby for support and action by city officials and political leaders, and in fund-raising efforts" (p340). Although it is not clear who assisted, a local campaign on hookah pipe smoking was implemented, including materials and press</p>	<p>12. Yes: The partners issued press releases, and press conferences were held. Yes, this was part of a larger campaign of PSAs, media stories, and community education.</p>

a well-thought out part of a bigger plan and campaign.			statements.	
13. Recognize that policy change takes a long time, and commit to staying involved over the long haul: Achieving policy change (and ensuring that a new measure or policy is in fact implemented) is likely to mean developing and implementing several strategies and working well beyond any funded grant period.	13. Yes: A review of policy is scheduled; it will again include "yarning."	13. Yes: Plans for long-term sustainability developed. Students stated "This is our baby," "This...needs to live on long after we are gone," and "so [it] is still here years from now" (p229).	13. Yes: The Trust as "local ownership of the research findings and a commitment change as a long-term process" (p342).	13. Yes: "Partnerships' commitment to continue working together after funding for the partnership ended; long-term commitments...to engage in policy change; institutionalized a grassroots mobilization strategy" (pS104) applied to tobacco, breast cancer, and Medicaid policy.

ACCHO, Aboriginal Controlled Community Health Organization; SCC, Smoking Cessation Coalition; WHOCCUH, World Health Organization Collaborating Centre for Urban Health; PSAs, public service ads.

CHAPTER 4

MANUSCRIPT 3: METHODS AND FINDINGS

Title:

A Statewide Study of Tobacco Smoke Pollution Exposure in a Rural State

Abstract

Objectives: Describe specific factors that influence tobacco smoke pollution levels and compare the quantity of tobacco smoke pollution in rural and non-rural venues. The study built on current scientific literature as it was the first U.S. statewide study on tobacco smoke pollution levels in hospitality venues, the first to use random sampling, and it quantified indoor tobacco smoke pollution specifically in rural areas.

Methods: A cross-sectional study in a predominantly rural state was conducted May – July 2012. The indoor air quality indicator of particulate matter 2.5 μm aerodynamic diameter or smaller ($\text{PM}_{2.5}$) was measured in a stratified random sample of 136 venues using a modification of Travers' method.

Results: A partial mediation model found that, controlling for venue type, 69.1% of smoke free policy's impact on tobacco smoke pollution levels was mediated by observed smoking. A significant association (Welch's $F(2, 43.63) = 9.55, p < .001$) between rurality and tobacco smoke pollution in bars was also observed.

Conclusions: Smoke-free laws had both indirect and direct impacts on tobacco smoke pollution. As rurality increased, tobacco smoke pollution in bars significantly increased.

Regulation of tobacco use in public places and workplaces is growing globally,¹⁻³ in part due to scientific evidence of immediate and long-term health effects caused by tobacco smoke pollution.^{1,4-6} In a recent report, the American Lung Association⁷ identified rural disparities in tobacco control and recommended protecting the rural public from tobacco smoke pollution. A gap exists in the global literature on tobacco smoke pollution exposure regarding comparing rural and non-rural venues. Although previous studies discussed rurality in their sampling frames or were conducted in rural areas, none provided a comparison between rural and non-rural areas or analyzed results by rurality.⁸⁻¹⁷ Additionally, there have been no statewide studies in the United States on tobacco smoke pollution using random sampling.

Particulate matter (PM) is one valid atmospheric marker used to measure tobacco smoke pollution levels¹⁸ and PM_{2.5} is the standard size measured.^{18,19} A comparison between PM_{2.5} and nicotine as measures of tobacco smoke pollution revealed that PM_{2.5} is highly sensitive to tobacco smoke, and has a high correlation with nicotine measurements.²⁰ Training protocols are available for assessment of PM_{2.5} levels²⁰

Protecting people from tobacco smoke pollution and banning smoking in public places are considered two of the “best buys” in reducing deaths, disease, and costs associated with non-communicable diseases.²¹ Because there is no safe level of tobacco smoke pollution,⁵ numerous organizations recommend the passage of laws protecting people against exposure.²²⁻²⁴ The only method that fully protects people from tobacco smoke pollution is the prohibition of smoking in all indoor areas without exemptions.⁵ Travers et al., for instance, reported an average 90% reduction in PM_{2.5} levels in 14 restaurants and bars after passage of the state of New York’s smoke-free air law.²⁵

High-risk populations affected disproportionately by tobacco use include people living in rural communities. Smoking prevalence is higher outside of metropolitan statistical areas.²⁶ Interestingly, despite the fact that more than 80% of both rural and urban residents agree that there is no safe level of tobacco smoke pollution, significantly more rural homes allow smoking than do urban homes; public support for smoke-free work policies in rural areas is significantly less than in urban areas, and rural areas have fewer workplace policies against smoking.²⁷ Once a workplace smoke-free policy is in place, however, there is no significant difference in compliance between rural and urban areas.²⁷ Also, rural children's tobacco smoke pollution exposure levels are higher due to the higher smoking rates.²⁸

The aims of this study were to 1) describe specific factors that influence tobacco smoke pollution levels and to 2) compare the quantity of tobacco smoke pollution in rural and non-rural venues. This study built on the current scientific literature in three aspects. First, it was the first U.S. statewide study on tobacco smoke pollution levels in hospitality venues. Second, it addressed a gap in the global literature by quantifying indoor tobacco smoke pollution in rural areas. Third, it used random selection, a sampling method infrequently used in the United States and globally in studying indoor tobacco use.

METHODS

This natural experimental study was cross-sectional. Natural experimental studies are those that evaluate interventions that were not intended for study and that permit causal inferences based on exposure or outcome variations.²⁹

Setting

The settings for this study were hospitality venues in North Dakota (ND), specifically restaurants and bars. Venues located within American Indian reservations were not included. During data collection, restaurants were required to be smoke free by state law.³⁰ Bars were not required to be smoke free by state law, although sufficient local ordinances were in place to allow for analysis of tobacco smoke pollution by presence of smoke-free law.³¹

Sample

A list of ND hospitality venues was obtained from various sources. State and local public health agencies provided restaurant lists. The ND Attorney General's Office provided a list of all licensed alcohol venues, which served as the bar population. Each list was reviewed to remove venues that met specific exclusion criteria, as described elsewhere.³¹ Several venues were on both the alcohol and restaurant lists; these venues were placed in a combined list and then reviewed to determine whether the venue operated primarily as a bar or a restaurant. All venues were categorized using the 2003 Rural Urban Continuum Codes (RUCC) as completely rural (RUCC 8-9), semi-rural/urban (RUCC 4-7), or non-rural (RUCC 1-3).³² Venues were also categorized as being within or outside of communities with an ordinance that required smoke-free bars and thus more stringent than the state law.

For this study, hospitality venues were stratified into three groups: restaurants, bars *within* communities with local ordinances that required bars to be smoke-free and thus stronger than the state law, and bars *outside* of communities with local ordinances that required bars to be smoke-free and thus stronger than the state law. Sample selection

included at least 30 venues per strata to meet standard guidelines for conducting independent samples t tests. A power analysis indicated at least 114 venues were required for planned regression analyses. Therefore, 54 cases were included from the large category of bars in communities without ordinances. An additional category comprised of 16 restaurants with 16 enclosed bars that allowed smoking was included in the sample. Ten of the 146 venues in this potential total sample were out of business, did not have seating, or were misclassified, leaving a total sample size of 136. Data from the 136 restaurants and bars was gathered between May 11, 2012 and July 13, 2012. The $PM_{2.5}$ levels were unable to be obtained in one venue; thus analysis that included $PM_{2.5}$ levels had a sample size of 135.

Measurement

Roswell Cancer Park Institute data collection protocols³³ were modified slightly and used for training and data collection for this study. SidePak™ AM510 Personal Aerosol Monitors (TSI Group, Shoreview, MN) were used for data collection. In short, data collection was discreet with observers counting the number of people and the number of burning cigarettes every 15 minutes. The Sidepak was set to a one-minute logging interval. Average $PM_{2.5}$ levels were calculated for each venue by removing the first and last minute of data and averaging the remaining data points. A calibration factor of 0.32, appropriate for secondhand smoke, was applied to all the $PM_{2.5}$ data.^{25,34,35} Room volume was measured using a sonic measurement device. Active smoker density (ASD) was defined as the average number of burning cigarettes per 100 m³. Occupant density (OD) was defined as the average number of occupants in an area per 100 m³. Restaurant data were collected from 11:30 am to 1:30 pm or from 5:00 pm to 8:00 pm on

all days of the week. Bar data were collected Thursday through Saturday, from 7:00 PM to midnight. Data were collected for all the venues on the required days, and the vast majority of data was collected during the specified times (94.1%).

The U.S. Environmental Protection Agency (EPA) sets the National Ambient Air Quality Standards for PM_{2.5} 24-hour and annual standards for outdoor air.³⁶ No standards exist for indoor air. The standards were revised on December 14, 2012, to improve public health protection.³⁶ The Air Quality Index (AQI) is the EPA's color-coded notification system designed to inform the public about the cleanliness of the air in relation to the standards and to provide health warnings with PM_{2.5} levels ranging from 0 µg/m³ to 500 µg/m³ categorized as good to hazardous. A significant harm level (SHL) for PM_{2.5} levels at 500 µg/m³ was recommended by the EPA in 2009 to indicate imminent and substantial endangerment to public health.^{37,38} The AQI, including the 2009 SHL, are used for interpretation of PM_{2.5} levels in this article.

Analysis

Descriptive statistics for categorical and ordinal variables included frequencies and percentages, and Fisher's exact test and chi-square tests were used to assess statistical significance of associations between categorical variables. Analysis of all continuous variables included standard deviations (SD) as a measure of variability and arithmetic means (AM) as a measure of central tendency. Statistical significance of observed differences in group means was assessed via independent samples *t* tests or one-way ANOVAs depending on whether means of two or more than two groups were compared. Alternate versions of each statistical test were used in the presence of a significant ($p < .05$) Levene's test indicating lack of homogeneity of variance. The ω^2 statistic was used

an effect size measure for ANOVAs, and $r_{contrast}$ was calculated as an effect size measure for follow up contrasts. As $PM_{2.5}$ levels were strongly right skewed, natural log transformed values for $PM_{2.5}$ ($\log PM_{2.5}$) were calculated and used as the dependent variable in linear regression analyses. Also, geometric means (GM) and geometric standard deviations (GSD) were calculated for $PM_{2.5}$ levels by exponentiating the means and SDs of the log transformed values, and exponentiated regression coefficients were calculated in order to allow for multiplicative interpretations of transformed coefficients. Correlations were calculated prior to regression analyses to assess the strength of bivariate associations.

Following initial linear regressions, a mediation model was fit for factors found to significantly influence $PM_{2.5}$ levels. Statistical testing of this mediation model with covariate proceeded as follows. First, linear regressions were conducted for each path in the mediation model, controlling for the covariate, to determine the significance of each path in the mediation model. Second, the indirect effect ($a*b$) was calculated and the Sobel test, $t_{a*b} = a*b / se_{a*b}$ where $se_{a*b}^2 = a^2*se_b^2 + b^2*se_a^2$ was used to determine if there was a significant indirect effect.³⁹ Third, the quotient of the indirect effect and the total effect was calculated to determine the percent of mediation.

RESULTS

The distribution of venue characteristics across AQI categories as well as descriptive statistics of venue characteristics are shown in Tables 1 and 2. Significant differences in observed smoking rates by venue type ($P < .001$), rurality ($P = .003$), state laws requiring smoke-free venues ($P < .001$), local laws requiring smoke-free venues ($P < .001$), and the presence of any law requiring smoke-free venues ($P < .001$) were

observed in Table 2. Using arithmetic means, the average EPA air quality category for venues where smoking was observed was “very unhealthy” ($PM_{2.5} = 182.2 \mu\text{g}/\text{m}^3$) compared to “moderate” ($PM_{2.5} = 18.8 \mu\text{g}/\text{m}^3$) for venues where smoking was not observed. The air quality for bars was “unhealthy” ($PM_{2.5} = 112.4 \mu\text{g}/\text{m}^3$) compare to “moderate” ($PM_{2.5} = 29.4 \mu\text{g}/\text{m}^3$) for restaurants.

Factors Influencing Tobacco Smoke Pollution

For all venues with sampling completed ($n = 135$), the GM $PM_{2.5}$ was $28.3 \mu\text{g}/\text{m}^3$ (GSD = $5.3 \mu\text{g}/\text{m}^3$). The highest tobacco smoke pollution level ($PM_{2.5} = 656 \mu\text{g}/\text{m}^3$) was in a bar where smoking was observed; this is above the SHL.^{37,38} The arithmetic mean tobacco smoke pollution levels for venues without smoking observed was 90% lower than in venues where smoking was observed. Stated another way, venues where smoking was observed had more than 9.7 times higher mean tobacco smoke pollution levels than did venues where smoking was not observed. The average levels for restaurants was 74% lower than in bars; or, bar venues had more than 3.8 times higher mean tobacco smoke pollution levels than did restaurants.

Pearson correlation coefficients indicated that the quantity of tobacco smoke pollution ($\log PM_{2.5}$) was positively associated with smoking observed ($r = .793$, $P < .001$), ASD ($r = .503$, $P < .001$), and type of venue ($r = .274$, $P = .001$). The presence of a smoke-free law was negatively associated with the quantity of tobacco smoke pollution ($r = -.678$, $P < .001$). Room volume ($r = -.134$, $P = .060$) and OD ($r = .030$, $P = .365$) were not significantly associated with quantity of tobacco smoke pollution. To determine the relative impact of specific factors on tobacco smoke pollution on hospitality venues statewide in ND, the following factors were included in a linear forward multiple

regression: presence of *any* law requiring venue to be smoke free, venue type (restaurant or bar), venue volume, OD, ASD, and observed smoking.

Accordingly, three models were compared in a stepwise fashion. The final model, $R^2 = .664$, $F(3,131) = 86.18$, $P < .001$, included the significant variables of observed smoking, type of venue, and presence of *any* law requiring the venue to be smoke free.

Following the regression results, a mediation model was tested as described above, see Figure 1. The linear regressions for each path, controlling for the covariate of type of venue; were all significant. A negative indirect effect was found ($a*b = -.833*2.344 = -1.953$; -1.95 exponentiated = 0.14) that may partially explain the total effect ($c = -2.821$; -2.82 exponentiated = 0.06). The Sobel test determined there was a significant indirect effect, $t_{a*b} = -6.75$, $P < .001$.³⁹ Thus, the relationship between the presence of *any* smoke-free law and quantity of tobacco smoke pollution was mediated by observed smoking after having statistically controlled for type of venue. A calculation of the percent of mediation ($-1.95/-2.82$) showed that 69.1% of the total effect was indirect as influenced by smoking observed, whereas 30.9% of the total effect was the residual direct impact of the policy on tobacco smoke pollution levels.

Rurality and Tobacco Smoke Exposure

The hypothesis of the study's second aim was: In hospitality venues, the quantity of tobacco smoke pollution will increase as rurality increases. The observed overall arithmetic mean tobacco smoke pollution levels for restaurant and bars was 36% lower in non-rural (RUCC 1-3) than in rural (RUCC 8-9) venues. For bars only, the corresponding percentage difference in arithmetic means was a 39% decrease. Stated another way, rural

venues had more than 1.6 times higher mean tobacco smoke pollution levels than did non-rural venues, this was true for restaurants and bars or for only bars.

Planned one-way analysis of variance (ANOVA) of logPM_{2.5} levels by rurality showed, overall, an association between rurality and tobacco smoke pollution, $F(2,132) = 7.921, P = .001, n = 135$, with a medium effect size ($\omega^2 = .09$). The planned contrasts revealed that tobacco smoke pollution increased significantly from non-rural to semi-rural and rural counties, $t(132) = 3.66, P < .001$, with a medium effect, $r_{contrast} = .30$. The planned contrasts revealed that tobacco smoke pollution did not change significantly from semi-rural to rural counties, $t(132) = 0.62, P = .54$, the effect, $r_{contrast} = .05$, was small.

A follow-up one-way ANOVA of logPM_{2.5} levels of only bars ($n = 95$) by rurality was conducted, Welch's $F(2, 43.633) = 9.552, P < .001$, with a large effect size ($\omega^2 = 0.15$). Follow-up contrasts within only bars revealed significantly increased tobacco smoke pollution levels between the non-rural counties and the combined semirural and rural counties, $t(62.695) = 3.481, P = .001$, with a medium effect, $r_{contrast} = .40$. Although the second contrast, between the semirural and rural counties, was not significant, $t(26.578) = 1.34, P = .193$, the effect size, $r_{contrast} = 0.25$, was medium. A similar follow up ANOVA of logPM_{2.5} levels by rurality in only restaurants was conducted, $F(2, 37) = 1.464, P = .244, n = 40$, and was not significant with a small effect size ($\omega^2 = 0.02$).

DISCUSSION

This was the first tobacco smoke pollution study conducted using random sampling and it is the first U.S. statewide study. A mediation model indicated that although smoke-free laws had a direct effect on the level of indoor tobacco smoke

pollution, the majority of the laws' effect was indirect. The presence of a smoke-free law negatively influenced the behavior of smoking. This decreased observed smoking influenced a decrease in tobacco smoke pollution levels. That is, smoke-free laws primarily decreased tobacco smoke pollution by influencing people's behaviors in the form of decreased observed smoking in the hospitality venues. Additionally, presence of a smoke-free law had a direct impact on the total effect on tobacco smoke pollution level.

This study differs from previous studies that identified ASD as highly correlated with tobacco smoke pollution levels.^{40,41} Although this study also found a significant correlation of tobacco smoke pollution with ASD, ASD was not a significant predictor in a linear regression model with other key variables. Instead, the type of venue, observed smoking, and the presence of *any* smoke-free law were significant predictors of PM_{2.5} levels in this model.

Two important policy implications emerge from the mediation model. First, the model suggests that smoke-free laws decreased the level of tobacco smoke pollution, mostly through influencing people's behaviors, although smoke-free laws by themselves were associated with decreased tobacco smoke pollution in hospitality venues. Second, when smoking was observed, it increased tobacco smoke pollution levels; thus, compliance with smoke-free laws is needed to effectively decrease tobacco smoke pollution levels. A research implication is that the observation of smoking may be sufficient to determine the effectiveness of smoke-free laws in decreasing exposure to tobacco smoke pollution, negating the necessity of expensive and time-consuming studies using equipment to assess tobacco smoke pollution.

This study also found a significant association between rurality and average tobacco smoke pollution levels in bars: bars in the combined semi-rural/urban (RUCC 4-7) and rural (RUCC 8-9) counties had higher levels of tobacco smoke pollution than did bars in non-rural counties (RUCC 1-3). However, there was only a small effect size change and no significant difference in tobacco smoke pollution levels in bars when county rurality increased from RUCC 4-7 to RUCC 8-9. Among restaurants only, however, no significant differences were found in tobacco smoke pollution levels by rurality. Thus, the impact of rurality on tobacco smoke pollution depends on the type of venue, affecting bars much more than restaurants. Restaurants, overall, have consistently low tobacco smoke pollution levels which seem to reflect compliance with smoke-free restaurant laws and the relatively uniform policy environment for restaurants across the state of ND. More rural bars have, in contrast, significantly higher tobacco smoke pollution levels than do non-rural bars. In sum, although rurality does not appear to affect tobacco smoke pollution levels in restaurants, there are substantial differences in tobacco smoke pollution in bars between non-rural venues (RUCC 1-3) and semirural/urban and rural combined venues (RUCC 4-8).

Policy implications of these findings on rurality and tobacco smoke pollution include that, as an issue of social justice, a continuing recognition of disparities in exposure to tobacco smoke pollution in rural areas is needed. Also, policymakers need to continue to be informed that when smoking is allowed, especially in areas with smaller populations, adverse role modeling and social norming occurs.

Directions for further research

Future studies need to be conducted to determine whether the mediation model was an isolated finding for ND or whether it can be replicated. Also, additional studies of tobacco smoke exposure and policy impact in rural areas are needed. Specifically, as this was the first study that compared rural and non-rural venues and as the number of venues in semi-rural areas was limited in this study, greater sampling of semi-rural venues will be important to include in future proposals. Studies of successful policy strategies adapted to rural cultures are also needed. These studies could inform tobacco policy advocates on best practices to collaborate with people in rural areas and increase coverage of rural populations by smoke-free laws.

Conclusions

This study built on current scientific literature as it used random sampling and was the first U.S. statewide study on tobacco smoke pollution levels in hospitality venues. This study also begins to fill the gap in the global literature on tobacco smoke pollution exposure regarding comparing rural and non-rural venues. Smoke-free laws had both indirect and direct impacts on tobacco smoke pollution as a partial mediation model found smoke free policy's impact on tobacco smoke pollution levels was mediated by observed smoking. The study also found that as rurality increased, tobacco smoke pollution in bars significantly increased; these findings support the theory that people living in rural communities constitute a high-risk population affected disproportionately by tobacco use.⁷

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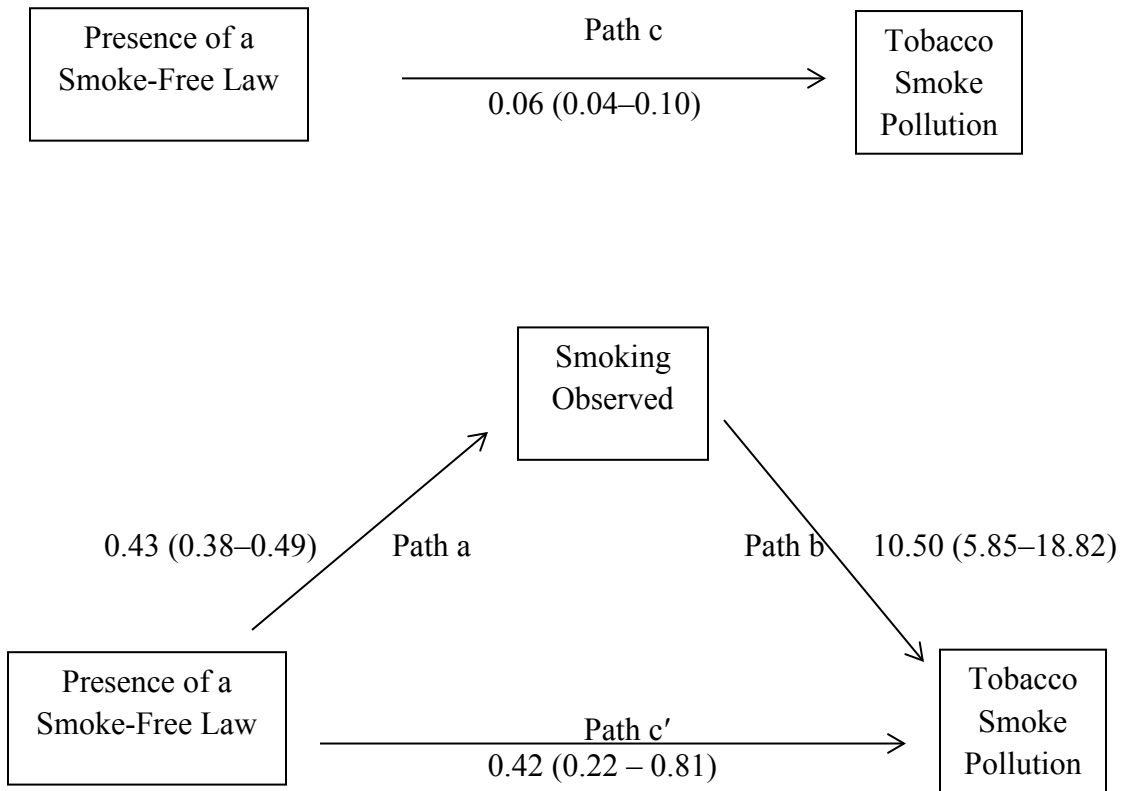


FIGURE 1—Partially mediated model of variables influencing tobacco smoke pollution (PM_{2.5}): North Dakota, 2012. This model controlled for type of venue (restaurant or bar). Path a, b, c, and c' values are exponentiated unstandardized regression coefficients and exponentiated 95% confidence intervals.

TABLE 1—Number of Sampled Venues in each AQI Category by Selected Venue Category: North Dakota, 2012

AQI Revisé Breakpoints PM _{2.5} (µg/m ³) ^a	AQI Category	Color Code	All Venues, n = 135	Restaurants, n = 40	Bars, n = 95	Smoking Observed, n = 57	Smoking Not Observed, n = 78	Local Ordinance, n = 41	No Local Ordinance, n = 94
0.0–12.0	Good	Green	53	18	35	1	52	32	21
12.1–35.4	Moderate	Yellow	19	14	5	2	17	8	11
35.4–55.4	Unhealthy for Sensitive Groups	Orange	4	2	2	2	2	1	3
55.5–150.4	Unhealthy	Red	31	5	26	25	6	0	31
150.5–250.4	Very Unhealthy	Violet	15	1	14	14	1	0	15
250.5–350.4	Hazardous	Maroon	7	0	7	7	0	0	7
350.5–500	Very Hazardous	Maroon	4	0	4	4	0	0	4
>500	Significant Harm	Black	2	0	2	2	0	0	2

Note. PM_{2.5} = particulate matter with a median aerodynamic diameter of less than 2.5 microns particulate matter < 2.5 micron in diameter.

^aAccording to the United States Environmental Protection Agency Air Quality Index

TABLE 2—Sample Descriptive Characteristics and Differences of Smoking Observed by Characteristics: North Dakota, 2012

Characteristics	n	PM _{2.5} μg/m ³ AM (SD)	AQI Color Code ^a by AM PM _{2.5}	PM _{2.5} μg/m ³ GM (GSD)	AQI Color Code ^a by GM PM _{2.5}	Room Volume m ³ AM (SD)	No. of People AM (SD)	OD AM (SD)	No. of Lit Cigarettes AM (SD)	ASD AM (SD)	Smoking Observed n (%) ^{b,c}
Sample	136 ^c	87.8 (122.2)	Red	28.6 (5.3)	Yellow	494 (601)	18.5 (16.9)	5.7 (5.8)	0.9 (1.7)	0.29 (5.78)	57 (41.9)
Venue type											
Not co-located restaurant	29	19.2 (25.7)	Yellow	10.2 (3.1)	Green	540 (935)	19.2 (17.9)	6.5 (6.8)	0.2 (0.8)	0.05 (0.21)	2 (6.9)
Not co-located bar	83	111.8 (142.6)	Red	33.2 (6.2)	Yellow	503 (440)	18.3 (17.1)	4.6 (3.3)	1.1 (1.8)	0.33 (0.53)	44 (53.0)
Co-located restaurant	12 ^c	56.5 (63.5)	Red	32.1 (3.1)	Yellow	205 (195)	11.6 (7.4)	8.2 (6.3)	0.0 (0.0)	0.00 (0.00)	0 (0.0)
Co-located bar	12	116.2 (78.9)	Red	96.6 (1.9)	Red	587 (777)	24.8 (18.5)	8.9 (12.0)	2.4 (2.2)	0.82 (1.14)	11 (91.7)
Rurality											
RUCC 1- 3	51	66.0 (130.2)	Red	14.1 (5.3)	Yellow	646 (835)	23.9 (22.0)	5.7 (4.8)	0.6 (1.5)	0.20 (0.52)	12 (23.5)

Characteristics	n	PM _{2.5} µg/m ³ AM (SD)	AQI Color Code ^a by AM PM _{2.5}	PM _{2.5} µg/m ³ GM (GSD)	AQI Color Code ^a by GM PM _{2.5}	Room Volume m ³ AM (SD)	No. of People AM (SD)	OD AM (SD)	No. of Lit Cigarettes AM (SD)	ASD AM (SD)	Smoking Observed n (%) ^{b,c}
RUCC 4–7	26	97.0 (127.7)	Red	36.6 (4.8)	Orange	466 (492)	23.3 (16.4)	8.5 (10.1)	1.8 (2.5)	0.56 (0.93)	14 (53.9)
RUCC 8–9	59 ^c	102.9 (111.3)	Red	46.3 (4.6)	Orange	373 (311)	11.6 (6.6)	4.4 (3.0)	0.8 (1.2)	0.23 (0.35)	31 (53.5)
Law requiring smoke-free ^d											
Local ordinance	41	8.7 (9.1)	Green	6.4 (2.1)	Green	581 (544)	26.9 (24.1)	6.2 (5.2)	0.0 (0.0)	0.00 (0.00)	0.0 (0.0)
No ordinance	95 ^c	122.3 (132.3)	Red	53.9 (4.8)	Orange	457 (624)	14.9 (10.8)	5.5 (6.0)	1.3 (1.9)	0.41 (0.66)	57 (60.6)
State law	41 ^c	29.4 (42.3)	Yellow	14.0 (3.5)	Yellow	448 (813)	17.1 (16.0)	6.9 (6.6)	0.2 (0.7)	0.39 (0.65)	2 (5.0)
Any law	70 ^c	19.6 (34.2)	Yellow	9.3 (3.0)	Green	535 (742)	20.5 (20.4)	6.1 (5.7)	0.1 (0.5)	0.02 (0.14)	2 (2.9)

Note. PM_{2.5} = Particulate matter with a median aerodynamic diameter of less than 2.5 microns; AM = arithmetic mean; SD = standard deviation; GM = geometric mean; GSD = geometric standard deviation; OD = occupant density = [(average number of people / room volume m³) * 100]; ASD = active smoker density = [(average number of lit cigarettes / room volume m³) * 100]; RUCC = rural urban continuum code; RUCC 1 – 3 = non-rural; RUCC 4 – 7 = semirural/urban; RUCC 7 – 8 = rural.

* $P < .05$; ** $P = < .01$; *** $P < .001$.

^aAccording to the United States Environmental Protection Agency Air Quality Index

^b%of subcategory (example, not co-located venues = $2/29 = 6.90$).

^cOne co-located restaurant not accessible during data collection.

^dVenues may be included in one or more “law requiring smoke-free” categories

CHAPTER 5

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

Exposure to tobacco smoke pollution is an unacceptable and avoidable health risk. In addition to the significant immediate and long term morbidity and mortality caused by tobacco smoke exposure, it also contributes to the social norming of tobacco use leading youth and young adults to begin using tobacco. Numerous public health organizations, including the World Health Organization (2007) and the U.S. Center for Disease Control and Prevention (USDHHS, 2010b), and Healthy People 2020 (USDHHS, 2010a), recommend passage of legislation to prevent exposure. Thus, regulation of tobacco use in public places and workplaces is growing globally. This study, the first statewide random sample study in the U.S., and the largest rural study known globally, reveals important contributions to the science of tobacco control.

Chapter 2: Social Justice: A Concept Analysis

Chapter 2 addressed the issue of tobacco control as a social justice issue; specifically, the social justice attributes of fairness, just policies, equity in human rights, and sufficiency of well-being pertain to tobacco control (Buettner-Schmidt & Lobo, 2011). Increasingly tobacco use in the U.S. is more prevalent in populations experiencing health disparities, including people residing in rural areas and those with lower socioeconomic resources. Additionally, on a global level, the tobacco companies have responded to decreasing tobacco use and profits in the U.S. by marketing and selling tobacco in countries without the regulations on its production and marketing like that in the U.S. By including rural venues and a planned post-hoc analysis of venues by location in poverty areas, this study adds to the current literature and science of these populations experiencing health disparities. A research implication is to analyze social justice's

dimensions of process and product, as parts of the whole social justice concept, with separate, yet related, attributes, antecedents and consequences. This may provide clarity to increase the effectiveness of social justice actions and its advocates (Buettner-Schmidt & Lobo, 2011).

Chapter 3: Community-Based Participatory Research and Tobacco Control Policy

The third chapter was a paper that critically reviewed the use of community-based participatory research (CBPR) for policy action, with a focus on tobacco control policy advocacy. The Institute of Medicine (2003) identified CBPR as one competency public health professionals need to address health challenges. Passage of policy and legislation frequently requires building and maintaining public knowledge, engagement, and support. CBPR characteristics coincide with these policy advocacy elements, thereby assisting tobacco policy advocates to advance policy efforts in conjunction with the community.

Two analyses determined CBPR can inform tobacco control. One analysis identified a new CBPR model that focused directly on policy and included the dimensions of contexts, CBPR processes, policy strategies, and outcomes (Cacari-Stone, et al., in preparation; see Chapter 3, Figure 1). This model divided policy change into five categories: policy environment, policies, public voice, procedural justice, and distributive justice. This newest framework seems to hold the most promise to guide future tobacco control policy including policy development, analysis, and other related studies due to its intense focus on policy strategies and the outcomes of CBPR processes.

An analysis of *Clearing the Air* (2011), a well-known tobacco policy advocacy model, for inclusion of CBPR principles (Israel et al., 1998, 2005) found several principles present, explicitly or implicitly. This provided support for the potential of

CBPR to facilitate tobacco control policy advocacy efforts. A recommendation was made to revise *Clearing the Air* (2011) to include CBPR language and principles to be more empowering, increase power-sharing, increase the likelihood of capacity building, and increase sustainability. As one example, the language of the model's booklet could be written to speak to coalitions or partnerships instead of individuals.

The conduct of this study was feasible, and successful, only by the involvement of several agencies and individuals. This author's extensive public health experience and a large network of public health professionals, combined with a belief in collaboration and partnerships, and study of CBPR allowed for informal incorporation of some of community-based participatory research principles (Israel, et al, 2008) into the study.

For example, the principle of recognizing community as a unit of identity was incorporated as the study was conducted within various communities and stratified the sample by the rurality of the community and presence of local ordinances. A second principle of building on strengths and resources in the community was evident by ongoing communications with tobacco prevention coordinators in local public health entities during the study. These communications included acknowledging and relying on the local coordinators as knowledgeable local resource persons who assisted in identifying the study's population characteristics such as smoking status of venues, location of venues, and so forth. The local tobacco prevention coordinators, staff, and tobacco coalition members also assisted in data collection. Several have expressed a desire to assist with similar studies in the future.

A third principle, integrating and achieving a balance between research and action for the mutual benefit of all partners, will be evidenced during the dissemination of this

study. As North Dakota passed a comprehensive statewide smoke-free law in November 2012 (NDCC, §23-12-09 - §23-12-11, *Smoking in Public Places and Places of Employment*, see Appendix R), the results of this will be distributed by the ND Center for Tobacco Prevention and Control Policy to the ND Legislature during the 2013 legislative session. See Appendix Q for a policy brief. Fourth, a long term process and commitment to sustainability, was evidenced by the history of this author's involvement in tobacco control since 1992 with several related publications, reports, and peer-reviewed presentations (Buettner-Schmidt, 2005, 2007; Buettner-Schmidt, Mangskau, & Boots, 2007; Buettner-Schmidt & Moseley, 2003; Buettner-Schmidt, K., Muhlbradt, M., & Brierley, 2003). Additionally, an ongoing funding and collaboration of this author with the ND Center for Tobacco Prevention and Control Center in the form of a post-statewide law implementation study during 2013.

CBPR presents an opportunity for those interested in strengthening tobacco control policy advocacy and policy research. Future research expanding the terms related to CBPR and tobacco control policy in a literature search to include other participatory action research terms, such as *action research* and *participatory evaluation*, may strengthen future literature reviews and research. Upon publication of Cacari-Stone (in preparation), the newest CBPR policy focused model, studies could be conducted of the model's relevance to tobacco control policy processes or guiding documents. In sum, CBPR principles pertain to and have the potential to facilitate successful efforts in tobacco control for both advocacy action and policy related studies, thereby reducing the worldwide epidemic of tobacco use.

Chapter 4: Methods and Findings and Appendix N: Unpublished Results.

The results of this natural experimental study that was cross-sectional revealed findings valuable to the field of tobacco control. Natural experimental studies are those that evaluate interventions that permit causal inferences based on exposure or outcome variations that were not intended for study and that exposure or outcome variations may allow for causal inferences (Craig, et al., 2011).

Aim 1

First, the study provided baseline data of tobacco smoke exposure in hospitality venues throughout North Dakota. With the recent passage of a statewide smoke-free law in North Dakota, a follow up study to examine the impact of the new legislation will be feasible. During data collection, restaurants were required to be smoke-free by state law. Bars were not required to be smoke-free by state law, although sufficient local ordinances were in place to allow for analysis of tobacco smoke pollution by presence of smoke-free law.

For all venues with sampling completed ($n = 135$), the GM $PM_{2.5}$ was $28.3 \mu\text{g}/\text{m}^3$ (GSD = $5.3 \mu\text{g}/\text{m}^3$). The highest tobacco smoke pollution level ($PM_{2.5} = 656 \mu\text{g}/\text{m}^3$) was in a bar where smoking was observed; this is above the SHL.^{37,38} The arithmetic mean tobacco smoke pollution levels for venues without smoking observed was 90% lower than in venues where smoking was observed. The mean levels for restaurants was 74% lower than in bars

A unique partial mediation model indicated that although smoke-free laws had a direct effect on the level of indoor tobacco smoke pollution, the majority of the laws' effect was indirect. The partial mediation model found, that controlling for venue type, 69.1% of smoke-free policy's impact on tobacco smoke pollution was mediated by

observed smoking and 30.9% of the total effect was the direct impact of policy on tobacco smoke pollution levels. The presence of a smoke-free law negatively influenced the behavior of smoking. This decreased observed smoking influenced a decrease in tobacco smoke pollution levels. That is, smoke-free laws primarily decreased tobacco smoke pollution by influencing people's behaviors in the form of decreased observed smoking in the hospitality venues. Additionally, presence of a smoke-free law had a direct impact on the total effect on tobacco smoke pollution level.

This study differs from previous studies that identified active smoker density (ASD) as highly correlated with tobacco smoke pollution levels (King et al., 2012; Liu et al., 2010). Although this study also found a significant correlation of tobacco smoke pollution with ASD, ASD was not a significant predictor in a linear regression model with other key variables. Instead, the type of venue, observed smoking, and the presence of *any* smoke-free law were significant predictors of PM_{2.5} levels in this model.

Two important policy implications emerge from the mediation model. First, the model suggests that smoke-free laws decreased the level of tobacco smoke pollution, mostly through influencing people's behaviors, although smoke-free laws by themselves were associated with decreased tobacco smoke pollution in hospitality venues. Second, when smoking was observed, it increased tobacco smoke pollution levels; thus, compliance with smoke-free laws is needed to effectively decrease tobacco smoke pollution levels. A research implication is that the observation of smoking may be sufficient to determine the effectiveness of smoke-free laws in decreasing exposure to tobacco smoke pollution, negating the necessity of expensive and time-consuming studies using equipment to assess tobacco smoke pollution. Future studies need to be conducted

to determine whether the mediation model is an isolated finding for ND; or whether it can be replicated. Also, additional studies of tobacco smoke exposure and policy impact in rural areas are needed. Studies of successful policy strategies adapted to rural cultures are also needed.

Aim 2

A second finding of import was that the quantity of tobacco smoke pollution in bars increased as rurality increased. The observed overall arithmetic mean tobacco smoke pollution levels for restaurant and bars was 36% lower in non-rural (RUCC 1-3) than in rural (RUCC 8-9) venues. For bars only, the corresponding percentage difference in arithmetic means was a 39% decrease.

This study found a significant association between rurality and mean tobacco smoke pollution levels in bars: bars in the combined semi-rural/urban and rural counties had higher levels of tobacco smoke pollution than did bars in non-rural counties. Among restaurants only, however, no significant differences were found in tobacco smoke pollution levels by rurality. Thus, the impact of rurality on tobacco smoke pollution depends on the type of venue, affecting bars much more than restaurants. Restaurants, overall, have consistently low tobacco smoke pollution levels which seem to reflect compliance with smoke-free restaurant laws and the relatively uniform policy environment for restaurants across the state of ND. More rural bars have, in contrast, significantly higher tobacco smoke pollution levels than do non-rural bars.

In sum, although rurality does not appear to affect tobacco smoke pollution levels in restaurants, there are substantial differences in tobacco smoke pollution in bars

between non-rural venues (RUCC 1-3) and semirural/urban and rural combined venues (RUCC 4-8).

This study begins to fill the gap in the global literature of tobacco smoke pollution exposure studies comparing rural and non-rural venues. A literature review for this study was unable to locate any tobacco smoke pollution studies that included a rural analysis or comparison of rural to non-rural locations. Although some studies discussed rurality in the sampling frames or were conducted in rural areas (Gotz et al., 2008; Hahn, Lee, Robertson, Cole, & Whitten, 2009; Hahn, Lee, Vogel, & Whitten, 2008; Hahn, Lee, Vogel, Whitten, & Robertson, 2009; Hahn, Lee, Whitten, & Robertson, 2009; Jones et al., 2006; Lee et al., 2007; Semple et al., 2010; Semple, Maccalman, et al., 2007; & Travers & Vogl, 2010).

The findings supported the theory that people living in rural communities constitute a high-risk population affected disproportionately by tobacco use (American Lung Association, 2012). Indicators of this disparity include that smoking prevalence is higher outside of metropolitan statistical areas (USDHHS, 2010c); that public support for smoke-free work policies in rural areas is significantly less than in urban areas, and rural areas have fewer workplace policies against smoking (American Academy of Pediatrics Julius B. Richmond Center of Excellence [AAP], 2008).

Policy implications of these findings on rurality and tobacco smoke pollution include that, as an issue of social justice, a continuing recognition of disparities in exposure to tobacco smoke pollution in rural areas is needed. Also, policymakers need to continue to be informed that when smoking is allowed, especially in areas with smaller populations, adverse role modeling and social norming occurs.

Additional studies of tobacco smoke exposure and policy impact in rural areas are needed. Specifically, as this was the first study known that compared rural with non-rural venues and as the number of venues in semi-rural areas was limited in this study, greater sampling of semi-rural venues will be important to include in future proposals. Studies of successful policy strategies adapted to rural cultures are also needed. These studies could inform tobacco policy advocates on best practices to collaborate with people in rural areas and increase coverage of rural population by smoke-free laws.

Aim 3

The study's third aim was to compare the quantity of tobacco smoke pollution in hospitality venues located within and outside of communities with local ordinances that required bars to be smoke-free and thus more stringent than the state law. The results revealed that the mean tobacco smoke pollution level was lower in hospitality venues located within communities with local ordinances that required bars to be smoke-free and thus more stringent than state law than those located outside of communities with such an ordinance.

Using geometric means, bars within communities with a local ordinance that required bars to be smoke-free had a 94% lower mean tobacco smoke pollution level than did those outside of a community with a local ordinance. Using arithmetic means, the decrease was 96%. An interaction was identified, meaning the impact of local ordinances on tobacco smoke pollution levels varied by the type of venue. In communities with an ordinance with the requirement that bars to be smoke-free and thus stronger than state law, bars experienced significant reductions in mean tobacco smoke pollution levels.

Although not significant, restaurants experienced a reduction of 38% by geometric means and 58% by arithmetic means, in tobacco smoke pollution levels based upon being within or outside a community with a local ordinance. The lack of a significant reduction in tobacco smoke pollution levels in restaurants may be due to that the state law required all restaurants to be smoke-free; therefore presence of a local ordinance did not change the legal requirement for restaurants to be smoke-free.

This finding also supported the mediation model identified in aim 1 that policies reduce tobacco smoke pollution levels significantly, albeit indirectly. The results specifically identified an interaction of the presence of a local ordinance that required bars to be smoke-free and the venue type as having significant influence in decreasing mean tobacco smoke pollution levels.

Policy implications of these results may include the enhanced positive influence of having local laws in communities in addition to a state law requiring smoke-free hospitality venues. Theoretically, it is thought that the amount of community education that occurs during the policy process to pass a local law helps to inform the public of the health effects of tobacco smoke exposure, increases knowledge that the only way to prevent exposure is to create smoke-free environments, and that these policies are the norm in numerous communities. Further investigation of the interaction effect is needed to determine if it can be replicated and if differences in tobacco smoke pollution occurs when a local smoke-free law is passed even if a statewide smoke-free law is in place.

Compliance with smoke-free laws was also studied, first by comparing venues within and outside of communities with a local ordinance that required bars to be smoke-free and thus stronger than state law. Using arithmetic means, venues within communities

with a local ordinance, had 66.5% mean lower tobacco smoke pollution levels than did those compliant venues outside of communities with ordinance. Venues within communities with a local ordinance, all of which were compliant, had 87.7% lower tobacco smoke pollution levels than did those non-compliant venues outside of communities with ordinance. The findings revealed that compliance increased significantly in the presence of a local ordinance that required bars to be smoke-free and thus stronger than state law. Venues within communities with local ordinances had the highest compliance rate and the lowest mean tobacco smoke pollution level. Venues not within communities with local ordinances had the lowest compliance rate; of those noncompliant had the highest mean tobacco smoke pollution levels.

Compliance was also analyzed by co-location status of venues, as the study included co-located bars and restaurants where restaurants could not allow smoking but bars could allow smoking provided regulations requiring separately enclosed bars were followed. Venues not co-located had significantly higher compliance rates than co-located venues. Using arithmetic means, the compliant not co-located venues had 83.2% lower mean tobacco smoke pollution levels than the compliant co-located venues. Perhaps the most noteworthy compliance finding was that mean tobacco smoke pollution levels in co-located venues that were compliant had 6 times higher mean tobacco smoke pollution levels than the compliant not co-located venues. Additionally, simply by being a co-located venue, whether compliant or not, mean tobacco smoke pollution levels were higher than compliant not co-located venues.

In conclusion, compliance and tobacco smoke pollution levels were affected by both the presence of a local ordinance that required smoke-free bars and by venue co-

location status. A medium effect occurred between compliance and the presence of a local ordinance, meaning the presence of a local ordinance increased compliance. A large negative effect occurred between compliance and co-location; meaning co-location negatively impacted compliance, and thus was associated with decreased compliance. Of the 10% (n = 7) noncompliant venues, smoking was observed in 2 of the 70 (2.9%) venues; both were in restaurants not co-located. Observation of the co-location requirements for restaurants with enclosed separate smoking bars found 5 of the 12 (41.7%) noncompliant. As expected, compliant venues had the lowest mean tobacco smoke pollution levels.

These findings related to compliance rates within communities with local laws followed previous research that the presence of a smoke-free law typically has high compliance. That local ordinances increased compliance even in the presence of a state law may be a new finding; additionally the increased compliance appeared to decrease mean tobacco smoke pollution levels. The finding that co-location of venues decreased compliance is not new for North Dakota, as a previous study of compliance (Buettner-Schmidt, Mangskau, and Boots, 2007) with the then state smoke-free law also found decreased compliance in co-located venues.

In terms of policy recommendations, that co-location significantly decreases compliance and appears to increase tobacco smoke exposure provides another rationale to the existing public health recommendation to require venues to be completely smoke-free to assure the highest protection against tobacco smoke exposure. Also any law that permits co-located venues should mandate studies of tobacco smoke pollution levels to inform future policy decisions. Although compliance with smoke-free laws is typically

high, future studies in rural areas on the presence of local laws increasing compliance with state laws with a potential corresponding decrease in tobacco smoke exposure should be investigated.

Aim 4

An attempt to study socioeconomic status influence on tobacco smoke pollution levels was confounded as venues in the highest poverty areas were all required to be smoke-free by state or local law and all were compliant. This study used SES as an indicator for poverty; other poverty indicators may have provided different results. Further conceptual and theoretical development of the influences of poverty, in conjunction with planned, rather than post-hoc analysis, to assess SES influence on tobacco smoke pollution levels in hospitality venues is recommended. Also selected case studies of North Dakota venues within low SES communities may advance the understanding of the relationship between poverty and tobacco smoke pollution. As with rural populations, the continuing recognition of populations in poverty experiencing disparities of tobacco use and exposure to tobacco smoke pollution is an issue also of social justice.

Summary of Findings, Policy Implications, and Research Findings

Findings

1. This research indicated that smoke-free laws have both an indirect (60.1%) and direct (30.9%) effect on indoor tobacco smoke pollution levels. That is, smoke-free laws primarily decreased tobacco smoke pollution by influencing people's behaviors in the form of decreased observed smoking in the hospitality venues. The presence of a smoke-free law also a direct impact on tobacco smoke pollution levels.

2. Observed smoking increased mean tobacco smoke pollution levels. Mean tobacco smoke pollution levels for venues without smoking observed was 90% lower than in venues where smoking was observed. The highest tobacco smoke pollution level ($PM_{2.5} = 656 \mu\text{g}/\text{m}^3$) was in a bar where smoking was observed.
3. As rurality increased, tobacco smoke pollution in bars significantly increased. Mean tobacco smoke pollution levels in non-rural bars were 39% lower than in rural bars.
4. Restaurants, overall, have consistently low mean tobacco smoke pollution levels which seem to reflect compliance with smoke-free restaurant laws and the relatively uniform policy environment for restaurants across the state of ND.
5. Although rurality does not appear to affect tobacco smoke pollution levels in restaurants, there are substantial differences in tobacco smoke pollution in bars between non-rural venues (RUCC 1-3) and semirural/urban and rural combined venues (RUCC 4-8).
6. Within communities with a local ordinance requiring bars to be smoke-free, bars experienced a significant reduction in mean tobacco smoke pollution levels. Although restaurants also experienced a reduction, it was not significant.
7. Compliance with smoke-free laws increased significantly in communities with a local ordinance requiring smoke-free bars. Hospitality venues within communities with local ordinances requiring smoke-free bars had the highest compliance rates and the lowest average tobacco smoke pollution levels.
8. Compliance with smoke-free laws decreased significantly in venues that were co-located. Even in compliant co-located venues, the average tobacco smoke pollution

levels were 6 times higher than in venue not co-located and compliant. Decreased compliance of co-located venues was not a new finding in ND.

Policy Implications

1. Smoke-free laws decreased the average level of tobacco smoke pollution mostly through influencing people's behaviors in the form of decreased observed smoking in hospitality venues (Aim 1).
2. Smoke-free laws in and of themselves were associated with decreased tobacco smoke pollution in hospitality venues (Aim 1).
3. When smoking is observed, it increased mean tobacco smoke pollution levels; thus compliance with smoke-free laws is needed to effectively decrease tobacco smoke pollution levels (Aim 1).
4. Observation of smoking may be sufficient to determine the effectiveness of smoke-free laws in decreasing exposure to tobacco smoke pollution, negating the necessity of expensive and time consuming studies using equipment to measure tobacco smoke pollution (Aim 1).
5. As an issue of social justice, a continuing recognition of disparities in exposure to tobacco smoke pollution in rural areas is needed (Aim 2).
6. Policymakers need to continue to be informed that when smoking is allowed, especially in areas with smaller populations, adverse role modeling and social norming occurs (Aim 2).
7. Local ordinances requiring smoke-free hospitality venues may enhance the positive influence of statewide smoke-free laws in terms of tobacco smoke exposure and compliance (Aim 3).

8. Co-location of venues that allow smoking significantly decreases compliance and appears to increase tobacco smoke exposure; therefore venues should be completely smoke-free to assure the highest protection against tobacco smoke exposure (Aim 3).
9. Any law permitting co-located venues to allow smoking should mandate studies of tobacco smoke pollution levels to inform future policy decisions (Aim 3).
10. As with rural populations, a continuing recognition of populations in poverty experiencing disparities in exposure to tobacco smoke pollution is needed and is an issue of social justice (Aim 4).

Research Recommendations

1. Future studies need to be conducted to determine whether the mediation model is an isolated finding for North Dakota or if it can be replicated (Aim 1).
2. Additional studies of tobacco smoke exposure and policy impact in rural areas are needed. Specifically, as this was the first study that compared rural and non-rural venues and as the number of venues in semi-rural areas was limited in this study, greater sampling of semi-rural venues will be important to include in future proposals. (Aim 2).
3. Studies of successful policy strategies adapted to rural cultures are needed to inform tobacco policy advocates on best practices to collaborate with people in rural areas to increase coverage of rural populations by smoke-free laws (Aim 2).
4. Further investigation of the interaction effect of local ordinances and types of venue on tobacco smoke pollution levels is needed to determine if it can be replicated (Aim 3).

5. Further exploration of the dynamics of the interaction effect and the differences in tobacco smoke pollution levels occurring is needed when a local smoke-free law is passed even if a statewide smoke-free law is in place (Aim 3).
6. Studies in rural areas on the presence of local laws increasing compliance with state laws with a potential corresponding decrease in tobacco smoke exposure should be investigated (Aim 3).
7. Further conceptual and theoretical development of the influences of poverty, in conjunction with planned analysis to assess SES influence, on tobacco smoke pollution levels in hospitality venues is recommended (Aim 4).

Recommendations to the ND Center for Tobacco Prevention and Control Policy.

As the North Dakota Center for Tobacco Prevention and Control Policy contributed to the conduction of this study, additional North Dakota specific recommendations are described next.

1. A post-study following implementation of the new state law (NDCC, §23-12-09 - §23-12-11, *Smoking in Public Places and Places of Employment*, see Appendix R) should include measuring tobacco smoke pollution levels in venues that experienced elevated tobacco smoke pollution levels before passage of the law.
2. A post-study following implementation of the new state law should include observational assessments of changes in:
 - a) compliance with the new law,
 - b) the presence of outdoor smoking, and
 - c) the presence of outdoor smoking shelters or huts.

3. A study of the health impact of the new state law on those who work in venues now required to be smoke-free is recommended.
4. Further studies on tobacco smoke exposure in low SES populations are needed. Additionally, selected case studies of North Dakota venues within low SES communities may advance the understanding of the relationship between poverty and tobacco smoke pollution.

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Appendix A

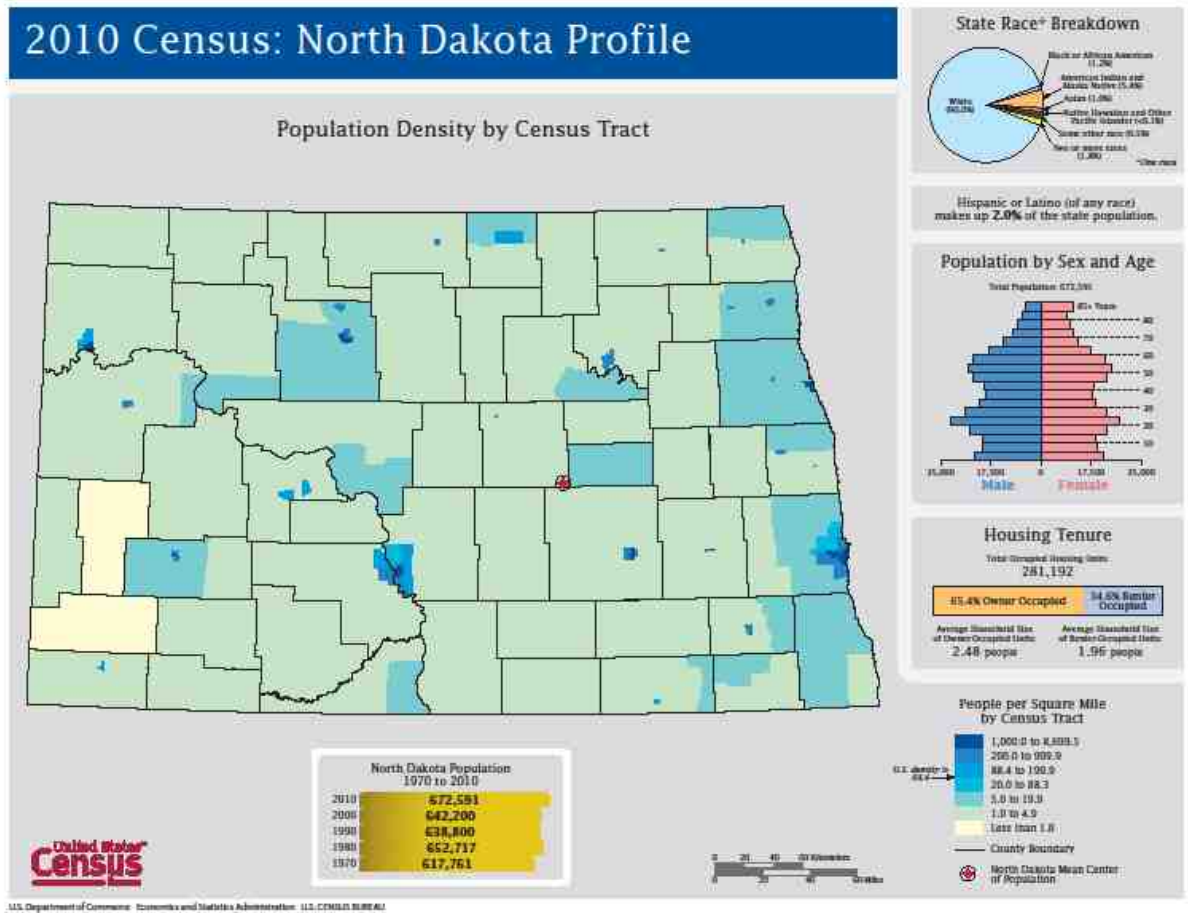


Figure 1. 2010 Census: North Dakota Profile. This map showed the majority of ND as being less than the US density of 88.4 people per square mile by census track. Retrieved from http://www2.census.gov/geo/maps/dc10_thematic/2010_Profile/2010_Profile_Map_North_Dakota.pdf

Appendix B

Examination of the Literature Tables

Table 1

Articles Cited In and Meeting Cochrane Review Criteria (n = 8; Callinan, Doherty, & Kelleher, 2010)

1st Author (Year)	Cesaroni et al. (2008)**	Ellingson et al. (2001)*	Goodman et al. (2007)		Gotz et al. (2008)
Country/State	Italy	Norway	Ireland		England
Rural	No	No	No		Yes
Random	No	No	No		No
Venue	Rome	Bars, restaurants	Pubs		Public houses, bars, clubs, bingo halls, private member clubs, cafes, betting shops
n =	n = 2.7 million people	n = 13	n = 42		n = 49
Exposure Measurement	Outdoor PM ₁₀	Gaseous phase nicotine	PM _{2.5}	PM ₁₀	PM _{2.5}
Pre-legislation Levels, µg/m ³	46	28.3	35.5	72.1	217
Post-legislation Levels, µg/m ³	39	0.6	5.8	45.5	11
Results	Statistically significant reduction in acute coronary events in the adult population after the smoking ban.	Significant difference p < 0.0001	Significant difference p < 0.01	Not Significant	Significant difference p < 0.001; 95% reduction

Policy Impact	Public health interventions that prohibit smoking can have enormous public health implications	Legislation significantly reduced nicotine levels.	Legislation significantly decreased PM _{2.5} but not PM ₁₀ levels. A total work-place ban significantly reduced air pollution in pubs.	Legislation had positive effects on air quality and SHS exposure in hospitality industry sector.
Notes	The purpose of this study was to determine the effects on acute coronary events			Percent of sample that was rural was 2% (n=1) pre and 5% (n=2) post legislation

Note. * = also included in WHO (2009); ** also included in WHO (2009) as a coronary study.

Table 1 (continued)

Articles Cited In and Meeting Cochrane Review Criteria (n = 8; Callinan, Doherty, & Kelleher, 2010)

1st Author (Year)	Heloma et al. (2003)*	Larsson et al. (2008)	Mulcahy et al. (2005)*	Semple, Maccalmanet al. (2007)*
Country/State	Finland	Sweden	Ireland	Scotland
Rural	No	No	No	Yes
Random	No	No	Yes	Mixed
Venue	Private and public workplaces in industry, service sector, and offices	Study of workers in bingo halls, bars, casinos, restaurants. Venue sample size is not stated.	Bars	Bar workers

n =	n = 8 workplaces; n = 18 sites	Workers (n = 43) in 9 communities; Venue sample size unknown	n = 20	n = 72 bars randomly chosen; 3 cities & 2 rural regions by convenience sample; 6 workers by convenience sampling for PM _{2.5} levels
Exposure Measurement	Indoor air nicotine concentrations	Vapor phase nicotine	Vapor phase nicotine	PM _{2.5}
Pre-legislation Levels, µg/m ³	0.9	7.5	35.5	202
Post-legislation Levels, µg/m ³	0.1	0.16	5.95	28
Results	Decreased indoor air nicotine concentrations	Median µg/m ³ reduced with the largest decrease for gaming workers (11.0 µg/m ³ to 0.22 µg/m ³) versus other workers (2.95 µg/m ³ to 0.12 µg/m ³).	Significant difference p < 0.001; 83% reduction	86% reduction
Policy Impact	Legislation was associated with reduced SHS exposure in workplaces.	Legislation reduced workplace nicotine exposure.	The ban significantly reduced but did not eliminate SHS exposure; exposure is possible for those working where smoking is allowed and where smoke may migrate for outdoors.	Legislation produced large reductions in SHS workplace exposure in bars that have been sustained for a year.
Notes		The purpose of the study was to identify changes in SHS exposure, symptoms, & attitudes among hospitality workers.		Other exposure assessments included saliva, cotinine, self-reports.

Table 2

Articles Cited In and Not Meeting Cochrane Review Criteria (n = 4; Callinan, Doherty, & Kelleher, 2010)

1st Author (Year)	Akbar-Khanzadeh et al. (2004)	Gorini et al. (2008)	Nebot et al. (2009)	Semple, Creely, et al. (2007)*
Country/State	Ohio	Italy	Spain	Scotland
Rural	No	No	No	No
Random	Yes	No	No	Yes
Venue	Restaurants	Restaurants, discos/pubs, bars	Workplaces include public administration offices (n= 90), universities premises (n = 43), & private offices (n = 162). Hospitality venues included bars and restaurants (n = 79), & discotheques and pubs (n = 24).	Bars
n =	n = 4	n = 28	n = 398	n = 41
Exposure Measurement	ETS related contaminants included: nicotine, 3-ethenylpyridine, RSP, respirable suspended particulate matter, respirable suspended ultraviolet particulate matter, & fluorescent particulate matter	Vapor-phase nicotine	Vapor-phase nicotine	PM _{2.5}
Pre-legislation Levels, µg/m ³	NA	8.86	See results	246
Post-legislation Levels, µg/m ³	NA	0.01	See results	20

Results	Nonsmoking restaurants had significantly lower ETS-related contaminants than both the smoking and nonsmoking sections of smoking restaurants. The contaminants were significantly higher in the smoking sections than the nonsmoking sections of the smoking restaurant. Restaurants with separate smoking sections were not compliant with the ordinance. The study also compared results with a previous pre-law study and found no significant difference between the pre and post ordinance adoption data in the nonsmoking and smoking sections of restaurants post-ordinance adoption.	Significant differences p < 0.001; 95% reduction	Venues that allowed smoking had a non-significant reduction of 19.4%. Significant reductions (96.7%) occurred in venues that became smoke-free (offices & university premises). In the other venues with smoking zones, the no-smoking zones had a significant reduction of 88.9% ; in smoking areas the median concentration increased slightly (37.2%).	86% reduction; 91% geometric mean reduction
Policy Impact	Strict enforcement of ordinances that allow smoking rooms s needed to achieve reasonable protections from SHS; full protection from ETS-related contaminants can be achieved only through 100% smoke-free policies.	Legislation significantly reduced nicotine concentrations.	The law allowed for smoking zones and smoking without restrictions in certain venues. Overall the law had a positive impact in offices and a lack of effect in venues that did not become smoke-free as workers continue to be exposed to high levels of nicotine. The results support a complete ban on smoking in all indoor places including hospitality venues.	Legislation markedly reduced PM _{2.5} levels reducing SHS exposure to bar workers and patrons.
		Pre-ban measures from previous studies.	Partial ban	Unable to complete all measurements at certain times.

Note. * = also included in WHO (2009); ** also included in WHO (2009) as a coronary study.

Table 3

World Health Organization (n = 6, IARC, 2009)

1st Author (Year)	Alpert et al. (2007)	Heloma et al. (2001)			Johnsson et al. (2006)	Lee et al. (2007)		Repace (2004)	Valente et al. (2007)
Country/State	Massachusetts	Finland			Finland	Kentucky		Delaware	Italy
Rural	No	No			No	No		No	No
Random	No	No			No	No		No	Yes
Venue	Free-standing bars; restaurants with bars	Industrial places	Service sector	Office	Restaurants, bars	Restaurants	Bowling ally	Casino, bars, pool hall	Bars, restaurants, video game parlors, pubs
n =	n = 27	n = 9 total venues; no breakdown by categories of venues reported			n = 20	n = 9	n = 1	n = 8	n = 40
Exposure Measurement	PM _{2.5}	Vapor-phase nicotine			Indoor air nicotine concentrations	PM _{2.5}		Respirable size particles (RSP) & particulate polycyclic aromatic hydrocarbons (PPAH)	PM _{2.5}
Pre-legislation Levels, µg/m ³	206	1.2	1.5	0.4	7.1	84	226	Mean RSP = 231 MeanPPAH=134	119.3

Post-legislation Levels, $\mu\text{g}/\text{m}^3$	14	0.05	0.2	0.1	7.3	18	43	RSP was little different than outdoor levels & PPAH was very close or below outdoor levels	38.2 after 3 months & 43.3 after a year
Results	93% reduction	Decreased indoor air nicotine concentrations were significant in all 3 venues.			Minimal reduction overall; variable reductions dependent upon venue.	Significant reduction in $\text{PM}_{2.5}$	Reduction in $\text{PM}_{2.5}$ when venue became compliant with the law	Post-ban levels of RSP averaged 9.4% of pre-ban levels; and post-ban levels of PPAH averaged 4.7% of pre-ban levels.	Significant reduction in average $\text{PM}_{2.5}$ values; $p = 0.005$ after 3 months and $p = 0.01$ a year later

Policy Impact	The state wide law has improved indoor air quality in this sample.	Legislation was more effective than voluntary restrictions or health promotion alone.	This partial smoking ban legislation allowed smoking within certain parameters. The policy did not decrease exposure as intended.	The policy law decreased PM _{2.5} levels within one week.	The law decreased PM _{2.5} levels after the venue became compliant with the law after 3 months.	The legislation generally reduced workers exposure to RSP & PPAH levels except for RSP levels in a pool hall. Smoke free workplace laws eliminate these hazards; this policy significantly reduced health risks among workers and customers in hospitality venues.	Implementation of a smoking ban reduced PM _{2.5} levels in hospitality venues.
Notes			Partial ban			This study found that SHS is responsible for 90% - 95% of RSP air pollution and 85% - 95% of PPAH.	

Table 4

Articles Located by a Search of PubMed and CDC's Smoking and Health Resources Library (n = 6 in rural areas)

1st Author (Year)	Hahn, Lee, Vogel, & Whitten (2008)	Hahn, Lee, Robertson et al. (2009)	Hahn, Lee, Vogel et al. (2009)	Hahn, Lee, Whitten et al. (2009)	Jones et al. (2006)	Travers et al. (2010)
Country/ State	Kentucky	Kentucky	Kentucky	Kentucky	Kentucky	North Dakota
Rural	Yes	Yes	Yes	Yes	Yes	Yes
Random	No	No	No	No	No	No
Venue	Hospitality venues	Restaurants	Restaurants, entertainment venues, government centers	Restaurants	Bars, restaurants, one bowling center, and a public office	Bar/restaurants
n =	10	13	10	9	11	5
Exposure Measurement	PM _{2.5}	PM _{2.5}	PM _{2.5}	PM _{2.5}	PM _{2.5}	PM _{2.5}
Pre-legislation Levels, µg/m ³	NA	126	NA	NA	NA	NA
Post-legislation Levels, µg/m ³	NA	21	NA	NA	NA	NA
Results	Average PM _{2.5} = 112µg/m ³	84% decline post-implementation	Average PM _{2.5} = 109 µg/m ³ ; the one smoke free venue had PM _{2.5} = 3 µg/m ³	Average PM _{2.5} = 44 µg/m ³	In all 11 venues, the average PM _{2.5} = 177 µg/m ³ ; in all smoking venues average PM _{2.5} = 195 µg/m ³ ; in all smoking hospitality the average PM _{2.5} = 200 µg/m ³ ; the average smoke-free venue PM _{2.5} = 3 µg/m ³	Average PM _{2.5} = 495 µg/m ³

Policy Impact	NA: No pre and post data for policy implementation	As 3 venues had PM _{2.5} levels > 135 µg/m ³ ; the authors stated this was related to enforcement	No pre and post data; the one smoke free venue had PM _{2.5} = 3 µg/m ³	NA: Baseline study; No pre and post data	Indoor air of smoking venues had 11 time higher PM _{2.5} levels than the smoke free venues; physical separation of smokers & nonsmokers does not provide adequate protection from SHS.	NA: No pre and post data for policy implementation
Notes		Purpose of the study was to assess and to compare levels to other studies.	Purpose of the study was to assess and to compare levels to other studies.	The purpose of the study was to assess air quality and compare levels to other studies.	Purpose was determine if indoor air has less pollution in venues where smoking is prohibited and where smoking does not occur, than in places where smoking is present.	Purpose of the study was to assess and to compare levels to other studies.

Table 5

Articles Located by a Search of PubMed and CDC's Smoking and Health Resources Library (n = 8 used random sample)

1st Author (Year)	Bohac et al. (2010)			Daly et al. (2010)	Goniewicz et al. (2009)	Haliotis et al. (2009)	Lai et al. (2011)
Country/State	Minnesota			Switzerland	Poland	Greece	China
Rural	No			No	No	No	No
Random	Yes			Yes	Yes	Yes	Yes
Venue	Drinking places	Limited service restaurant	Full service restaurants	Nonsmoking sections of bars, restaurants, cafes	Pubs	Nightclubs	Fast food restaurants, catering
n =	19	8	35	102		10	99

Exposure Measurement	PM _{2.5}			PM _{2.5}	CO	PM ₁ PM _{2.5}	PM _{2.5}
Pre-legislation Levels, µg/m ³	113.0	84.7	55.8	NA	NA	NA	NA
Post-legislation Levels, µg/m ³	2.7	3.3	2.9	NA	µg/m ³	NA	NA
Results	PM _{2.5} Median reduction was significant (drinking places 98.6%, limited service 98.5%, full service 95.6%) and > than 95% for all 3 venues. The average reduction = 87.4%.			Average PM _{2.5} = 64.7 µg/m ³ ; each smoker increases levels by 15 µg/m ³	Average CO 1.04 +/- 1.87 ppm; 9 pubs exceeded WHO and EU limits	Indoor PM ₁ = 181.8 µg/m ³ ; PM _{2.5} = 454 µg/m ³	Smoking venues PM _{2.5} = 211.6 µg/m ³ ; nonsmoking venues PM _{2.5} = 60.3 µg/m ³ ; smoking venues has 4.4 times high PM _{2.5} levels than nonsmoking venues
Policy Impact	Smoking bans resulted in significant reductions of SHS constituents and protect the customers and worker from PM _{2.5} levels.			NA; Baseline study	NA; Baseline study	NA: Baseline study; no pre post data	Smoking prohibitions can, on average, reduce PM _{2.5} levels more than 75%.
Notes				Purpose was to study PM _{2.5} in nonsmoking sections of venues that allow smoking; the impact of PM _{2.5} sources, and venue characteristics of PM _{2.5} levels	The study purpose was to determine if SHS causes significant exposure to CO	Purpose of study was to assess quality of indoor air & determine occupants exposure when no ban is in place	Purpose was to study lung function & SHS in venues exempt from law

Table 5 (continued)

Articles Located by a Search of PubMed and CDC's Smoking and Health Resources Library (n = 8 used random sample)

1st Author (Year)	Marin et al. (2010)		Rosen et al. (2010)			Semple et al. (2010)		
Country/State	Puerto Rico		Israel			Scotland	England	Wales
Rural	No		No			No, some rural bars, but no rural analysis		
Random	Yes		Yes			Yes,		
Venue	Restaurants	Pubs & discos	Bars & pubs	Cafes	Combined	Bars		
n =	32	23	15	18	33	42	52/52/49	12
Exposure Measurement	PM _{2.5}		PM _{2.5}			PM _{2.5}		
Pre-legislation Levels µg/m ³	0.169	0.626	436	85	245	197	92	184
Post-legislation Levels µg/m ³	0.028	0.028	273	68	161	15	11 & 18	24
Results	Significant reduction occurred in both restaurants (83.6%, p = 0.013) and pubs & discos (95.6%, p = 0.004).		PM _{2.5} levels declined significantly (p = 0.0043) by 34% from pre to post implementation. Some venue's policies allowed smoking; bars & pubs had significantly higher PM _{2.5} levels (p = 0.0004); the number of smoke free venues increased and was significant (p = 0.0047) between year and venue smoking status.			> 80% reduction across the three countries. Mean reductions: Scotland 91%, England 93% & 84 %, Wales 85%		
Policy Impact	The smoke-free workplace law considerably reduced SHS exposure to workers and customers in all 3 venues.		Some venues continue to have very hazardous smoke levels and enforcement is essential to protect workers and the public.			Legislation in all 3 countries improved indoor air quality.		

Notes		<p>Authors raised questions about enforcement, compliance, & time between implementation and measurements. Also cafes had been smoke free by a previous law and had lower PM2.5 levels with modest changes expected.</p>	<p>Scotland had 2 measurements: (1) pre-legislation, (2) 2 months post-implementation. England had 3 measurements: (1) pre-legislation, (2) 2 months post-implementation, & (3) 12 months post-implementation. Wales had 2 measurements: (1) pre-legislation and (2) 12 months post-legislation.</p>
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Appendix C

ND Century Code 23-12-09 through 23-12-11 in Effect during the Study

CHAPTER 23-12 PUBLIC HEALTH, MISCELLANEOUS PROVISIONS

23-12-09. Smoking in public places and places of employment - Definitions.

In sections 23-12-09 through 23-12-11, unless the context or subject matter otherwise requires:

1. "Bar" means a retail alcoholic beverage establishment licensed under chapter 5-02 that is devoted to the serving of alcoholic beverages for consumption by guests on the premises and in which the serving of food is only incidental to the consumption of those beverages. The term includes a bar located within a hotel, bowling center, or restaurant that is not licensed primarily or exclusively to sell alcoholic beverages if the bar is in a separately enclosed area.
2. "Business" means a sole proprietorship, partnership, association, joint venture, corporation, or other business entity, either for profit or not for profit, including retail establishments where goods or services are sold and professional corporations and other entities where professional services are delivered.
3. "Employee" means an individual who is employed by an employer in consideration for direct or indirect monetary wages or profit, or an individual who volunteers services for an employer.
4. "Employer" means an individual, business, or the state and its agencies and political subdivisions that employs the services of one or more individuals.
5. "Enclosed area" means all space between a floor and ceiling that is enclosed on all sides by solid walls or windows, exclusive of doorways, which extend from the floor to the ceiling.

6. "Health care facility" means any office or institution providing health care services, including a hospital; clinic; ambulatory surgery center; outpatient care facility; nursing, basic, or assisted living facility; and laboratory.
7. "Health care services" include medical, surgical, dental, vision, chiropractic, and pharmaceutical services.
8. "Place of employment" means an area under the control of a public or private employer that employees normally frequent during the course of employment, including work areas, auditoriums, classrooms, conference rooms, elevators, employee cafeterias, employee lounges, hallways, meeting rooms, private offices, restrooms, and stairs.
9. "Public place" means an enclosed area to which the public has access or in which the public is permitted, including a publicly owned building or office, and enclosed areas available to and customarily used by the general public in businesses and nonprofit entities patronized by the public, including bars; bingo facilities; child care facilities subject to licensure by the department of human services, including those operated in private homes when any child cared for under that license is present; convention facilities; educational facilities, both public and private; facilities primarily used for exhibiting a motion picture, stage, drama, lecture, musical recital, or other similar performance; financial institutions; health care facilities; hotels and motels; laundromats; any common areas in apartment buildings, condominiums, mobile home parks, retirement facilities, nursing homes, and other multiple-unit residential facilities; museums, libraries, galleries, and aquariums; polling places; professional offices; public

transportation facilities, including buses and taxicabs, and ticket, boarding, and waiting areas of public transit depots; reception areas; restaurants; retail food production and marketing establishments; retail service establishments; retail stores; rooms, chambers, places of meeting or public assembly, including school buildings; service lines; shopping malls; sports arenas, including enclosed places in outdoor arenas; theaters; and waiting rooms.

10. "Publicly owned building or office" means a place owned, leased, or rented by any state or political subdivision, or by any agency supported by appropriation of, or by contracts or grants from, funds derived from the collection of taxes.

11. "Restaurant" includes every building or other structure, or any part thereof, and all buildings in connection therewith that are kept, used, maintained, advertised, or held out to the public as a place where food is served, including coffee shops, cafeterias, private and public school cafeterias, kitchens, and catering facilities in which food is prepared on the premises for serving elsewhere, and a bar area within a restaurant.

12. "Retail tobacco store" means a retail store utilized primarily for the sale of tobacco products and accessories and in which the sale of other products is merely incidental.

13. "Shopping mall" means an enclosed public walkway or hall area that serves to connect retail or professional businesses.

14. "Smoking" means possessing a lighted cigar, cigarette, pipe, weed, plant, or any other lighted tobacco product in any manner or in any form.

15. "Sports arena" means any facility or area, whether enclosed or outdoor, where members of the public assemble to engage in physical exercise, participate in athletic competition, or witness sports or other events, including sports pavilions, stadiums, gymnasiums, health spas, boxing arenas, swimming pools, roller and ice rinks, and bowling centers.

16. "Truckstop" means a roadside service station and restaurant that caters to truckdrivers.

23-12-10. Smoking restrictions - Exceptions - Retaliation - Application.

1. In order to protect the public health and welfare and to recognize the need for individuals to breathe smoke-free air, smoking is prohibited in all enclosed areas of: a. Public places; and b. Places of employment.

2. The following areas are exempt from subsection 1:

a. Private residences, except when operating as a child care facility subject to licensure by the department of human services and when any child cared for under that license is present in that facility.

b. Hotel and motel rooms, and other places of lodging, that are rented to guests and are designated as smoking rooms.

c. Retail tobacco stores, provided that smoke from these places does not infiltrate into areas where smoking is prohibited under this section.

d. Outdoor areas of places of employment, except a sports arena.

e. Any area that is not commonly accessible to the public and which is part of an owner-operated business having no employee other than the owner-operator.

f. Bars.

g. Any place of public access rented or leased for private functions from which the general public and children are excluded and arrangements for the function are under the control of the function sponsor.

h. Separately enclosed areas in truckstops which are accessible only to adults.

3. Smoking as part of a traditional American Indian spiritual or cultural ceremony is not prohibited.

4. No person or employer shall discharge, refuse to hire, or in any manner retaliate against an employee, applicant for employment, or other person because that person asserts or exercises any rights afforded by this section or reports or attempts to prosecute a violation of this section.

5. This section may not be interpreted or construed to permit smoking where it is otherwise restricted by other applicable laws.

6. Before October 1, 2007, the office of management and budget shall develop and implement a uniform policy regarding smoking restrictions with respect to the outdoor areas near the public entrances of all buildings on the state capitol grounds.

23-12-10.1. Responsibility of proprietors. Repealed by S.L. 2005, ch. 239, § 7.

23-12-10.2. Complaints and enforcement - City and county ordinances and home rule charters.

1. State agencies with statutory jurisdiction over a state-owned building or office shall enforce section 23-12-10. These agencies include the fire marshal

department, state department of health, department of human services, legislative council, and office of management and budget. The agencies may mutually agree as to the manner in which enforcement is to be accomplished and may adopt administrative rules to ensure compliance with section 23-12-10, including referral of violations to an appropriate law enforcement agency for enforcement pursuant to section 23-12-11.

2. A city or county ordinance, a city or county home rule charter, or an ordinance adopted under a home rule charter may not provide for less stringent provisions than those provided under sections 23-12-09 through 23-12-11. Nothing in this Act shall preempt or otherwise affect any other state or local tobacco control law that provides more stringent protection from the hazards of environmental tobacco smoke. This subsection does not preclude any city or county from enacting any ordinance containing penal language when otherwise authorized to do so by law.

23-12-10.3. Exceptions - Medical necessity.

1. Notwithstanding the provisions of any other state or local law, a patient may smoke in a hospital licensed by the state or on the grounds of a hospital licensed by the state if the patient's attending physician authorizes the activity based on medical policies adopted by the hospital organized medical staff.

2. Notwithstanding the provisions of any other state or local law, a resident of a licensed basic care facility or a licensed nursing facility may smoke in the facility or on the grounds of the facility if approved by the board of the facility.

23-12-11. Penalty.

1. An individual who smokes in an area in which smoking is prohibited under section 23-12-10 is guilty of an infraction.
2. An owner or other person with general supervisory responsibility over a public place or place of employment who willfully fails to comply with section 23-12-10 is guilty of an infraction, subject to a fine not to exceed one hundred dollars for the first violation, to a fine not to exceed two hundred dollars for a second violation within one year, and a fine not to exceed five hundred dollars for each additional violation within one year of the preceding violation.

Appendix D

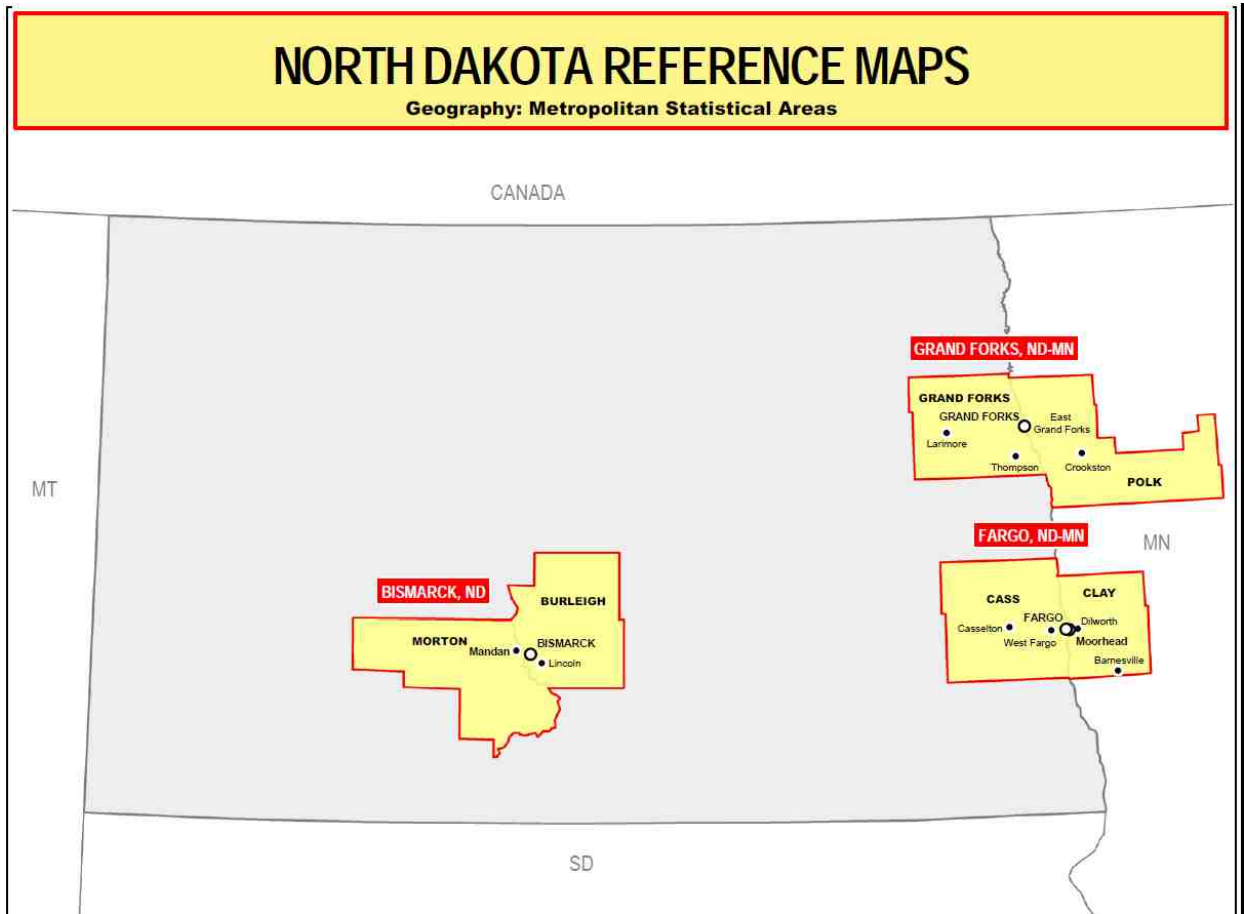


Figure 1. North Dakota Reference Map. Geography: Metropolitan statistical areas.

Retrieved from

<https://www.ndworkforceintelligence.com/admin/gsipub/htmlarea/uploads/>

lmi_ndrefmapmetrosa.pdf

Appendix E

Indoor Air Monitoring Protocol Adapted from Travers (2010)

Equipment overview.

1. Real-time aerosol monitor to measure respirable suspended particulates (RSPs)
2. Zircon DM S50 Sonic Measure, an ultrasonic ruler to determine room volumes
3. PC computer running Microsoft Windows with a USB and serial port

A *TSI SidePak AM510 Personal Aerosol Monitor* (TSI, Inc., St. Paul, MN, www.tsi.com) was used to sample and record the levels of RSP in the air. The SidePak used a built-in sampling pump to draw air through the device where the particulate matter in the air scatters the light from a laser. Based on the amount of light scattered the device displays the real-time concentration of particles in milligrams per cubic meter. The device weighed slightly over one pound and measures 5.1 in. x 3.7 in. x 2.8 in. The aerosol monitor was fitted with a 2.5 μm impactor in order to measure the concentration of particulate matter with a mass median aerodynamic diameter less than 2.5 μm , or $\text{PM}_{2.5}$. Particles of this size are referred to as “fine particles” and are released in large quantities from burning cigarettes. Fine particles are easily inhaled deep into the lungs and are associated with adverse health effects. The impactor was designed to remove half of the particles at 2.5 μm and larger particles with increasing efficiency. The SidePak continuously measured the particle concentration and was set to record into memory the average level every one minute. The recorded measurements were downloaded to a PC for analysis.

Zircon DM S50 Sonic Measure was an ultrasonic ruler used to measure the volume of each of the venues. By aiming the device at a 90 degree angle to a wall and

pushing the button it provided an accurate measure of the distance from the back of the device to the wall in question. This was used to quickly and easily measure the dimensions of a room (length, width and height), which was used to calculate the room's volume.

A PC computer running Windows 98 or later was necessary to download and analyze the data from the air monitoring device. The computer had an available USB port to communicate with the TSI SidePak. The computer also had the data analysis software TRAKPRO version 3.4 or later installed. This software came bundled with the air monitoring instruments or was available free from TSI (http://www.tsi.com/iaq/downloads/trakpro_download.shtml)

Appendix F

Appendix F

Data Collection Procedures Booklet

A Rural Tobacco Smoke Pollution Study

May 21, 2012

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Introduction

The purpose of this *Data Collection Procedures Booklet* is to assist the data collectors in gathering data for a rural tobacco smoke pollution study when they are in the field. A full description of the study, procedures, and references can be obtained by contacting Kelly Buettner-Schmidt, Principal Investigator at 701-858-3256, or kelly.buettner-schmidt@minotstateu.edu.

The information in this booklet is either directly from, or edited from, Travers (2011) *Indoor Air Monitoring Protocol*.

Confidentiality and Discreet Sampling

This study uses discreet sampling methods. Discreet sampling is an accepted method of obtaining accurate measures of tobacco smoke pollution for indoor air quality studies. Several authors have discussed the need for discreet sampling in terms of not altering the behaviors of people in public places, such as manager, workers, and patrons (Alpert, Carpenter, Travers, & Connolly, 2007; Daly, Schmid, & Riediker, 2010; Repace, Hyde, & Brugge 2006; Rosen, Zucker, Rosen, & Connolly, 2010; Semple, Creely, Naji, Miller, & Ayres, 2007). Data collectors are to act as normal paying customers (Proescholdbell, Steiner, Goldstein, & Malek, 2009). A recent study conducted in Minnesota (Bohac, et al., 2010) and published in the American Journal of Preventive Medicines states:

All visits were conducted unannounced without the knowledge of the venue staff or customers. This was expected to provide less-biased results since the venue would not make any operational changes for the monitoring period and, since the owner approval was not required, it allowed complete freedom in selecting a statistically representative sample of venues. (p. S5)

Discreet sampling for this study requires data gatherers to do the following related to confidentiality and discreet behaviors.

1. Do not discuss with anyone who is not associated with this study that you are assisting in the conduction of this study until such time as all data collection by all data gatherers is completed. Kelly Buettner-Schmidt will determine when data collection is complete; please contact Kelly for any questions.
2. At no time, even after dissemination of the study results, discuss any specific venues you entered or the results of the air sampling. At no time will the results of this study release the names or identities of venues entered.
3. While gathering the data please behave as a regular patron of the establishment by ordering food and nonalcoholic beverages as appropriate. Please see the section "Forms and Reimbursement Requirements."
4. While in the venue do not discuss the study, purpose, and/or procedure for data collection with your team members or anyone else.

Team Members

Personnel to gather the air samples and make the observations will consist of one to four people assigned to each venue with the following responsibilities. At least one person in each team will be the Team Leader who is highly knowledgeable and skilled in use of the *TSI™ SidePak™ AM510 Personal Aerosol Monitor*, *TrakPro™ Software*, the sonic measuring device, the laptop, the observational assessment, and the related paperwork. The Team Leader may include this researcher, Minot State University (MSU) employees, or other individuals who have worked or volunteered in tobacco control and understand the risks involved, and may include those who have previously conducted air sampling with the *SidePak™* and who attend the web-based training.

The Team Leader will be ultimately responsible for all the protocols, equipment, data collection, and after monitoring steps. The Team Leader may or may not enter the venues to complete the actual air sampling, room measurements, and observational assessments.

Team Assistants will be instructed by the Team Leader and may assist with the room measurements and observational items while in the venue. Team Assistants may be local persons to assist the Team Leader and other Team Assistants to blend into the venue environments. The Team Leaders, who are data collectors, will also be MSU employees or other individuals who have worked or volunteered in tobacco control and understand the risks involved, and may include those who have previously conducted air sampling with the *TSI™ SidePak™* and who attend the web-based training.

Teams *may not enter* venues where there appears to be illegal activities occurring or venues that local public health tobacco control staff express safety concerns.

The below information on Equipment Preparation, Venue Monitoring Protocol, and After Monitoring can also be found in an accompanying PowerPoint presentation and as short Vimeo clips. The Vimeo clips can be found at: <http://vimeo.com/channels/84864>.

Video	Length (min)	Description	Need to View?
Video 1	2:03	Introduction (Discussion)	Not Necessary
Video 2	2:32	Explanation of <i>SidePak™</i> & what it measures	Yes
Video 3	4:51	<i>SidePak™</i> Case & Contents	Yes
Video 4	1:42	Charging Battery	Yes
Video 5	2:55	Clean & Grease	Yes
Video 6	1:39	Zero Calibration	Yes
Video 7	3:26	Logging Data (Setting Machine to Log Data)	Yes
Video	1:50	Preparing to Collect Data (Machine in	Yes

8		Bag)	
Video 9	3:41	Recording Observer Data (Notes Sheet)	Yes
Video 10	4:53	In the Field (Completing Observations)	Yes
Video 11	4:39	Downloading Data to Computer	Yes
Video 12	1:11	One Time Setup (Discussion)	No
Video 13	0:58	Setting Time Constant	No
Video 14	1:19	Setting Logging Interval	No
Video 15	1:03	Set Date/Time	No
Video 16	1:54	Calibrate Flow Overview	No
Video 17	1:43	Calibrate Rate Flow Rotometer	No
Video 18	1:38	Calibrate Flow Digital Calibrator	No
Video 19	0:19	Credits	No

Equipment Preparation

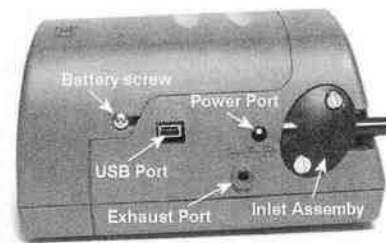
TSI™ SidePak™ AM510 Personal Aerosol Monitor.

The researcher (Buettner-Schmidt) will set the impactor at a flow rate of 1.7 l/minute to ensure the impactor operates properly.

There are three important steps the user must perform each day prior to testing to prepare the *TSI™ SidePak™* for operation.

1. The batteries must be charged.
2. The impactor must be cleaned and greased.
3. The monitor must be zero calibrated.

The *SidePak™* is equipped with an internal rechargeable battery pack that can easily provide 10 or more hours of continuous monitoring on a single charge. The *SidePak™* also has a convenient power management feature where the unit conveniently displays the approximate number of minutes the monitor can continue to operate. The impactor is a device attached to the inlet of the *SidePak™* that determines the cut-off size of particles entering the monitor. The *SidePak™* will be fitted with a 2.5 µm impactor that requires cleaning and greasing prior to each use. Finally, prior to each use, the *SidePak™* should be zero calibrated with the included HEPA filter. These three preparation steps are detailed in the “*Venue Monitoring Protocol.*”



TSJ™ SidePak™ Preparation

1. Charge the battery pack

- a. Plug the battery charger into the Power Port on the side of the *SidePak™* (!!!Only use the supplied battery charger to prevent damage to the device!!!)
- b. Plug the battery charger into a 3-prong AC outlet
- c. The display on the *SidePak™* should initially say “Detecting Battery Type” and then will say “Charging Battery.” The screen will indicate when charging is complete; charging may take up to 5.5 hours.

2. Clean and grease the impactor

- a. Remove the “Inlet Assembly” from the side of the *SidePak™* by removing the two screws with the supplied flat head screwdriver
- b. Make sure the outside of the inlet assembly is labeled “2.5µm.” This is the assembly that must be used to measure PM_{2.5}.
- c. Remove the impactor insert from the inlet assembly by popping it out with the screwdriver
- d. Wipe of the end of the impactor with a tissue or towel
- e. Smear a *very small* amount of the supplied grease on the end of the impactor and wipe off with finger
- f. Carefully slide the impactor back into the inlet assembly until it is fully seated
- g. Reattach the inlet assembly to the *SidePak™* with the two screws previously removed

3. Zero calibrate the device

- a. Press PAGE key to turn monitor on
- b. Wait about one minute for pump to start up and readings to stabilize. Display will read “SURVEY MODE.”
- c. Press PAGE key then down arrow until “Zero Cal” is displayed. Press ENTER.
- d. Attach Zero Filter and press ENTER again
- e. Wait until zero calibration is finished, this will take 60 seconds, then press PAGE key until back in survey mode.
- f. With the Zero Filter still attached, verify that the reading stays near 0.000 mg/m³ or below 0.003 mg/m³. If the reading is not near 0.00 mg/m³ then repeat the zero calibration until it is.
- g. Remove Zero Filter

TSJ™ SidePak™ Operation

1. If not already on, press PAGE key to turn the SidePak on.
2. Wait about 1 minute for pump to start up and readings to stabilize. Display will read “SURVEY MODE”.
3. Press PAGE key.
4. At “Data Log” press the ENTER key.
5. Press down arrows until “Run Manual” is displayed. Press ENTER key. Screen should now display “Data Logging”.
6. Lock the device: *Press and hold* the UP ARROW key and *then* press ENTER. This will lock the device and prevent accidentally pressing any of the buttons during logging.
7. Record the time at which you started logging.

8. Attach length of Tygon (clear plastic) tubing to the inlet. Place SidePak in bag with end of plastic tubing protruding from bag. Make sure the end of the plastic tubing is unobstructed. Also, make sure the small outlet hole on the left side of the SidePak is unobstructed.
9. When air monitoring is complete, remove the SidePak from the bag.
10. Unlock the device: The same as in Step 6, *Press and hold* the UP ARROW key and *then* press ENTER.
11. Press the ENTER key 2 times to stop data logging.
12. Press the PAGE repeatedly until the device returns to SURVEY MODE.
13. To turn off the SidePak hold down the PAGE key for 3 seconds.

Sonic Measure Preparation

Battery Installation

1. Open battery door on back of case
2. Connect a 9-volt battery to battery clip
3. Insert battery into case and replace battery door

When the low battery symbol comes on and stays on, it is time to change the battery. A dim display or inaccurate measurements also indicate a weak battery. Batteries last approximately two years under normal conditions, or for eight hours of continuous laser use, with a fresh alkaline battery.

Software for Desktop Preparation

Information gathered by the *TSI SidePak™* is downloaded using *TSI TrakPro™ Software*. Team Leaders will be responsible for downloading the data. The *TrakPro™ Software* can either be loaded onto a computer available to the Team Leader; or the Team Leader will be provided with a laptop pre-loaded with the software. In general, Team Leaders who are able to return to their homes each evening will be asked to download the software onto their computer, while Team Leaders who will be staying overnight away from home can be provided the pre-loaded laptop. To install the *TSI TrakPro™ Software* on your computer, an online link is available. The following steps should be used to install the *TSI TrakPro™ Software*:

- 1.1. Access the following link:
<http://www.tsi.com/SoftwareDownloads/>.
- 1.2. Enter the model number. For this enter: SIDEPAK Personal Aerosol Monitor AM510.
- 1.3. Select the download type, for this you will select from the drop down menu "software."
- 1.4. Hit search. A new page will come up requiring you to select with either the 32 bit or 64 bit version. Most computer systems use the 64 bit but if an error message is received two times while trying to install 64 bit version, then try the 32 bit version. Start with the 64 bit and follow the steps to install on your computer.

When the study is completed, HCI will notify you to delete all *TrakPro™* files from your computers.

Venue Monitoring Protocol

TSPTM SidePakTM Monitoring

The *SidePakTM* will be placed in a purse, shoulder bag, computer case, or backpack. One end of a length of *TygonTM* tubing is attached to the inlet of the *SidePakTM* and the other end should protrude outside the bag to collect the air to be sampled. The protocol to monitor the indoor air quality in the hospitality venue includes:

- spend five minutes outside, in a nonsmoking environment, before entering the venue
- record time of entry into venue
- a minimum of 30 minutes should be spent in the venue
- the monitoring bag should be located in a central area
- the bag can be located in a single location or circulated throughout the venue
- the bag can be carried or placed on a table or bar but not on the floor to avoid damage to the devices and to monitor air within people's normal breathing zone
- observational data should be collected according to protocol
- record time of exit from venue
- spend at least five minutes outside before entering the next venue

The air monitoring will be done discretely so as not to disturb the occupants' normal behavior. The team conducting the monitoring will patronize the venues as appropriate by buying food and/or nonalcoholic beverages.

Sonic Measurement Device

The sonic measurement device is the *Zircon DM S50 Sonic Measure*. This device is used to measure distances quickly and easily. For this study the device will be used to measure the length, width and height of the room where air monitoring is done. To use:

1. Turn on using PWR button. The device will be in feet/inches mode or the last mode used. For this study use the metric measurement (meters); select this measurement mode by pressing the ft/m button.
2. Position and point unit squarely to the target. To measure a distance, the device should be pointed at a 90-degree angle to the wall or ceiling in question. Measurement will start from back of the unit, which means the length of the tool is included in the number you see.
3. Press READ button to measure. Holding button down will allow continuous reading if you wish to move unit forward or back for positioning an item. The device will take about a second to measure the distance from the back of the device to the object it was pointed at.
4. Record the measurements on the *Data Collection Form*.

- **NOTE** This device does not save the measurements you make. So, each measurement must be recorded by hand on a sheet of paper after it is made.

- **For example**, in order to measure the length of a room you can stand somewhere in the middle of the room and measure the distance from you to the wall. Then, you can turn the device around (180-degrees) and measure the distance to the opposite wall. By adding these two measurements together you will have the length of the room (Write it down!).

- **Alternatively**, you can stand up against a wall and measure the distance from that wall to the opposite wall to get the length/width of the room.

- **NOTE** This device can only measure up to 50 feet. So, by standing up against a wall you can only measure the distance to the opposite wall if it is less than 50 feet away. However, by standing in the middle of the room you can measure a distance of up to 100 feet; i.e. 50 feet each way.

- **Things to watch for-**

- Sometimes it is difficult to get a clear line of sight to the wall you wish to measure the distance to. This is especially true in a crowded venue.
- You may have to hold the device over your head or wait for space to clear to get a good measurement.
- It is always best to estimate the distance you are measuring and compare it to what the sonic measure says. Sometimes you may think the device is measuring the distance to the wall but instead it actually measured the distance to the pole or person between you and the wall. Ask yourself, "Does this measurement make sense?"

- If it is *impossible* to obtain an accurate measurement due to the size of the venue, obstructions, or the number of people you can estimate the distances by pacing or walking the distance. One large stride for an average size person equals approximately three feet. So if you take 25 large paces to get across a room, the distance is 75 feet. Ideally, this method can be used to check the measurements you get with the sonic measure. However, only rely exclusively on pacing as a last resort. If measurements have to be estimated make sure to note which measurements are estimates.

- **Odd shaped rooms:** It is sometimes difficult to measure the size of a room if it is not rectangular or square shaped. The easiest thing to do is to measure the room in parts. For example, in an L-shaped room you could just treat this as two rectangular rooms and measure them separately. In cases like this it is best to draw a little diagram of the shape of the room and label the length of each wall on your diagram after you measure it.

5. Each measurement erases the previous one.
6. Pressing the READ button position half way will turn on the laser circle for adjusting your position to your target. Depressing fully will then take the measurement reading.
7. This unit will automatically turn itself off after 30 seconds of inactivity. When you press the PWR button to resume, the display will still show the last reading that was on the screen.

Using the Function Keys

Ft/m button: The ft/m switch toggles you from feet/inches to metric units. You will not lose your readings when changing this mode. For this study, be sure to record the readings as meters.

Double Segment button (fourth button down on left): This button you may use and described is its purpose. Press this button before measuring and you will be able to take two measurements that will be automatically added together. This is particularly helpful when measuring distances longer than 50 feet (15 m). From a marked spot in the middle of the area, you can take a reading in opposite directions to measure a longer space.

Volume button (first button on top left): It should be noted that you should not need to use this button but described is its purpose. For volume measurements, you follow the same steps selecting the VOLUME function button and taking measurements following the prompting bars on the display. Be sure to place the tool base against the surface and point perpendicular to the wall. If unsure of any of the three readings, press the RECALL button and you can step back through each of them with a flashing direction bar guiding your selection. Each number can be re-shot using the "Recall" mode and pressing the READ button while that segment bar is flashing.

Area button (second button from top on the left): It should be noted that you should not need to use this button but described is its purpose. For area measurements, select this button and take a measurement across the lengthwise of a room. Remember that the length of the tool is included in your measurement, so place the back end of the unit against a wall on one side and shoot across to an open area of wall directly opposite. The first number will show on your screen and the blinking line will prompt you to take a second reading across the room in the other direction. The resulting calculation will show on the screen.

Length button (and continuous function) (third button from the bottom on left): It should be noted that you should not need to use this button but described is its purpose. This tool will automatically come on in this mode for taking a single length measurement. If using other modes, you can press this button to get back to single length measurements. You can hold the READ button down in this mode and move forward or backward to reach a certain distance for positioning of equipment.

Recall button: When taking a square footage, volume, or double segment measurement, you may use this button to scan back through any of the previous segments to check a number. Each segment bar will flash to show you which number you are seeing and, if you are concerned with that particular length being accurate, you can take a replacement measurement by pressing the READ button again while it is flashing. It will then replace the flashing segment's number with your new reading and update your calculations.

Observational Data

Observational data assists in better understanding tobacco smoke pollution in these venues; and it helps determine if venues are operating in compliance with state and local laws. Observational data will also be collected on each venue during air monitoring on both indoor and outdoor areas. Items to be observed and to be noted are on the *Data Collection Forms*.

There are three types of forms:

1. The *Data Collection Form: Cover Page* will be completed one form per day.
2. The *Data Collection Form* is completed for each venue that is not a restaurant with an enclosed bar.
3. *Restaurant with Enclosed Bars: Data Collection Form* is completed only for the pre-identified restaurant venues with an enclosed bar.

Observations will begin with the outdoor area by first noting whether anyone is smoking within 10 feet of the entranceways.

Then, upon entry, the total number of people in the venue will be counted. This count will be repeated every 15 minutes until the venue is exited. Since a minimum of 30 minutes is spent in each venue, there will be at least three observations of the number of people in the venue. These observations will be averaged to determine the average number people in the venue during air monitoring.

Next, the number of burning cigarettes should be counted upon entry and again every 15 minutes until exit. As with the number of people, there will be at least three observations and these will be averaged to yield the average number of burning cigarettes in the venue during air monitoring. Please note: this is a count of the number of burning cigarettes and not the number of smokers in the venue. For example, if someone has a pack of cigarettes in front of them but is not actively smoking, they do not get counted. The point is to count the actual number of cigarettes burning at each 15-minute time point.

While waiting for the next counts, carefully complete the questions on the appropriate data collection forms later in this document. Please note the “if yes...” questions. If the answer to the original question is no, skip to the next numbered question. Also sketch the room shape and briefly describe the venue (diner, supper club, serves only lunch, bar with open fireplace, etc.) where indicated on the form. Place an “x” to indicate the location of the monitor. Also please provide a brief description of any smoking shelters, butt huts, or other circumstances of interest.

Air Monitoring Checklist

Below is a copy of the *Air Monitoring Checklist*. The checklist is useful as a simplified step by step reminder of each step for the data collection. You may want to bring a copy of this with you into each venue also.

Air monitoring check list

Prepare *SidePak*TM (3 steps)

- Charge battery
- Clean and grease the impactor
- Zero calibrate
- Start logging data (record the time!)
- Lock the *SidePak*TM keypad
- Visit venues and record observations
(Stand outside venue for 5 minutes before entering and when leaving venue)
- Times of entry, counts and exit
- Count # people every 15 minutes
- Count # burning cigarettes every 15 minutes
- Measure room volumes (use sonic measure)
- A few descriptive sentences on each place
- Buy something in each place you visit (be a patron)
- Draw room dimensions

- When you're done monitoring
 - Unlock the *SidePak*TM keypad
 - Stop logging (record the time!)
 - Turn off the device, recharge it for next time
 - Connect *SidePak*TM to PC
 - Download the data using *TrakPro*TM Software
 - Complete Data Collection Forms and Data Collection Form Cover Page
 - Email *TrakPro*TM (.tpk), Data Collection Cover Page and Data Collection Forms to Cassie Loard at the end of each day.
 - Mail all forms and reimbursement forms to Cassie Loard

Cassie Loard
Minot State University
500 University Avenue West
Minot, ND 58707
cassie.loard@minotstateu.edu
(701) 858-3459
(701) 858-3020 fax

Data Collection Forms

Data Collection Form

Cover Page

Return form to HCI at the end of each day to:

Fax# 701-858-3020 OR

Scan & E-mail to cassie.loard@minotstateu.edu

Date: _____

Day of Week:

Team Leader (HCI staff or designee):

SidePak™ #: (Please Circle) 1 2 3 4 5

Name of other team members assisting: 1.

2.

3.

4.

Summary of Venues:

Venue 1 Observation ID #: _____ - _____ - _____

Venue 2 Observation ID #: _____ - _____ - _____

Venue 3 Observation ID #: _____ - _____ - _____

Venue 4 Observation ID #: _____ - _____ - _____

Venue 5 Observation ID #: _____ - _____ - _____

Venue 6 Observation ID #: _____ - _____ - _____

Venue 7 Observation ID #: _____ - _____ - _____

Venue 8 Observation ID #: _____ - _____ - _____

Please note: For some venues the last line may be blank. Ex: 51-1001- _____

Data Collection Form

Return form with Data Collection Cover Page to HCI at the end of each day.

Venue Observation ID #: _____ - _____ - _____

Date: _____ Day of Week: _____

Full Name of Venue: _____ City: _____ County: _____

Person Responsible for SidePak™ Measurement: _____

Person Responsible for Observational Assessments: _____

SidePak™ #: (Please Circle) 1 2 3 4 5

Name of other team members assisting: 1. _____ 2. _____

Time: Military Time (00:00 – 24:00; example: 9:10 am = 09:10 and 6:35 pm = 18:35)

Entry Time: _____ Exit Time: _____ (Please

Circle) MST CST

Room Dimensions in meters: Height: _____ m Length: _____ m Width: _____ m

Minimum of three counts of people and burning cigarettes upon entry, at 15 min after entry, and every 15 min thereafter. For counts 4-6, use only if applicable.

3 Counts	Time (Military)	# of People	# Burning Cigarettes
1 st Count			
2 nd Count			
3 rd Count			
4 th Count			
5 th Count			
6 th Count			
Average (round to 2 decimals)			

1. Is the venue 100% smoke-free by law?Yes
No

- a. Smoke-free by State Law?Yes No
- b. Smoke-free by Ordinance?Yes No
- 2. Is smoking observed in the room being monitored?Yes
No
- 3. Is there other evidence of smoking in the room being monitored?Yes
No
 - a. If yes to #3, is there smoke odor?Yes No
 - b. If yes to #3, are there ashtrays?.....Yes No
 - c. If yes to #3, are there cigarette butts?.....Yes No
- 4. Is there a separate enclosed smoking room?Yes
No
 - a. If yes to #4, is smoking observed in smoking room?Yes No
 - b. If yes to #4, is the smoking room door kept closed other than when a person is entering or exiting the smoking room?.....Yes No
- 5. Is there any outdoor dining with seating?Yes
No
 - a. If yes to #5, is smoking observed in outdoor seating area?Yes No
- 6. Is there a smoking shelter (outside area that is designed to shelter smokers)?.....Yes
No
 - a. If yes to #6, is smoking observed in smoking shelter?Yes No
- 7. Is there a butt hut (separate building outside of main building meant only for smoking)? Yes
No
 - a. If yes to #7, is smoking observed in butt hut?Yes No
- 8. Is there smoking in the indoor entranceway where smoking is not allowed?..... Yes
No
- 9. Is there smoking outside the entranceway and within 10 ft of the entrance?..... Yes
No
- 10. Was smoking observed in any location not noted above? Yes
No
 - a. If yes to #10, where was smoking observed?

Please use below to sketch room dimensions and to briefly describe the venue (place an X where the SidePak™ was used):

Restaurants with Enclosed Bars

Data Collection Form

Return form with Data Collection Cover Page to HCI at the end of each day.

Venue Observation ID #: _____ - _____ - _____

Date: _____ Day of Week: _____

Full Name of Venue: _____ City: _____

County: _____

Person Responsible for *SidePak*TM Measurement: _____

Person Responsible for Observational Assessments: _____

*SidePak*TM #: (Please Circle) **1** **2** **3** **4**
5

Name of other team members assisting: 1. _____ 2. _____

Restaurant (Smoke-Free) Section

Time: Military Time (00:00 – 24:00; example: 9:10 am = 09:10 and 6:35 pm = 18:35)

Entry Time: _____ Exit Time: _____

(Please Circle) **MST** **CST**

Room Dimensions in meters: Height: _____ m Length: _____ m Width: _____ m

Minimum of three counts of people and burning cigarettes upon entry, at 15 min after entry, and every 15 min thereafter. For counts 4-6, use only if applicable.

3 Counts	Time (Military)	# of People	# Burning Cigarettes
1 st Count			
2 nd Count			
3 rd Count			
4 th Count			
5 th Count			
6 th Count			
Average (round to 2 decimals)			

1. Is the venue 100% smoke-free by law?

.....Yes No

a. Smoke-free by State Law?Yes No

b. Smoke-free by Ordinance?Yes No

2. Is smoking observed in the room being monitored?

.....Yes No

3. Is there other evidence of smoking in the room being monitored?

.....Yes No

a. If yes to #3, is there smoke odor?Yes No

b. If yes to #3, are there ashtrays?Yes No

c. If yes to #3, are there cigarette butts?Yes No

4. Is there a separate enclosed smoking room?
 **Yes No**
- a. If yes to #4, is smoking observed in smoking room? **Yes No**
- b. If yes to #4, is the smoking room door kept closed other than when a person is entering or exiting the smoking room? **Yes No**
5. Is there any outdoor dining with seating?
 **Yes No**
- a. If yes to #5, is smoking observed in outdoor seating area? **Yes No**
6. Is there a smoking shelter (outside area that is designed to shelter smokers)?
 **Yes No**
- a. If yes to #6, is smoking observed in smoking shelter? **Yes No**
7. Is there a butt hut (separate building outside of main building meant only for smoking)? . **Yes No**
- a. If yes to #7, is smoking observed in butt hut? **Yes No**
8. Is there smoking in the indoor entranceway where smoking is not allowed?.....
 **Yes No**
9. Is there smoking outside the entranceway and within 10 ft of the entrance?..
 **Yes No**
10. Was smoking observed in any location not noted above?
 **Yes No**
- a. If yes to #10, where was smoking observed?

Room dimensions sketch and brief description of the venue (place an X where the SidePak™ was used):

Bar (Smoking) Section

Venue Observation ID #: _____ - _____ - _____

Time: Military Time (00:00 – 24:00; example: 9:10 am = 09:10 and 6:35 pm = 18:35)

Entry Time: _____ Exit Time: _____

(Please Circle) MST CST

Room Dimensions in meters: Height: _____ m Length: _____ m Width: _____ m

Minimum of three counts of people and burning cigarettes upon entry, at 15 min after entry, and every 15 min thereafter. For counts 4-6, use only if applicable.

3 Counts	Time (Military)	# of People	# Burning Cigarettes
1 st Count			
2 nd Count			
3 rd Count			
4 th Count			
5 th Count			
6 th Count			
Average (round to 2 decimals)			

1. Is the venue 100% smoke-free by law?
 ...Yes No
 a. Smoke-free by State Law?
 ...Yes No
 b. Smoke-free by Ordinance?
Yes No
2. Is smoking observed in the room being monitored?
Yes No
3. Is there other evidence of smoking in the room being monitored?
Yes No
 a. If yes to #3, is there smoke odor? Yes No
 b. If yes to #3, are there ashtrays?..... Yes No
 c. If yes to #3, are there cigarette butts?.....Yes No
4. Is there a separate enclosed smoking room?
Yes No
 a. If yes to #4, is smoking observed in smoking room?Yes No
 b. If yes to #4, is the smoking room door kept closed other than when a person is entering or exiting the smoking room?.....Yes No
5. Is there any outdoor dining with seating?
Yes No
 a. If yes to #5, is smoking observed in outdoor seating area?Yes No
6. Is there a smoking shelter (outside area that is design to shelter smokers)?
Yes No

- a. If yes to #6, is smoking observed in smoking shelter?Yes No
- 7. Is there a butt hut (separate building outside of main building meant only for smoking)? .Yes No
 - a. If yes to #7, is smoking observed in butt hut?Yes No
- 8. Is there smoking in the indoor entranceway where smoking is not allowed? Yes No
- 9. Is there smoking outside the entranceway and within 10 ft of the entrance?.. Yes No
- 10. Was smoking observed in any location not noted above? Yes No
 - a. If yes to #10, where was smoking observed?

Please use below to sketch room dimensions and to briefly describe the venue (place an X where the SidePak™ was used):

After Monitoring

Always at the end of each day, and when possible after each air monitoring session, the TSI™ SidePak™ must be immediately connected to a PC and the data for that session should be downloaded using the TrakPro™ software. The TrakPro™ file is to be sent to Healthy Communities International (HCI) at the end of each day; see the directions on the next page.

Also review the Data Collection Forms to double check that the data were recorded properly. All data collection forms are to be scanned and emailed to HCI or faxed if necessary at either the end of each day or immediately the following day if unable to fax due to late evening hours. The original data collection form is to be mailed to HCI along with other forms described later in this document.

Downloading TSI™ SidePak™

1. Turn on the PC and make sure that the *TrakPro™* software version 3.40 or later is installed.
2. If not already on, press PAGE key to turn the *SidePak™* on.
3. Take the larger end of the USB cable and insert it into an available USB port on the PC.
4. Take the small (miniUSB) end of the USB cable and insert it into the USB port on the side of the *SidePak™*.
5. Open the *TrakPro™* software.
6. Make sure “*SidePak™* Aerosol Monitor” is selected from the drop-down menu.
7. Go to the “File” menu and select “Receive.” The PC will then communicate with the *SidePak™* and display the logged data currently stored in the *SidePak™* memory.
8. Select the **relevant** logged data and click “Receive.” The PC will then download the selected logged data to the PC.
9. Verify the data has been downloaded by opening the *TrakPro™* program, clicking the File tab and selecting Open.
10. Save the file to your hard drive, labeling it with your initials and then the date. For example, a file downloaded by Kelly Buettner-Schmidt on May 10, 2012 is labeled as “KBS05102012.” This file is to be emailed to HCL, along with the appropriate data observation forms.

Forms and Reimbursement Requirements

The forms to be completed for this study include:

1. HCI – Tobacco Smoke Pollution Study Venue Tracking/Time Card

A partially completed venue tracking/time card will be sent to you. You will need to complete it, along with the MSU payroll documents, to receive payment. A time card should be completed for each week of testing; each venue must be listed on the contract, along with the times in each venue. The original time card will need to be mailed to HCI in a prepaid envelope provided by HCI. All paperwork required by the payroll department will be explained and tracked by that office.

2. No Alcohol Compliance Form

To receive payment, you will also need to complete the below No Alcohol Compliance Form and attach it to the Venue Tracking/Time Card. The original will need to be mailed to HCI in a prepaid envelope provided by HCI.

3. Agreement For Off-Campus Use Of MSU Equipment

MSU requires the below agreement form, stating MSU equipment is being used off-campus, be signed and scanned and faxed or emailed to HCI once the equipment is received. The original may be placed in the *SidePak™* case upon completion of the testing. Please be sure to sign the top portion when you receive the equipment and the bottom portion when you are returning the equipment. The return date that HCI will put on the form is an approximate date of return and arrangements can be made for an earlier or later pick up of the equipment.

4. Other reimbursement forms may be forthcoming as two funding sources are used for this study.

Reimbursement will be made in the following manner: per diem for tests conducted in restaurants (\$9 for lunch, \$15 for dinner) and \$3 per venue for tests conducted in bars. If hotel stays are necessary, hotel receipts in the Team Leader's name will be required. The receipts must show a zero balance (no direct billing allowed) and at the state rate of \$69.30 plus tax. Hotel rates above the state rate (\$69.30 plus tax) will only be reimbursed at the state rate plus appropriate tax rate.

All original forms, the Data Collection Forms, the Agreement For Off-Campus Use Of MSU Equipment, HCI - Tobacco Smoke Pollution Study Venue Tracking/Time Card, No Alcohol Compliance Forms, and other reimbursement forms are all to be sent to HCI in a prepaid envelope provided by HCI.

**TOBACCO SMOKE POLLUTION STUDY
NO ALCOHOL COMPLIANCE FORM**

By signing this document, I acknowledge that no alcohol was consumed or purchased while conducting the tobacco smoke pollution study.

The following venues were tested on _____ (enter date here):

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Signed _____

Date

Please attach to MSU Contract for Temporary Services and return to:
Cassie Loard, Business Manager
Healthy Communities International
Minot State University
500 University Avenue West
Minot, ND 58707

Thank you for assisting with the Tobacco Smoke Pollution Study!

AGREEMENT FOR OFF-CAMPUS USE OF MSU EQUIPMENT

I accept full responsibility for any loss or damage to the following equipment items that I will be taking off-campus to use for the following specific assignment(s)

Equipment Description: _____

University Inventory Number: _____

Serial Number: _____

The Equipment will be located at: _____

Anticipated return date: _____

Equipment Description: _____

University Inventory Number: _____

Serial Number: _____

The Equipment will be located at: _____

Anticipated return date: _____

I understand that the department has the right to request that I return the equipment to the University at any time.

I understand it may be necessary for auditors or MSU personnel to visually verify that the equipment is located at the above mentioned location and it is being used as intended.

I understand that personal use of University property is a violation of Section 12.1-23-07 of the North Dakota Century Code.

I understand that if I fail to return the equipment to the University, appropriate sanctions may be taken against me, including withholding of money due me by the University until such equipment is returned.

SIGNED: _____ DATE: _____

Employee

APPROVED: _____ DATE: _____

Supervisor

Return original to the Business Office and keep copy in Department.

EQUIPMENT RETURNED

Equipment Description: _____

University Inventory Number: _____

Serial Number: _____

Date Returned: _____

Equipment Description: _____

University Inventory Number: _____

Serial Number: _____

Date Returned: _____

Signed: _____ DATE:

Employee

Signed: _____ DATE:

Supervisor

Obtain original from the Business Office or sign department copy and return to Business Office with original returned signatures.

Technical Assistance Contact Information

Unless otherwise instructed, please contact the below in the following order for any assistance and questions.

Kelly Buettner-Schmidt

Cell: 701-340-6240
Office: 701-858-3256
Home: 701-839-5253

Cassie Loard

Cell: 701-720-6287
Office: 701-858-3459
Home: 701-852-4482

Tricia Vondal

Cell: 701-721-2729
Office: 701-858-4133
Home: 701-838-8661

Tara Bjornson

Cell: 701-721-8055
Office: 701-858-3464

Ann Rivera

Cell: 701-509-6149
Office: 701-858-4083

Appendix G

ND Population and RUCC Change from 2000 - 2010

RUCC Code	Description					
Metro counties:						
1	Counties in metro areas of 1 million population or more					
2	Counties in metro areas of 250,000 to 1 million population					
3	Counties in metro areas of fewer than 250,000 population					
Nonmetro counties:						
4	Urban population of 20,000 or more, adjacent to a metro area					
5	Urban population of 20,000 or more, not adjacent to a metro area					
6	Urban population of 2,500 to 19,999, adjacent to a metro area					
7	Urban population of 2,500 to 19,999, not adjacent to a metro area					
8	Completely rural or less than 2,500 urban population, adjacent to a metro area					
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area					
FIPS	County Name	Pop 2000	Pop 2010	2000 RUCC	Population change that may affect RUCC	RUCC Code Change
38000	North Dakota	642,237	672,591			
38001	Adams	2,593	2,343	9	Decreased < 2,500	No
38003	Barnes	11,772	11,066	6		
38005	Benson	6,961	6,660	9		
38007	Billings	888	783	9		
38009	Bottineau	7,156	6,429	9		
38011	Bowman	3,243	3,151	9		
38013	Burke	2,243	1,968	9		
38015	Burleigh	69,408	81,308	3		
38017	Cass	123,171	149,778	3		
38019	Cavalier	4,832	3,993	9		
38021	Dickey	5,768	5,289	9		
38023	Divide	2,283	2,071	9		
38025	Dunn	3,606	3,536	9		
38027	Eddy	2,756	2,385	9	Decreased < 2,500	No
38029	Emmons	4,327	3,550	8		
38031	Foster	3,761	3,343	9		
38033	Golden Valley	1,925	1,680	9		
38035	Grand Forks	66,119	66,861	3		
38037	Grant	2,841	2,394	8	Decreased < 2,500	No
38039	Griggs	2,754	2,420	9	Decreased < 2,500	No
38041	Hettinger	2,715	2,477	9	Decreased < 2,500	No
38043	Kidder	2,738	2,435	8	Decreased < 2,500	No
38045	LaMoure	4,690	4,139	9		

38047	Logan	2,315	1,990	9		
38049	McHenry	5,983	5,395	9		
38051	McIntosh	3,388	2,809	9		
38053	McKenzie	5,738	6,360	9		
38055	McLean	9,346	8,962	8		
38057	Mercer	8,634	8,424	6		
38059	Morton	25,301	27,471	3		
38061	Mountrail	6,636	7,673	9		
38063	Nelson	3,706	3,126	8		
38065	Oliver	2,057	1,846	8		
38067	Pembina	8,620	7,413	9		
38069	Pierce	4,667	4,357	7		
38071	Ramsey	12,062	11,451	7		
38073	Ransom	5,896	5,457	8		
38075	Renville	2,612	2,470	9	decreased < 2,500	No
38077	Richland	17,992	16,321	6		
38079	Rolette	13,674	13,937	9		
38081	Sargent	4,362	3,829	9		
38083	Sheridan	1,711	1,321	9		
38085	Sioux	4,043	4,153	8		
38087	Slope	765	727	9		
38089	Stark	22,635	24,199	7		
38091	Steele	2,252	1,975	8		
38093	Stutsman	21,912	21,100	7		
38095	Towner	2,878	2,246	9	decreased < 2,500	No
38097	Traill	8,479	8,121	8		
38099	Walsh	12,375	11,119	6		
38101	Ward	58,799	61,675	5		
38103	Wells	5,095	4,207	9		
38105	Williams	19,754	22,398	7	Increased > 20,000	Yes to 5

Appendix H

ND Counties 2000 and 2010 Population and RUCC Categorizations

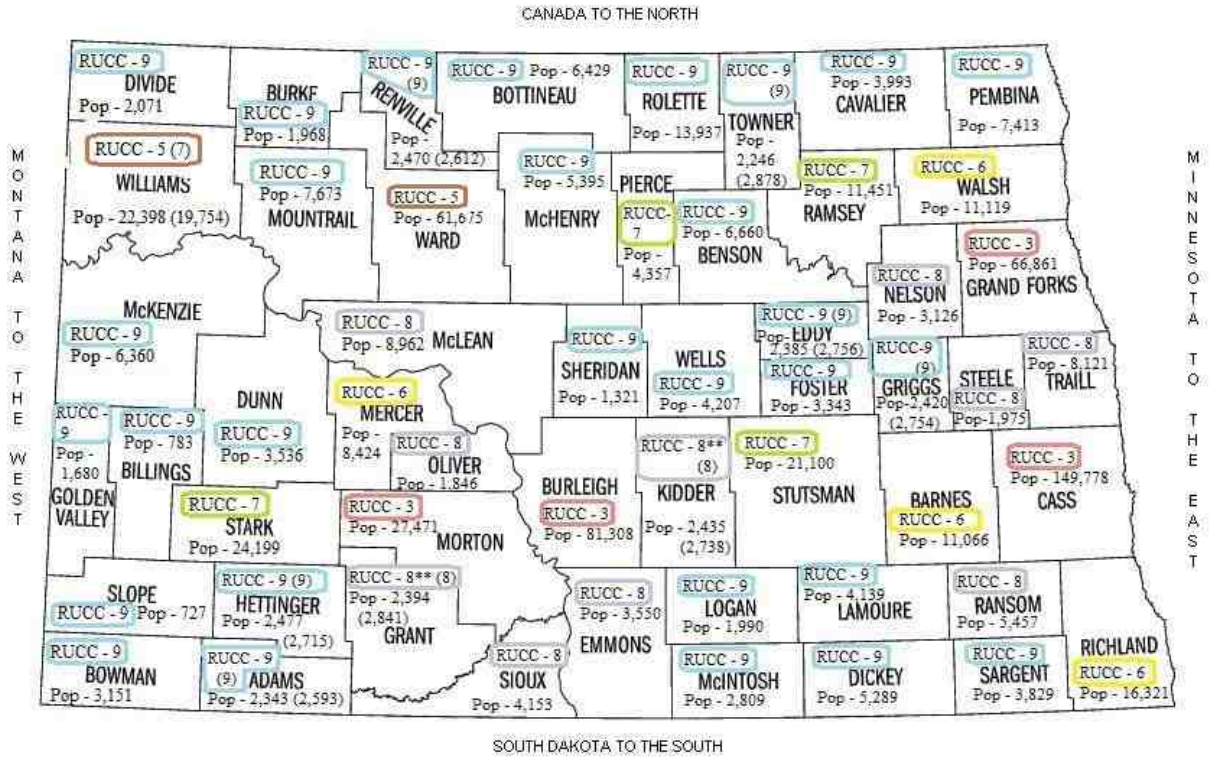


Figure 1. In the nine counties with potential change in RUCC classification, the 2000 Population and RUCC classification is in parenthesis. The only county with a change in RUCC classification was Williams County from a 7 to a 5. RUCC Classification color are as follows: 3 is red; 5 is brown; 6 is yellow; 7 is green; 8 is purple; and 9 is blue.

Appendix I

RUCC Categories Applied to ND 2010 Population

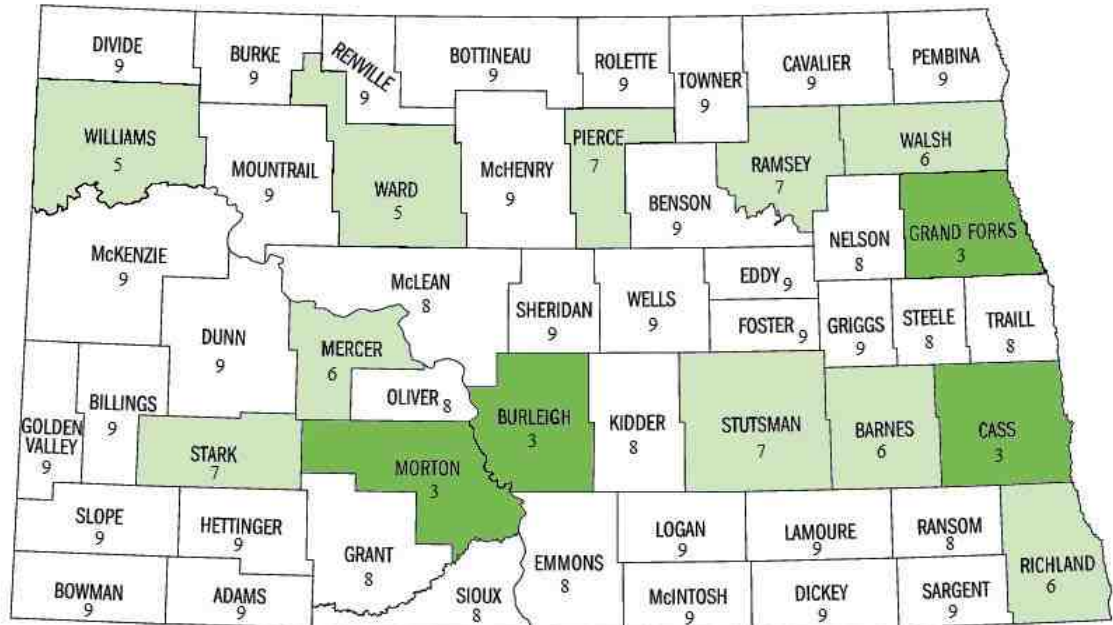


Figure 1. Application of the RUCC categories to North Dakota’s population per the 2010 decennial census, see also Appendices G & H. The county assignment to specific color codes remained unchanged from 2003, where the darkest green indicated metropolitan counties, light green indicated nonmetropolitan counties with an urban population of 2,500 or more; and white indicated completely rural or less than 3,500 urban population. The only county with a change in RUCC classification for the 2010 population was Williams County from a Code 7 to a Code 5; the color coding remained light green. Adapted from “Rural-Urban Continuum Codes for North Dakota: 2003,” by USDA ERS. Retrieved from http://www.ndsu.edu/sdc/data/ruralurbanmetro/ND_MAP_RUCA.pdf.

Appendix J

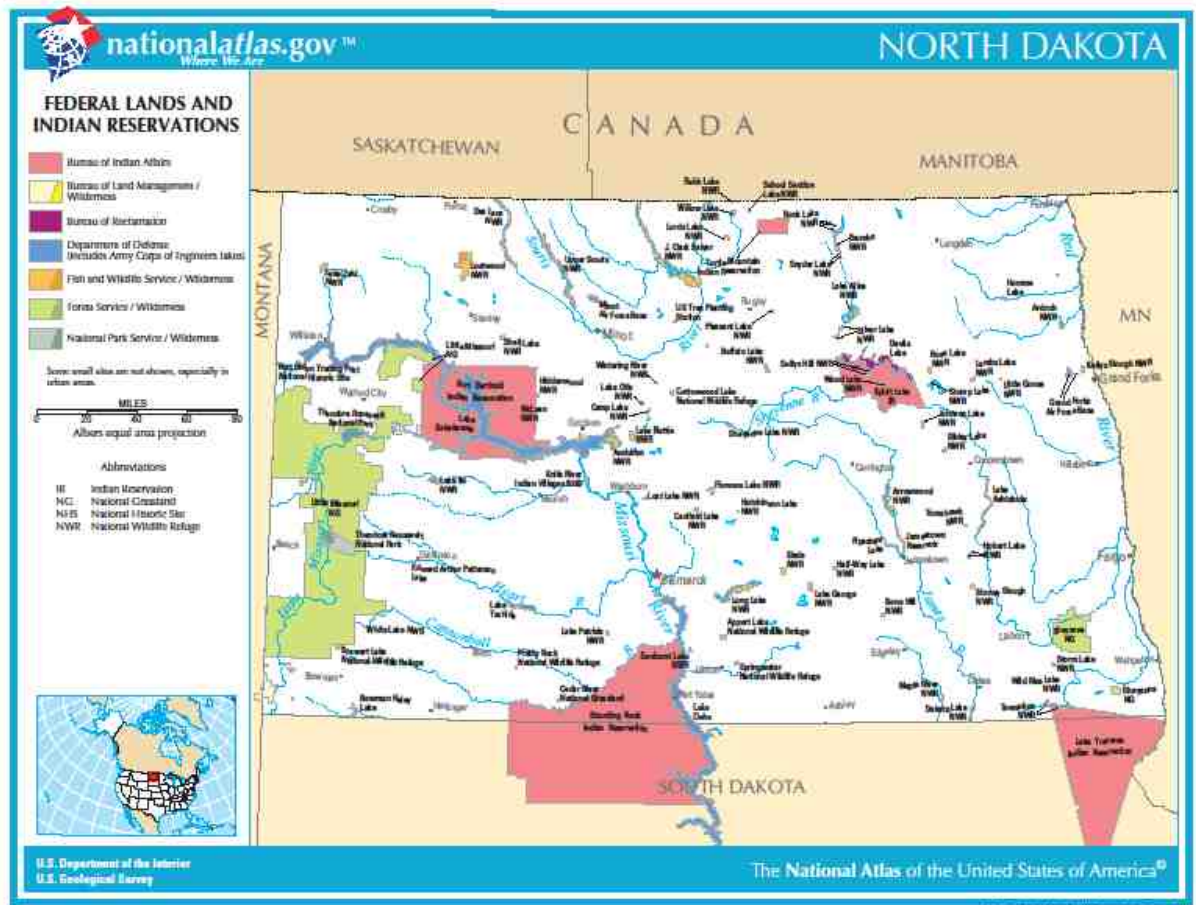
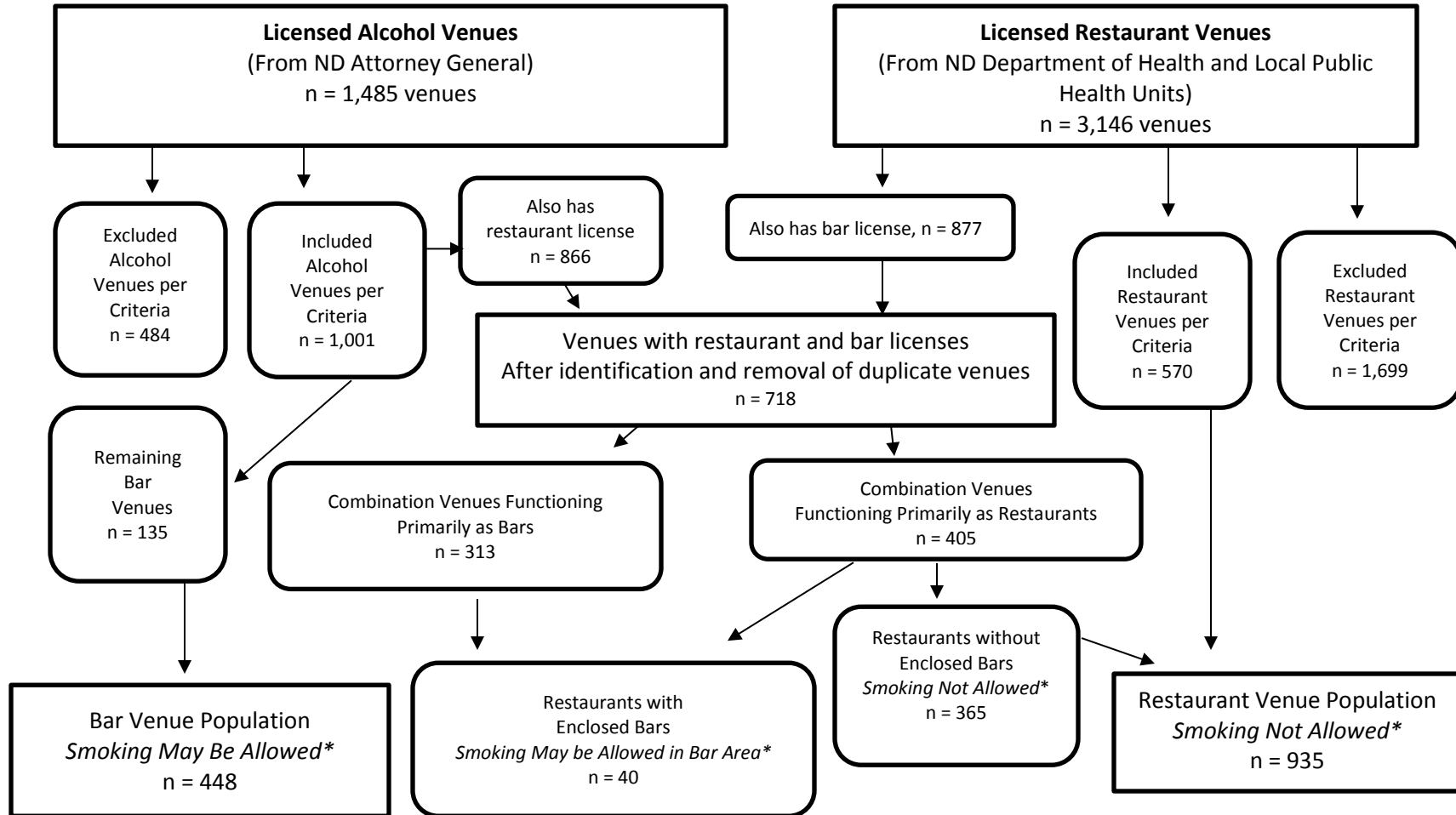


Figure 1. Federal lands and Indian reservations: North Dakota. Pink color indicates reservation land. Retrieved from <http://nationalatlas.gov/printable/images/pdf/fedlands/ND.pdf>

Appendix K

Venue Categorization Summary



Appendix L

Data Collection and Entry Form

4Digit	Data Entered by	Data Verified by	CtyCode	Date	Day	Venue			City	SidePak	CST/MST
0000	AAA	BBB	01	10/13/2005	Thursday	Burgundy Room			Smalltown	1	CST
StartLog	StopLog	TLeader	EntryTim	ExitTime	Hm	Lm	Wm	ObsTime1	ppl1	cig1	
18:00	20:00	CCC	18:25	18:55	2.20	10.99	8.07	18:25	12.00	1.00	
ObsTime2	ppl2	cig2	ObsTime3	ppl3	cig3	ObsTime4	ppl4	cig4	ObsTime5	ppl5	
18:40	13.00	2.00	18:55	8.00	1.00	-	-	-	-	-	
cig5	ObsTime6	ppl6	cig6	SfbyLaw	StateLaw	Ordinanc	SRmMontr	OthrEvdC	EvdcOdor	EvdcAsht	
-	-	-	-	No	No	No	Yes	Yes	Yes	Yes	
EvdcButt	EncSmkR	SEncSmkR	DoorClsd	OutDng	SOutDg	Shelter	SShelter	Bhut	SBhut	SIndrEnt	
Yes	No	No	No	No	No	No	No	No	No	No	
SmkOuts	SEIsWhr	Where	RmVolume m3 (h*I*w)	RmArea m2 (l*w)	AvgPpl	AvgCigs	OD per 10m2 [(AvgPpl / RmArea) *10]	ASD per 100 m3 (Avg Cigs / RmVol) * 100	Avg PM _{2.5} microgram	RUCC 1 - 9 by County	
No	No	No	195.12	88.69	11	1.33	1.24	0.68	349	9	
Population Estimate per Census Tract	Estimate Percent Below Poverty Level per Census Tract	Percent Below Poverty Level Margin of Error									
1986	14.00%	5.5%									

Appendix M

Data Analysis Plan

AIM 1	To describe a baseline quantity of tobacco smoke pollution and the impact of specific factors on tobacco smoke pollution in hospitality venues statewide in North Dakota. These factors include: presence of law requiring venue to be smoke-free law (state or local), venue type, venue size, occupant density, smoke density, and observed smoking.
Hypothesis	The quantity of tobacco smoke pollution in hospitality venues will alter depending upon specific factors. These factors include: presence of law requiring venue to be smoke-free law (state or local), venue type, venue size, occupant density, smoke density, and observed smoking.
Variables	Dependent variable (DV): Continuous: quantity of tobacco smoke pollution. Independent variables (IV): Continuous: Room Volume, Occupant Density, Active Smoker Density, Categorical/Nominal: Venue type (bar, restaurant, restaurants with enclosed bars) Categorical/Dichotomous: Observed Smoking; Smoke free by law (either presence of local ordinance stronger than state law requiring smoke free or smoke free by state law)
Statistical Analysis	Multiple regression, forward method; with exploratory analysis of relationships between variables.
Power Analysis	Multiple Regression power analysis, assuming alpha 0.5, power 0.8, and 6 predictor (may need to change variables); for the overall deviation of the multiple linear regression model R-square from zero, a small effect size ($f^2=0.2$) requires a sample size of 688, a medium effect ($f^2=.15$) requires 98, and a large effect ($f^2=.35$) requires 46.
AIM 2	To compare the quantity of tobacco smoke pollution in hospitality venues in completely rural versus semi-rural/urban versus non-rural locations statewide in North Dakota.
Hypothesis	In hospitality venues, the quantity of tobacco smoke pollution will be higher as the county population lowers.
Variables for Consideration	DV: Continuous: Quantity of tobacco smoke pollution IV: Ordinal: Rurality: (As per RUCC Code: Completely rural = RUCC 8-9; Semi-rural/Urban = RUCC 4-7; Non-rural = RUCC 1-3.) Categorical Dichotomous: Smoking status
Statistical Analysis	Multiple Regression

Power Analysis	Measuring rurality as ordinal data, regression power analysis, alpha 0.5, power 0.8, and 3 predictor variables; for the overall deviation of the multiple linear regression model R-square from zero, a small effect size ($f^2=0.2$) requires a sample size of 550, a medium effect ($f^2=.15$) requires 77, and a large effect ($f^2=.35$) requires 36.	
AIM 3	To compare the quantity of tobacco smoke pollution in hospitality venues located within and outside of communities with a local ordinance statewide in North Dakota.	
Hypothesis	3a: The quantity of tobacco smoke pollution will be lower in hospitality venues located within communities with an ordinance more stringent than state law than those located outside of communities with an ordinance more stringent than state law.	3b. <i>Compliance</i> with smoke free laws will be higher in hospitality venues located within communities with an ordinance more stringent than state law than those located outside of communities with an ordinance more stringent than state law.
Variables	DV: Continuous: Quantity of tobacco smoke pollution in all venues IV: Categorical/Dichotomous: Local ordinance(Yes/No) Dichotomous: Type of Venue (Bar, Restaurant)	DV: Categorical/Dichotomous: Compliant (Yes/No) IV: Categorical/Dichotomous: Local Ordinance (Yes/No)
Statistical Analysis	Two way ANOVA (two way; fixed effects, special, main effects and interactions)	For relationship: Pearson's chi-square test (χ^2) (My Notes: a 2 x 2 contingency table; χ^2 compares the frequencies in each category to the frequencies that might occur by chance.)
Power Analysis	Power analysis for (F-test)	Power analysis for Goodness of Fit: Contingency Tables (chi-square test), with 1 degree of freedom, assuming alpha 0.5, power 0.8, a small effect size ($w = .10$) requires 785 sample size; a medium effect ($w = .30$) requires 88 sample size; and a large effect ($w = .50$) requires 32 total sample size.
AIM 4	To determine the direct influence of socio-economic status of the venue location on the quantity of tobacco smoke pollution in hospitality venues statewide in North Dakota.	
Hypothesis	The quantity of tobacco smoke pollution will increase as the socio-economic status of the venue locations decreases in hospitality venues in North Dakota.	

Variables	<p>DV: Continuous: Quantity of Tobacco Smoke Pollution.</p> <p>IV: Poverty can be measured in two ways. Both ways will be investigated in separate models.</p> <ul style="list-style-type: none"> (1) Percent poverty per census tract; continuous data (2) Level of poverty rates by census tracts (ordinal): Category I = less than 13.8%; Category II = 13.8% - 19.9%; Category III = 20.0 – 39.9%; Category IV = 40.0% or more. <p>Dichotomous: Presence of Ordinance Dichotomous: Venue Type: Restaurant, Bar</p>
Statistical Analysis	Multiple regression
Power Analysis	Multiple Regression power analysis, using poverty categories, assuming alpha 0.5, power 0.8, and 5 predictors; for the overall deviation of the multiple linear regression model R-square from zero, a small effect size ($f^2=0.2$) requires a sample size of 647, a medium effect ($f^2=.15$) requires 92, and a large effect ($f^2=.35$) requires 43.

Appendix N

Unpublished Results

METHODS

This natural experimental study was cross-sectional. Natural experimental studies are those that evaluate interventions that were not intended for study and that permit causal inferences based on exposure or outcome variations.¹

Setting

The settings for this study were hospitality venues in North Dakota (ND), specifically restaurants and bars. Venues located within the ND American Indian reservations of Spirit Lake, Standing Rock, Three Affiliated Tribes, and Turtle Mountain, were not included (Appendix J).

Sample

A list of ND hospitality venues was obtained from various sources. State and local public health agencies provided restaurant lists. According to the ND Department of Health's (NDDoH) Director of Food and Lodging (K. L. Bullinger, B.S. Biology, oral communication, November 2011); the NDDoH licenses approximately 50% of all restaurant venues. The following eight local public health agencies license the remaining restaurant venues: Bismarck / Burleigh Public Health, Central Valley District Health, Custer District Health Unit, Fargo / Cass Public Health, First District Health, Grand Forks Public Health Unit, Southwestern District Health Unit, Upper Missouri District Health Unit. The ND Attorney General's Office provided a list of all licensed alcohol venues, which served as the bar population. Local tobacco control coordinators provided lists of truck stops and retail tobacco stores that allowed smoking, with only one truck

stop and two retail tobacco stores identified, these venues were not included in the study. The one truck stop did operate a restaurant and was classified as a restaurant with no note being made of its truck stop status.

Each list was reviewed to remove venues that met specific exclusion criteria. The ND Century Code (NDCC) § 23-09-01 defined limited restaurants as "... a food service establishment that is restricted to a specific menu as determined by the department or an establishment serving only prepackaged foods, such as frozen pizza and sandwiches, which receive no more than heat treatment and are served directly in the package or on single-serve articles."² The NDDoH separated limited restaurants from other restaurants. However, not all the local public health agencies identified restaurants as limited. Therefore, in developing the population, the NDDoH list of limited restaurants was not included in the population, and any restaurants identified by the public health entities as limited were not included in the population. All the restaurant lists from local public health agencies were reviewed closely to exclude any other restaurants that may have been limited and also were labeled as per the exclusion criteria described next.

Bar venue exclusion criteria included:

1. alcohol was not being consumed on-site,
2. on tribal reservation land,
3. closed for business,
4. private clubs, such as Elks Lodges, American Legions, and so forth,
5. golf courses (a seasonal venue in ND),
6. other seasonal venues, such as rodeos, county fairs, summer resorts, and so forth, and

7. other, such as catering, sports stadiums, strip-clubs, and so forth.

Restaurant venue exclusion criteria included:

1. venues 2 – 7 in the bar exclusion list,
2. national fast food chains such as Burger King, McDonalds, and so forth,
3. catering and event only venues, such as city facilities,
4. cafeterias,
5. duplicate listings,
6. oilfield “man camps”,
7. drive up only,
8. assisted living or nursing homes,
9. concessions,
10. daycare or school,
11. meat processing,
12. continental breakfast at hotels,
13. grocery stores,
14. senior citizen centers, and
15. other.

Several venues were on both the alcohol and restaurant lists; these venues were placed in a combined list and then reviewed to determine whether the venue operated primarily as a bar or a restaurant. A summary of the venue categorizations is in Appendix K. Table 1 summarizes the excluded venues by category.

All venues were categorized using the 2003 Rural Urban Continuum Codes (RUCC) prior to data collection as completely rural (RUCC 8-9), semi-rural/urban

(RUCC 4-7), or non-rural (RUCC 1-3).³ Venues were also categorized as being within or outside of communities with an ordinance requiring smoke-free bars and thus more stringent than the state law. Table 2 lists the communities that had smoke-free ordinances requiring smoke-free bars, their 2010 population, ordinance effectiveness dates, the county the community was located within, and the corresponding RUCC. The table was ordered by ascending population.

TABLE 1—Categories and Number of Venues Excluded from the Study: North Dakota, 2011

	Alcohol, n	Restaurants, n	Total, n
Total Venues	1,485	3,146	4,631
Off-Sale Only	161		161
Tribal Reservation	19	9	28
Closed	49	33	82
Private Clubs	103	94	197
Golf Courses (Seasonal)	82	65	147
Other Seasonal	41	27	68
Other	24	131	155
Fast Food		768	768
Catering or Events Only		170	170
Cafeteria		111	111
Multiple Listings		51	51
Oilfield Man Camp		20	20
Drive-up		12	12
Assisted Living or Nursing Homes		17	17

	Alcohol, n	Restaurants, n	Total, n
Concessions		12	12
Daycare or School		10	10
Meat Processing		17	17
Hotel Breakfast		29	29
Grocery		107	107
Senior Center		16	16
Excluded Per Criteria	484	1,699	2,178

TABLE 2—Local Smoke-free Ordinances that Required Smoke-free Bars and Thus More Stringent than State Law, by 2010 Population, Effective Date, County, and Rurality: North Dakota, 2011

Community	2010 Population	Ordinance Effective	County	RUCC
Pembina	592	February 1, 2011	Pembina	9
Napoleon	792	August 8, 2010	Logan	9
Devils Lake	7,141	July 1, 2011	Ramsey	7
West Fargo	25,830	July 1, 2008	Cass	3
Grand Forks	52,838	August 15, 2010	Grand Forks	3
Bismarck	61,272	April 27, 2011	Burleigh	3
Fargo	105,549	July 1, 2008	Cass	3

Notes. RUCC = rural urban continuum code; RUCC 1 – 3 = non-rural; RUCC 4 – 7 = semi-rural/urban; RUCC 8 – 9 = rural.

Table 3 summarizes the study population by RUCC categories and by being located within or outside of communities with a local ordinance requiring bars to be smoke-free and thus more stringent than state law

TABLE 3—Overall Characteristics of the Study Population of Hospitality Venues by Rural Urban Continuum Code, Poverty, and Presence of Law Requiring Bars be Smoke-Free: North Dakota, 2011

Characteristic	Not Co-located Restaurant, n (%)	Not Co-located Bar, n (%)	Co-located Restaurant, n (%)	Co-located Bar, n (%)	Total Restaurant, n (%)	Total Bar, n (%)	Total Venues, n (%)
Population	935	448	40	40	975	488	1,463
RUCC (1-9)							
Non-rural (1-3)	378 (40.43)	131 (29.24)	15 (37.5)	15 (37.5)	393 (40.31)	146 (29.92)	
Semi-rural/urban (4-7)	256 (27.38)	141 (31.47)	7 (17.5)	7 (17.5)	263 (26.97)	148 (30.33)	
Completely rural (8-9)	301 (32.19)	176 (39.29)	18 (45.00)	18 (45.00)	319 (32.72)	194 (39.75)	
Total	935	448	40	40	975	488	1,463
Within community with ordinance							
Non-rural (1-3)	330 (92.70)	80 (90.91)	9 (100.00)	9 (100.00)	339 (92.88)	89 (91.75)	428 (92.64)
Semi-rural/urban (4-7)	20 (5.62)	6 (6.82)	0 (0.00)	0 (0.00)	20 (5.48)	6 (6.19)	26 (5.63)

Characteristic	Not Co-located Restaurant, n (%)	Not Co-located Bar, n (%)	Co-located Restaurant, n (%)	Co-located Bar, n (%)	Total Restaurant, n (%)	Total Bar, n (%)	Total Venues, n (%)
Completely rural (8-9)	6 (1.69)	2 (2.27)	0 (0.00)	0 (0.00)	6 (1.64)	2 (2.06)	8 (1.73)
Total	356	88	9	9	365	97	462
Outside community with ordinance							
Non-rural (1-3)	48 (8.29)	51 (14.17)	6 (19.35)	6 (19.35)	54 (8.85)	57 (14.58)	111 (11.09)
Semi-rural/urban (4-7)	236 (40.76)	135 (37.5)	7 (22.58)	7 (22.58)	243 (39.84)	142 (36.32)	385 (38.46)
Completely rural (8-9)	295 (50.95)	174 (48.33)	18 (58.06)	18 (58.06)	313 (51.31)	192 (49.10)	505 (50.45)
Total	579	360	31	31	610	391	1001

Notes. RUCC = rural urban continuum code.

The venues were stratified into three groups: restaurants, bars *within* communities with local ordinances that required bars to be smoke-free and thus stronger than state law, and bars *outside* of communities with local ordinances that required bars to be smoke-free. Sample selection included at least 30 venues per strata to allow for *t* tests to meet standard guidelines for conducting for conducting independent samples *t* tests. A power analysis indicated at least 114 venues were required for planned regression analysis. Therefore, 54 cases were included from the large category of bars in communities without ordinances. An additional category comprised the 40 restaurants with 40 attached and enclosed bars.

In determining sampling strategy, and with restaurants serving as controls, consideration was given to stratifying by 1) rurality and 2) venue location within or outside of communities with a local smoke-free ordinance that required bars to be smoke-free. Also considered was the power required to conduct the needed statistical analysis.

The venue population was similar across the three RUCC categories and between the restaurants' locations within or outside of communities with local smoke-free laws; therefore no stratification by these parameters was necessary. The bars within communities with ordinances (20%) were required to be smoke-free; and most of these bars were in non-rural areas (92%). Bars outside of communities with ordinances were not required to be smoke-free (80%), with most of the bars in rural or semi-rural areas. The study questions primarily relied on *t* test or related tests requiring a sample size of 30.

Therefore, the decision was made to randomly select 30 restaurants as controls, 30 bars within communities having local smoke-free ordinances, and 54 bars in communities

without ordinances (primarily located in rural or semi-rural areas). For sampling of the additional category of co-located restaurants with enclosed bars, it was determined to include in the sample all of those that allowed smoking on the bar side (restaurants, n = 16; enclosed bars, n = 16).

Procedures for data collection

Equipment and Synchronization

The following equipment was used: (1) five TSI SidePak™ AM510 Personal Aerosol Monitors (TSI Group, Shoreview, MN), (2) five Zircon DM S50 Sonic Measures (Zircon Corporation, Campbell, CA) to measure room volume, and (3) computers/laptops (Appendix E and F).

The five TSI SidePak™ AM510 Personal Aerosol Monitors used to measure PM_{2.5} were calibrated and synchronized for tobacco smoke pollution measurements with uncertainty and precision determined in advance of data collection. Travers previously validated the TSI SidePak™ AM510 Personal Aerosol Monitors for tobacco smoke pollution, with precision as a measure of the devices ability, given the same conditions, to provide the same result; and with uncertainty as the square root of the average of the variance of the 1 minute measurement divided by the number of devices being synchronized.⁴ All five SidePaks™ for this study, with the 2.5 micron impactor attached, were set to log at 1 minute intervals, with the flow rates ranging from 1.55 and 1.70 liters per minute (lpm) (\bar{x} = 1.61 lpm) and zero calibrated. Field synchronization was conducted by placing all five SidePaks™ in one shoulder bag with the tubing banded together and protruding from the bag. Data were logged simultaneously over a period of 136 minutes and in 6 venues (work, home, drugstore, 3 bars). Figure 1 shows the real

time plots of PM_{2.5} concentration of the 5 co-located SidePaks™ showing some degree of scatter. Table 4 shows the means, variances, and standard deviation for each of the five SidePaks™. The uncertainty value = 5.813 μg/m³ and precision = 5.39%. Data from each of the the SidePaks™ was used without further adjustment of the SidePaks™.

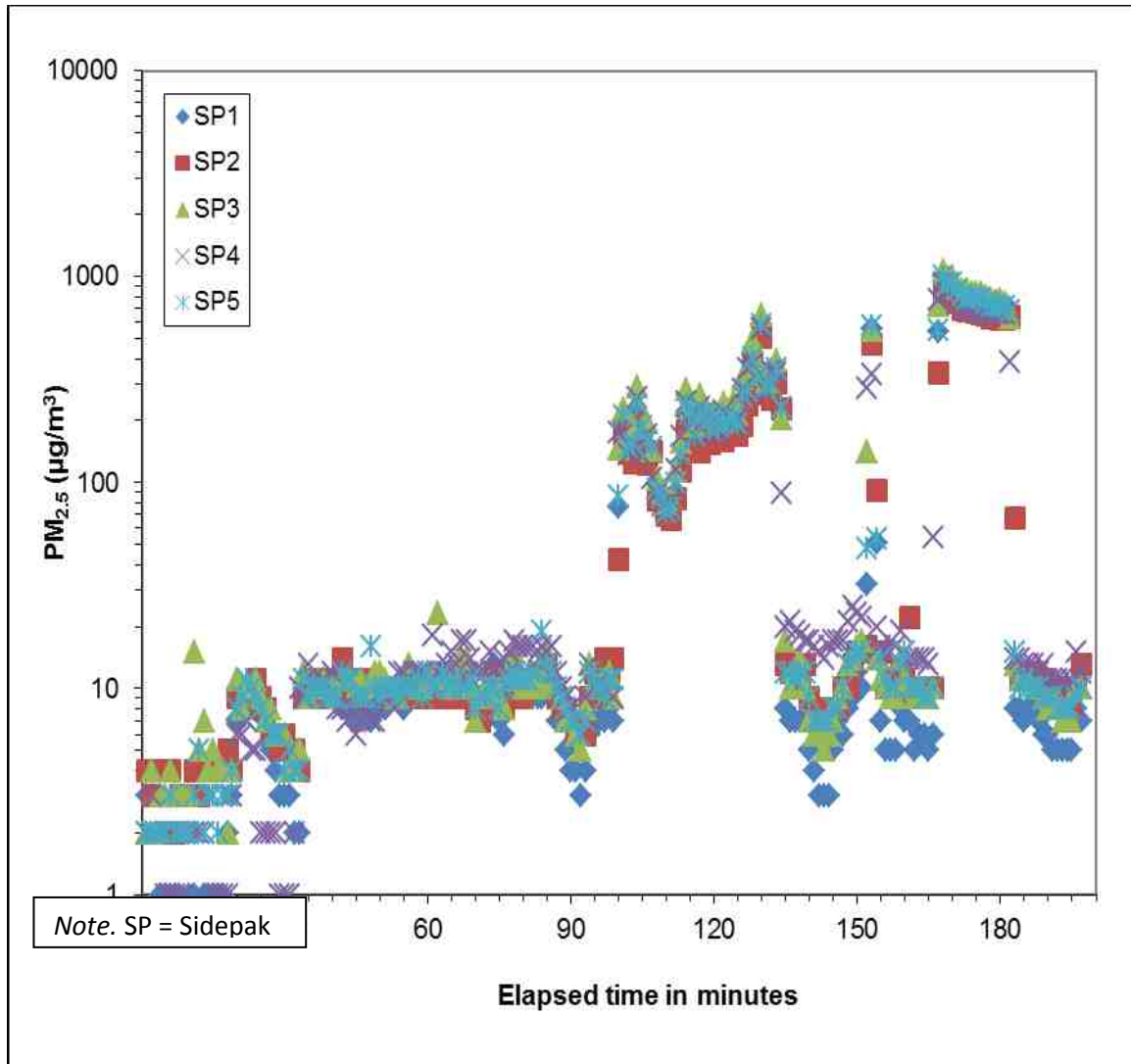


FIGURE 1—Real-time Plots of Field Test for TSI SidePak™ AM510 Personal Aerosol Monitors: North Dakota, 2012

TABLE 4—Mean, Variance, and Standard Deviation Results of Field Test for TSI SidePak™ AM510 Personal Aerosol Monitors, µg/m³: North Dakota, 2012

Sidepak	1	2	3	4	5
Mean	106.6	96.5	120.5	105.1	110.9
Variance	49547.5	37275.6	57501.5	40723.1	50153.0
SD	222.6	193.1	239.8	201.8	223.9

Use of the SidePaks™ allowed for immediate downloading of samples; continuous measurement of once per second for up to 6 – 14 hours, thereby allowing the ability to identify changes in PM_{2.5} over time; and with high sensitivity to tobacco smoke.⁵ Data collection and management protocols for measuring tobacco smoke pollution established by Travers,⁶ used world-wide, were modified for this study and included protocols from a previous ND compliance study⁷ (Appendix E-F).

Data collection involved three phases. The first phase was the training of research assistants and data collectors on the protocols; this phase included three steps. The first step was a web-based or telephone training for all by either Dr. Mark Travers or Kelly Buettner-Schmidt. The second step was the conduction of test runs by the research assistants and data collectors who would conduct the air sampling; these results were sent to Dr. Travers and/or Buettner-Schmidt to assure accuracy in the sampling. The third step was assuring inter-rater reliability for the observational assessments. To assess inter-rater reliability, two observers entered the same venue, separately completed the observation forms, and returned their forms to Buettner-Schmidt for analysis. Acceptable inter-rater

reliability was 85% agreement in the counts of people and cigarettes; and 90% agreement with all other observational items.

The second phase was collection of the air samples and observational assessments. The research assistants and data collectors worked primarily in teams to discreetly gather the air samples and complete the observations, including counting the average number of people and the number of burning cigarettes every 15 minutes, with the following responsibilities. At least one person in each team was the Team Leader who was highly knowledgeable and skilled in use of the TSI SidePakTM, the sonic measuring device, the laptop, the observational assessment, and the related paperwork. The Team Leader(s) included this researcher, Minot State University employees, or other individuals who have worked in tobacco control and understood the risks involved, and included those who have previously conducted air sampling with the SidePakTM and who attended the web-based training. The Team Leader was always responsible for all protocols (Appendix E – F). Team Assistants were instructed by the Team Leader and assisted in the completion of the protocols. Some Team Assistants were local persons to assist the Team Leader and other Team Assistants to blend into the establishments, especially in ND's more remote areas. Teams were instructed to not enter venues where there appeared to be illegal or unsafe activities occurring or venues that local public health tobacco control staff expressed safety concerns.

The third phase was processing the air sample data, including extraction of PM_{2.5} levels from the SidePaksTM using Trakpro v4.5 (TSI, Shoreview, MN, USA), application of the proper calibration factor to the PM data, determining the average levels of PM_{2.5},

and creating real-time plots of the measured parameters. The observational data were entered into, processed, and analyzed using Microsoft Excel and SPSS.

Data management

Data management was rigorous to assure data integrity by following the data collection protocol, thorough training of data collectors, and assuring integrity of the data.⁸ As discussed previously, the data collection and management protocols originally developed by Travers⁶ have been used world-wide; the protocol was modified for this study and included protocols from a previous ND compliance study.⁷ The training of data collectors was provided by web-based training or per phone conference. Each person collecting data conducted a test run with data sent to either Travers or Buettner-Schmidt for processing and analysis to assure reliability. Assuring the integrity of the data included following the After Monitoring Protocol (Appendix F). Data cleaning to reduce errors in the database occurred by data inspection, correction of any errors, and assessing for outliers before data analysis began. The collected data were removed from the laptops and backed up to a secure server at least weekly. The names of individual venue names and codes were kept in a separate locked file and were available for access only by this researcher, the research assistants, and the administrative assistant. Removal of any identifying information occurred before public release of data. The data will be stored for a minimum of five years after completion of the study; at that time the data will be eliminated from the server.

Data analysis

Data analysis included assessment of missing data and outliers and descriptive statistics, including appropriate measures of central tendency and frequency distributions, for the sample as a whole and for each stratum. Data were evaluated to determine if assumptions for each method of analysis was met.

Descriptive statistics for categorical and ordinal variables included frequencies and percentages, and Fisher's exact test and chi-square tests were used to assess statistical significance of associations between categorical variables. Analysis of all continuous variables included standard deviations (SD) as a measure of variability and arithmetic means (AM) primarily as a measure of central tendency. Statistical significance of observed differences in group means was assessed via independent samples *t* tests or one-way ANOVAs depending on whether means of two or more than two groups were compared. Alternate versions of each statistical test were used in the presence of a significant ($p < .05$) Levene's test indicating lack of homogeneity of variance. The ω^2 statistic was used as an effect size measure for ANOVAs, and $r_{contrast}$ was calculated as an effect size measure for follow up contrasts.

Although the sample size of this study typically would not require transformation of data for the type of analyses being performed, $\log PM_{2.5}$ enabled inclusion of multiplicative statements in the results. With $PM_{2.5}$ levels strongly right skewed, natural log transformed values for $PM_{2.5}$ ($\log PM_{2.5}$) were calculated and used as the dependent variable in linear regression analyses. Also, geometric means (GM) and geometric standard deviations (GSD) were calculated for $PM_{2.5}$ levels and also used for analysis of the quantity of tobacco smoke as $PM_{2.5}$ levels are typically log-normally distributed. The

GM and GSD were calculated by exponentiating the means and SDs of the log transformed values. Exponentiated regression coefficients were calculated in order to allow for multiplicative interpretations of transformed coefficients. Correlations were calculated prior to regression analyses to assess the strength of bivariate associations. Active smoker density (ASD) was defined as the average number of burning cigarettes per 100 m³. Occupant density (OD) was defined as the average number of occupants in an area per 100 m³.

A calibration factor of 0.32, appropriate for tobacco smoke, was applied to all PM_{2.5} data from the Sidepak.^{6,9,10} The first and last minute of Sidepak data in each location was removed, to avoid averaging data from outdoors or in entranceways, and the remaining data points were averaged to determine the mean PM_{2.5} concentration in each location visited. Further analysis is described in the data analysis plan, see Appendix M.

The variables and their level of measure for this study include the below.

1. Quantity of tobacco smoke pollution: Continuous.
2. Venue dimension (Room Area and Room Volume): Continuous.
3. Occupant density (OD): Continuous.
4. Active smoker density (ASD): Continuous.
5. Rural: Categorical/nominal
6. Presence of local law ordinance stronger than state law that required smoke-free bars: Yes/No, categorical/dichotomous.
7. Smoke-free required by state law: Yes/No, categorical/dichotomous.
8. Level of Poverty (I – IV) per census tracts: Ordinal.
9. Compliance: Yes/No, categorical/dichotomous.

10. Venues: See below, categorical/nominal.

All variables were defined previously. Venues were collapsed into the following four separate variables:

1) Location: Rural/semi-rural/non-rural.

2) Type of venue: Restaurant or bar.

3) Restaurant with a separately enclosed bar; co-located restaurant or co-located bar.

3) Law: Presence of local law ordinance that required smoke-free bars and thus were stronger than the state law required.

The below are a list of all possible variables.

A. Type of Restaurants.

1. Restaurants

2. Co-located venues. Restaurants with separately enclosed bars (restaurants were required to be smoke-free; bar areas were not required to be smoke-free). This was the same as #9 below.

3. Completely rural restaurants (RUCC 8-9).

4. Semi-rural/urban restaurants (RUCC 4-7).

5. Non-rural restaurants (RUCC of 1-3).

6. Restaurants within communities with local ordinances that required smoke-free bars and thus were stronger than state law.

7. Restaurants outside of communities with local ordinances that required smoke-free bars.

B. Type of Bars.

1. Bars. A bar was defined as “a retail alcoholic beverage establishment licensed under chapter 5-02 that is devoted to the serving of alcoholic beverages for consumption by guests on the premises and in which the serving of food is only incidental to the consumption of those beverages. The term included a bar located within a hotel, bowling center, or restaurant that was not licensed primarily or exclusively to sell alcoholic beverages if the bar was in a separately enclosed area” (NDCC § 23-12-09.1).
2. Co-located venues. Bars separately enclosed within restaurants, hotels, or bowling centers (Bar area not required to be smoke-free per state law; restaurant itself required to be smoke-free).
3. Completely rural bars (RUCC 8-9).
4. Semi-rural/urban bars (RUCC 4-7).
5. Non-rural bars (RUCC Codes of 1-3).
6. Bars within communities with local ordinances that required bars to be smoke free and thus stronger than state law.
7. Bars outside of communities with local ordinances stronger than state law (bars were not required to be smoke-free).

Adequacy of protection against risks

This study was submitted to the University of New Mexico Health Sciences Center Human Research Review Committee and the Minot State University Institutional Review Board; both entities indicated as human subjects were not to be involved in this study, IRB review was not necessary. Specific venue names will not be released.

RESULTS

The results of the study are presented next. Please see Chapter 5 of this dissertation for the discussion of the study and its findings.

A random sample of 136 restaurants (30.1%, $n = 41$) and bars (69.9%, $n = 95$) were assessed between May 11, 2012, and July 13, 2012. Table 5 shows the original sample ($n = 146$), the venues that were not assessed upon arrival at the venue ($n = 22$), and the final sample size ($n = 136$). Replacement venues ($n = 12$) were included in the original randomization procedure and were substituted for most of the venues unable to be assessed. Ten venues were not substituted for reasons described below.

1. Co-located venues ($n = 8$): as these included the full population of co-located venues allowing smoking. Of these, 4 were no longer in business and 4 were misclassified.
2. One restaurant venue: as discovery of its misclassification did not occur until during data analysis.
3. One bar's PM levels were contaminated due to a fog machine for the dance floor.

Figure 2 shows the number of venues assessed per county. Of the 5 non-rural counties, 4 had the largest sample sizes: Burleigh ($n = 10$), Cass ($n = 23$), Grand Forks ($n = 12$), and Morton ($n = 6$) as expected when using random selection. The 5th semi-rural county of Ward had a sample of 8. The four most populated cities were located in Burleigh (Bismarck), Cass (Fargo), Grand Forks (Grand Forks) and Ward (Minot). Morton County is adjacent to Burleigh County; the counties are coupled as Bismarck, ND MetroSA (Appendix D).

TABLE 5 – Characteristics of the Selected Sample Venues Not Included in Data Analysis: North Dakota, 2012

	Restaurants, n	Bars 1, n	Bars 2, n	Co-located Restaurants, n	Co-located Bars, n	Total, n
Original sample	30	30	54	16	16	146
Out of business	4 ^a	3 ^a	1 ^a	2	2	12
No seating ^b	2 ^{a,b}	0	0	0	0	2
Misclassified	1 ^c	1 ^a	1 ^a	2	2	7
Contaminated	0	1	0	0	0	1
Final sample	29	29	54	12	12	136

Note. Bars 1 = venues within communities with an ordinance that required smoke-free bars, thus stronger than state law; Bars 2 = venues outside of communities with an ordinance stronger than state law.

^aVenues replaced using random list

^bUpon arrival at venues these were “take out” only without a place to sit.

^cMisclassification identified during data analysis.

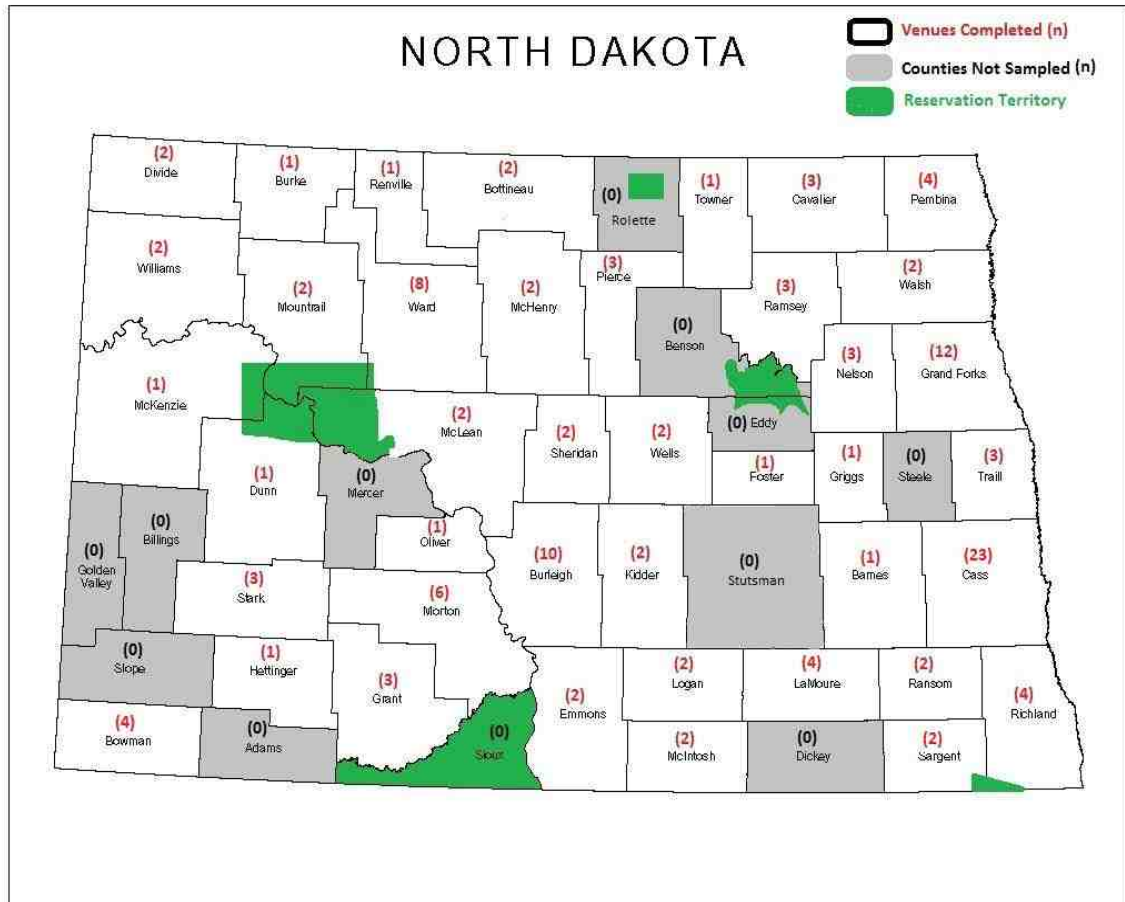


FIGURE 2—Number of Venues Sampled per County: North Dakota, 2012

Table 6 shows the day of week and time of day requirements for data collection. Data collectors arrived to collect data for all venues on the required days of the week (n = 136, 100%). Of the venues where data were collected (n = 135), the vast majority data was collected during the required time (94.1%). Data collection occurred within 10 minutes of the required time in five venues (3.7%); in two co-located restaurants (1.5%), data collection began up to 56 minutes early, and one co-located restaurant (0.7%) was only open for lunch, and thus data collection occurred during that time.

TABLE 6—Data Collection Day & Time Required and Actual, North Dakota, 2012

Venue Type and Requirements	n (%)
<p>Restaurant, n = 29</p> <p>Day of Week Required: Any</p> <p>Monday 3 (10.3)</p> <p>Tuesday 5 (17.2)</p> <p>Thursday 6 (20.7)</p> <p>Friday 12 (41.4)</p> <p>Saturday 3 (10.3)</p> <p>Time Required:</p> <p>11:30 am-1:30 pm 11 (37.9)</p> <p>5:00 pm-8:00 pm 16 (55.2)</p> <p>Other Times Entered</p> <p>4:50 pm 1 (3.4)</p> <p>8:05 pm 1 (3.4)</p>	
<p>Bars, n = 83</p> <p>Day of Week Required:</p> <p>Thursday 32 (38.6)</p> <p>Friday 28 (33.7)</p> <p>Saturday 23 (27.7)</p> <p>Time Required:</p> <p>7:00 pm-12:00 am 82 (98.8)</p> <p>Other Times Entered</p> <p>6:54 pm 1 (1.2)</p>	
<p>Co-located Restaurant, n = 12^a</p> <p>Day of Week Required:</p> <p>Thursday 1 (8.3)</p> <p>Friday 6 (50.0)</p>	

Saturday	5 (41.7)
Time Required:	
7:00 pm-12:00 am	7 (63.6)
Other Times Entered	
11:00 am ^b	1 (9.0)
6:04 pm-6:24 pm	2 (18.2)
Co-located Bar, n= 12	
Day of Week Required:	
Thursday	1 (8.3)
Friday	6 (50.0)
Saturday	5 (41.7)
Time Required:	
7:00 pm-12:00 am	10 (83.3)
Other Times Entered	
6:50 pm-6:56 pm	2 (16.7)

Note. Co-located venues were sampled in both the restaurant and bar sides, one immediately after the other, with five minutes spent outside prior to entering the second side.

^aOne co-located restaurant was unable to be assessed at time of data collection, n = 12 for day, n = 11 for time entered.

^bOne co-located restaurant was only open for lunch.

Table 7 summarizes the study sample characteristics by RUCC categories, poverty category, smoke-free as required by any law, located within or outside of communities with a local ordinance that required smoke-free bars and thus stronger than state law. Descriptive data for the sample are in Appendix O.

TABLE 7—Sample Characteristics of Hospitality Venues by Rural Urban Continuum Code, Poverty, and Presence of Law Requiring Venue be Smoke-Free: North Dakota, 2012

Characteristic	Not Co-located Restaurant, n (%)	Not Co-located Bar, n (%)	Co-located Restaurant, n (%)	Co-located Bar, n (%)	Total Restaurant, n (%)	Total Bars, n (%)	Total Venues, n (%)
Sample	29	83	12	12	41	95	136
RUCC (1-9)							
Non-rural (1-3)	12 (41)	37 (45)	1 (8)	1 (8)	13 (32)	38 (40)	51 (38)
Semi-rural/urban (4-7)	5 (17)	15 (18)	3 (25)	3 (25)	8 (20)	18 (19)	26 (19)
Completely rural (8-9)	12 (41)	31 (37)	8 (67)	8 (67)	20 (49)	39 (41)	59 (43)
Total	29	83	12	12	41	95	136

Characteristic	Not Co-located Restaurant, n (%)	Not Co-located Bar, n (%)	Co-located Restaurant, n (%)	Co-located Bar, n (%)	Total Restaurant, n (%)	Total Bars, n (%)	Total Venues, n (%)
Poverty category, % census tract							
I = <13.8%	17 (59)	46 (55)	9 (75)	9 (75)	26 (63)	55 (58)	81 (60)
II = 13.8-19.9%	5 (17)	20 (24)	3 (25)	3 (25)	8 (20)	23 (24)	31 (23)
III = 20.0-39.9%	3 (10)	13 (16)	0 (0)	0 (0)	3 (7)	13 (14)	16 (12)
IV = 40.0% or >	4 (14)	4 (5)	0 (0)	0 (0)	4 (10)	4 (4)	8 (6)
Total	29	83	12	12	41	95	136
Within ordinance community							
Non-rural (1-3)	10 (91)	25 (86)	0 (0)	0 (0)	10 (83)	25 (86)	35 (83)
Semi-rural/urban (4-7)	1 (9)	3 (10)	1 (100)	0 (0)	2 (17)	3 (10)	5 (12)
Completely rural (8-9)	0 (0)	1 (3)	0 (0)	0 (0)	0 (0)	1 (3)	1 (2)
Total	11	29	1	0	12	29	41

Characteristic	Not Co-located Restaurant, n (%)	Not Co-located Bar, n (%)	Co-located Restaurant, n (%)	Co-located Bar, n (%)	Total Restaurant, n (%)	Total Bars, n (%)	Total Venues, n (%)
<i>Outside ordinance community</i>							
Non-rural (1-3)	2 (11)	12 (22)	1 (9)	1 (8)	3 (10)	13 (20)	16 (17)
Semi-rural/urban (4-7)	4 (22)	12 (22)	2 (18)	3 (25)	6 (21)	15 (23)	21 (22)
Completely rural (8-9)	12 (67)	30 (56)	8 (72)	8 (67)	20 (69)	38 (58)	58 (61)
Total	18	54	11	12	29	66	95
<i>Required to be smoke-free^a</i>							
By State Law	29 (100)	0 (0)	12 (100)	0 (0)	41 (100)	0 (0)	41 (30)
By Local Ordinance	11 (38)	29 (100)	1 (8)	0 (0)	12 (29)	29 (100)	41 (30)

Notes. RUCC = rural urban continuum code.

^aVenues may have either, neither or both the state law and a local ordinance (that required smoke-free bars) that is stronger than state law requiring smoke-free.

Figures 3 and 4 and Appendix O provide descriptive statistics of the sample. Chi-square or Fisher's Exact test showed significant associations with venue type ($P < .001$), rurality ($P = .003$) and laws requiring smoke-free venues ($P < .001$), and poverty ($P < .001$).

Venues were assessed for smoking in outdoor dining areas, smoking shelters/butt huts, near entranceways, and other similar areas. Outdoor dining areas were identified in 18 (13.3%, $n = 135$) venues, with smoking observed in 8 of the 18 (44.4%) areas. Smoking shelters and / or butt huts were noted in 9 (0.07%, $n = 136$) venues, with smoking observed in 4 of the 9 venues (44.4%). Smoking was observed inside the entranceway of 1 (0.07%, $n = 136$) venue. Smoking was observed within 10 feet of the entranceway in 16 (11.8%, $n = 136$) venues. Other areas smoking was observed included one fenced area behind a bar where a live band was playing ($n = 1$), a separate area where a wedding was being held ($n = 1$), and an outdoor patio ($n = 1$).

Of the 70 venues required to be smoke-free by *any* law, 12 (17.1%) had outdoor dining areas, with smoking observed in 6 (50.0%). Six of the 70 (2.9%) had smoking shelters, all 6 were by bars that were not co-located with smoking observed in 4 (67%) of the shelters. No smoking was observed in any of the indoor entrance areas. However, 13 (18.6%) venues had smoking outside within 10 feet of the entrance; 2 were restaurants and 11 were bars, none were co-located venues. Two other areas where smoking was

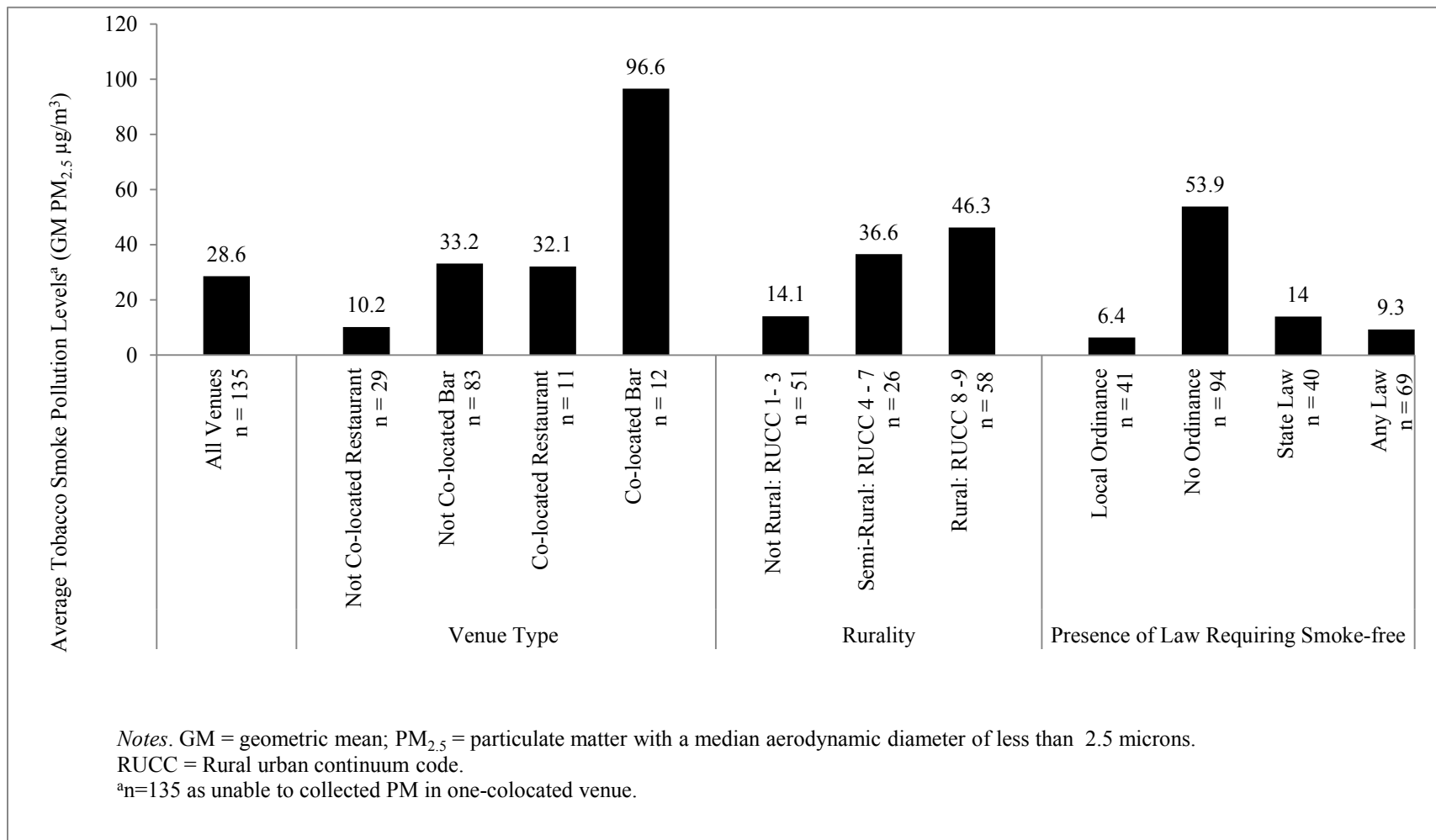


FIGURE 3—Mean Tobacco Smoke Pollution (GM PM_{2.5}) of Sample Venues, North Dakota, 2012

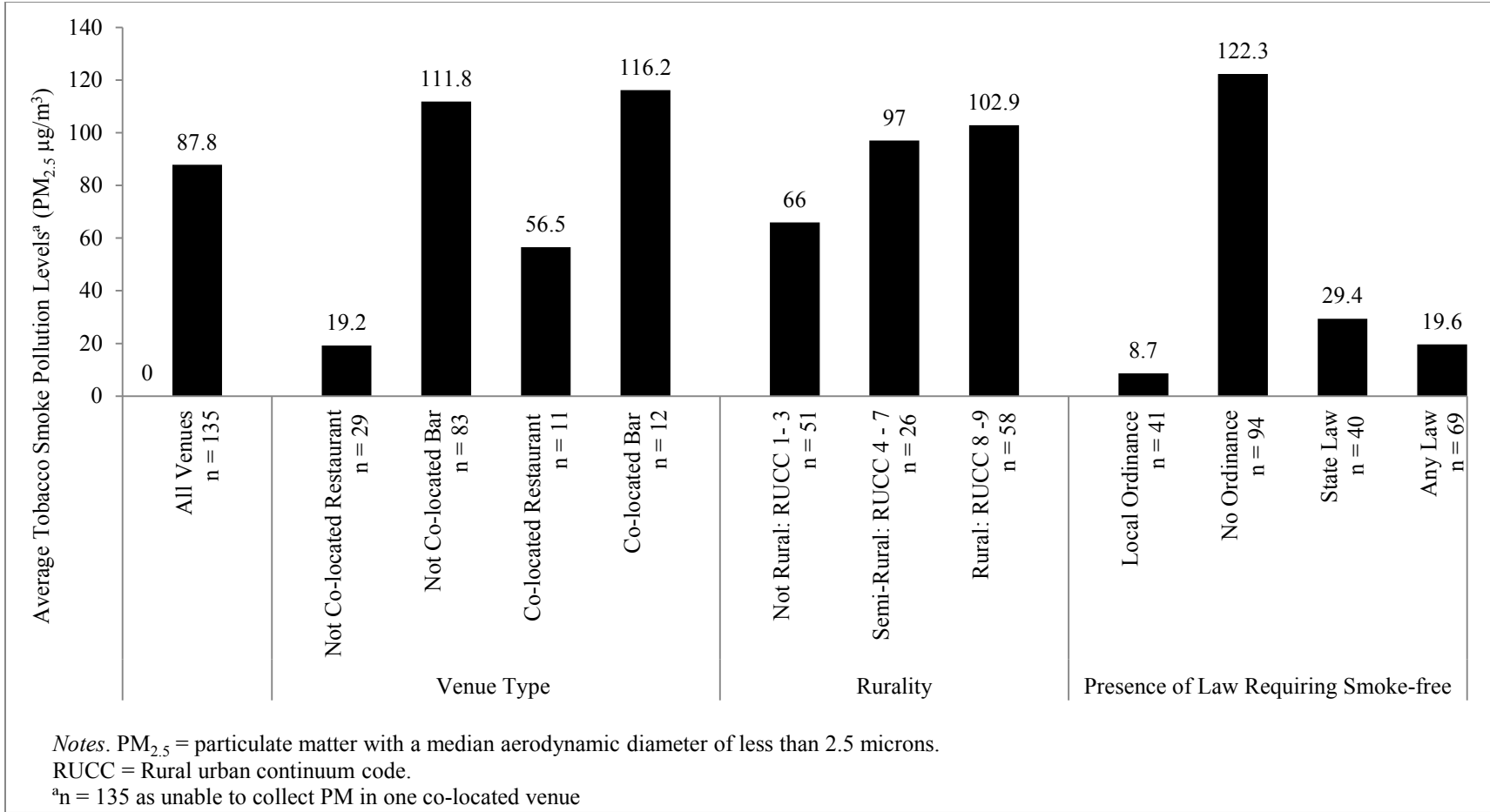


FIGURE 4—Mean Tobacco Smoke Pollution (PM_{2.5}) of Sample Venues: North Dakota, 2012

observed included a fenced area behind a bar where a live band was playing (n = 1) and an outdoor patio (n = 1); both were in bars that were not co-located.

A correlation matrix of variables of interest found five significant relationships (Table 8). The largest correlation was between smoking observed and logPM_{2.5} levels, $r = .793$. Other large correlations were between smoking observed and ASD ($r = .580$), ASD and logPM_{2.5} levels ($r = .503$), and ASD and OD ($r = .453$). Lastly, room volume was negatively correlated to occupant density ($r = -.276$).

TABLE 8—Correlations of Selected Sample Variables: North Dakota, 2012

	Average Occupant Density	Average Room Volume m ³	Average Active Smoker Density	Average PM _{2.5} µg/m ³	Average LogPM _{2.5} µg/m ³	Smoking observed
Average occupant density						
Average room volume	-.276**					
Average active smoker density	.453***	-.139				
Average PM _{2.5} µg/m ³	-.005	-.049	.454***			
Average logPM _{2.5} µg/m ³	.030	-.134	.503***	.821***		
Smoking observed	-.018	-.040	.580***	.663***	.793***	

Notes. Occupant density = (average # of people in a room / room volume m³) x 100; Active smoker density = (average # of lit tobacco products in a room / room volume m³) x 100; PM_{2.5} = particulate matter with a median aerodynamic diameter of less than 2.5 microns; logPM_{2.5} = natural log transformation of PM_{2.5} values.

* $P < .05$; ** $P < .01$; *** $P < .001$

Aim 1

The first aim of the study was to describe a baseline quantity of tobacco smoke pollution and the impact of specific factors on tobacco smoke pollution in hospitality venues statewide in ND. These factors included presence of *any* law requiring venues to be smoke-free, venue type (restaurant or bar), venue volume, OD, ASD, and observed smoking.

The specific hypothesis tested was: The quantity of tobacco smoke pollution in hospitality venues will alter depending upon specific factors. These factors included: presence of *any* law requiring venues to be smoke-free, venue type, venue volume, OD, ASD, and observed smoking. Planned analysis included a linear forward multiple regression using log transformed PM_{2.5}. Follow up *t* tests were planned for selected comparisons. As data analysis progressed, a partially mediated model was identified, also a post-hoc exploratory stepwise regression was conducted; thus it was decided post-hoc not to conduct the ANOVA.

For all venues with sampling completed ($n = 135$), the GM PM_{2.5} was 28.3 $\mu\text{g}/\text{m}^3$ (GSD = 5.3 $\mu\text{g}/\text{m}^3$). The highest tobacco smoke pollution level (PM_{2.5} = 656 $\mu\text{g}/\text{m}^3$) was in a bar where smoking was observed. The arithmetic mean tobacco smoke pollution levels for venues without smoking observed was 90% lower than in venues where smoking was observed. Stated another way, venues where smoking was observed had more than 9.7 times higher mean tobacco smoke pollution levels than did venues where smoking was not observed. The mean levels for restaurants was 74% lower than in bars; or, bar venues had more than 3.8 times higher mean tobacco smoke pollution levels than did restaurants.

Pearson correlation coefficients indicated that the quantity of tobacco smoke pollution ($\log\text{PM}_{2.5}$) was directly predicted by, and positively associated with, smoking observed ($r = .793, P < .001$), ASD ($r = .503, P < .001$), and by type of venue ($r = .274, P < .001$). The presence of a smoke-free law inversely predicted the quantity of tobacco smoke pollution ($r = -.678, P < .001$). Room volume ($r = .134, P = .060$) and occupant density ($r = .030, P = .365$) were not significantly associated with the quantity of tobacco smoke pollution.

As per the planned analysis, a forward multiple regression of the log transformed $\text{PM}_{2.5}$ was conducted to determine the specific factors, or predictors, that significantly influenced the quantity of tobacco smoke pollution in hospitality venues in ND. The predictor variables examined included: observed smoking, presence of *any* law requiring venues to be smoke-free, ASD, type of venue (bar or restaurant), room volume, and OD. Three models were compared in a stepwise fashion. The best fit and final fitting model included observed smoking, type of venue (restaurant or bar), and presence of *any* law requiring venues to be smoke free ($R^2 = .664, F(1,131) = 86.18, P = .001$). The variance inflation factors (VIF) for the best fit model were: smoking observed VIF = 3.0; type of venue VIF = 1.7; and required to be smoke-free by any law VIF = 3.8. Thus the model's maximum VIF was 3.8 and its average 2.8 indicated some multicollinearity; but the values were below recommended levels for concern (Field, 2009, p. 224). Additionally, the significant predictor variables, even with inflated standard errors, showed strong levels of significance (Table 9).

TABLE 9—Forward Regression Model Predicting Impact of Specific Factors on the Quantity of Tobacco Smoke Pollution (GM PM_{2.5} µg/m³): North Dakota, 2012

	exp(b)	95% CI
Constant	68.4***	22.3 – 209.6
Smoking observed	10.50***	5.85 - 18.82
Bar versus restaurant	0.43***	0.27 - 0.69
Presence of any smoke-free law	0.42**	0.22 - 0.81

Notes. GM = geometric mean; PM_{2.5} = particulate matter with a median aerodynamic diameter of less than 2.5 microns. exp(b) = exponentiated unstandardized regression coefficients; CI = exponentiated confidence intervals.

P* < .05; *P* < .01; ****P* < .001.

As per the planned analysis, analysis of the relationships between the forward regression model’s variables was explored by conducting *t* tests for both the AM PM_{2.5} and the GM PM_{2.5} values to identify statistical significance. All three variables had significant differences (Table 10 and Figure 5 & 6).

Following linear regression results, a mediation model was fit for factors found to significantly influence PM_{2.5} levels. Statistical testing of this mediation model with covariate proceeded as follows. First, linear regressions were conducted for each path in the mediation model, controlling for the covariate of type of venue (restaurant or bar), to determine the significance of each path in the mediation model. Second, the indirect effect (*a***b*) was calculated and the Sobel test¹¹, $t_{a*b} = a*b / se_{a*b}$ where $se_{a*b}^2 = a^2*se_b^2 +$

$b^2*se_a^2$ was used to determine if there was a significant indirect effect.³⁹ Third, the quotient of the indirect effect and the total effect was calculated to determine the percent of mediation.

Results for testing the mediation model is described next, see Figure 7. The linear regressions for each path, controlling for the covariate of type of venue; were all significant. A negative indirect effect was found ($a*b = -.833*2.344 = -1.953$; -1.95 exponentiated = 0.14) that may partially explain the total effect ($c = -2.821$; -2.82 exponentiated = 0.06). The Sobel test determined there was a significant indirect effect, $t_{a*b} = -6.75, P < .001$.¹¹ Thus, the relationship between the presence of *any* smoke-free law and quantity of tobacco smoke pollution was mediated by observed smoking after having statistically controlled for type of venue. A calculation of the percent of mediation (indirect effect/magnitude of total effect = $-1.95/-2.82$) showed that 69.1% of the total effect was indirect as influenced by smoking observed, whereas 30.9% of the total effect was the residual direct impact of the policy on tobacco smoke pollution levels. These results indicated that although policy was partially mediated by observed smoking; policy also had a direct effect.

TABLE 10— Means and Independent Samples *t* tests for Tobacco Smoke Pollution (PM_{2.5} µg/m³) Levels Across the Categories of Significant Regression Model Variables: North Dakota, 2012

Characteristic	n	AM (SD)	df	<i>t</i>	GM (SD)	df	<i>t</i>
Venue type							
Restaurant	40	29.4 (42.3)	126.152	-5.363*** ^a	14.0 (3.5)	101.987	-3.76*** ^a
Bar	95	112.4 (135.9)			38.0 (5.8)		
Smoking observed							
No	78	18.8 (32.6)	60.711	-8.876*** ^a	9.1 (3.0)	133	-15.02***
Yes	57	182.2 (136.2)			133.0 (2.5)		
Smoke-free any law							
No	66	159.1 (139.5)	72.439	7.901*** ^a	89.9 (3.9)	133	10.64***
Yes	69	19.6 (34.1)			9.3 (3.0)		

Notes. PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; AM = arithmetic mean of; SD = standard deviation; GM = geometric mean; GSD = exponentiated geometric standard deviation.

^aLevene's test for homogeneity of variance was significant, therefore the unequal variance *t* test was reported.

n = 135 as unable to collect PM in one co-located restaurant.

P* < .05; *P* < .01; ****P* < .001.

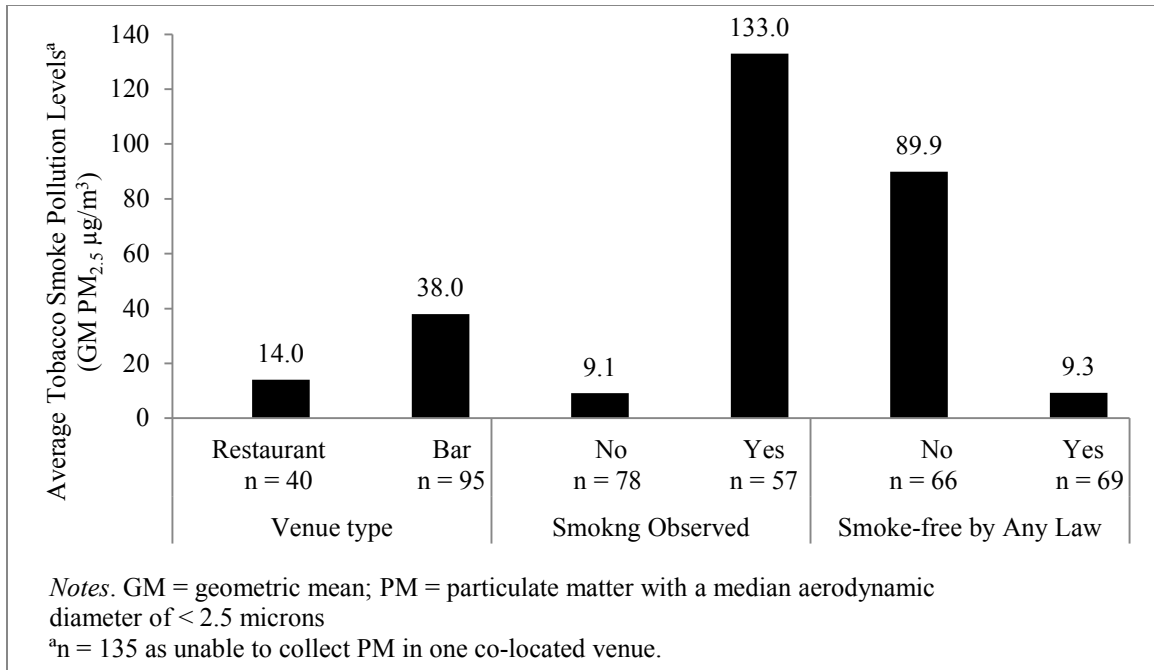


FIGURE 5—Significant Regression Model Variables Differences (*t* tests) of Predictors Influencing Tobacco Smoke Pollution (GM PM_{2.5}): North Dakota, 2012

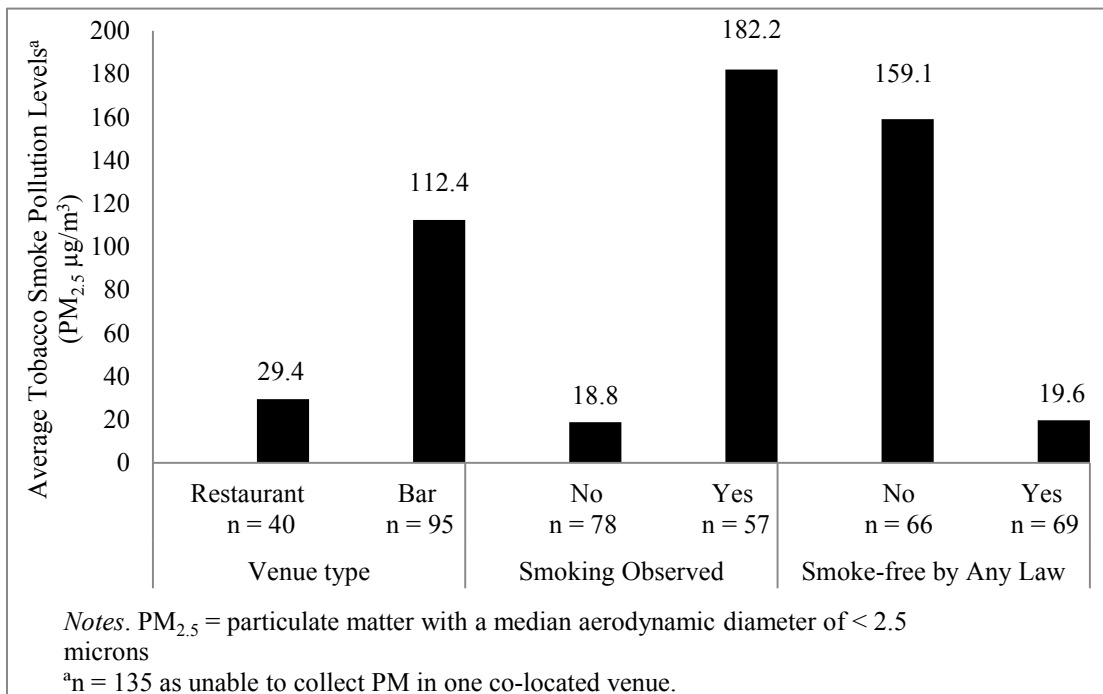


FIGURE 6—Significant Regression Model Variables Differences (*t* tests) of Predictors Influencing Tobacco Smoke Pollution (PM_{2.5}): North Dakota, 2012.

An unplanned post-hoc exploratory stepwise regression was conducted by first inputting the three model variables from the forward linear regression (observed smoking, venue type, and smoke-free required by any law); then the rurality and poverty categories were added. Three model summaries were found; the best fit included the same three forward regression model variables of observed smoking, venue type, and required to be smoke-free by *any* law (adjusted $R^2 = .656$, $R^2 = .664$, $F(1, 131) = 86.18$, $P = .001$). Thus both poverty and rurality were non-significant with the other variables in the model.

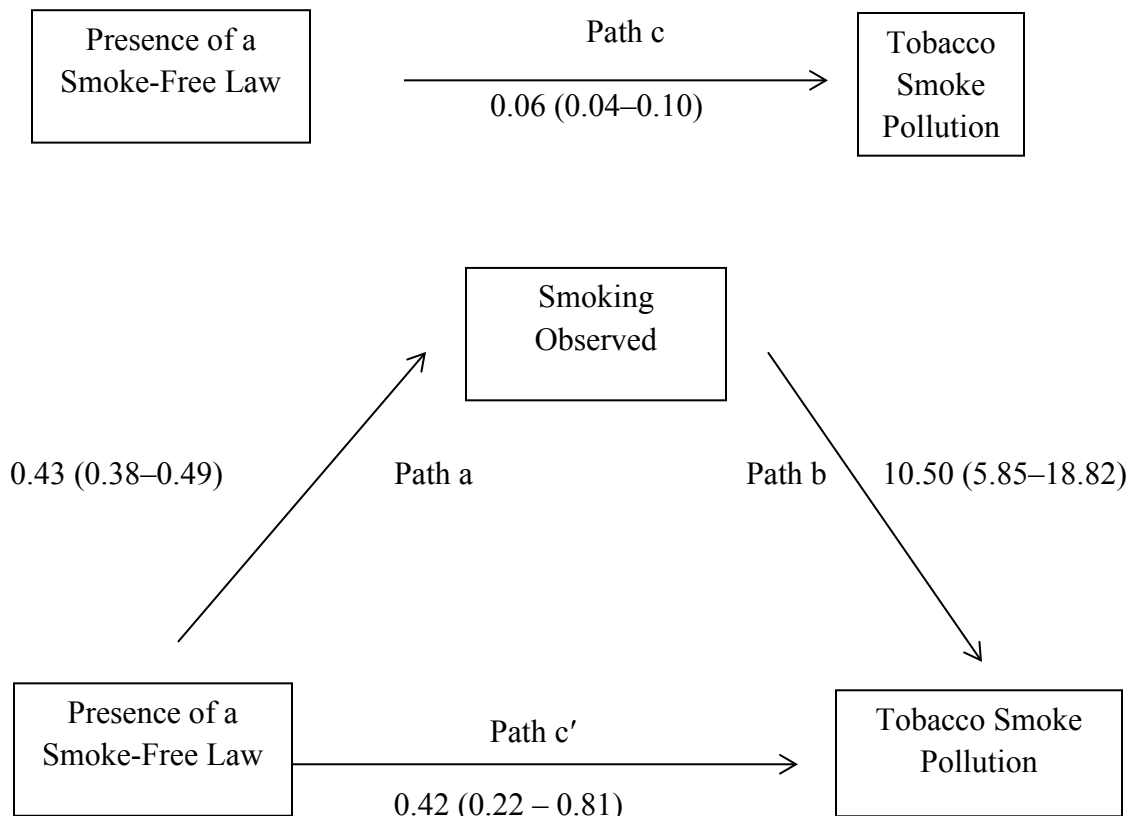


FIGURE 7—Partially mediated model of variables influencing tobacco smoke pollution: North Dakota, 2012. This model controlled for type of venue (restaurant or bar). Path a, b, c and c' values are exponentiated unstandardized regression coefficients and exponentiated 95% confidence intervals.

In conclusion, the first aim of this study was to describe a baseline of, and the impact of specific factors, on tobacco smoke pollution in hospitality venues statewide in ND. Baseline tobacco smoke pollution levels in venues are shown in Appendix O.

A mediation model indicated that although smoke-free laws had a direct effect on the level of indoor tobacco smoke pollution, the majority of the laws' effect was indirect. The presence of a smoke-free law negatively influenced the behavior of smoking. This decreased observed smoking influenced a decrease in tobacco smoke pollution levels. That is, smoke-free laws primarily decreased tobacco smoke pollution by influencing people's behaviors in the form of decreased observed smoking in the hospitality venues. Additionally, presence of a smoke-free law had a direct impact on the total effect on tobacco smoke pollution level.

This study differs from previous studies that identified ASD as highly correlated with tobacco smoke pollution levels.^{12,13} Although this study also found a significant correlation of tobacco smoke pollution with ASD, ASD was not a significant predictor in a linear regression model with other key variables. Instead, the type of venue, observed smoking, and the presence of *any* smoke-free law were significant predictors of PM_{2.5} levels in this model.

Two important policy implications emerge from the mediation model. First, the model suggests that smoke-free laws decreased the level of tobacco smoke pollution, mostly through influencing people's behaviors, and smoke-free laws by themselves were associated with decreased tobacco smoke pollution in hospitality venues. Second, when smoking was observed, it increased tobacco smoke pollution levels; thus, compliance

with smoke-free laws is needed to effectively decrease tobacco smoke pollution levels. A research implication is that the observation of smoking may be sufficient to determine the effectiveness of smoke-free laws in decreasing exposure to tobacco smoke pollution, negating the necessity of expensive and time-consuming studies using equipment to assess tobacco smoke pollution. Future studies need to be conducted to determine if the mediation model is an isolated finding for ND or if it can be supported in other studies and additional settings.

Aim 2

The second aim of the study was to compare the quantity of tobacco smoke pollution in hospitality venues in completely rural versus semi-rural/urban versus non-rural locations statewide in ND. The hypothesis tested was: In hospitality venues, the quantity of tobacco smoke pollution will increase as the county population decreases.

Aim 2 Results

The mean tobacco smoke pollution levels (PM_{2.5}) by rurality are in Table 11 and Figure 8 and 9. The observed overall arithmetic mean tobacco smoke pollution levels for restaurant and bars was 36% lower in non-rural (RUCC 1-3) than in rural (RUCC 8-9) venues. For bars only, the corresponding percentage difference in arithmetic means was a 39% decrease. Stated another way, rural (RUCC 8-9) venues had more than 1.6 times higher mean tobacco smoke pollution levels than did non-rural (RUCC 1-3) venues, this was true for restaurants and bars or for only bars.

Using geometric means, the observed overall mean tobacco smoke pollution levels for restaurant and bars was 70% lower in non-rural (RUCC 1-3) than in rural (RUCC 8-9) venues. For bars only, the corresponding percentage difference in geometric

means was an 80% decrease. Stated another way, rural (RUCC 8-9) venues had more than 3 times higher mean tobacco smoke pollution levels than did non-rural (RUCC 1-3) venues. For bars only, rural (RUCC 8-9) venues had more than 5 times higher mean tobacco smoke pollution levels than did non-rural (RUCC 1-3) venues.

TABLE 11— Mean Tobacco Smoke Pollution (PM_{2.5} µg/m³) by Rurality: North Dakota, 2012.

	n	AM (SD)
All venues		
RUCC 1-3	51	66.0 (130.2)
RUCC 4-7	26	97.0 (127.7)
RUCC 8-9	58	102.9 (111.3)
Bar venues only		
RUCC 1-3	38	83.7 (146.9)
RUCC 4-7	18	117.3 (142.6)
RUCC 8-9	39	138.1 (118.6)

Notes. PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; RUCC = rural urban continuum code; AM = arithmetic mean; SD = standard deviation. n = 135 as unable to obtain PM in one co-located restaurant.

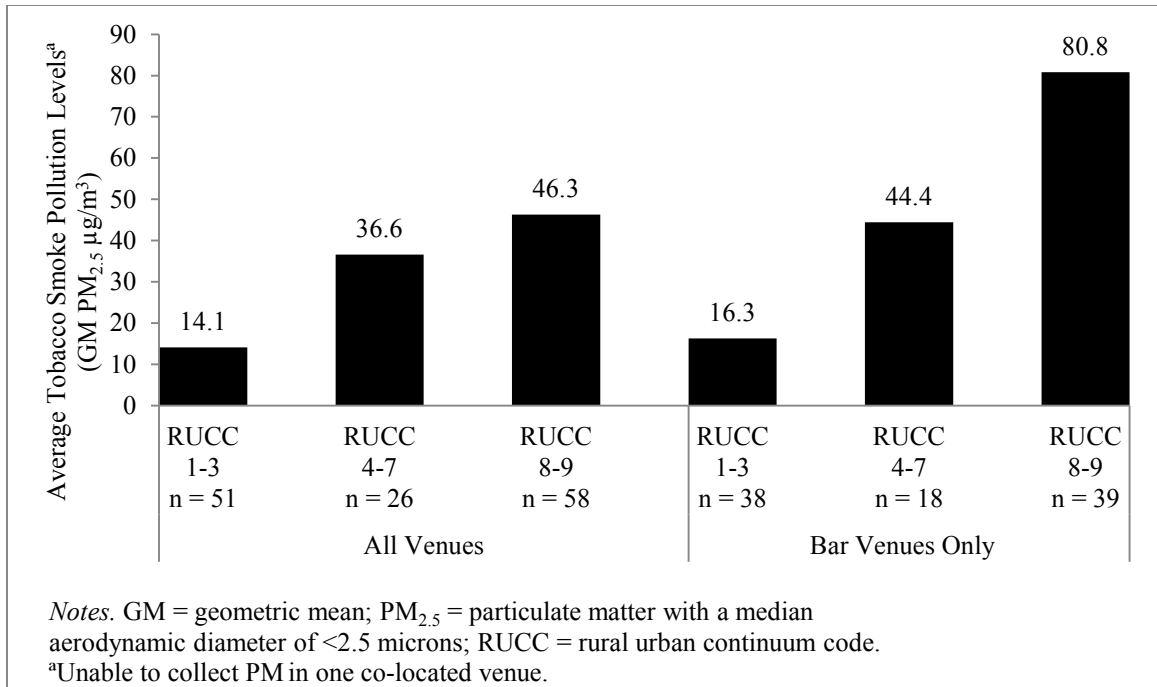


FIGURE 8—Mean Tobacco Smoke Pollution (GM PM_{2.5}) by Rurality: North

Dakota, 2012

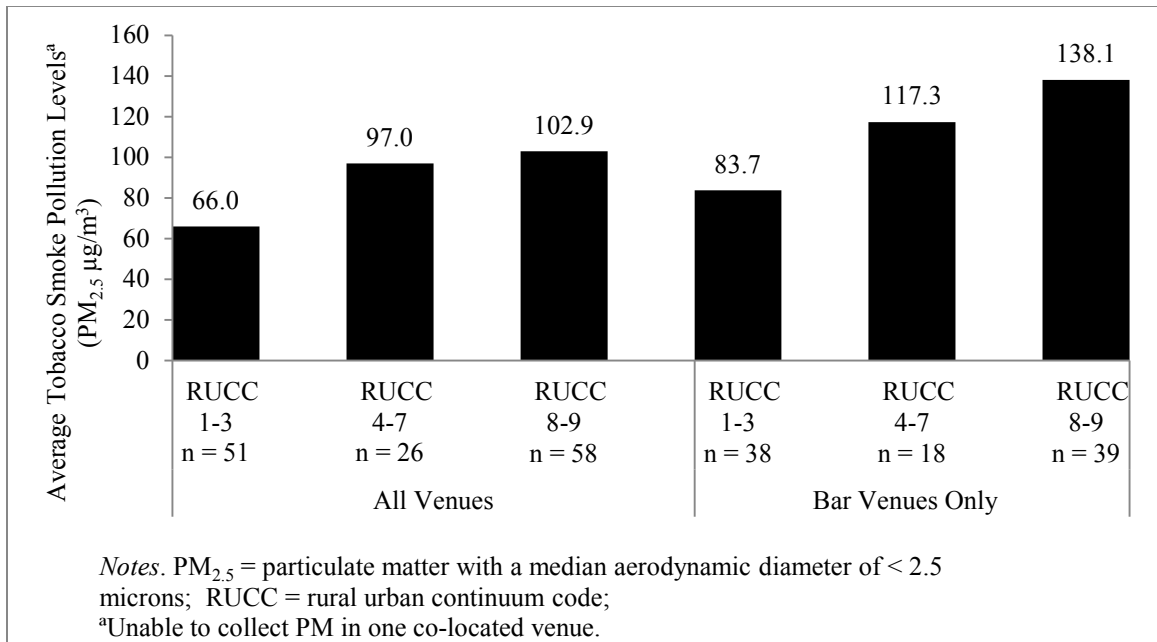


FIGURE 9—Mean Tobacco Smoke Pollution (PM_{2.5}) by Rurality: North Dakota,

2012

Planned one-way analysis of variance (ANOVA) of logPM_{2.5} levels by rurality showed, overall, an association between rurality and tobacco smoke pollution, $F(2,132) = 7.921, P = .001, n = 135$, with a medium effect size ($\omega^2 = .09$). The planned contrasts revealed that tobacco smoke pollution increased significantly from non-rural (RUCC 1-3) to the combined semi-rural and rural counties (RUCC 4 – 9), $t(132) = 3.66, P < .001$, with a medium effect, $r_{contrast} = .30$. The planned contrasts revealed that tobacco smoke pollution did not change significantly from semi-rural (RUCC 4- 7) to rural counties (RUCC 8 – 9), $t(132) = 0.62, P = .54$, the effect, $r_{contrast} = .05$, was small. See Table 12.

A follow up one-way ANOVA of logPM_{2.5} levels of only bars ($n = 95$) was significant, $F(2, 92) = 9.646, P < .001, n = 95$, with a large effect size ($\omega^2 = 0.15$). However, Levene's test for homogeneity of variance was significant indicating a violation of this assumption, Levene's $F(2, 92) = 6.658, P = .002$. Therefore, an alternate ANOVA test that did not require homogeneity of variance, was conducted and was significant, Welch's $F(2, 43.633) = 9.552, P < .001$, with a large effect size ($\omega^2 = 0.15$). Follow up reported contrasts within only bars were for equal variances not assumed. Within only bars, the first contrast revealed significantly increased tobacco smoke pollution levels between the non-rural counties and the combined semirural and rural counties, $t(62.695) = 3.481, P = .001$, with a medium effect, $r_{contrast} = .40$. Although the second contrast, between the semirural and rural counties, was not significant, $t(26.578) = 1.34, P = .193$, interestingly the effect size, $r_{contrast} = 0.25$, was medium (Table 12).

A similar follow up ANOVA of logPM_{2.5} levels by rurality in only restaurants was conducted, $F(2, 37) = 1.464, P = .244, n = 40$, and was not significant, with a small effect

size ($\omega^2 = 0.02$). Levene's test for homogeneity of variance was not significant; thus, this assumption for ANOVAs was met, Levene's $F(2, 37) = .339, P = .715$).

TABLE 12—Differences (one-way ANOVA) of Tobacco Smoke Pollution (GM PM_{2.5} µg/m³) by Rurality: North Dakota, 2012.

	Effect Size	GM (GSD)	95% CI
All Venues	$\omega^2 = .09^{***}$	28.3(5.3)	21.2 - 37.6
Contrast 1 ^a	$r_{contrast} = .30^{***}$		
Contrast 2 ^b	$r_{contrast} = .05$		
RUCC 1-3, n = 51		14.1 (5.3)	8.8 - 22.6
RUCC 4-7, n = 26		36.6 (4.8)	19.4 - 69.2
RUCC 8-9, n = 58		46.3 (4.6)	30.9 - 69.2
Bar Venues Only	$\omega^2 = .15^{***}$	38.0 (5.8)	26.6 - 54.3
Contrast 1 ^a	$r_{contrast} = .40^{***}$		
Contrast 2 ^b	$r_{contrast} = .25$		
RUCC 1-3, n = 38		16.3 (6.3)	8.9 - 29.9
RUCC 4-7, n = 18		44.4 (5.4)	19.2 - 102.8
RUCC 8-9, n = 39		80.8 (3.6)	53.1 - 122.9

Notes. PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; GM = geometric mean; GSD = geometric standard deviation; CI = exponentiated confidence level; RUCC = rural urban continuum code.

^aContrast 1 RUCC 1-3 and RUCC 4-8

^bContrast 2 RUCC 4-6 and RUCC 7-8

n = 135 as unable to collect PM in one co-located restaurant.

* $P < .05$; ** $P < .01$; *** $P < .001$.

In conclusion, the hypothesis for aim 2 was supported by this study as the quantity of tobacco smoke pollution increased as rurality increased. There was a significant association between rurality and tobacco smoke pollution as the more rural counties (RUCC 4-7 and 8-9) had higher levels of tobacco smoke pollution than did non-rural counties (RUCC 1-3). However, although there was a small effect, a significant association was not revealed in tobacco smoke pollution levels when the population decreased from RUCC 4-7 to RUCC 8-9.

Further analysis revealed that these findings were generally the same when *only* bars were included in the analysis. The bars in the combined semi-rural/urban (RUCC 4-7) and rural (RUCC 8-9) counties had higher levels of tobacco smoke pollution than did bars in non-rural counties (RUCC 1-3). Among restaurants only, however, no significant differences were found in tobacco smoke pollution levels by rurality. Thus, the impact of rurality on tobacco smoke pollution depends upon the type of venue, affecting bars much more than restaurants. Restaurants, overall, have consistently low tobacco smoke pollution levels which seem to reflect compliance with smoke-free restaurant laws and the relatively uniform policy environment for restaurants across the state of ND. More rural bars have, in contrast, significantly higher tobacco smoke pollution levels than do non-rural bars.

In sum, although rurality did not appear to affect tobacco smoke pollution levels in restaurants, there were substantial differences in tobacco smoke pollution in bars between non-rural venues (RUCC 1-3) and semirural/urban and rural combined venues (RUCC 4-8).

Policy implications of these findings on rurality and tobacco smoke pollution include that, as an issue of social justice, a continuing recognition of disparities in exposure to tobacco smoke pollution in rural areas is needed. Also, policymakers need to continue to be informed that when smoking is allowed, especially in areas with smaller populations, adverse role modeling and social norming occurs.

Also, additional studies of tobacco smoke exposure and policy impact in rural areas are needed. Specifically, as this was the first study that compared rural and non-rural venues and as the number of venues in semi-rural areas was limited in this study, greater sampling of semi-rural venues will be important to include in future proposals. Studies of successful policy strategies adapted to rural cultures are also needed. These studies could inform tobacco policy advocates on best practices to collaborate with people in rural areas and increase coverage of rural populations by smoke-free laws.

Aim 3 Hypothesis 1

The study's third aim was to compare the quantity of tobacco smoke pollution in hospitality venues located within and outside of communities with local ordinances. This aim had two hypotheses. The first hypothesis was: The quantity of tobacco smoke pollution will be lower in hospitality venues located within communities with local ordinances more stringent than state law than those located outside of communities with an ordinance more stringent than state law. The ordinances more stringent than state law required all bars to be smoke-free.

Using arithmetic means, venues within communities with local ordinances that required all bars to be smoke-free and thus were more stringent than state law had 93% lower mean tobacco smoke pollution levels than did those located outside of communities

with such an ordinance. Stated another way, venue located outside of communities with an ordinance had 14.0 times higher mean tobacco smoke pollution levels than did venues within communities with local ordinances. For bars alone, a 96% reduction in mean tobacco smoke pollution levels occurred for those within communities with local ordinance. Although not statistically significant, for restaurants alone a 58% reduction in mean tobacco smoke pollution levels occurred.

Using geometric means, venues within communities with local ordinances that required all bars to be smoke-free and thus were more stringent than state had 88% lower mean tobacco smoke pollution levels than did those located outside of communities with such an ordinance. Stated another way, venue located outside of communities with an ordinance that required all bars to be smoke-free and thus were more stringent than state law had 8.4 times higher mean tobacco smoke pollution levels than did venues within communities with such local ordinances. For bars alone, a 94% reduction occurred reduction in mean tobacco smoke pollution levels for those venues within communities with local ordinance. Although not statistically significant, restaurants alone had a corresponding 38% reduction in mean tobacco smoke pollution levels.

An unplanned independent *t* test, assuming unequal variances, comparing the mean logPM_{2.5} levels between venues required to be smoke-free by an ordinance and those not required to be smoke-free by an ordinance was significant (*n* = 135, equal variances not assumed, $t(132.27) = 10.79, P < .001$). Venues within communities with local ordinances had lower mean tobacco smoke pollution levels (*n* = 41, GM PM_{2.5} = 6.4 μg/m³, GSD = 2.1 μg/m³) compared to venues in communities without local ordinances stronger than state law (*n* = 94, GM PM_{2.5} = 53.9 μg/m³, GSD = 4.8 μg/m³).

The planned analysis included a two-way ANOVA (factorial ANOVA) for a comparison of means of the logPM_{2.5} levels by 1) required to be smoke-free by ordinance (ordinance) and by 2) type of venue (restaurant or bar). The test for homogeneity of variance was significant, (Levene's $F(3,131) = 4.51, P = .005$), indicating this assumption of the two-way ANOVA was not met. A forward multiple regression with the logPM_{2.5} by ordinance, type of venue, and an interaction term (type of venue*ordinance) was conducted to determine if a significant interaction effect was present. The model summary included all three independent variables and was significant (adjusted $R^2 = .495, R^2 = .506, F(1, 131) = 22.97, P < .001$). Table 13 shows that the interaction term and the type of venue had appropriate unstandardized beta coefficients and standard errors; along with robust significance and large t values. However, with the significant Levene's indicating possible heteroskedasticity, the ordinance variable's unstandardized standard error being large, the ordinance variable not significant within the model, and the smaller t values, acceptance of the significance of the model need to cautious.

TABLE 13—Forward Regression of Tobacco Smoke Pollution (GM PM_{2.5} µg/m³) by Ordinance, Type of Venue, and an Interaction Term (Type of Venue x Ordinance): North Dakota, 2012

	exp(b)	t	95% CI
Constant	16.1	12.36***	10.3-25.2
Interaction term	0.10	-4.79***	0.04-0.25
Bar versus restaurant	5.57	6.40***	3.28-9.48
Required to be smoke-free by ordinance	0.62	-1.162	0.28-1.43

Notes. GM = geometric mean; PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; exp(b) = exponentiated unstandardized regression coefficients; exponentiated CI = confidence intervals.

* $P < .05$; ** $P < .01$; *** $P < .001$.

Therefore, a robust variance estimator based on heteroscedasticity consistent covariance matrix (HCCM) known as HC3 revealed the model remained significant ($n = 135$, $R^2 = 0.5062$, $F(3, 131) = 70.47$, $P < .001$).¹⁴ Of the predictor variables, the interaction term and type of venue significantly predicted the amount of tobacco smoke pollution, presence of an ordinance did not ($P = .22$) (Table 14).

TABLE 14—Linear Regression with Heteroskedasticity-Consistent *t* test Based Regression of Tobacco Smoke Pollution (PM_{2.5} µg/m³) by Ordinance, Type of Venue, and an Interaction Term (Type of Venue x Ordinance): North Dakota, 2012

	exp(b)	t	95% CI
Constant	16.1	10.87***	9.7-26.8
Interaction term	0.10	-5.38***	0.04-0.23
Bar versus restaurant	5.57	5.61***	3.04-10.22
Required to be smoke-free by ordinance	0.62	-1.23	0.29-1.34

Notes. Regression used HC3, a robust variance estimator based on heteroscedasticity consistent covariance matrix; GM = geometric mean; PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; exp(b) = exponentiated unstandardized regression coefficients; exponentiated CI = confidence intervals.

* $P < .05$; ** $P < .01$; *** $P < .001$.

Exploratory independent t-test analysis of logPM_{2.5} of only restaurants within and outside of communities with local ordinances was not significant, $n = 40$, $t(38) = 1.12$, $P = .27$; the effect size was small ($d = .41$). Cohen's d effect sizes are .2 = small, .5 = medium, and .8 = large.¹⁵ An exploratory independent t test analysis of only bars (logPM_{2.5} by ordinance) was significant, with reporting equal variances not assumed, $n = 95$, $t(91.854) = 14.61$, $P < .001$. Bar venues within communities with local ordinances

requiring smoke-free bars, and thus stronger than state law, had significantly lower mean tobacco smoke pollution levels, $n = 29$, $GM\ PM_{2.5} = 5.4\ \mu\text{g}/\text{m}^3$, $GSD = 1.7\ \mu\text{g}/\text{m}^3$, compared to bars in communities without local ordinances stronger than state law, $n = 66$, $GM\ PM_{2.5} = 89.9\ \mu\text{g}/\text{m}^3$, $GSD = 3.9\ \mu\text{g}/\text{m}^3$. See Figures 10 and 11.

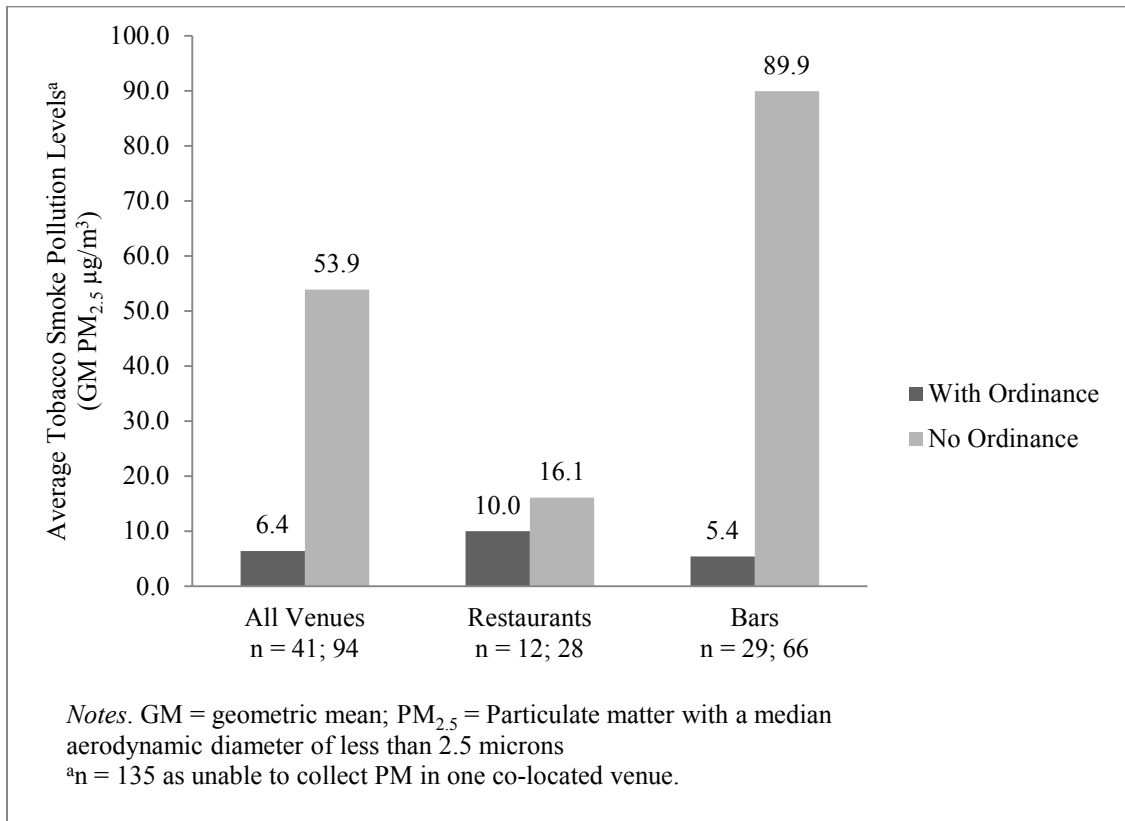


FIGURE 10—Mean Tobacco Smoke Pollution (GM $PM_{2.5}$) by Presence of a Local Ordinance: North Dakota, 2012.

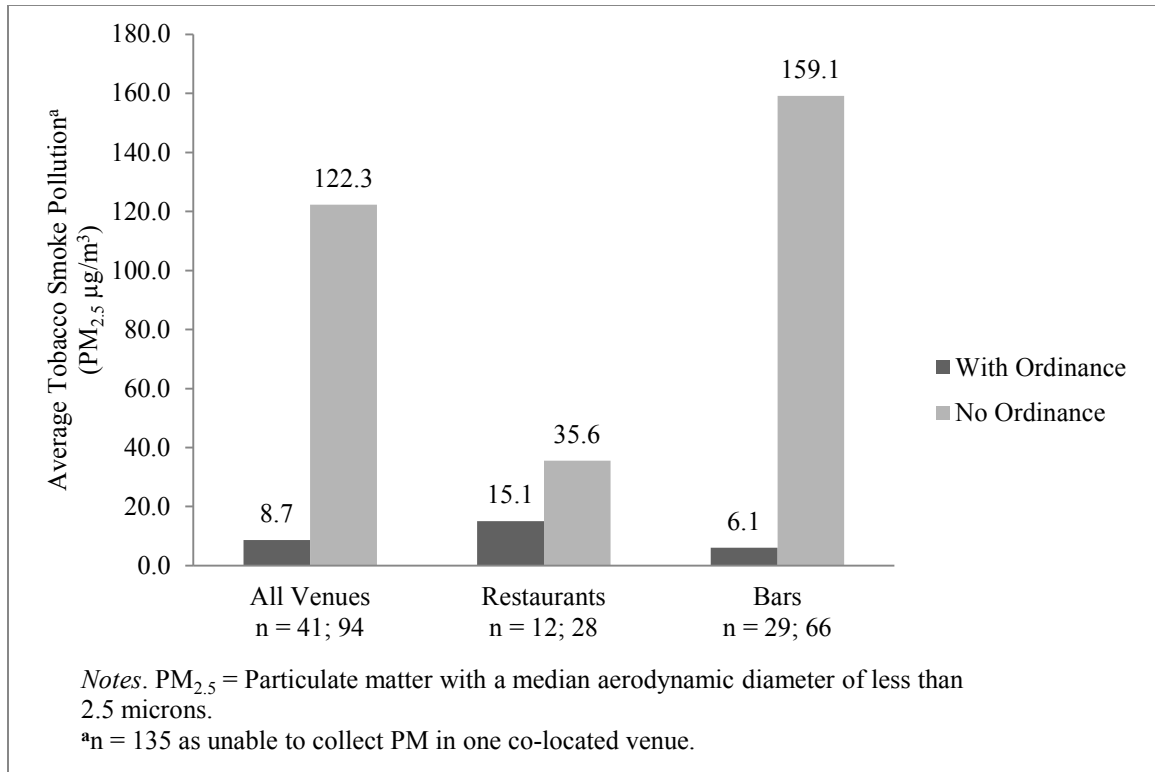


FIGURE 11—Mean Tobacco Smoke Pollution (PM_{2.5}) by Presence of a Local Ordinance: North Dakota, 2012.

In conclusion, the analysis supported the hypothesis that as the quantity of tobacco smoke pollution was lower in hospitality venues located within communities with local ordinances that required bars to be smoke-free and thus more stringent than state law than did those located outside such communities. An interaction effect was identified, meaning the impact of local ordinances on tobacco smoke pollution levels varied by the type of venue. In communities with an ordinance requiring bars to be smoke-free and thus stronger than state law, the bars experienced significant reductions in tobacco smoke pollution levels.

In communities with an ordinance requiring bars to be smoke-free and thus stronger than state law, restaurant venues experienced a decrease in tobacco smoke pollution, although not significantly so. This may be due to the state law that required all restaurants to be smoke-free; therefore the presence of a local ordinance did not change the legal requirement for restaurants to be smoke-free.

This finding also supported the mediation model identified in Aim 1 that policies reduce tobacco smoke pollution levels significantly. Also, although restaurants that were required to be smoke-free by state law did not experience a significant reduction; lower levels of tobacco smoke pollution were also found in these venues.

Aim 3 Hypothesis 2

The second hypothesis of Aim 3 was: Compliance with smoke-free laws will be higher in hospitality venues located within communities with an ordinance more stringent than state law than those located outside of communities with an ordinance more stringent than state law. The ordinances more stringent than state law required all bars to be smoke-free. Unplanned analysis of compliance by co-location status was included in this analysis.

Compliance with smoke-free laws was assessed in the sample venues required to be smoke-free by *any* law (n=70). This included all restaurants as required by state law and bars located within communities with an ordinance requiring bars to be smoke-free. State law required all co-located restaurants to be smoke-free with the co-located bars that allowed smoking required to be separately enclosed. Co-located bars within communities with an ordinance requiring all bars to be smoke-free were also required to be smoke-free regardless of the co-location status. This study only included co-located

venues that allowed smoking; therefore, the only co-located bars included in this study were those that could allow smoking. During the study's timeframe, the NDCC (§23-12-09.5) defined separately enclosed area: "Enclosed area' means all space between a floor and ceiling that is enclosed on all sides by solid walls or windows, exclusive of doorways, which extend from the floor to the ceiling."

Compliance was measured by observational assessment of the venues' indoor areas. Indicators of non-compliance included observed smoking (burning cigarettes); presence of ashtrays, cigarette butts, or odor; separately enclosed areas not completely enclosed; and separately enclosed area doors not shut unless a person was moving through the doors. The indicators were collapsed into a dichotomous variable of compliant or noncompliant. Noncompliance on any one indicator resulted in the venue being considered noncompliant. Data collection was unable to be completed in one co-located restaurant as it was dark and the data collectors were unable to sit in the restaurant area; the bar area was open and all data were collected in the bar area. This venue's data were included in the analysis when possible and the venue was considered non-compliant as discussed later.

The average room volume for venues ($n = 69$) required to be smoke-free and with data able to be collected was 535 m^3 ($SD = 741.6 \text{ m}^3$); the average number of people observed in the venues was 20.5 ($SD = 20.4$) and the average number of lit cigarettes in 69 venues observed was 0.09 ($SD = 0.5$). The average OD = 6.1 per 100 m^3 ($SD = 5.7$ per 100 m^3) and the ASD = 0.02 per 100 m^3 ($SD = 0.14$ per 100 m^3).

Table 15 presents data on compliance with all smoke-free laws by presence of a local smoke-free ordinance that required smoke-free bars. Non-compliance as indicated

by observed smoking occurred in only 2 (2.9%) of the 70 venues required to be smoke-free by *any* law; both were restaurants that were not co-located. The same two restaurants also had other evidence of smoking including smoke odor, ashtrays, and cigarette butts. Three other venues had smoke odor and were co-located restaurants. It was assumed that smoke may have infiltrated the smoke-free area of these co-located restaurants and therefore these three restaurants were considered compliant.

Compliance with co-location requirements of the state law included observational assessment of the 12 co-located restaurants that had a co-located bar and allowed smoking in the bar. Follow up questions to the data collectors to clarify compliance with the separately enclosed requirement occurred. Of the 12 co-located restaurants with bars that allowed smoking, 5 were not compliant for a 41.7% noncompliance rate. Of those not compliant, one had an open hallway between the restaurant and bar; the restaurant side of this co-located venue did not have observational data fully collected as it was dark and data collectors were unable to sit in the restaurant area during dinner. Therefore to eat dinner, the data collectors had to sit in the bar area that allowed smoking. This venue was at least noncompliant in the spirit if not the letter of the law. Of the remaining four venues that were not compliant all had doors that were open either during the entire time the data collectors were present (n = 3) or were propped open part of the time (n = 1). Of the 3 venues with open doors the entire time: one had an open door between the bar and the kitchen with the restaurant side open to the kitchen; one had two doors between the restaurant and bar that were both open; and one had a room that connected the restaurant and bar and the doors to the room were left open.

TABLE 15—Compliance with All Smoke-free Laws by Presence of a Local Smoke-free Ordinance That Required Smoke-Free Bars: North Dakota, 2012

	Total, n (%)	Within a Community with a Local Ordinance, n (%)	Outside a Community with a Local Ordinance, n (%)
n (%)	136 (100.0)	41 (30.1)	95 (69.9)
Restaurant	41 (30.1)	12 (29.3)	29 (70.7)
Bar	95 (69.9)	29 (30.5)	66 (69.5)
Also required to be smoke-free by state law ^a	41 (30.1)	12 (29.3)	29 (70.7)
Required smoke-free by any law ^{a,b} , n = 70	70 (51.5)	41 (100.0)	29 (30.5)
Smoking observed ^a	2(2.9)	0 (0.0)	2 (6.8)
Other evidence of smoking ^c	5 (7.1)	0 (0.0)	5 (7.1)
Smoke odor	5 (7.1)	0 (0.0)	5 (7.1)
Ashtrays	2 (2.9)	0 (0.0)	2 (6.9)
Cigarette butts	2 (2.9)	0 (0.0)	2 (6.9)
Not fully separated/enclosed ^a	5 (7.1)	0 (0.0)	5 (17.2)
Compliant ^c	63 (90.0)	41 (100.0)	22 (75.9)
Not Compliant ^c	7 (10.0)	0 (0.0)	7 (24.1)

Notes. ^aVenues may have either, both, or neither the state law and the local ordinance requiring smoke-free bars and thus stronger than the state.

^bPercent reflect within venue categorization

^cData collection was unable to be completed in one co-located restaurant as it was dark and data collectors unable to sit in the restaurant area.

Analysis of Compliance by Presence of a Local Ordinance

Planned data analysis, of all venues required to be smoke-free by *any* law, was a chi-square of compliance by presence of a local ordinance that required smoke-free bars; results also included tobacco smoke pollution levels. Chi-square of compliance by presence of local ordinance resulted in cells with less than the expected count of five; therefore the Fisher's Exact test was appropriate and was significant, $n = 70$, $P < .01$, $\phi = .40$), with a medium effect size. Thus the presence of a local ordinance increased compliance significantly. The highest compliance rates were within communities with local ordinances (100%).

Additionally, the venues (restaurants and bars) within a community with a local ordinance ($n = 41$) had significantly lower mean tobacco smoke pollution levels (equal variances not assumed, $t(38.2) = 3.33$, $P = .002$).

Using geometric means, venues within communities with a local ordinance ($n = 41$), all of which were compliant, had 44.3% lower mean tobacco smoke pollution levels than did those compliant venues outside of communities with an ordinance ($n = 22$). Of venues outside of communities with a local ordinance ($n = 29$), compliant venues ($n = 22$) had 79.4% times lower mean tobacco smoke pollution levels than did non-compliant venues where tobacco smoke pollution was able to be assessed ($n = 6$). Venues within communities with a local ordinance ($n = 41$), all of which were compliant, had 88.5% lower mean tobacco smoke pollution levels than did those non-compliant venues outside of communities with an ordinance where tobacco smoke pollution was able to be assessed ($n = 6$). Conversely, non-compliant venues outside of communities with an ordinance where tobacco smoke pollution was able to be assessed ($n = 6$) had nearly 9

times higher mean tobacco smoke pollution levels than did those within a community with a local ordinance (n = 41).

Using arithmetic means, venues within communities with a local ordinance, all of which were compliant, had 66.5% lower mean tobacco smoke pollution levels than did those compliant venues outside of communities with an ordinance. Of venues outside of communities with a local ordinance, compliant venues had 63.3% lower mean tobacco smoke pollution levels than did noncompliant venues outside of communities with an ordinance where tobacco smoke pollution was able to be assessed. Venues within communities with a local ordinance, all of which were compliant, had 87.7% lower mean tobacco smoke pollution levels than did those non-compliant venues outside of communities with an ordinance where tobacco smoke pollution was able to be assessed. Conversely, non-compliant venues outside of communities with ordinance where tobacco smoke pollution was able to be assessed had 8 times higher mean tobacco smoke pollution levels than did those within a community with a local ordinance.

In comparing venues required by to smoke-free by *any* law by the presence of a local ordinance, those venues within communities with local ordinances had the highest compliance rate (100%) and the lowest mean tobacco smoke pollution levels (GM PM_{2.5} = 6.4 µg/m³; PM_{2.5} = 8.7 µg/m³). Venues not within communities with local ordinances had a lower compliance rate (75.9%) of those, the noncompliant venues had higher mean tobacco smoke pollution levels (GM PM_{2.5} levels = 55.7 µg/m³; PM_{2.5} = 70.8 µg/m³). Table 16 and Figure 12 present compliance rates and mean tobacco smoke pollution levels by presence of a local ordinance that required smoke-free bars.

**TABLE 16—Compliance Rates and Tobacco Smoke Pollution Levels (PM_{2.5} µg/m³),
in Venues Required to be Smoke-Free by Any Law, by Presence of a Local
Ordinance That Required Smoke-Free Bars: North Dakota, 2012**

	Within Communities with a Local Ordinance	Outside of Communities with a Local Ordinance	Total
n, (%)	41 (58.6)	29 (41.4)	70 (100)
Compliant, n (%)	41 (100.0)	22 (75.9)	63 (90)
AM (SD)	8.7 (9.1)	26.0 (47.2)	
GM (95% CI)	6.4 (5.1 - 8.1)	11.5 (6.7 – 19.9)	
Not compliant, n (%)	0 (0.0)	7 (24.1%)	7 (10)
AM (GSD)	na	70.8 (39.2) ^a	
GM (95% CI)	na	55.7 (21.7 – 143.0) ^a	

Notes. PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; AM = arithmetic mean; SD = standard deviation; GM = geometric mean; GSD = geometric standard deviation; CI = confidence levels.

^an = 6 as unable to collect PM_{2.5} in one noncompliant venue

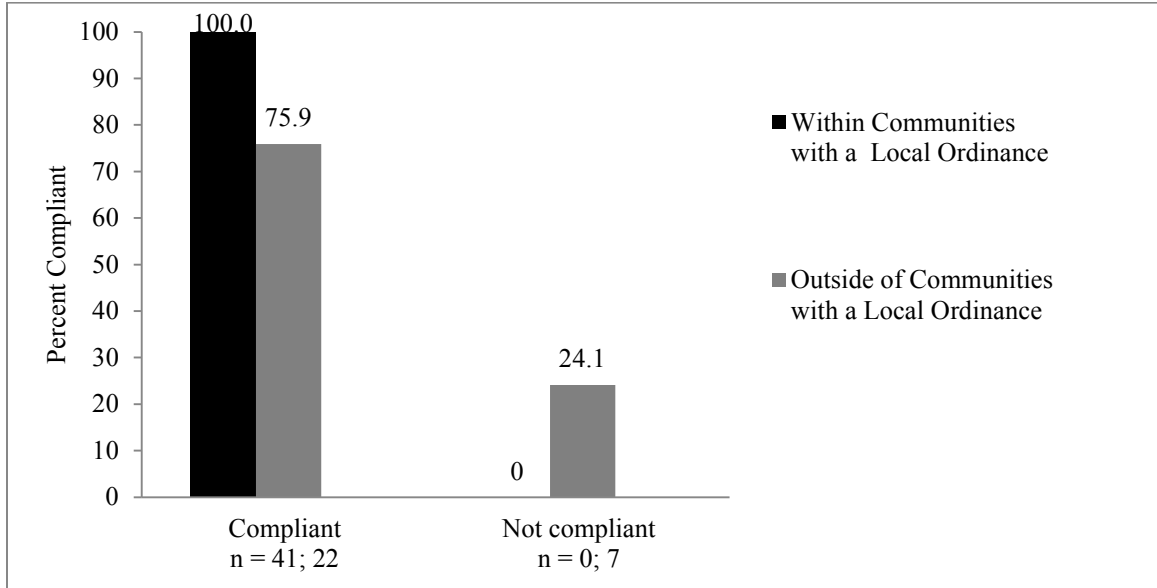


FIGURE 12—Compliance Rates, in Venues Required to be Smoke-Free by Any Law, by Presence of a Local Ordinance that Required Smoke-Free Bars: North Dakota, 2012

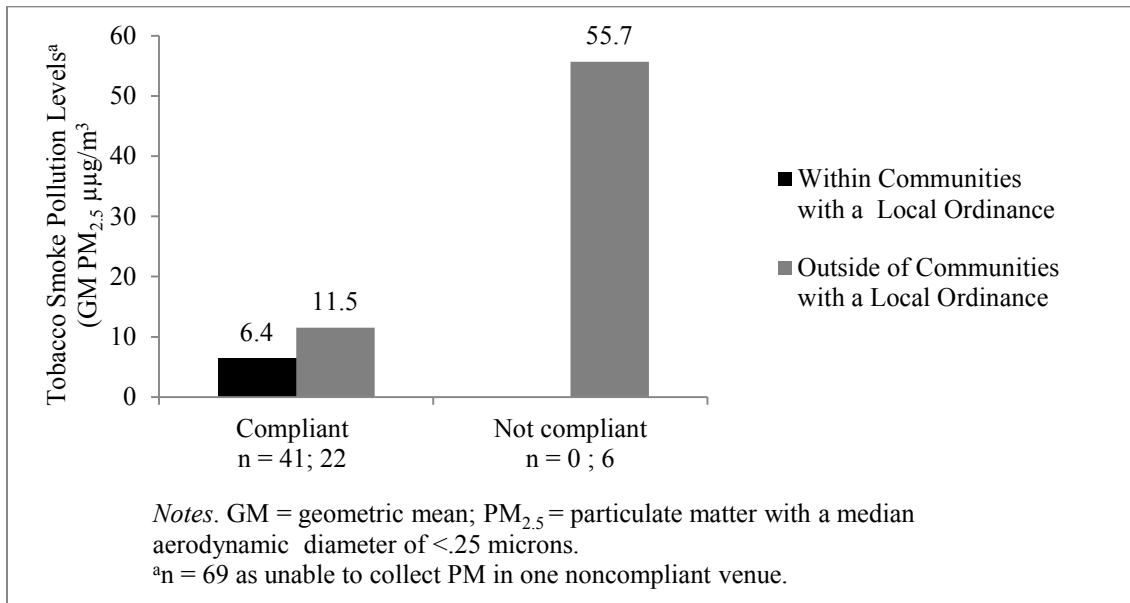


FIGURE 13—Tobacco Smoke Pollution Levels (GM PM_{2.5}) by Compliance, in Venues Required to be Smoke-Free by Any Law, by Presence of a Local Ordinance that Required Smoke-Free Bars: North Dakota, 2012

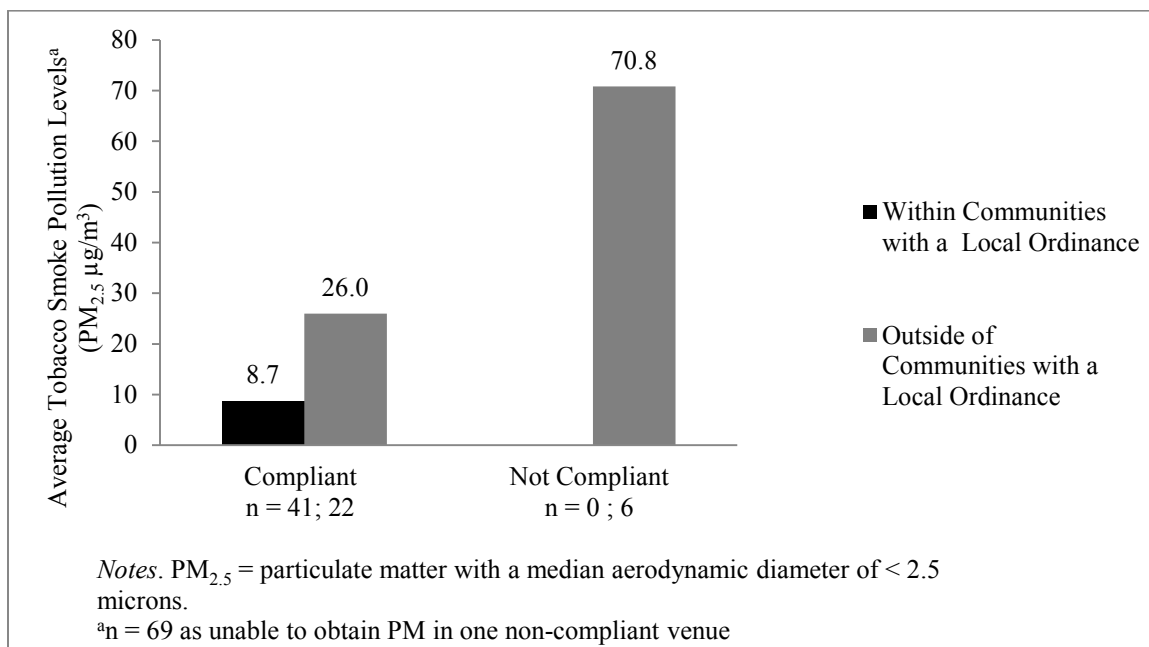


FIGURE 14—Tobacco Smoke Pollution Levels (PM_{2.5}) by Compliance, in Venues Required to be Smoke-Free by Any Law, by Presence of a Local Ordinance that Required Smoke-Free Bars: North Dakota, 2012

Analysis by Co-location Status

Analysis of compliance, in venues required to be smoke free by any law, by the presence of a local ordinance that required smoke-free bars, revealed an opportunity to conduct unplanned analysis of compliance and tobacco smoke pollution levels of the same venues by co-location status. See Table 17 and Appendix P.

TABLE 17—Compliance and Tobacco Smoke Pollution (PM_{2.5}), in Venues Required to be Smoke-Free by Any Law, by Co-location Status: North Dakota, 2012

	Not Co-located Restaurants n (%)	Not Co-located Bars n (%)	Co-located Restaurants n (%)	Total n (%)
n (%)	29 (41.4)	29 (41.4)	12 (17.1)	70 (100.0)
Required smoke-free by any law ^{a,b}				
Within community with local ordinance ^{a,b}	11 (37.9)	29 (100.0)	1 (8.3)	41 (58.6)
Required to be smoke-free by state law ^{a,b}	29 (100.0)	0 (0.0)	12 (100.0)	41 (58.6)
Compliant ^c	27 (93.1)	29 (100)	7 (58.3)	63 (90.0)
Not compliant ^c	2 (6.9)	0 (0.0)	5 (41.7)	7 (10.0)
Smoking observed ^c	2 (6.9%)	0 (0.0)	0 (0.0)	2 (2.9)
Other evidence of smoking ^c	2 (6.9) ^c	0 (0.0)	3 (25.0) ^{c,d}	5 (7.1)

	Not Co-located Restaurants n (%)	Not Co-located Bars n (%)	Co-located Restaurants n (%)	Total n (%)
Smoke odor	2 (6.9)	0 (0.0)	3 (25.0) ^{c,d}	5 (7.1)
Ashtrays	2 (6.9)	0 (0.0)	0 (0.0) ^c	2 (2.9)
Cigarette butts	2 (6.9)	0 (0.0)	0 (0.0) ^c	2 (2.9)
Not fully separated and enclosed	na	na	5 (41.7)	5 (41.7)
PM _{2.5} µg/m ³ , AM (SD) ^c	19.2 (25.6)	6.1 (3.1)	56.5 (63.5) ^c	19.6 (34.1)
PM _{2.5} µg/m ³ , GM (GSD) ^c	10.2 (3.1)	5.4 (1.7)	32.1 (3.1) ^c	9.3 (3.0)

Notes. PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; AM = arithmetic mean; SD = standard deviation; GM = geometric mean; GSD = geometric standard deviation.

^aVenues may have either, both, or neither the state law and the local ordinance stronger than the state law requiring smoke-free bars.

^bPercent reflect within venue categorization

^cData collection not completed in one co-located restaurant as it was dark and data collectors unable to sit in the restaurant area.

^dThree co-located restaurants had smoke odor; it was assumed that smoke likely infiltrated the smoke-free area of these co-located restaurants and therefore these three restaurants were considered compliant.

Unplanned Chi-square exploratory analysis of compliance by venue co-location status was significant, $n = 70$, Fisher's Exact test, $P < .01$, $\phi = -.48$, with a negative large effect size. Thus venues that were co-located had significantly decreased compliance than did those not co-located. Compliance was higher in venues not co-located (96.6%). Additionally, venues not co-located ($n = 58$) had significantly lower mean tobacco smoke pollution levels (equal variances not assumed, $t(12.69) = -4.025$, $P = .002$) than did co-located venues ($n = 11$) (GM $PM_{2.5} = 7.4 \mu\text{g}/\text{m}^3$ and $32.1 \mu\text{g}/\text{m}^3$ respectively). Table 18 and Figures 15 - 20 present compliance rates and mean tobacco smoke pollution levels by co-location status.

TABLE 18—Compliance Rates and Tobacco Smoke Pollution Levels (Mean $PM_{2.5}$ $\mu\text{g}/\text{m}^3$), in Venues Required to be Smoke-Free by Any Law, by Co-location Status: North Dakota, 2012

	Not Co-located Venues	Co-located Venues	Total
n, (%)	58 (82.9)	12 (17.1)	70 (100)
Compliant, n (%)	56 (96.6)	7 (58.3)	63 (90.0)
AM (SD)	9.5 (9.7)	56.7 (76.8)	
GM (95% CI)	6.7 (5.4 - 8.4)	27.8 (8.6 - 89.6)	
Not compliant, n (%)	2 (3.4)	5 (41.7)	7 (10.0)
AM (SD)	100.5 (7.8)	56.0 (40.7) ^a	
GM (95% CI)	100.4 (50.0 - 201.3)	41.5 (8.5 - 203.1) ^a	

Notes. $PM_{2.5}$ = particulate matter with a median aerodynamic diameter of < 2.5 microns; AM = arithmetic mean; SD = standard deviation; GM = geometric mean; CI = confidence intervals.

^an = 4 as unable to collect $PM_{2.5}$ in one noncompliant venue

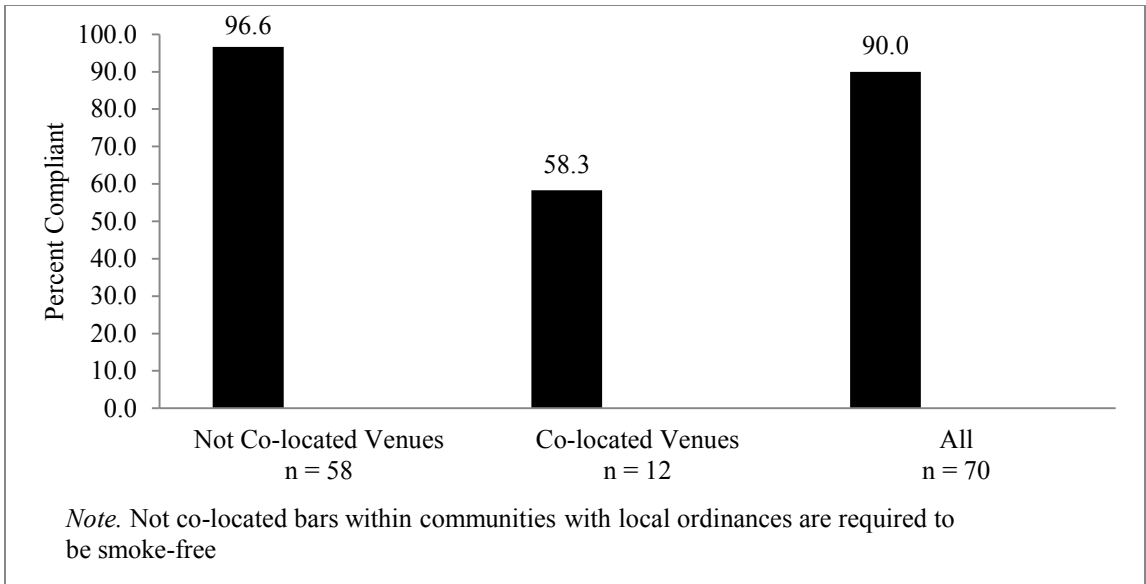


FIGURE 15—Compliance Rates, in Venues Required to be Smoke-Free by Any Law, by Co-location Status: North Dakota, 2012

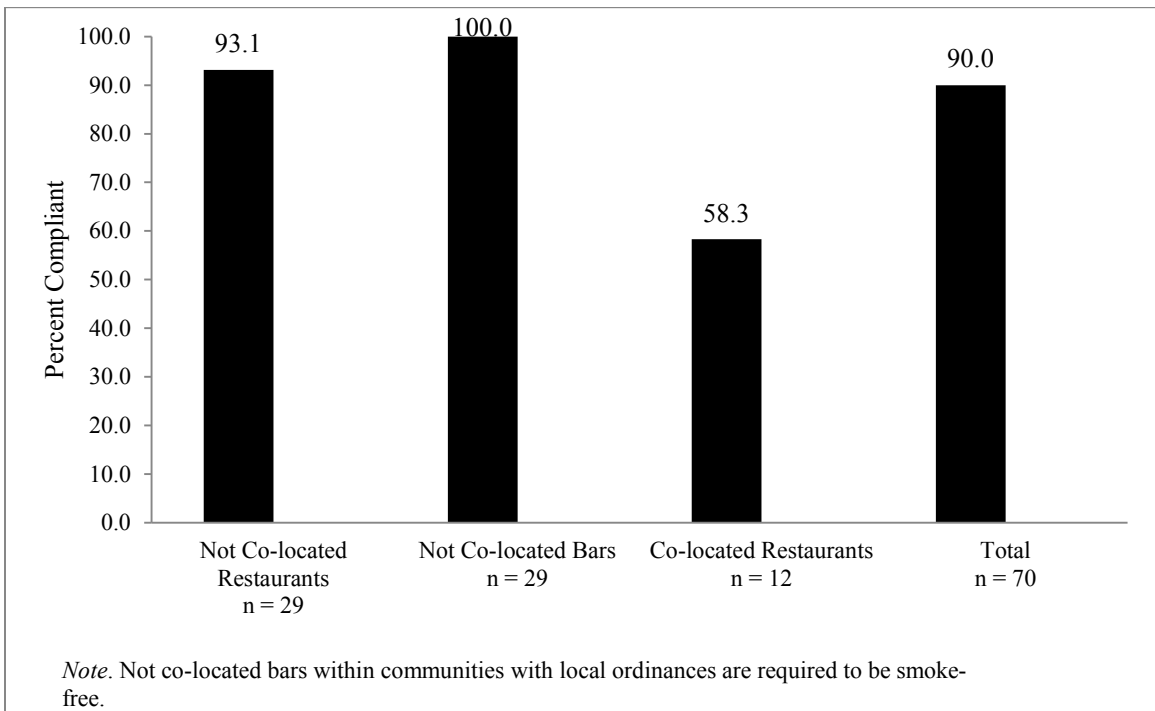


FIGURE 16—Compliance Rates, in Venues Required to be Smoke-Free by Any Law, by Venue Type and Co-location Status: North Dakota, 2012

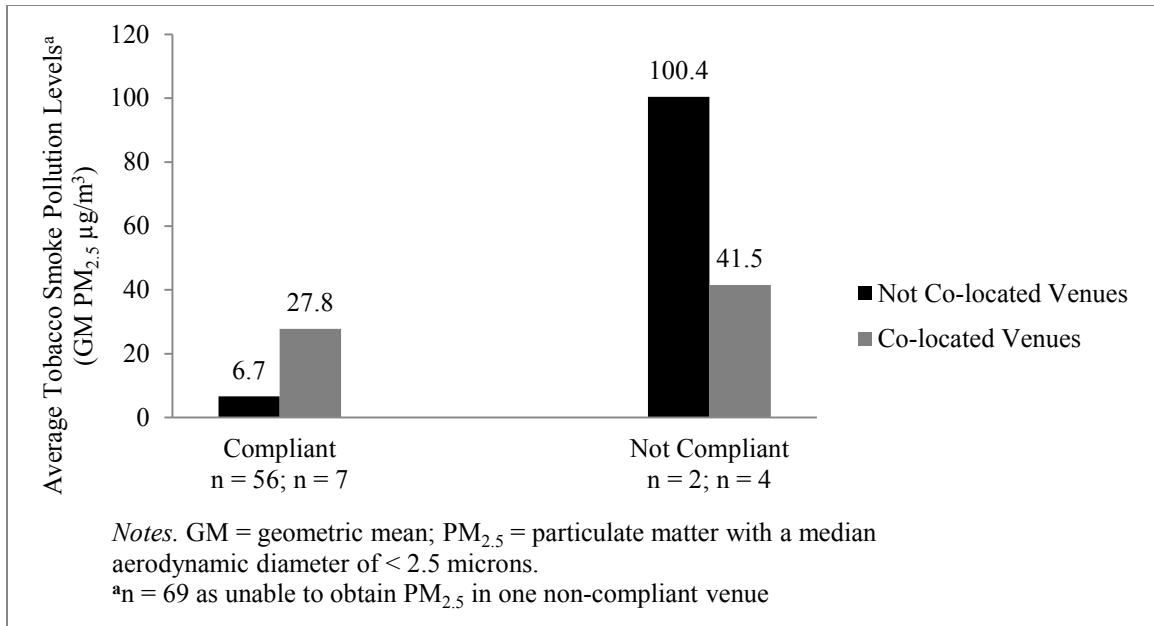


FIGURE 17—Tobacco Smoke Pollution (GM PM_{2.5}), in Venues Required to be Smoke-Free by Any Law, by Compliance and Co-location Status: North Dakota, 2012

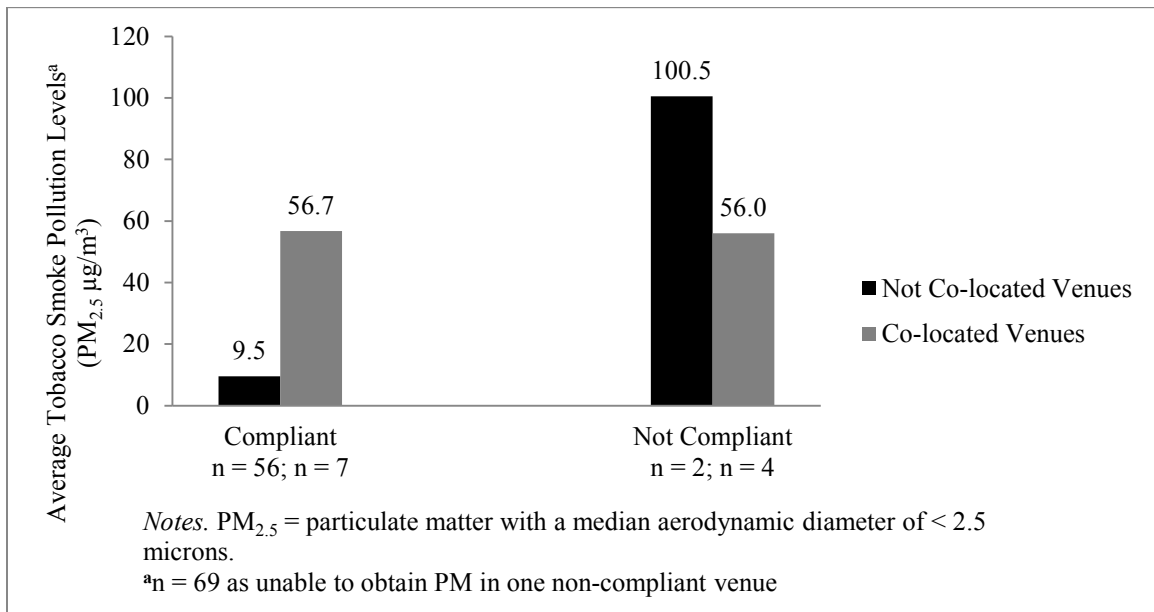


FIGURE 18—Tobacco Smoke Pollution (PM_{2.5}), in Venues Required to be Smoke-Free by Any Law, by Compliance and Co-location Status: North Dakota, 2012

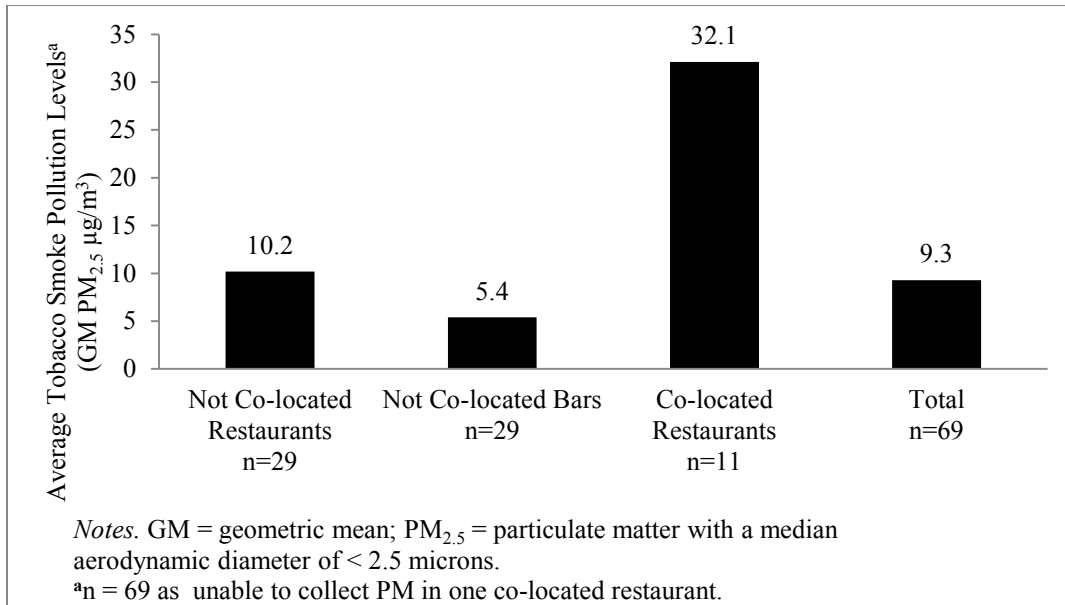


FIGURE 19—Tobacco Smoke Pollution (GM PM_{2.5}), in Venues Required to be Smoke-Free by Any Law, by Venue Type and Co-location Status: North Dakota, 2012

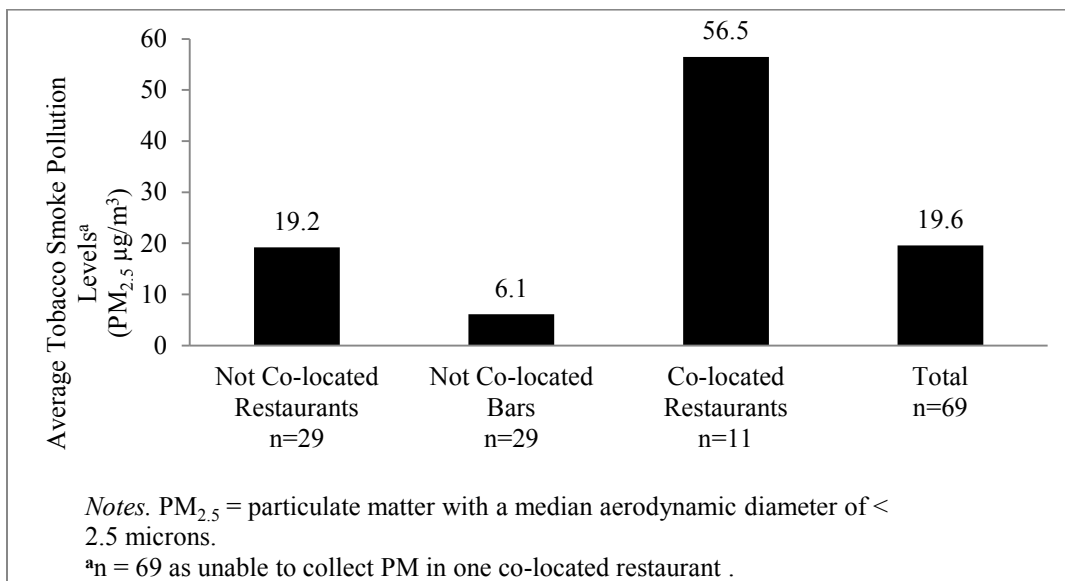


FIGURE 20—Tobacco Smoke Pollution (PM_{2.5}), in Venues Required to be Smoke-Free by Any Law, by Venue Type and Co-location Status: North Dakota, 2012

In venues where tobacco smoke pollution levels were able to be assessed (n = 69), the non-compliant venues (n = 6) had higher mean levels of tobacco smoke pollution than did compliant venues (n = 3). Venues required to be smoke free that were not co-located and not compliant had the highest mean levels using either geometric ($PM_{2.5} = 100.4 \mu\text{g}/\text{m}^3$) or arithmetic means ($PM_{2.5} = 100.5 \mu\text{g}/\text{m}^3$). Using geometric means, in venues required to be smoke free, the second highest mean tobacco smoke pollution levels were in co-located, non-compliant venues ($PM_{2.5} = 41.5 \mu\text{g}/\text{m}^3$), followed by co-located compliant venues ($PM_{2.5} = 27.8 \mu\text{g}/\text{m}^3$). Using arithmetic means, in venues required to be smoke-free, the co-located venues whether compliant or not had similar mean tobacco smoke pollution levels ($56.7 \mu\text{g}/\text{m}^3$ and $56.0 \mu\text{g}/\text{m}^3$ respectively). In venues required to be smoke free, compliant and not co-locate venues required to be smoke free had the lowest mean tobacco smoke pollution levels, using either geometric ($PM_{2.5} = 6.7 \mu\text{g}/\text{m}^3$) or arithmetic ($PM_{2.5} = 9.5 \mu\text{g}/\text{m}^3$) means.

Using geometric means, in venues required to be smoke-free by law where tobacco smoke pollution levels were able to be assessed and that were compliant with the law (n = 63), those not co-located (n = 56) had 75.9% lower mean tobacco smoke pollution levels than did those co-located (n = 6). Conversely, in venues required to be smoke-free by law that were compliant with the law, those co-located had 4 times higher mean levels of tobacco smoke pollution than did those not co-located. Using arithmetic means, in venues required to be smoke-free by law that were compliant with the law, those not co-located had 83.2% lower mean tobacco smoke pollution levels than did those co-located. Or conversely, in venues required to be smoke-free by law that were

compliant with the law, those co-located had 6 times higher mean levels of tobacco smoke pollution than did those not co-located.

By co-location status, in comparing venues required by to smoke-free by any law, venues not co-located had the higher compliance rate (96.6%) and the lowest mean tobacco smoke pollution levels (GM $PM_{2.5} = 6.7 \mu\text{g}/\text{m}^3$; $PM_{2.5} = 9.5 \mu\text{g}/\text{m}^3$). Non-compliant not co-located venues had the highest mean tobacco smoke pollution levels (GM $PM_{2.5} = 100.4 \mu\text{g}/\text{m}^3$; $PM_{2.5} = 100.5 \mu\text{g}/\text{m}^3$).

Co-located venues had only a 58.3% compliance rate. Additionally, simply by being a co-located venue, whether compliant or not, mean tobacco smoke pollution levels were high, (GM $PM_{2.5} = 27.8 \mu\text{g}/\text{m}^3$ and $41.5 \mu\text{g}/\text{m}^3$; $PM_{2.5} = 56.7 \mu\text{g}/\text{m}^3$ and $56.0 \mu\text{g}/\text{m}^3$ respectively) compared to compliant not co-located venues (GM $PM_{2.5} = 6.7 \mu\text{g}/\text{m}^3$; $PM_{2.5} = 9.5 \mu\text{g}/\text{m}^3$).

Perhaps the most noteworthy finding was that tobacco smoke pollution levels in co-located venues that were compliant (GM $PM_{2.5} = 27.8 \mu\text{g}/\text{m}^3$) had 4 times higher mean tobacco smoke pollution levels than did the compliant not co-located venues (GM $PM_{2.5} = 6.7 \mu\text{g}/\text{m}^3$). Using arithmetic means, the difference was 6 times higher between compliant co-located and not collocated venues ($PM_{2.5} = 56.7 \mu\text{g}/\text{m}^3$ and $9.5 \mu\text{g}/\text{m}^3$ respectively).

In conclusion, compliance and tobacco smoke pollution levels were affected by both the presence of a local ordinance that required smoke-free bars and by venue co-location status. In total, of the venues required to be smoke-free ($n = 70$), 90% were compliant, with only 7 (10%) non-compliant. Of the noncompliant venues, smoking was observed in 2 of the 70 (2.9%) venues; both were in restaurants not co-located.

Observation of the co-location requirements for restaurants with enclosed separate smoking bars found 5 of the 12 (41.7%) noncompliant.

This study supports the second hypothesis of aim 3, that compliance with smoke-free laws was significantly higher in hospitality venues located within communities with an ordinance requiring smoke-free bars, thus more stringent than state law, than did those located outside of communities with an ordinance more stringent than state law. A medium effect ($\phi = .40$) occurred between compliance and the presence of a local ordinance, meaning the presence of a local ordinance increased compliance. Compliance was also significantly associated with co-location status. A large negative effect ($\phi = -.48$) occurred between compliance and co-location, meaning co-location negatively impacted compliance (decreased compliance). Additionally, compliant venues had the lowest mean tobacco smoke pollution levels, for both those venues within communities with ordinances requiring smoke-free bars (GM $PM_{2.5} = 6.4 \mu\text{g}/\text{m}^3$; $PM_{2.5} = 8.7 \mu\text{g}/\text{m}^3$) and those venues not co-located (GM $PM_{2.5} = 6.7 \mu\text{g}/\text{m}^3$; $PM_{2.5} = 9.5 \mu\text{g}/\text{m}^3$).

Aim 4

The fourth and final aim was a planned post-hoc analysis to determine the direct influence of socio-economic status (SES) of the venue locations on the quantity of tobacco smoke pollution in hospitality venues statewide in ND. The hypothesis for Aim 4 was: The quantity of tobacco smoke pollution will increase as the SES of the venue locations decreases in hospitality venues in ND.

The U.S. Census Bureau's (USCB) percent poverty estimates by census tract for each venue location was obtained and then collapsed into the USCB's poverty

categorization.¹⁶ Category I included census tracts with poverty rates of less than 13.8%, Category II included poverty rates of 13.8% to 19.9%, Category III included poverty rates of 20.0% to 39.9%, and Category IV included poverty rates of 40.0% or more. The USCB defined *poverty areas* as census tracts with poverty rates of 20% or more.¹⁷

Descriptive data for the venues by the poverty categories is in Table 19.

Interestingly, as poverty increased by category and thus the percent of poverty increased, the number of venues sampled decreased. All the venues in the two categories meeting the definition of *poverty areas* (III and IV) were required to be smoke-free by law. Of the venues in categories III (n = 16) and IV (n = 8), all except 1 were located in communities with local ordinances requiring all restaurants and bars to be smoke-free. The remaining venue (n = 1), a restaurant, was required to be smoke-free by state law. Additionally no smoking was observed in any Category III or IV venues. As can be expected the tobacco smoke pollution levels in Category III and IV venues were low.

The planned analysis was a forward multiple regression of the log transformed PM_{2.5} with the predictor variables of poverty, presence of a local ordinance that required smoke-free bars, and type of venue (restaurant or bar). The first multiple regression included poverty collapsed into the four categories; the second included poverty as the estimated percent below poverty level per census tract. Both regressions revealed similar results with two models each; none of the models included poverty. The best fitting model (adjusted $R^2 = .411$, $R^2 = .420$, $F(1, 132) = 17.41$, $P < .001$) revealed significant predictors of required to be smoke-free by local ordinance and type of venue (Table 20).

TABLE 19—Descriptive Data and Tobacco Smoke Pollution Levels (PM_{2.5}) of Venues by U.S. Census Bureau Poverty Categories (USCB): North Dakota, 2012

USCB Poverty Categories	I: < 13.8 %	II: 13.8 – 19.9 %	III: 20.0 – 39.9 %	IV: ≥ 40.0 %	Total
Total, n (%)	81 (59.6)	31 (22.8)	16 (11.8)	8 (5.9)	136 (100)
Venue type, n (%)					
Restaurants	26 (32.1)	8 (25.8)	3 (18.8)	4 (50)	41 (30.1)
Bars	55 (67.9)	23 (74.2)	13 (81.2)	4 (50)	95 (69.9)
Smoke-free by any law, n (%) ^a	29 (35.8)	17 (54.8)	16 (100.0)	8 (100.0)	70 (51.5)
Local ordinance ^a	6 (7.4)	12 (38.7)	15 (93.8)	8 (100.0)	41 (30.1)
State law ^a	26 (32.1)	8 (25.8)	3 (18.8)	4 (50.0)	41 (30.1)
Observed smoking, n (%) ^b	44 (55.0)	13 (41.9)	0 (0.0)	0 (0.0)	57 (42.4)
PM _{2.5} µg/m ³ , \bar{x} (SD) ^b	113.6 (124.7)	83.9 (136.7)	7.3 (7.0)	6.3 (3.5)	
PM _{2.5} µg/m ³ , GM (GSD) ^b	49.1 (4.8)	23.9 (5.4)	5.6 (2.0)	5.6 (1.6)	

Notes. PM_{2.5} = Particulate matter with a median aerodynamic diameter of less < 2.5 microns; SD = standard deviation; GM = geometric mean; GSD = geometric standard deviation.

^aVenues may be included in one or more categories of smoke-free by law.

^bn = 135 as unable to collect PM_{2.5} in one co-located Category I venue.

TABLE 20—Forward Regression of Tobacco Smoke Pollution (GM PM_{2.5} µg/m³) by Poverty, Presence of a Local Ordinance That Required Smoke-Free Bars, and Type of Venue: North Dakota, 2012

	exp(b)	t	95% CI
Constant	26.5	5.228***	17.3 – 40.6
Required to be smoke-free by ordinance	0.12	-8.856***	0.07 - 0.19
Bar versus restaurant	2.75	4.172***	1.70 – 4.44

Notes. GM = geometric mean; PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; exp(b) = exponentiated unstandardized regression coefficients; exponentiated CI = confidence intervals.

P* < .05; *P* < .01; ****P* < .001.

Unplanned analysis of the poverty is described next; first with the four poverty categories and then with the estimated percent below poverty by census tract. A one-way ANOVA of the logPM_{2.5} by the four poverty categories resulted in a significant Levene’s test for homogeneity of variance, *n* = 135, Levene’s *F*(3, 131) = 9.63, *P* < .001); thus the ANOVA assumptions were not met. A *t* test of logPM_{2.5} by poverty categories I and II (*n* = 101) found significant difference, *t*(109) = 2.128, *P* = .036). Category I venues had higher levels of tobacco smoke pollution (*n* = 80, GM PM_{2.5} = 49.1 µg/m³, GSD = 4.8 µg/m³) than did Category II venues (*n* = 31, GM PM_{2.5} = 23.9 µg/m³, GSD = 5.4µg/m³). As this was an unexpected finding, an unplanned analysis comparing the difference in tobacco smoke pollution levels in only bars (as all restaurants were required to be smoke-free by state law), located in communities without local ordinances requiring bars to be smoke-free, and located within poverty Categories I and II (as all venues sampled in Categories III and IV were required to be smoke-free by law) was conducted. There was

no significant difference in the mean tobacco smoke pollution levels between Categories I (n = 52) and II (n = 14), $t(64) = .177, P = .86$, GM PM_{2.5} = 91.3 µg/m³, GSD = 3.6 µg/m³ and 84.9 µg/m³, GSD = 5.3 µg/m³ respectively.

Next poverty as the estimated percent below poverty by census tract was analyzed. Correlational analysis of logPM_{2.5} by estimated percent below poverty by census tract was significant, n = 135, $r = -.434, P < .001$). However, a correlation analysis of logPM_{2.5} by estimated percent below poverty by census tract of only bars (as all restaurants were required to be smoke-free), located in communities without local ordinances requiring bars to be smoke free, and located within poverty Categories I and II (as all venues sampled in Categories III and IV were required to be smoke-free by law) revealed small, positive, non-significant correlation (n = 66; $r = .053, P = .672$).

In conclusion, the poverty variable was confounded as venues in the highest poverty areas (Categories III and IV) were all required to be smoke-free by state or local law. Additionally, smoking was not observed in any Category III and IV venues. The planned forward regression analyses models did not include poverty in any models. It is important to recall that this aim was designed as a post-hoc analysis of the data.

Unplanned analysis of poverty per the four poverty categories initially revealed significant differences in tobacco smoke pollution. However, no significance differences were found once analysis was restricted to venues that could allow smoking, this included only bars (as all restaurants were required to be smoke-free by state law), located in communities without local ordinances requiring bars to be smoke-free, and located within poverty Categories I and II (as all venues sampled in Categories III and IV were required to be smoke-free by law). Similarly, unplanned analysis of poverty as the estimated

percent below poverty by census tract, initially found significant differences in tobacco smoke pollution levels. However, once again when only the venues that could allow smoking were included a small, positive, but non-significant relationship was revealed between poverty and tobacco smoke pollution levels.

This study used SES as an indicator of poverty; other poverty indicators may have provided different results. Further conceptual and theoretical development of the influences of poverty, in conjunction with planned, rather than post-hoc analysis, to assess SES influence on tobacco smoke pollution levels in hospitality venues was recommended. Also selected case studies of ND venues within low SES communities may advance the understanding of the relationship between poverty and tobacco smoke pollution.

NATIONAL AMBIENT AIR QUALITY STANDARDS

As described in Chapter 1, the U.S. Environmental Protection Agency (EPA) sets the PM_{2.5} 24-hour and annual standards for outdoor air. The EPA's National Ambient Air Quality Standards for PM_{2.5} for 24 hour averages were just revised on December 14, 2012 to improve public health protection.¹⁸ The Air Quality Index (AQI) is the EPA's color coded notification system designed to inform the public about the cleanliness of the air and to provide health warnings. Table 21 combined the previous and newly revised current AQI for PM_{2.5} µg/m³ including the AQI color coded categories, index values, current and proposed breakpoints, and health advisory. The Good through Very Hazardous breakpoints were on the 2012 revised breakpoints. This author added the term "Very Hazardous" to the category names to separate out the two levels of Hazardous of

the new breakpoints. The Significant Harm Level was not included in the 2012 revision but had implications for this study and was included in Table 21.^{19,20}

Tables 22 – 23 provides the number of venues in per AQI category by selected venue categories. Table 24 provides the tobacco smoke pollution levels by venue type, rurality, and required to be smoke-free by law with corresponding AQI color codes for all venues sampled (n = 135). Using arithmetic means, the EPA air quality category for venues where smoking was observed was “very unhealthy” ($PM_{2.5} = 182.2 \mu\text{g}/\text{m}^3$) compared to “moderate” ($PM_{2.5} = 18.8 \mu\text{g}/\text{m}^3$) for venues where smoking was not observed. The air quality for bars was “unhealthy” ($PM_{2.5} = 112.4 \mu\text{g}/\text{m}^3$) compare to “moderate” ($PM_{2.5} = 29.4 \mu\text{g}/\text{m}^3$) for restaurants.

Table 25 presents tobacco smoke pollution levels and AQI color codes in venues required to be smoke-free by any law (n = 70), by compliance and by the presence of a local ordinance that required smoke-free bars. In venues required to be smoke-free by any law, those that were compliant were, on average, either in the green (good) or yellow (moderate) AQI categories. Noncompliant venues were, on average, in the red (unhealthy) category.

Table 26 presents tobacco smoke pollution levels and AQI color codes in venues required to be smoke-free by any law (n = 70), by compliance and by co-location status. For venues that were not co-located, the AQI for compliant venues was green (good) and noncompliant venues were red (unhealthy). In co-located venues, AQI categories ranged from yellow (moderate) to red (unhealthy).

TABLE 21—US EPA’s Previous (1999) and Current (2012) PM_{2.5} Air Quality Index with Health Advisory

AQI Category	Index Values	Previous Breakpoints (1999 AQI) ($\mu\text{g}/\text{m}^3$, 24-hour average)	Revised Breakpoints (2012) ($\mu\text{g}/\text{m}^3$, 24-hour average)	Health Advisory
Good	0 – 50	0.0 – 15.0	0.0 - 12.0	None.
Moderate	51 - 100	>15.0 – 40	12.1 – 35.4	Unusually sensitive people should consider reducing prolonged or heavy exertion.
Unhealthy for Sensitive Groups	101 - 150	>40 – 65	35.4 – 55.4	People with heart or lung disease, older adults, and children should reduce prolonged or heavy exertion.
Unhealthy	151 - 200	>65 – 150	55.5 – 150.4	People with heart or lung disease, older adults, and children should avoid prolonged or heavy exertion. Everyone else should reduce prolonged or heavy exertion.
Very Unhealthy	201 - 300	>150 – 250	150.5 – 250.4	People with heart or lung disease, older adults, and children should avoid all physical activity outdoors. Everyone else should avoid prolonged or heavy exertion.
Hazardous	301 - 400	>250 – 350	250.5 – 350.4	People with heart or lung disease, older adults, and children should remain indoors and keep activity levels low. Everyone else should avoid all physical activity outdoors.
Very Hazardous	401 - 500	>350 – 500	350.5 – 500	People with heart or lung disease, older adults, and children should remain indoors and keep activity levels low. Everyone else should avoid all physical activity outdoors.
Significant Harm Level	>500	Not Included in 1999	>500	Imminent and substantial endangerment to public health

Notes. AQI = Air Quality Index; Good through Very Hazardous categories are the current 2012 AQI PM_{2.5} $\mu\text{g}/\text{m}^3$ breakpoints, with the term “Very Hazardous” added by this author to separate out the two levels of Hazardous; the Significant Harm Level (EPA, 2009) was not included in the 2012 proposed revisions but has implications for this study. Adapted from “The national ambient air quality standards for particulate pollution. Revised air quality standards for particle pollution and updates to the air quality index (AQI).” *Environmental Protection Agency* and “Fact sheet. Proposed revisions to air quality index reporting and significant harm level for fine particulate matter.” *Environmental Protection Agency* (2009).

TABLE 22—Number of Venues per AQI Categories by Venue Type and Observed Smoking: North Dakota, 2012

AQI Revises Breakpoints PM _{2.5} µg/m ³	AQI Category	Color Code	All Venues, n = 135	Restaurants, n = 40	Bars, n = 95	Smoking Observed, n = 57	Smoking Not Observed, n = 78
0.0 - 12.0	Good	Green	53	18	35	1	52
12.1 - 35.4	Moderate	Yellow	19	14	5	2	17
35.4 - 55.4	Unhealthy for Sensitive Groups	Orange	4	2	2	2	2
55.5 - 150.4	Unhealthy	Red	31	5	26	25	6
150.5 - 250.4	Very Unhealthy	Violet	15	1	14	14	1
250.5 - 350.4	Hazardous	Maroon	7	0	7	7	0
350.5 - 500	Very Hazardous	Maroon	4	0	4	4	0
>500	Significant Harm	Black	2	0	2	2	0

Notes. AQI = U.S. Environmental Protection Agency's 2012 PM_{2.5} Air Quality Index;

TABLE 23—Number of Venues per AQI Categories by Co-location Status and Presence of an Ordinance: North Dakota, 2012

AQI Revised Breakpoints PM _{2.5} (µg/m ³)	AQI Category	Color Code	Co-located Restaurants, n = 11	Co-located Bars, n = 12	Not Co-located Restaurants, n = 29	Not Co-located Bars, n = 83	Local Ordinance, n = 41	No Local Ordinance, n = 94
0.0 - 12.0	Good	Green	2	0	16	35	32	21
12.1 - 35.4	Moderate	Yellow	5	0	9	5	8	11
35.4 - 55.4	Unhealthy for Sensitive Groups	Orange	0	2	2	0	1	3
55.5 - 150.4	Unhealthy	Red	3	7	2	19	0	31
150.5 - 250.4	Very Unhealthy	Violet	1	2	0	12	0	15
250.5 - 350.4	Hazardous	Maroon	0	1	0	6	0	7
350.5 - 500	Very Hazardous	Maroon	0	0	0	4	0	4
>500	Significant Harm	Black	0	0	0	2	0	2

Notes. AQI = U.S. Environmental Protection Agency's 2012 PM_{2.5} Air Quality Index.

TABLE 24—Mean Tobacco Smoke Pollution (PM_{2.5} µg/m³) and AQI Color Codes by Venue Type, Rurality, and Smoke-free by Law: North Dakota, 2012

Characteristics	n	AM	Color	GM	Color
Sample	135	87.8	Red	28.6	Yellow
Venue type					
Not co-located restaurant	29	19.2	Yellow	10.2	Green
Not co-located bar	83	111.8	Red	33.2	Yellow
Co-located restaurant	11	56.5	Red	32.1	Yellow
Co-located bar	12	116.2	Red	96.6	Red
Rurality					
RUCC 1- 3	51	66.0	Red	14.1	Yellow
RUCC 4 - 7	26	97.0	Red	36.6	Orange
RUCC 8 - 9	58	102.9	Red	46.3	Orange
Presence of law requiring smoke-free					
Local ordinance	41	8.7	Green	6.4	Green
No ordinance	94	122.3	Red	53.9	Orange
State law	40	29.4	Yellow	14.0	Yellow
Any law	69	19.6	Yellow	9.3	Green

Notes. PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; AM = arithmetic mean, GM = geometric mean. AQI = U.S. Environmental Protection Agency's 2012 PM_{2.5} Air Quality Index; n = 135 as unable to collect PM in one co-located, RUCC 8-9 venue.

TABLE 25—In Venues Required to be Smoke-Free by Any Law: Tobacco Smoke Pollution Levels (PM_{2.5} µg/m³) and AQI Color Code by Compliance and by Presence of a Local Ordinance That Required Smoke-Free Bars: North Dakota, 2012

	Within Communities with Local Ordinance	AQI Color Code	Outside of Communities with Local Ordinance	AQI Color Code	Total
n (%),	41 (58.6)		29 (41.4)		70
Compliant, n	41 (100.0)		22 (75.9)		63
AM	8.7	Green	26.0	Yellow	
GM	6.4	Green	11.5	Green	
Not compliant, n	0 (0.0)		7 (24.1)		7
AM	na		70.8 ^a	Red	
GM (95% CI)	na		55.7 ^a	Red	

Notes. PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; AM = arithmetic mean; GM = geometric mean; AQI = U.S. Environmental Protection Agency's 2012 PM_{2.5} Air Quality Index.

^an = 6 as unable to collect PM_{2.5} in one noncompliant venue

TABLE 26—AQI Color Code, Compliance Rates, and Tobacco Smoke Pollution Levels (PM_{2.5} µg/m³), in Venues Required to be Smoke-Free by Any Law, by Co-location Status: North Dakota, 2012

	Not Co-located Venues	Color Coded	Co-located Venues	Color Coded	Total
n, (%)	58 (82.9)		12 (17.1)		70 (100)
Compliant, n (%)	56 (96.6)		7 (58.3)		63 (90.0)
AM	9.5	Green	56.7	Red	
GM	6.7	Green	27.8	Yellow	
Not compliant, n (%)	2 (3.4)		5 (41.7)		7 (10.0)
AM	100.5	Red	56.0 ^a	Red	
GM	100.4	Red	41.5 ^a	Orange	

Notes. PM_{2.5} = particulate matter with a median aerodynamic diameter of < 2.5 microns; AM = arithmetic mean; GM = geometric mean; AQI = U.S. Environmental Protection Agency's 2012 PM_{2.5} Air Quality Index.

^an = 4 as unable to collect PM_{2.5} in one noncompliant venue

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Appendix O

Sample Venue Descriptive Characteristics, Distributions by Selected Variables, and Difference Testing of Smoking Observed

by Venue Characteristics: North Dakota, 2012

Characteristics	n	PM _{2.5} μg/m ³ AM (SD)	LogPM _{2.5} μg/m ³ GM (GSD) ^a	Room Volume m ³ AM (SD)	No. of People AM (SD)	OD AM (SD)	No. of Lit Cigarettes AM (SD)	ASD AM (SD)	Smoking observed n (%) ^{bc}	P- Value ^d
Sample	136 ^c	87.8 (122.2)	28.6 (5.3)	494 (601)	18.5 (16.9)	5.7 (5.8)	0.9 (1.7)	0.29 (5.78)	57 (41.9)	
Venue type										<.001 ^e
Not co-located restaurant	29	19.2 (25.7)	10.2 (3.1)	540 (935)	19.2 (17.9)	6.5 (6.8)	0.2 (0.8)	0.05 (0.21)	2 (6.9)	
Not co-located bar	83	111.8 (142.6)	33.2 (6.2)	503 (440)	18.3 (17.1)	4.6 (3.3)	1.1 (1.8)	0.33 (0.53)	44 (53.0)	
Co-located restaurant	12 ^c	56.5 (63.5)	32.1 (3.1)	205 (195)	11.6 (7.4)	8.2 (6.3)	0.0 (0.0)	0.00 (0.00)	0 (0.0)	
Co-located bar	12	116.2 (78.9)	96.6 (1.9)	587 (777)	24.8 (18.5)	8.9 (12.0)	2.4 (2.2)	0.82 (1.14)	11 (91.7)	

Characteristics	n	PM _{2.5} μg/m ³ AM (SD)	LogPM _{2.5} μg/m ³ GM (GSD) ^a	Room Volume m ³ AM (SD)	No. of People AM (SD)	OD AM (SD)	No. of Lit Cigarettes AM (SD)	ASD AM (SD)	Smoking observed n (%) ^{bc}	P- Value ^d
Rurality										.003
RUCC 1- 3	51	66.0 (130.2)	14.1 (5.3)	646 (835)	23.9 (22.0)	5.7 (4.8)	0.6 (1.5)	0.20 (0.52)	12 (23.5)	
RUCC 4 - 7	26	97.0 (127.7)	36.6 (4.8)	466 (492)	23.3 (16.4)	8.5 (10.1)	1.8 (2.5)	0.56 (0.93)	14 (53.9)	
RUCC 8 - 9	59 ^c	102.9 (111.3)	46.3 (4.6)	373 (311)	11.6 (6.6)	4.4 (3.0)	0.8 (1.2)	0.23 (0.35)	31 (53.5)	
Presence of law requiring smoke-free ^f										
Local ordinance	41	8.7 (9.1)	6.4 (2.1)	581 (544)	26.9 (24.1)	6.2 (5.2)	0.0 (0.0)	0.00 (0.00)	0.0 (0.0)	<.001
No ordinance	95 ^c	122.3 (132.3)	53.9 (4.8)	457 (624)	14.9 (10.8)	5.5 (6.0)	1.3 (1.9)	0.41 (0.66)	57 (60.6)	
State law	41 ^c	29.4 (42.3)	14.0 (3.5)	448 (813)	17.1 (16.0)	6.9 (6.6)	0.2 (0.7)	0.39 (0.65)	2 (5.0)	<.001
Any law	70 ^c	19.6 (34.2)	9.3 (3.0)	535 (742)	20.5 (20.4)	6.1 (5.7)	0.1 (0.5)	0.02 (0.14)	2 (2.9)	<.001

Characteristics	n	PM _{2.5} μg/m ³ AM (SD)	LogPM _{2.5} μg/m ³ GM (GSD) ^a	Room Volume m ³ AM (SD)	No. of People AM (SD)	OD AM (SD)	No. of Lit Cigarettes AM (SD)	ASD AM (SD)	Smoking observed n (%) ^{bc}	P- Value ^d
Poverty category by census tract										<.001 ^e
I = <13.8%	81 ^c	113.6 (124.7)	49.1 (4.8)	466 (668)	14.9 (10.4)	5.3 (4.6)	1.1 (1.7)	0.33 (0.51)	44 (55.0)	
II = 13.8-19.9%	31	83.9 (136.7)	23.9 (5.4)	463 (552)	19.1 (16.1)	7.0 (8.6)	1.1 (2.1)	0.38 (0.85)	13 (41.9)	
III = 20.0-39.9%	16	7.3 (7.0)	5.6 (2.0)	687 (417)	27.2 (19.8)	5.1 (4.8)	0.0 (0.0)	0.00 (0.00)	0 (0.0)	
IV = 40.0% or >	8	6.3 (3.5)	5.6 (1.6)	518 (318)	34.9 (40.7)	5.9 (5.7)	0.0 (0.0)	0.00 (0.00)	0 (0.0)	

Notes. PM_{2.5} = particulate matter with a median aerodynamic diameter of less than 2.5 microns; AM = arithmetic mean; SD = standard deviation; logPM_{2.5} = natural log transformed PM_{2.5} exponentiated; GM = geometric mean; GSD = geometric standard deviation; OD = occupant density = [(average number of people / room volume m³) * 100]; ASD = active smoker density = [(average number of lit cigarettes / room volume m³) * 100]; RUCC = rural urban continuum code; RUCC 1-3 = non-rural; RUCC 4-7 = semirural/urban; RUCC 7-8 = rural.

P* < .05; *P* < .01; ****P* < .001

^aGeometric mean & geometric standard deviation calculated by normal log transformation and exponentiation.

^b% of subcategory (example, not co-located venues = 2/29 = 6.90).

^cOne co-located restaurant not accessible during data collection.

^dPearson χ^2 for differences by observed smoking unless indicated otherwise

^eFisher's Exact test for differences by observed smoking

^fVenues may be included in one or more presence of law requiring smoke-free categories.

Appendix P

Additional Characteristics of Venues Required to be Smoke-free by Any Law by Co-location Status: North Dakota, 2012

	Not Co-located Restaurants n (%)	Not Co-located Bars, n (%)	Co-located Restaurants, n (%)	Total n (%)
n (%)	29 (41.4)	29 (41.4)	12 (17.1%)	70 (100.0)
Rurality (1- 9) ^a				
RUCC (1-3)	12 (31.6)	25 (65.8)	1 (2.6)	38 (100.0)
RUCC (4-7)	5 (45.5)	3 (27.3)	3 (27.3)	11 (100.0)
RUCC (8-9)	12 (57.1)	1 (4.8)	8 (38.1)	21 (100.0)
Total	29 (41.4)	29 (41.4)	12 (17.1)	70 (100.0)
Poverty category, % census tract ^b				
I = < 13.8	17 (58.6)	3 (10.3)	9 (31.0)	29 (100.0)
II = 13.8 – 19.9%	5 (29.4)	9 (52.9)	3 (17.6)	17 (100.0)
III = 20.0 – 39.9%	3 (18.8)	13 (81.2)	0 (0.0)	16 (100.0)
IV = 40.0 or >	4 (50.0)	4 (50.0)	0 (0.0)	8 (100.0)
Total	29 (41.4)	29 (41.4)	12 (17.1)	70 (100.0)

Notes. RUCC = rural urban continuum code.

^aPercent reflects within RUCC Code

^bPercent reflects within Poverty Category



A Rural Tobacco Smoke Pollution Study: A Legislative Summary

The Study

A random sample study of tobacco smoke pollution in 136 restaurants and bars throughout North Dakota was conducted in 2012 using a valid and reliable marker of secondhand smoke - particulate matter with a median aerodynamic diameter of less than 2.5 microns (PM_{2.5}).

Three aims of the study and the results are described.

Aim 1 was to describe a statewide baseline of the quantity of tobacco smoke pollution and the impact of specific factors on tobacco smoke pollution in hospitality venues.

Aim 2 was to compare statewide the quantity of tobacco smoke pollution in hospitality venues in completely rural, semi-rural/urban, and non-rural locations.

Aim 3 was to compare statewide the quantity of tobacco smoke pollution in hospitality venues and compliance of hospitality venues located within and outside of communities with a local ordinance requiring bars to be smoke-free.

The Results

Aim 1.

The average indoor tobacco smoke pollution level for all venues was 87.8 $\mu\text{g}/\text{m}^3$ and ranged from 1 $\mu\text{g}/\text{m}^3$ to 656 $\mu\text{g}/\text{m}^3$; these levels range from Good to Significant Harm according to the Air Quality Index (AQI). The AQI is the EPA's color-coded notification system designed to inform the public about the cleanliness of the outdoor air in relation to the standards and to provide health warnings with PM_{2.5} levels ranging from 0 to 500 $\mu\text{g}/\text{m}^3$ categorized as good to hazardous. A significant harm level (SHL) for levels at 500 $\mu\text{g}/\text{m}^3$ was recommended by the EPA in 2009 to indicate imminent and substantial endangerment to public health. The AQI, including the 2009 SHL, provide a tool to interpret indoor PM_{2.5} levels for this study.

Aim 1. (continued)

The below figure provides an overview of the tobacco smoke pollution levels and the AQI Category across the venues and the breakdown of venues sampled.

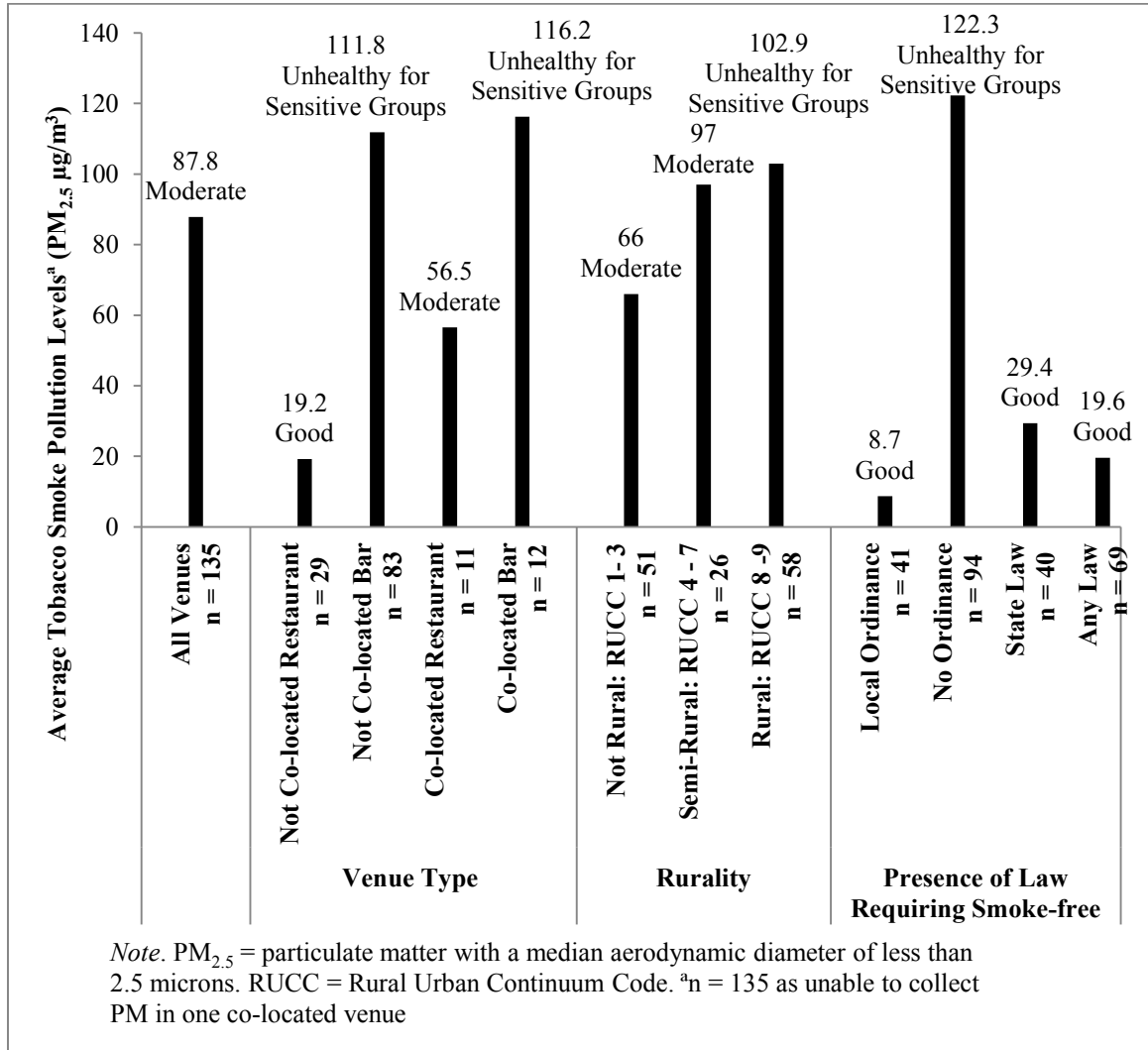


Figure 1. Average Tobacco Smoke Pollution (PM_{2.5} µg/m³) of Hospitality Venues: North Dakota, 2012

Aim 1. (continued)

The research indicated that smoke-free laws decreased tobacco smoke pollution with 69% of the effect being indirect. This is, smoke-free laws primarily decrease tobacco smoke pollution by influencing people's behaviors in the form of decreased observed smoking in hospitality venues. Additionally, the presence of a smoke-free law had a 31% direct impact on tobacco smoke pollution levels. The average tobacco smoke pollution level in venues without smoking observed was 90% lower than in venues where smoking was observed. The average tobacco smoke pollution level in restaurants was 74% lower than in bars. The highest level ($PM_{2.5} = 656 \mu\text{g}/\text{m}^3$) was in a bar where smoking was observed.

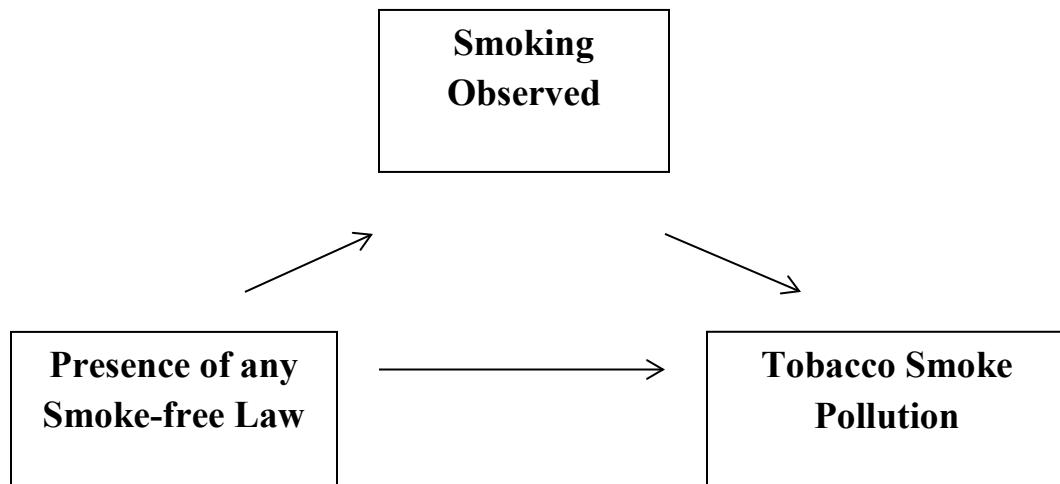


Figure 2. Partially Mediated Model of Variables Influencing Tobacco Smoke Pollution: ND, 2012

Aim 2. As rurality increased tobacco smoke pollution in bars increased significantly.

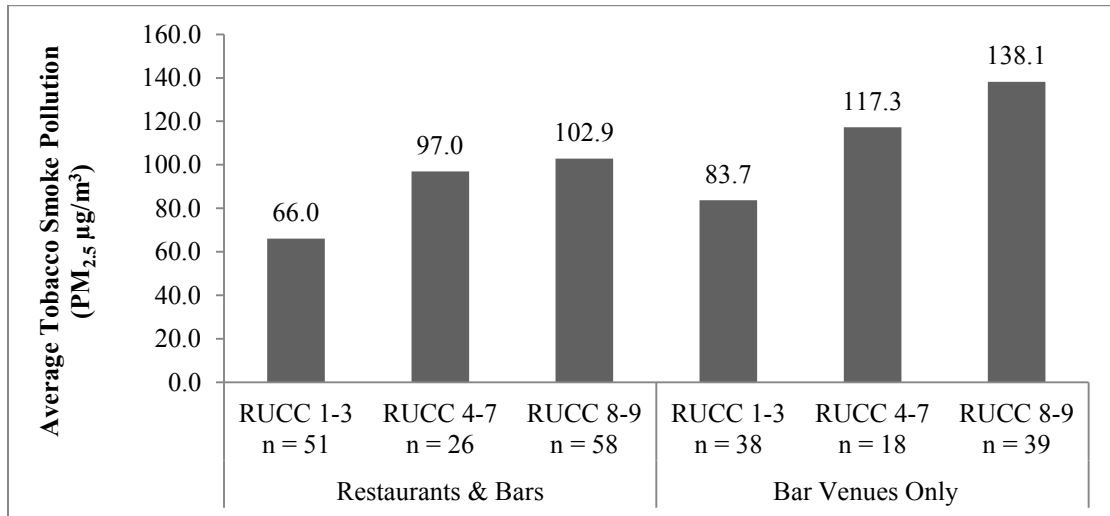


Figure 3. Average Tobacco Smoke Pollution (PM_{2.5}) by Rurality, ND 2012

Rurality was defined using the 2003 Rural Urban Continuum Codes (RUCC). RUCC 1-3 include non-rural counties; RUCC 4-7 are semi-rural/urban counties; and RUCC 8-9 are rural counties. The observed overall arithmetic average tobacco smoke pollution levels for restaurant and bars were 36% lower in non-rural (RUCC 1-3) than in rural (RUCC 8-9) venues. For bars only, the corresponding percentage difference in average levels was a 39% decrease. A significant association occurred between rurality and tobacco smoke pollution; bars in the combined semi-rural/urban (RUCC 4-7) rural counties (RUCC 8-9) had higher average levels of tobacco smoke pollution than non-rural counties (RUCC 1-3). Among restaurants only, however, no significant differences were found in tobacco smoke pollution levels by rurality. Thus, the impact of rurality on tobacco smoke pollution depends on the type of venue, affecting bars much more than restaurants. Restaurants, overall, have consistently low tobacco smoke pollution levels which seem to reflect compliance with smoke-free restaurant laws and the relatively uniform policy environment for restaurants across the state of ND. More rural bars have, in contrast, significantly higher tobacco smoke pollution levels than do non-rural bars. In sum, although rurality does not appear to affect tobacco smoke pollution levels in restaurants, there are substantial differences in tobacco smoke pollution in bars between non-rural venues (RUCC 1-3) and semirural/urban and rural combined venues (RUCC 4-8).

Aim 3:1. Average tobacco smoke pollution levels were lower in hospitality venues located within communities with local ordinances that required bars to be smoke-free, and thus more stringent than state law, than in venues located outside of communities with such an ordinance.

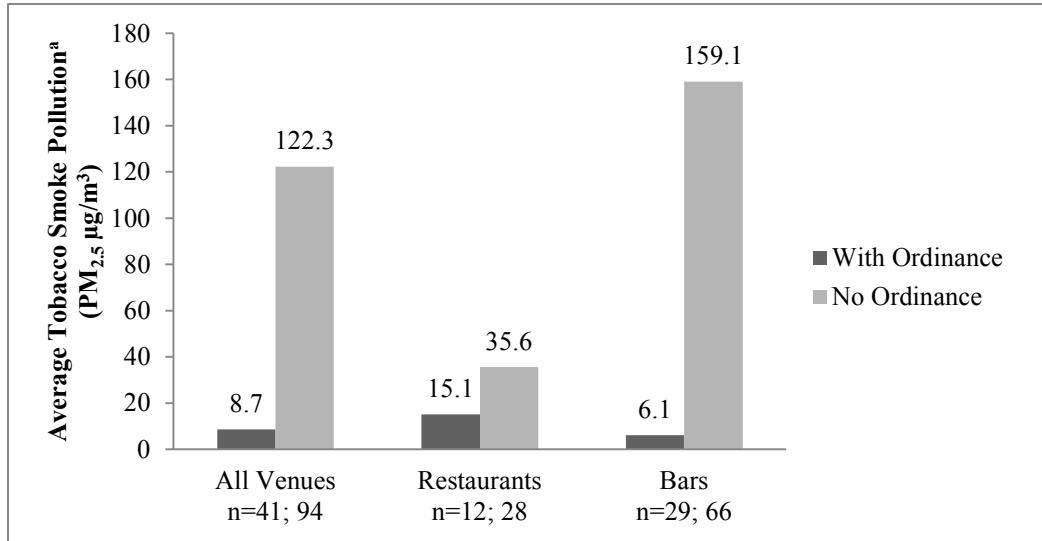


Figure 4. Average Tobacco Smoke Pollution (PM_{2.5}) by Presence of a Local Ordinance: ND, 2012

An interaction was identified, meaning the impact of local ordinances on tobacco smoke pollution levels varied by the type of venue. Average arithmetic tobacco smoke pollution levels were 96% lower in bars within communities with a local ordinance than in bars outside of a community with a local ordinance; this was a significant decrease. Although not significant, restaurants experienced an arithmetic average reduction of 58% in tobacco smoke pollution levels based upon being within or outside a community with a local ordinance. The lack of a significant reduction in tobacco smoke pollution levels in restaurants may be due to that the state law required all restaurants to be smoke-free; therefore presence of a local ordinance did not change the legal requirement for restaurants to be smoke-free.

Aim 3:2. The presence of a local ordinance requiring smoke-free bars significantly increased compliance and significantly decreased average tobacco smoke pollution levels.

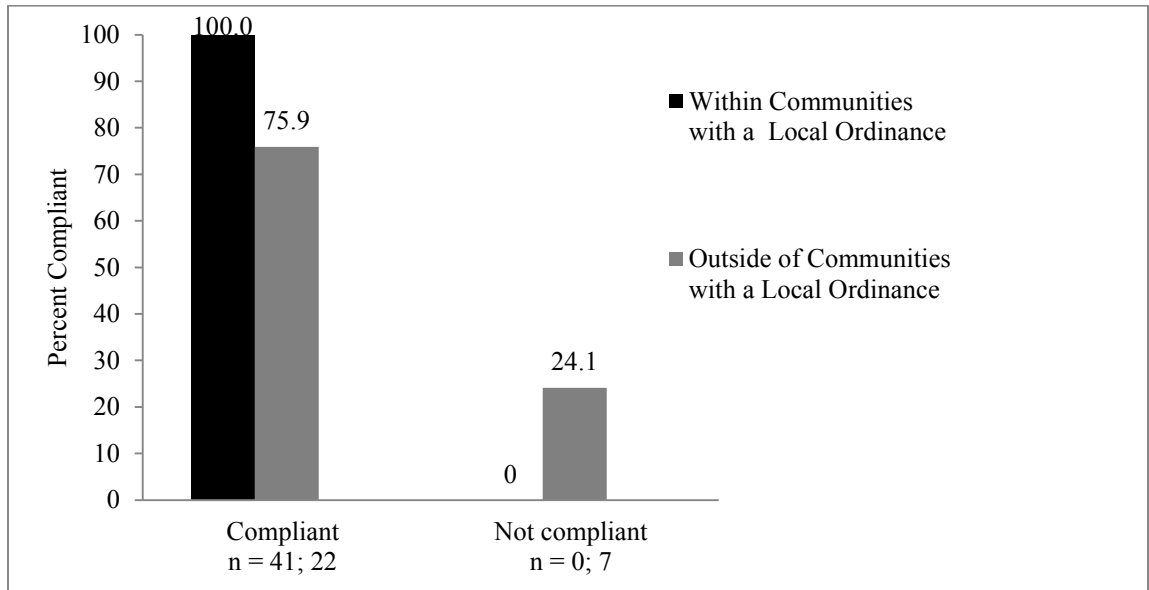


Figure 5. Compliance Rates, in Venues Required to be Smoke-Free by Any Law, by Presence of a Local Ordinance That Required Smoke-Free Bars: ND, 2012

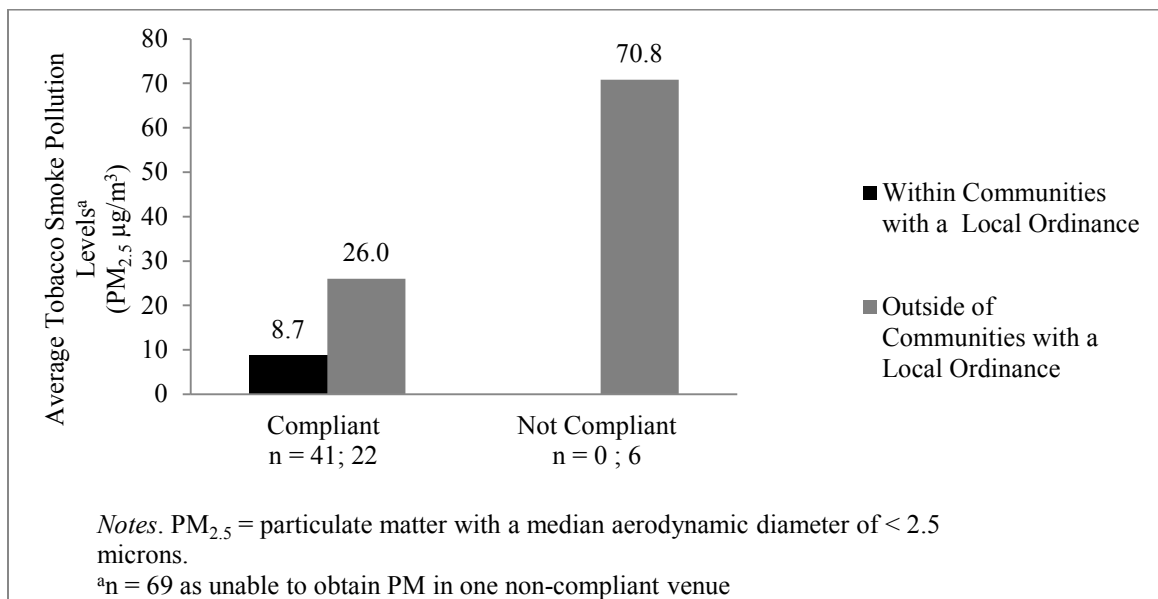


Figure 6. Tobacco Smoke Pollution Levels (PM_{2.5}) by Compliance, in Venues Required to be Smoke-Free by Any Law, by Presence of a Local Ordinance that Required Smoke-Free Bars: North Dakota, 2012

Aim 3:2. (continued)

The presence of a local ordinance increased compliance significantly. The highest compliance rates were *within* communities with local ordinances (100%); these venues also had significantly lower average tobacco smoke pollution levels ($PM_{2.5} = 8.7 \mu\text{g}/\text{m}^3$) than those outside such communities. Venues *outside* of communities with an ordinance had a lower compliance rate (76%); of those, the noncompliant venues had higher average tobacco smoke pollution levels ($PM_{2.5} = 70.8 \mu\text{g}/\text{m}^3$).

Venues *within* communities with a local ordinance, all of which were compliant, had 66.5% lower arithmetic average tobacco smoke pollution levels than did those *compliant* venues *outside* of communities with an ordinance. Venues *within* communities with a local ordinance, all of which were compliant, had 87.7% lower arithmetic average tobacco smoke pollution levels than did those *non-compliant* venues *outside* of communities with an ordinance. Of venues *outside* of communities with a local ordinance, *compliant* venues had 63.3% lower arithmetic average tobacco smoke pollution levels than did *noncompliant* venues.

Aim 3:3. Of venues required to be smoke-free by any law (n = 70), co-located venues had significantly decreased compliance and significantly increased average tobacco smoke pollution levels than did venues not co-located.

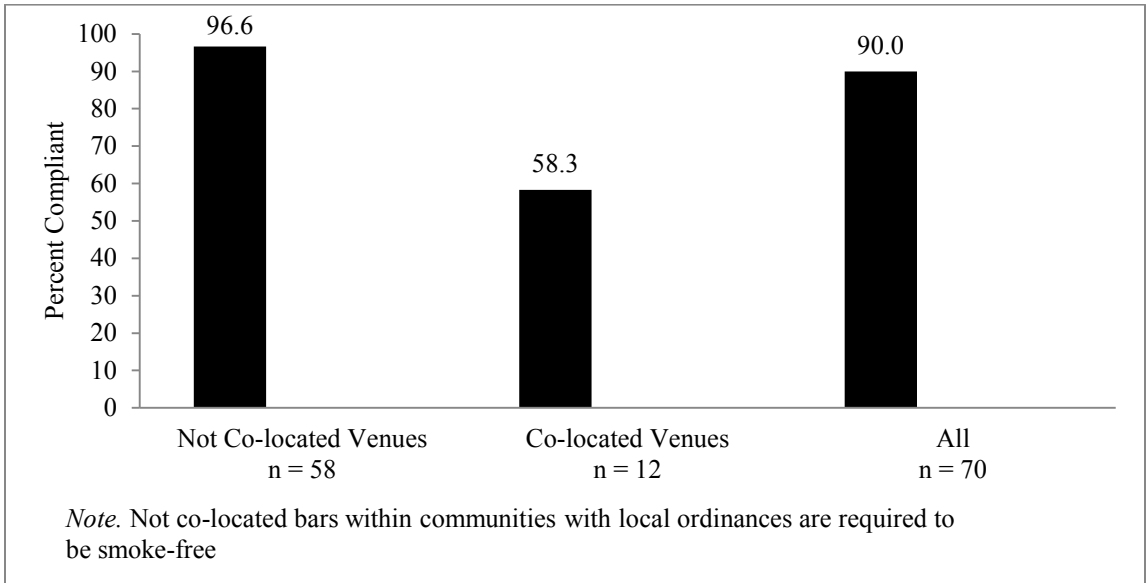


Figure 7. Compliance Rates, in Venues Required to be Smoke-Free by Any Law, by Venue Type and by Co-location Status: North Dakota, 2012

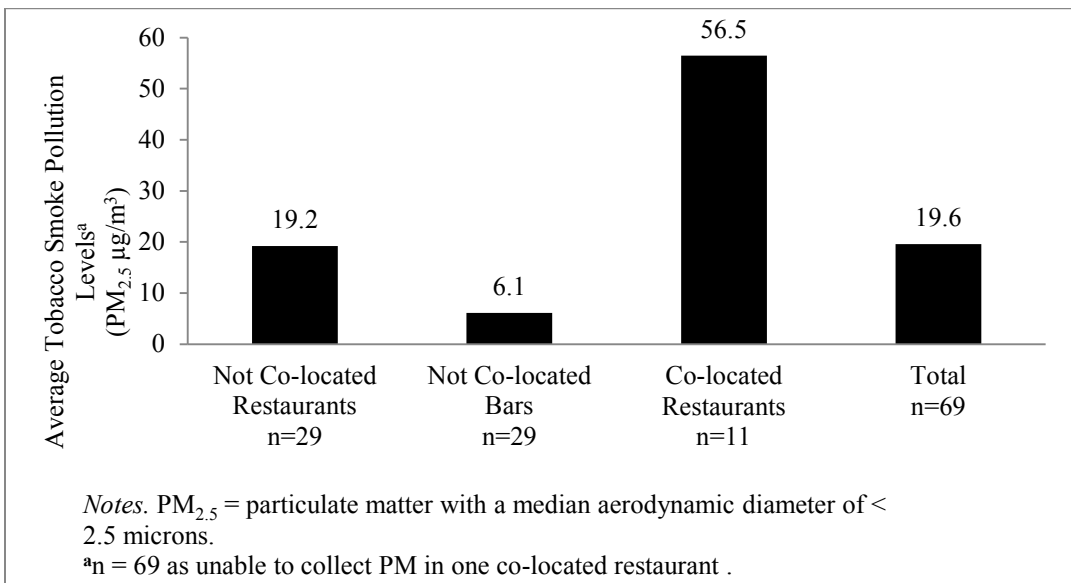


Figure 8. Tobacco Smoke Pollution (PM_{2.5} µg/m³), in Venues Required to be Smoke-Free by Any Law, by Venue Type and by Co-location Status: North Dakota, 2012

Aim 3:3. (continued)

Co-located venues had significantly decreased compliance and significantly higher average tobacco smoke pollution levels than did venues not co-located.

In comparing venues required by to smoke-free by any law, venues not co-located had high compliance rate (96.6%) and the lowest average tobacco smoke pollution levels ($PM_{2.5} = 9.5 \mu\text{g}/\text{m}^3$). In venues required to be smoke-free by any law and that were compliant with the law, those not co-located had 83.2% lower average tobacco smoke pollution levels than did those co-located.

Co-located venues had only a 58.3% compliance rate. Additionally, simply by being a co-located venue, whether compliant or not, average tobacco smoke pollution levels were high, ($PM_{2.5} = 56.7 \mu\text{g}/\text{m}^3$ and $56.0 \mu\text{g}/\text{m}^3$ respectively) compared to compliant not co-located venues ($PM_{2.5} = 9.5 \mu\text{g}/\text{m}^3$).

Perhaps the most noteworthy finding related to co-located venues was that in co-located venues, those that were compliant had 6 times higher tobacco smoke pollution levels than did the venues not co-located and compliant ($PM_{2.5} = 56.7\mu\text{g}/\text{m}^3$ and $9.5\mu\text{g}/\text{m}^3$ respectively).

Summary of Findings, Policy Implications, and Research Findings

Findings

1. This research indicated that smoke-free laws have both an indirect (60.1%) and direct (30.9%) effect on indoor tobacco smoke pollution levels. That is, smoke-free laws primarily decreased tobacco smoke pollution by influencing people's behaviors in the form of decreased observed smoking in the hospitality venues.
2. Observed smoking increased mean tobacco smoke pollution levels. Mean tobacco smoke pollution levels for venues without smoking observed was 90% lower than in venues where smoking was observed. The highest tobacco smoke pollution level ($PM_{2.5} = 656 \mu\text{g}/\text{m}^3$) was in a bar where smoking was observed.
3. As rurality increased, tobacco smoke pollution in bars significantly increased. Mean tobacco smoke pollution levels in non-rural bars were 39% lower than in rural bars.
4. Restaurants, overall, have consistently low mean tobacco smoke pollution levels which seem to reflect compliance with smoke-free restaurant laws and the relatively uniform policy environment for restaurants across the state of ND.
5. Although rurality does not appear to affect tobacco smoke pollution levels in restaurants, there are substantial differences in tobacco smoke pollution in bars between non-rural venues (RUCC 1-3) and semirural/urban and rural combined venues (RUCC 4-8).
6. Within communities with a local ordinance requiring bars to be smoke-free, bars experienced a significant reduction in mean tobacco smoke pollution levels. Although restaurants also experienced a reduction, it was not significant.
7. Compliance with smoke-free laws increased significantly in communities with a local ordinance requiring smoke-free bars. Hospitality venues within communities with local ordinances requiring smoke-free bars had the highest compliance rates and the lowest average tobacco smoke pollution levels.
8. Compliance with smoke-free laws decreased significantly in venues that were co-located. Even in compliant co-located venues, the average tobacco smoke pollution levels were 6 times higher than in venue not co-located and compliant. Decreased compliance of co-located venues was not a new finding in ND.

Policy Implications

1. Smoke-free laws decreased the average level of tobacco smoke pollution mostly through influencing people's behaviors in the form of decreased observed smoking in hospitality venues (Aim 1).
2. Smoke-free laws in and of themselves were associated with decreased tobacco smoke pollution in hospitality venues (Aim 1).
3. When smoking is observed, it increased mean tobacco smoke pollution levels; thus compliance with smoke-free laws is needed to effectively decrease tobacco smoke pollution levels (Aim 1).
4. Observation of smoking may be sufficient to determine the effectiveness of smoke-free laws in decreasing exposure to tobacco smoke pollution, negating the necessity of expensive and time consuming studies using equipment to measure tobacco smoke pollution (Aim 1).
5. As an issue of social justice, a continuing recognition of disparities in exposure to tobacco smoke pollution in rural areas is needed (Aim 2).
6. Policymakers need to continue to be informed that when smoking is allowed, especially in areas with smaller populations, adverse role modeling and social norming occurs (Aim 2).
7. Local ordinances requiring smoke-free hospitality venues may enhance the positive influence of statewide smoke-free laws in terms of tobacco smoke exposure and compliance (Aim 3).
8. Co-location of venues that allow smoking significantly decreases compliance and appears to increase tobacco smoke exposure; therefore venues should be completely smoke-free to assure the highest protection against tobacco smoke exposure (Aim 3).
9. Any law permitting co-located venues to allow smoking should mandate studies of tobacco smoke pollution levels to inform future policy decisions (Aim 3).

Research Recommendations

1. Future studies need to be conducted to determine whether the mediation model is an isolated finding for North Dakota or if it can be replicated (Aim 1).
2. Additional studies of tobacco smoke exposure and policy impact in rural areas are needed. Specifically, as this was the first study that compared rural and non-rural venues and as the number of venues in semi-rural areas was limited in this study, greater sampling of semi-rural venues will be important to include in future proposals. (Aim 2).
3. Studies of successful policy strategies adapted to rural cultures are needed to inform tobacco policy advocates on best practices to collaborate with people in rural areas to increase coverage of rural populations by smoke-free laws (Aim 2).
4. Further investigation of the interaction effect of local ordinances and types of venue on tobacco smoke pollution levels is needed to determine if it can be replicated (Aim 3).
5. Further exploration of the dynamics of the interaction effect and the differences in tobacco smoke pollution levels occurring is needed when a local smoke-free law is passed even if a statewide smoke-free law is in place (Aim 3).
6. Studies in rural areas on the presence of local laws increasing compliance with state laws with a potential corresponding decrease in tobacco smoke exposure should be investigated (Aim 3).

Study conducted by Kelly Buettner-Schmidt, PhD, RN, Healthy Communities International, Minot State University. A doctoral dissertation with funding from the Robert Wood Johnson Foundation Nursing and Health Policy Collaborative at the University of New Mexico (grant 60128) and the North Dakota Center for Tobacco Prevention and Control Policy.



A Rural Tobacco Smoke Pollution Study: One Page Handout

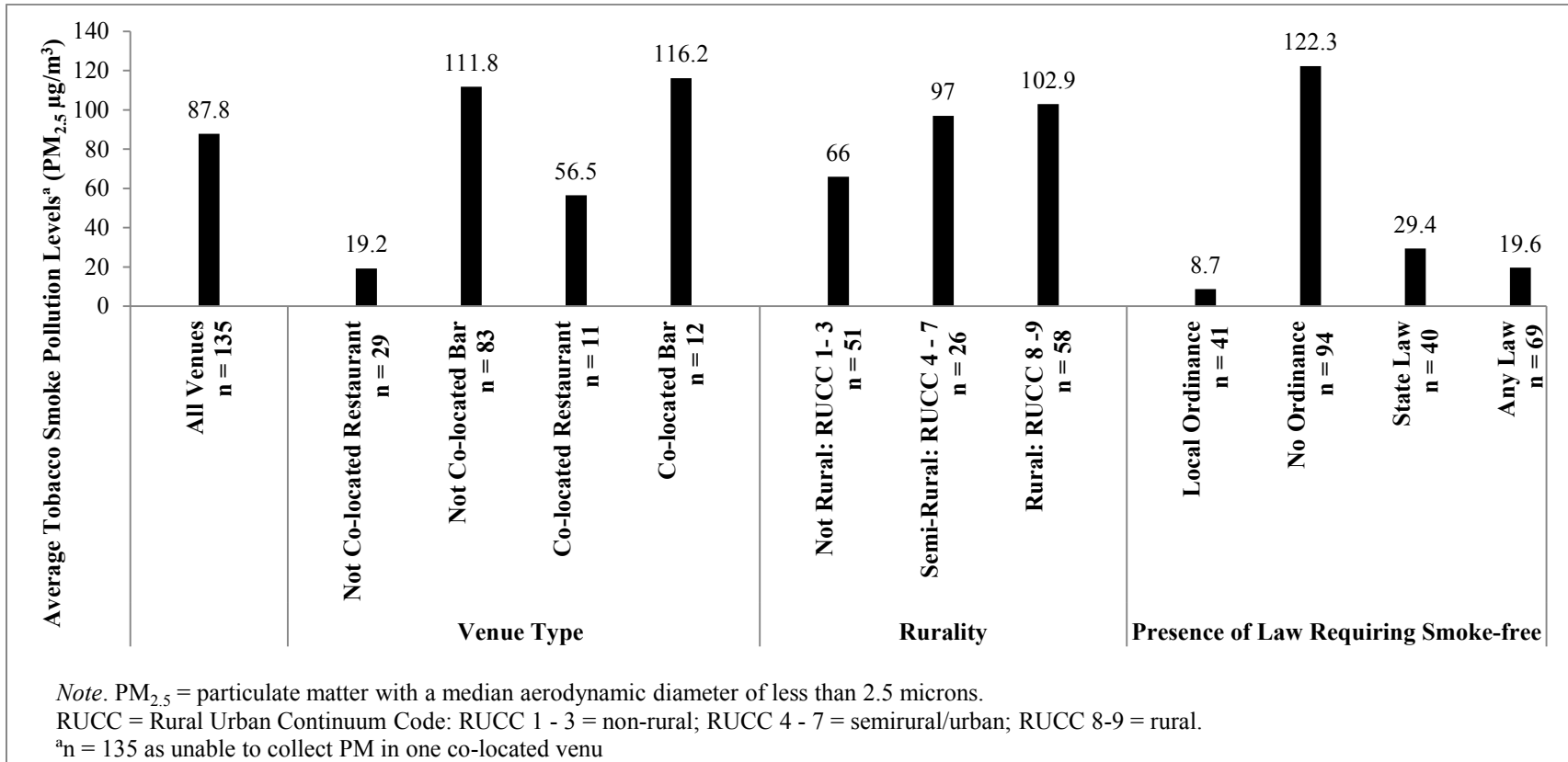


Figure 9. Average Tobacco Smoke Pollution Levels (PM_{2.5} µg/m³) of Hospitality Venues: North Dakota, 2012

Study conducted by Kelly Buettner-Schmidt, PhD, RN, Healthy Communities International, Minot State University. A doctoral dissertation with funding from the Robert Wood Johnson Foundation Nursing and Health Policy Collaborative at the University of New Mexico (grant 60128) and the North Dakota Center for Tobacco Prevention and Control Policy.

Appendix R

ND Century Code 23-12-09 through 23-12-11 as Passed November 2012

CHAPTER 23-12 PUBLIC HEALTH, MISCELLANEOUS PROVISIONS

23-12-09. Smoking in public places and places of employment - Definitions.

In sections 23-12-09 through 23-12-11, unless the context or subject matter otherwise requires:

1. "Bar" means a retail alcoholic beverage establishment licensed under chapter 5-02 that is devoted to the serving of alcoholic beverages for consumption by guests on the premises and in which the serving of food is only incidental to the consumption of those beverages. The term includes a bar located within a hotel, bowling center, restaurant, or other establishment that is not licensed primarily or exclusively to sell alcoholic beverages.
2. "Business" means a sole proprietorship, partnership, association, joint venture, corporation, or other business entity, either for profit or not for profit, including retail establishments where goods or services are sold and professional corporations and other entities where professional services are delivered.
3. "E-cigarette" means any electronic oral device, such as one composed of a heating element and battery or electronic circuit, or both, which provides a vapor of nicotine or any other substances, and the use or inhalation of which simulates smoking. The term shall include any such device, whether manufactured, distributed, marketed, or sold as an e-cigarette, e-cigar, and e-pipe or under any other product, name, or descriptor.

4. "Employee" means an individual who is employed by an employer in consideration for direct or indirect monetary wages or profit, or an individual who volunteers services for an employer.

5. "Employer" means an individual, business, or private club, including a municipal corporation or trust, or the state and its agencies and political subdivisions that employs the services of one or more individuals.

6. "Enclosed area" means all space between a floor and ceiling that has thirty-three percent or more of the surface area of its perimeter bounded by opened or closed walls, windows, or doorways. A wall includes any physical barrier regardless of whether it is opened or closed, temporary or permanent, or contains openings of any kind, and includes retractable dividers and garage doors.

7. "Health care facility" means any office or institution providing health care services or treatment of diseases, whether physical, mental or emotional, or other medical, physiological or psychological conditions. Some examples of health care facilities include hospitals; clinics; ambulatory surgery centers; outpatient care facilities; weight control clinics; nursing homes; homes for the aging or chronically ill; nursing, basic, long-term, or assisted living facilities; laboratories; and offices of any medical professional licensed under title 43, including all specialties and subspecialties in those fields. This definition shall include all waiting rooms, hallways, private rooms, semiprivate rooms, wards within health care facilities, and any mobile or temporary health care facilities.

8. "Health care services" means services provided by any health care facility.

Some examples of health care services are medical, surgical, dental, vision, chiropractic, psychological, and pharmaceutical services.

9. "Place of employment" means an area under the control of a public or private employer, including work areas, auditoriums, classrooms, conference rooms, elevators, employee cafeterias, employee lounges, hallways, meeting rooms, private offices, restrooms, temporary offices, vehicles, and stairs. A private residence is not a place of employment unless it is used as a licensed child care, adult day care, or health care facility.

10. "Public place" means an area which the public enters. Some examples of public places are publicly owned buildings, vehicles, or offices; bars; bingo facilities; gambling and gaming facilities as defined in section 12.1-28-01; child care and adult day care facilities subject to licensure by the department of human services, including those operated in private homes; convention facilities; educational facilities, both public and private; facilities primarily used for exhibiting a motion picture, stage, drama, lecture, musical recital, or other similar performance; financial institutions; health care facilities; hotels and motels, including all rooms that are rented to guests; laundromats; any common areas in apartment buildings, condominiums, mobile home parks, retirement facilities, nursing homes, and other multiple-unit residential facilities; private and semiprivate nursing home rooms; museums, libraries, galleries, and aquariums; polling places; professional offices; public transportation facilities, including buses, trains, airplanes and similar aircraft, taxicabs and similar vehicles such as

towncars and limousines when used for public transportation, and ticket, boarding, and waiting areas of public transit facilities, including bus and train stations and airports; reception areas; restaurants; retail food production and marketing establishments; retail service establishments; retail stores, including tobacco and hookah establishments; rooms, chambers, places of meeting or public assembly, including school buildings; shopping malls; sports arenas; theaters; and waiting rooms.

11. "Publicly owned building, vehicle, or office" means a place or vehicle owned, leased, or rented by any state or political subdivision, or by any agency supported by appropriation of, or by contracts or grants from, funds derived from the collection of taxes.

12. "Restaurant" includes every building or other structure, or any part thereof, and all buildings in connection therewith that are kept, used, maintained, advertised, or held out to the public as a place where food is served. Some examples of restaurants include coffee shops, cafeterias, sandwich stands, private and public school cafeterias, kitchens, and catering facilities in which food is prepared on the premises for serving elsewhere, and a bar area within a restaurant.

13. "Shopping mall" means an enclosed public walkway or hall area that serves to connect retail or professional businesses.

14. "Smoking" means inhaling, exhaling, burning, or carrying any lighted or heated cigar, cigarette, or pipe, or any other lighted or heated tobacco or plant product intended for inhalation, in any manner or in any form. Smoking also includes the use of an ecigarette which creates a vapor, in any manner or any

form, or the use of any oral smoking device for the purpose of circumventing the prohibition of smoking in this Act.

15. "Sports arena" means an indoor or outdoor place where members of the public assemble to engage in physical exercise, participate in athletic competition, or witness sports or other events. Some examples of sports arenas include sports pavilions, stadiums, gymnasiums, health spas, boxing arenas, swimming pools, roller and ice rinks, and bowling centers.

23-12-10. Smoking restrictions - Exceptions - Retaliation - Application.

1. In order to protect the public health and welfare and to recognize the need for individuals to breathe smoke-free air, smoking is prohibited in all enclosed areas of:

- a. Public places; and
- b. Places of employment.

2. Smoking is prohibited within twenty feet [6.10 meters] of entrances, exits, operable windows, air intakes, and ventilation systems of enclosed areas in which smoking is prohibited. Owners, operators, managers, employers, or other persons who own or control a public place or place of employment may seek to rebut the presumption that twenty feet [6.10 meters] is a reasonable minimum distance by making application to the director of the local health department or district in which the public place or place of employment is located. The presumption will be rebutted if the applicant can show by clear and convincing evidence that, given the unique circumstances presented by the location of entrances, exits, windows that open, ventilation intakes, or other factors, smoke will not infiltrate or reach

the entrances, exits, open windows, or ventilation intakes or enter into such public place or place of employment and, therefore, the public health and safety will be adequately protected by a lesser distance.

3. The following areas are exempt from subsections 1 and 2:

a. Private residences, except those residences used as a child care, adult day care, or health care facility subject to licensure by the department of human services.

b. Outdoor areas of places of employment, except those listed in subsection 2.

c. Any area that is not commonly accessible to the public and which is part of an owner-operated business having no employee other than the owner-operator.

4. Smoking as part of a traditional American Indian spiritual or cultural ceremony is not prohibited.

5. No person or employer shall discharge, refuse to hire, or in any manner retaliate against an employee, applicant for employment, or other person because that person asserts or exercises any rights afforded by this section or reports or attempts to prosecute a violation of this section. An employee who works in a setting where an employer allows smoking does not waive or surrender any legal rights the employee may have against the employer or any other party. Violations of this subsection shall be a class B misdemeanor.

6. This section may not be interpreted or construed to permit smoking where it is otherwise restricted by other applicable laws.

7. Notwithstanding any other provision of this chapter, an owner, operator, manager or other person in control of an establishment, facility, or outdoor area may declare that entire establishment, facility, or outdoor area as a nonsmoking place.

23-12-10.1. Responsibility of proprietors.

Repealed by S.L. 2005, ch. 239, § 7.

23-12-10.2. Complaints and enforcement - City and county ordinances and home rule charters.

1. State agencies with statutory jurisdiction over a state-owned building or office shall enforce section 23-12-10. These agencies include the fire marshal department, state department of health, department of human services, legislative council, and office of management and budget.

2. A city or county ordinance, a city or county home rule charter, or an ordinance adopted under a home rule charter may not provide for less stringent provisions than those provided under sections 23-12-09 through 23-12-11. Nothing in this Act shall preempt or otherwise affect any other state or local tobacco control law that provides more stringent protection from the hazards of secondhand smoke.

This subsection does not preclude any city or county from enacting any ordinance containing penal language when otherwise authorized to do so by law.

3. The provisions of this Act shall be enforced by state's attorneys who may ask the North Dakota attorney general to adopt administrative rules to ensure compliance with this Act. State and local law enforcement agencies may apply for injunctive relief to enforce provisions of this Act.

23-12-10.3. Exceptions - Medical necessity.

Repealed by I.M. approved November 6, 2012, S.L. 2013, ch. _____.

23-12-10.4. Responsibility of proprietors.

The owner, operator, manager, or other person in control of a public place or place of employment where smoking is prohibited by this Act shall:

1. Clearly and conspicuously post no smoking signs or the international no smoking symbol in that place.
2. Clearly and conspicuously post at every entrance to that place a sign stating that smoking is prohibited.
3. Clearly and conspicuously post on every vehicle that constitutes a place of employment under this Act at least one sign, visible from the vehicle's exterior, stating that smoking is prohibited.
4. Remove all ashtrays from any area where smoking is prohibited, except for ashtrays displayed for sale and not for use on the premises.
5. By December 6, 2012, communicate to all existing employees and to all prospective employees upon their application for employment that smoking is prohibited in that place.
6. For places under his or her control, direct a person who is smoking in violation of this Act to extinguish the product being smoked. If the person does not stop smoking, the owner, operator, manager, or employee shall refuse service and shall immediately ask the person to leave the premises. If the person in violation refuses to leave the premises, the owner, operator, manager, or employee shall immediately report the violation to an enforcement agency identified in this Act.

The refusal of the person to stop smoking or leave the premises in response to requests made under this section by an owner, operator, manager, or employee shall not constitute a violation of the Act by the owner, operator, manager, or employee.

23-12-10.5. Construction and severability.

This Act shall be construed liberally so as to further its purposes. The provisions of this Act are declared to be severable. If any provision, clause, sentence, or paragraph of this Act, or its application to any person or circumstances, shall be held invalid, that invalidity shall not affect the other provisions of this Act that can be given without the invalid provision or applications.

23-12-11. Penalty.

1. An individual who smokes in an area in which smoking is prohibited under section 23-12-10 is guilty of an infraction punishable by a fine not exceeding fifty dollars.
2. Except as otherwise provided in subsection 5 of section 23-12-10, an owner or other person with general supervisory responsibility over a public place or place of employment who willfully fails to comply with section 23-12-10 is guilty of an infraction, subject to a fine not to exceed one hundred dollars for the first violation, to a fine not to exceed two hundred dollars for a second violation within one year, and a fine not to exceed five hundred dollars for each additional violation within one year of the preceding violation.
3. In addition to the fines established by this section, violation of this Act by a person who owns, manages, operates, or otherwise controls a public place or

place of employment may result in the suspension or revocation of any permit or license issued to the person for the premises on which the violation occurred.

4. Violations of this Act are declared to be a public nuisance that may be abated by restraining order, preliminary or permanent injunction, or other means provided by law.

5. Each day on which a violation of this Act occurs shall be considered a separate and distinct violation.