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Editorial Board

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Editorial

Tobacco Use Patterns

Timothy A. McAfee[1] and Judy Kruger[2]

[1] *Office on Smoking and Health, NCCDPHP, CDC, 4770 Buford Highway, MS-K50, Atlanta, GA 30341, USA*
[2] *Epidemiology Branch, Office on Smoking and Health, NCCDPHP, CDC, 4770 Buford Highway, MS-K50, Atlanta, GA 30341, USA*

Correspondence should be addressed to Judy Kruger, jkruger@cdc.gov

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The use of combustible tobacco products (e.g., cigarettes, cigars, pipe, bidis, kreteks, and hookah) among adults remains widespread around the world. Unless dramatic progress is made diminishing the initiation and increasing cessation of combustible tobacco product use, a billion preventable deaths will occur in the 21st century [1]. These deaths will be accompanied by unimaginable human suffering and unaffordable economic loss from both preventable healthcare expenditures and loss of productivity from early death and disease. Health risks not only impact the smoker, but also hundreds of millions of individuals who inhale secondhand smoke from combustible tobacco products. In addition to the risks associated with smoking tobacco products, there are important concerns associated with the use of noncombustible tobacco products (e.g., chew, dip, snus, Gutka, and Ikmik). Concerns include both direct health effects from high-toxicant products, particularly in Southern Asia that account for the majority of global noncombustible use and the impact of dual use of noncombustible products with smoked tobacco products [2, 3]. This is a pattern being seen in youth, young adults [4, 5], and adults in the United States (as in the paper of R. McMillen et al. "*Use of emerging tobacco products in the United States*"), potentially increasing initiation and prolonging smoking.

In order to successfully tackle the immense challenges ahead, it is critical that public health workers and others committed to eradicating the harm caused by the tobacco epidemic have a full understanding of what is actually happening. Questions need to be answered such as: How are tobacco use patterns evolving? How are changes in the design of tobacco products impacting health outcomes? How are emerging tobacco products being marketed? and, How is their use impacting the use of combustible tobacco products? Which tobacco control policies and interventions work for different populations and use patterns? Few health risks have received as much attention from researchers and policy makers as the use of tobacco products. Articles recently published in the Journal of Environmental and Public Health can inform health policy decisions in several ways: by providing information on specific populations who use these products, by targeting interventions to products and users, and by identifying and characterizing emerging products developed and marketed by the tobacco industry. Scientific research, surveillance, and evaluation are valuable tools for informing health policy decisions because they can identify the introduction of new products, offer insight as to the prevalence of use of those products, and provide information on the effectiveness of specific interventions and tobacco control policy.

In the United States, 15.8% of high school students [6] and 19.3% of adults smoke cigarettes [7]. Attention to the marketing of new tobacco products and combinations of use of these products is essential to ending the tobacco epidemic. Current tobacco use trend indicators may provide insufficient information as the tobacco industry innovates its products and strategies. For example, a primary indicator of progress in the tobacco epidemic has been the prevalence of cigarette smoking and cigarette consumption. However, because of differences in taxation between cigarettes and other combustible products and lack of FDA authority to regulate flavoring and other product characteristics of cigars and pipe tobacco, consumption and prevalence of use of cigars and pipe tobacco (used in roll-your-own cigarettes) is increasing dramatically [8, 9]. An over-estimation of

progress in tobacco control, particularly among youth and young adults, would result if we do not pay appropriate attention to increases in use of these other tobacco products.

Another example highlighted in this issue in the paper by R. Sacks et al. "Exploring the next frontier for tobacco control: nondaily smoking among New York city adults" is a trend towards decreased consumption of cigarettes among smokers, resulting from both an increase in nondaily smoking and a decrease in the average number of cigarettes smoked per day. How is this trend evolving? What population groups are most affected? Have risk perceptions altered, including the perception of being a smoker? Conversely, there is concern that the percent of the smoking population with significant mental health or substance abuse disorders is increasing [10], but this information is less routinely collected in surveys. What are the implications of these trends for clinical interventions, media and education campaigns, and public policy approaches that were designed and tested in a time when most people who smoked did so daily, smoked a pack of cigarettes or more a day, and where people who had mental health and substance abuse disorders were often excluded from studies?

Federal and state tobacco control efforts will benefit greatly from the information provided by studies such as those found within this special issue, especially given the new potential of regulatory action to profoundly diminish the death, disease, and suffering caused by tobacco use. With the authority to regulate toxicant exposure, including potentially requiring the lowering of nicotine content to nonaddictive levels, major alterations in the tobacco product marketplace are possible, especially if combined with proven nonregulatory tobacco control interventions such as raising the price of tobacco products, eliminating secondhand smoke exposure, fully funding tobacco control programs (including high-impact tobacco control mass media campaigns), and barrier-free access to quit help for those who want it. However, while this new path presents opportunity, it is also fraught with challenges and even peril. The role of broad-spectrum research ranging from surveillance, to laboratory studies, to market research is essential to help evaluate the impact, as well as monitor for unanticipated consequences of these interventions, which will help guide policy evolution and provide needed support for the regulatory process.

The goal of this special issue is to educate the readership of the Journal of Environmental and Public Health about emerging tobacco products and their patterns of use and to stimulate research in tobacco control. Through these and other papers, we hope to provide information that will eventually have an impact on reducing the number of tobacco users and help those who use it to quit. The list of topics is broad and impressive; the studies cover a wide range of areas: prevalence; secondhand smoke exposure; dual use; smoking cessation efforts; and product design.

Disclosure

The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Conflict of Interests

There is no conflicts of interests.

Timothy A. McAfee
Judy Kruger

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Review Article

Impact of Tobacco Control Interventions on Smoking Initiation, Cessation, and Prevalence: A Systematic Review

Lisa M. Wilson,[1] Erika Avila Tang,[2,3] Geetanjali Chander,[1] Heidi E. Hutton,[4] Olaide A. Odelola,[5] Jessica L. Elf,[2,3] Brandy M. Heckman-Stoddard,[6] Eric B. Bass,[1,7] Emily A. Little,[1] Elisabeth B. Haberl,[1] and Benjamin J. Apelberg[2,3]

[1] *Division of General Internal Medicine, Johns Hopkins University School of Medicine, Baltimore, MD 21205, USA*
[2] *Department of Epidemiology, Institute for Global Tobacco Control, Johns Hopkins University Bloomberg School of Public Health, Baltimore, MD 21205, USA*
[3] *Department of Health, Behavior and Society, Institute for Global Tobacco Control, Johns Hopkins University Bloomberg School of Public Health, Baltimore, MD 21205, USA*
[4] *Department of Psychiatry and Behavioral Sciences, Johns Hopkins University School of Medicine, Baltimore, MD 21287, USA*
[5] *Department of Internal Medicine, Albert Einstein Medical Center, Philadelphia, PA 19141, USA*
[6] *Cancer Prevention Fellowship Program, Division of Cancer Prevention, National Cancer Institute, Bethesda, MD 20892, USA*
[7] *Department of Health Policy and Management, Johns Hopkins University Bloomberg School of Public Health, Baltimore, MD, USA*

Correspondence should be addressed to Lisa M. Wilson, lisawilson@jhmi.edu

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Background. Policymakers need estimates of the impact of tobacco control (TC) policies to set priorities and targets for reducing tobacco use. We systematically reviewed the independent effects of TC policies on smoking behavior. *Methods*. We searched MEDLINE (through January 2012) and EMBASE and other databases through February 2009, looking for studies published after 1989 in any language that assessed the effects of each TC intervention on smoking prevalence, initiation, cessation, or price participation elasticity. Paired reviewers extracted data from studies that isolated the impact of a single TC intervention. *Findings*. We included 84 studies. The strength of evidence quantifying the independent effect on smoking prevalence was high for increasing tobacco prices and moderate for smoking bans in public places and antitobacco mass media campaigns. Limited direct evidence was available to quantify the effects of health warning labels and bans on advertising and sponsorship. Studies were too heterogeneous to pool effect estimates. *Interpretations*. We found evidence of an independent effect for several TC policies on smoking prevalence. However, we could not derive precise estimates of the effects across different settings because of variability in the characteristics of the intervention, level of policy enforcement, and underlying tobacco control environment.

1. Introduction

Tobacco smoking is one of the leading causes of preventable death, responsible for over 5 million deaths annually [1]. Currently, more than 1 billion people smoke, with over 80% living in low- and middle-income countries [2]. However, countries are at different stages of the tobacco epidemic [3]. Many countries have achieved substantial declines in smoking and tobacco-related disease through the implementation of comprehensive tobacco control programs, while others are experiencing increases in smoking prevalence. Tobacco control efforts have evolved over time as evidence has grown to support the use of different approaches. The population-based approaches most commonly used have included increased taxes, public education through mass media campaigns and health warnings, tobacco marketing restrictions, and the introduction of smoke-free indoor environments.

With the introduction of the World Health Organization's (WHO) Framework Convention on Tobacco Control (FCTC) [4] and MPOWER (Monitor, Protect, Offer, Warn, Enforce, Raise) policy package [5], tobacco control policies

are being implemented worldwide. To model the impacts of these policies and develop achievable targets for smoking prevalence, policy makers need estimates of the independent effects of interventions on smoking behavior. We performed a systematic review to evaluate the independent effect on smoking prevalence of four tobacco control policies outlined in the WHO MPOWER Package [5]: increasing taxes on tobacco products, banning smoking in public places, banning advertising and sponsorship of tobacco products, and educating people through health warning labels and antitobacco mass media campaigns (Table 1). We focused on the degree of certainty in the estimated impact and factors that may influence the impact.

2. Methods

2.1. Study Design and Scope. For our systematic review of published studies, smoking was defined as the use of cigarettes and/or other smoked products, such as cigars, cigarillos, bidis, hookahs, water pipes, and kreteks. We excluded smokeless tobacco products. Outcomes of interest were smoking prevalence, initiation or cessation rates, and price participation elasticity (PPE) (the relative percentage change in smoking prevalence for every 1% change in price). We excluded outcomes such as quit attempts or tobacco consumption because they did not directly address the impact of interventions on smoking prevalence.

2.2. Search Strategy. We searched five databases: MEDLINE (accessed via PubMed, January 1950 through January 2012), EMBASE (January 1974 through February 2009), The Cochrane Library (Issue 1, 2009), the Cumulative Index to Nursing and Allied Health Literature (CINAHL, January 1982 through February 2009), and PsycInfo (from inception through February 2009). Our electronic search strategy used medical subject headings and text words for smoking and the tobacco control interventions and was limited to human subjects (see the appendix for the MEDLINE search string). We reviewed recent issues of ten economics and public health journals, reference lists of included articles, relevant reviews, books, and reports.

2.3. Study Selection. Two reviewers independently assessed titles, abstracts, and articles for inclusion. We included peer-reviewed studies published in any language that: measured smoking prevalence, initiation, cessation, or PPE; assessed the independent effects of at least one of the tobacco control interventions; met our study design criteria (Table 1). Because modeling approaches typically require estimates of independent effects, we excluded studies evaluating multicomponent interventions. Studies published prior to 1990 were excluded because the smoking population may have changed over time. Conflicts on eligibility were resolved through consensus.

2.4. Data Extraction. Reviewers used a Web-based system to extract data from eligible studies on study design, interventions, and smoking prevalence. Extracted data were checked by a second reviewer. Study quality was assessed independently by two reviewers.

We were unable to conduct meta-analyses because of the heterogeneity of the studies. Instead, we prepared a qualitative summary of results by intervention type and highlighted key sources of heterogeneity.

2.5. Grading of Evidence. We graded the quantity, quality, and consistency of results based on the GRADE working group criteria [6]. "High" strength of evidence indicates high confidence that the evidence reflects the true effect, and further research is very unlikely to change the result. "Moderate" strength of evidence indicates moderate confidence that the evidence reflects the true effect, and further research may change the result. "Low" strength of evidence indicates low confidence that the evidence reflects the true effect, and further research is likely to change the result. An "insufficient" grade indicates that no evidence was available to quantify the independent effect.

2.6. Role of the Funding Source. The International Union Against Tuberculosis and Lung Disease suggested the topic, but was not involved in the collection, analysis, and interpretation of the data, or in the writing of the paper. The authors retained full control over the conduct and reporting of the paper.

3. Results

3.1. Search Results. From our search of 20,102 unique citations, we included 84 studies (88 publications) (Figure 1). Thirty-five evaluated taxation, 29 evaluated smoking bans, 5 evaluated advertising or sponsorship bans, 4 evaluated health warning labels, and 19 evaluated mass media campaigns. Twelve studies assessed smoking initiation (11 among youths), 25 assessed smoking cessation (4 among youths), and 52 (19 among youths) assessed smoking prevalence. Eight studies were conducted in low- and middle-income countries. The overall summary of the evidence for these interventions is presented in Table 2.

3.2. Increasing Taxes on Tobacco Products. We found high strength of evidence to quantify the impact of increases in tobacco pricing. The PPEs ranged from -1.41 to -0.10 (interpreted as a 1–14% decrease in smoking prevalence for every 10% increase in price) among youths and -0.45 to 0.10 among adults. The larger PPE for youths is consistent with prior evidence that young people are more price sensitive due to lower levels of disposable income.

3.2.1. Youths. Five [7–11], one [12], and nine studies [13–21] evaluated the impact of increased taxes on smoking initiation, cessation, and prevalence among youths, respectively (Table 3). All but four [8, 15, 16, 19] were conducted in the US. One study was conducted among youths in 17 low- and middle-income countries [15]. Of the five studies examining smoking initiation, four found a statistically significant negative association with increasing taxes/prices

Table 1: Definitions of the tobacco control interventions.

Key question	Intervention definition	Study design criteria
Taxation	Any change in price or tax on cigarettes	(i) cluster randomized trial (ii) longitudinal study (iii) pre-/post- repeated cross-sectional study with a comparison group (iv) pre-/post- repeated cross-sectional study without a comparison group* (v) time series analysis
Banning smoking in public places	Policy or legislative change at the national, state, or community level that prohibits or restricts smoking in indoor environments. The target of the ban or restriction could include worksites, public places, and bars and/or restaurants. Smoking bans are classified as (1) complete when 100% smoke-free or no smoking allowed in any indoor area; (2) partial when smoking is restricted or limited to designated areas. We excluded smoking bans that were conducted among a specialized population, such as hospitalized patients, military recruits, or prisoners. While we did not include specific worksite smoking bans, we included studies conducted among specific workers if it evaluated a policy or legislative smoking ban	
Banning advertising and sponsorship	Ban or restriction on advertising or sponsorship, which may include television, radio, print, or internet advertising, point of purchase displays, product placement, and sponsorship of any type of event	
Health warning labels	Any required changes to the packaging of tobacco products intended to disseminate health warnings or eliminate the use of terms implying a safer product (e.g., changes to graphic images or text of health warning labels or restrictions on the use of terms, such as "mild," "low tar," or "light")	
Mass media campaigns	Any campaign intended to reduce tobacco use using "channels of communication such as television, radio, newspapers, billboards, posters, leaflets, or booklets intended to reach large numbers of people, which are not dependent on person-to-person contact" [108]	

* Excluded from the mass media campaign review.

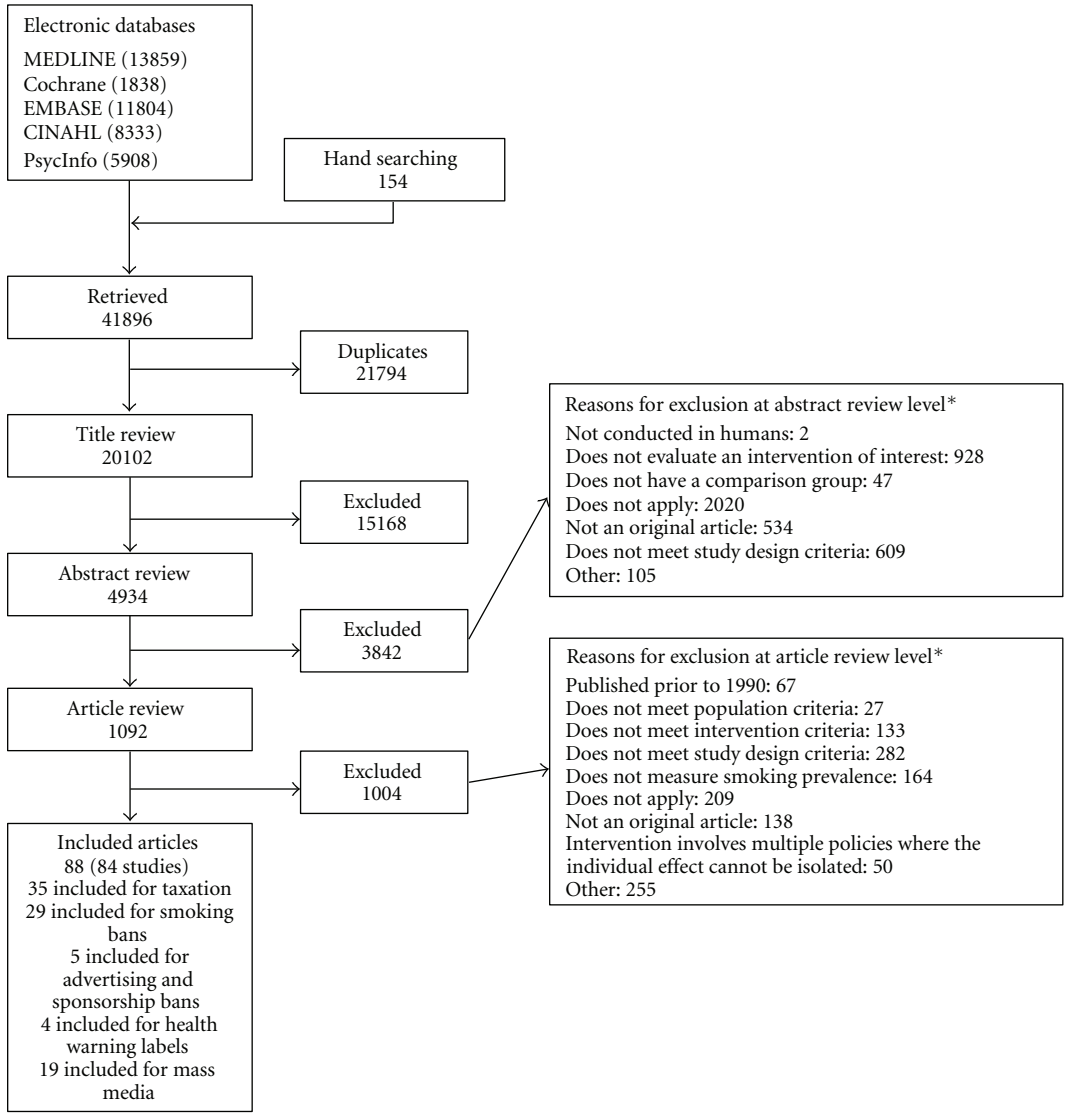
(PPE for initiation ranged from −0.65 to −0.09) [7–10], while the other did not (PPE for initiation, −0.003) [11]. All nine studies evaluating youth smoking prevalence found a significant negative effect of taxes/prices, at least among a subset of their samples [13–21]. The study conducted among low- and middle-income countries reported a PPE for local brands of −0.74 and a PPE for foreign brands of −1.09 [15]. The study examining smoking cessation found a price elasticity of cessation of 1.15 among males and 1.17 among females [12].

3.2.2. Adults. Six studies evaluated the impact of taxes/prices on smoking cessation among adults [12, 22–26]. Three found a statistically significant effect of taxes/price [12, 24, 25], while one found an impact only in the short term (4 months) [26]. One study found a significant association when evaluating prices, but not province-level taxes [22]. One study conducted in Mexico reported a 13% quit rate after a tax increase [23]. Twelve [25, 27–37] of 16 studies evaluating the effects of taxes/prices on adult smoking prevalence demonstrated a significant negative impact among at least a subset of their sample. Statistically significant effects of price/tax on smoking prevalence were consistently found in studies in high-income countries, such as the US [25, 31–33, 37], Australia [27, 30, 35], and Italy [34]. However, one study conducted in the European Union failed to find a correlation between cigarette affordability and smoking prevalence [38]. The results from low- and middle-income countries were more heterogeneous. Studies in South Africa and Russia found a significant decrease in smoking prevalence after a tax/price increase, with an estimated PPE of −0.30 and −0.10, respectively [29, 36]. A study in Mexico found a price elasticity of demand (i.e., the relative percentage change in demand for a 1% change in price) of −0.52, but the PPE was only −0.06 [39]. However, data on smoking participation was based on the purchasing patterns of all members of the household, meaning that an impact is only observed if all members of the household quit. A recent study in China [29] also found a relatively small PPE, which may be explained by the high level of affordability and the wide range of cigarette prices, which allows smokers to substitute a lower cost brand [40].

3.3. Banning Smoking in Public Places. We found moderate strength of evidence to quantify the impact of smoking bans. Twenty-nine studies measured the independent effect of smoking bans on initiation (2 studies), cessation (9 studies), and/or prevalence of smoking (20 studies). The strongest evidence was observed among studies of smoking prevalence, compared with studies assessing smoking initiation and cessation.

The studies that evaluated smoking initiation reported mixed results (Table 4) [41, 42].

Of the nine studies that evaluated smoking cessation, three had a concurrent comparison group [41, 43, 44]. Two studies found no significant association between the smoking ban and cessation rates (adjusted odds ratios ranging from 0.91 to 0.95) [43, 44], while the other found a significantly lower cessation rate (adjusted odds ratios ranging from 0.65 to 0.66) [41]. The other studies lacked a comparison group, making it difficult to draw conclusions. Four studies reported quit rates ranging from 5% to 15% [45–48], another reported a 5.1% increase in the quit rate in the 3-month period prior to the ban [49], and the other reported a 7.0% absolute



*Total may exceed number in corresponding box, as articles could be excluded for more than one reason at this level.

Figure 1: Summary of the literature search (number of articles).

difference in quit rates between those employed and those unemployed [50].

The effectiveness of a smoking ban likely depends on the comprehensiveness of legislation, level of enforcement, public support, and degree of prior legislation in place. Three studies evaluating a new, local, and comprehensive smoking ban reported the strongest effects on smoking prevalence [51–53]. In Saskatoon, Canada, smoking prevalence dropped from 24.1% to 18.2% one year after the ban [53]. In Lexington-Fayette County, Kentucky, smoking prevalence declined from 25.7% to 17.5% 20 months after the ban [52]. Another study conducted among college students in two different counties in Kentucky (Lexington-Fayette county and Louisville Metro) reported significant decreases in smoking prevalence 3.5 years ($P = 0.005$) and 8 months after their respective smoking bans [51]. However, a cohort study in Minnesota found no significant impact on smoking prevalence [54].

Studies conducted at the national level, where tobacco control activities have been ongoing tended to find less dramatic changes in smoking prevalence. For example, an Italian pre-/post- study without a comparison group found a significant decline in smoking prevalence among men (-8.5%, $P < 0.05$) and younger Italians (-7.4%, $P < 0.05$) following the introduction of a complete smoking ban [55]. In Spain, a study found a lower than expected smoking prevalence 1 year after the implementation of a partial smoking ban, but smoking prevalence returned to normal 3 years after the ban [56]. Similarly, a time series analysis in Scotland found a significant reduction in smoking prevalence 3–6 months before the law (which may have been influenced by the media coverage preceding the ban),

Table 2: Overall summary of the impact of tobacco control interventions on smoking initiation, cessation, and prevalence.

Intervention	Smoking behavior
Increasing the price through taxation	*Overall*: high* evidence to estimate the independent impact on smoking behavior Initiation: moderate evidence, 4 out of 5 longitudinal studies demonstrated some effectiveness; PPE of initiation ranged from −0.65 to −0.09 Cessation: moderate evidence, price elasticity of cessation ranged from 0.375 to 1.17 Prevalence: high evidence, suggesting effectiveness PPEs ranged from −1.41 to −0.10 among youths and −0.45 to 0.10 among adults
Banning smoking in public places	*Overall*: moderate evidence to estimate the independent impact on smoking behavior Initiation: low evidence, unable to make a conclusion due to equivocal results Cessation: low evidence, 2 of 3 longitudinal studies with comparison groups did not find a significant change in cessation rates after implementation Prevalence: moderate evidence, suggesting effectiveness; Percentage change in prevalence† ranged from −31.9% to −7.4% compared with control groups after 1 to 3.5 years
Banning advertising and sponsorship of tobacco products	*Overall*: insufficient evidence to estimate the independent impact on smoking behavior Initiation: insufficient evidence, unable to make a conclusion because no studies were included Cessation: insufficient evidence, unable to make a conclusion because no studies were included Prevalence: low evidence, unable to make a conclusion due to low quality studies; Two studies among adults showing no effectiveness, 2 studies among youths showing some effectiveness‡, and 1 found an increased prevalence with stronger laws
Educating people about the dangers of smoking through health warning labels	*Overall*: insufficient evidence to estimate the independent impact on smoking behavior Initiation: insufficient evidence, unable to make a conclusion because no studies were included Cessation: low evidence, 2 studies showing no effectiveness Prevalence: low evidence, 2 studies showing no effectiveness
Educating people about the dangers of smoking through mass media campaigns	*Overall*: moderate evidence to estimate the independent impact on smoking behavior Initiation: moderate evidence, suggesting effectiveness One cluster RCT demonstrated no effectiveness, but 4 longitudinal studies suggested a reduced initiation rate (odds of initiating smoking ranged from 0.67 to 0.8)¶ Cessation: low evidence, unable to make a conclusion due to equivocal results. Seven studies with comparison groups showed equivocal results^ Prevalence: moderate evidence, suggesting effectiveness. Odds of being a smoker 1 to 6 years after start of intervention* ranged from 0.62 to 0.93§, but one cluster RCT showed no effect on smoking prevalence

*Grading classification: *high* strength of evidence indicates high confidence that the evidence reflects the true effect, and further research is very unlikely to change the result. *Moderate* strength of evidence indicates moderate confidence that the evidence reflects the true effect, and further research may change the result. *Low* strength of evidence indicates low confidence that the evidence reflects the true effect, and further research is likely to change the result. *Insufficient* indicates that no evidence was available.

†One of these studies stratified results by gender and age (% impact on prevalence rate after 2 years for those under age 45 years = −7.4% and for those aged 45 years and older = −1.4%).

‡These studies had severe methodological flaws that limit our ability to make conclusions.

¶The strongest study methodologically showed a hazard ratio of 0.8 (95% CI: 0.71, 0.91; $P = 0.001$) per 10,000 GRP cumulative exposure.

^Two of the pre-/post- cross-sectional studies were methodologically stronger than the others. One study reported an odds ratio of cessation = 1.27 (95% CI: 0.77 to 2.08). The other reported a relative risk of quitting = 1.1 (95% CI: 0.98 to 1.24) per 5,000 GRPS.

§Additionally, a well-conducted time series analysis reported a decrease in percentage point prevalence two months later of −0.00077 per 1 GRP per month increase ($P = 0.025$). This is the equivalent of each person viewing an average of 4 ads per month to achieve a 0.30 percentage point decline in smoking prevalence.

CI: confidence intervals; GRP: gross rating point; PPE: price participation elasticity; RCT: randomized controlled trial.

but no significant change 9 months after the law [57]. In Ireland, two studies (reported in the same publication [58]) found a nonsignificantly lower smoking prevalence 1 year after implementation of a complete smoking ban among bartenders and the general public. Other studies conducted in Spain [59], Scotland [41, 60], England [61, 62], Germany [63], and The Netherlands (a partial smoking ban exempting the hospitality industry) [64] found no significant impact of a smoking ban on smoking prevalence. Wakefield et al. found no significant impact of an incremental increase in the population covered by smoke-free restaurant-specific laws on monthly smoking prevalence in Australia [27]. However, another study conducted in Australia among youths 12–17 years old found a lower smoking prevalence with stronger smoking bans (adjusted odds ratio, 0.93; 95% confidence interval (CI), 0.92–0.94) [16]. Two US studies evaluated the effects of venue-specific smoking bans among workers most affected by those laws [65, 66]. Both studies found a decreased smoking prevalence among bartenders after smoking bans in bars, but no change in other workers [66]. Another study conducted in the US-categorized state smoking bans by the number and type of restrictions and reported their results stratified by age group [33]. State smoking bans were largely insignificant, but this is probably

Table 3: Effects of taxation/price on smoking initiation, cessation, and prevalence.

Author, year	Country (data source)	Study design	Dates of data collection	Population (n)	Intervention (currency)	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Smoking initiation							
Nonnemaker and Farrelly, 2011 [7]	US (NLSY97)	Longitudinal	1997–2006	Youths, age 12–17 (8984); mean age = 15 51% male	Change in real state-level taxes* (1996 US$)	Ever smoked a cigarette	*Overall* OR (se): 0.88 (0.06), $P = 0.06$ Elasticity: −0.09 *Males* OR (se): 0.93 (0.08), $P = 0.41$ Elasticity: −0.05 *Females* OR (se): 0.81 (0.06), $P = 0.001$ Elasticity: −0.15
Sen and Wirjanto, 2010 [8]	Canada (Waterloo Smoking Prevention Project)	Longitudinal	1993–1996	Youths, grade 9 (2364)	Change in real excise and sales taxes (C$)	Smoked in past month	Elasticity: −0.5, $P < 0.1$
Tauras, 2005 [10]	US (MTF)	Longitudinal study	1976–1995	Youths, high school seniors (5,383)	Changes in real price* (1982–1984 US$)	Progression from nondaily to daily smoking	Coeff. (z-statistic): −0.46 (−2.27), $P < 0.05$ Elasticity: −0.65
Cawley et al., 2004 [9]	US (NLSY97)	Longitudinal study	1997–2000	Youths, ages 12–16 (12,282)	Changes in real price* (NR)	Smoking any positive quantity of cigarettes	Coeff. (z-statistic): −0.15 (−1.45), $P < 0.1$ *Males* coeff. (z-statistic): −0.28 (−2.03), $P < 0.05$ *Females* coeff. (z-statistic): −0.03 (−0.17), $P > 0.05$
DeCicca et al., 2002 [11]	US (NELS:88)	Longitudinal study	1988–1992	Youths, 8th grade (12,089)	Changes in nominal tax* (1988 US$)	Daily smoking	Coeff. (t value): −0.003 (−1.31), $P > 0.05$
Smoking cessation							
Ross et al., 2010 [22]	US and Canada (ITC)	Longitudinal	2002–2004	Adults (1990): mean age = 41 41% male	(1) change in real price (US$); (2) change in province-level cigarette tax (US$)	Quit smoking	(1) coeff. (se): 0.0064 (0.0038), $P < 0.1$ (2) coeff. (se): 0.0036 (0.0046)
Saenz-de-Miera et al., 2010 [23]	Mexico (ITC-Mexico)	Longitudinal	2006-2007	Adults, age 18+ (728): mean age = 39 61% male	SPST tax increased from 110% of price to retailers to 140% in 2007	Quit smoking for at least 30 days	Quit rate: 13.1% (95% CI, 9.7 to 16.5%)

Table 3: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population (n)	Intervention (currency)	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Hanewinkel and Isensee, 2007 [24]	Germany (NA)	Longitudinal study	01/2002–09/2005	Adults, age 14+; mean age 46.5	Before and after each of 5 tax increases (Euros)	Quit rates 1–4 months after tax increase	Quit rates ranged from 4% to 7.9%; OR = 1.58, $P < 0.05$
Tauras and Chaloupka, 1999 [12]	US (MTF)	Longitudinal study	NR	Youths, high school seniors	Changes in real price* (1982–1984 US$)	30-day abstinence	*Males* Coeff.: 0.746; $P < 0.05$; Price elasticity: 1.15; *Females* Coeff.: 0.742; $P < 0.01$; Elasticity: 1.17
Franz, 2008 [25]	US (BRFSS)	Before/after w/o comparison	1993–2000	Adults, age 18+	Changes in real price* (1995 US$)	Quit daily smoking within previous year	Baseline: 13.8%; Final: 14.3%; Coeff.: 0.023, $P < 0.001$ Elasticity: 0.375
Reed et al., 2008 [26]	US (CTS)	Before/after w/o comparison	1995–1999	Adults, age 25+	Before and after Proposition 10 and MSA, which raised price by US$ 0.95 (NA)	Quit smoking entirely within previous year	OR = 1.04; $P = 0.76$
Smoking prevalence among youth							
Grossman, 2005 [13]	US (MTF)	Time series	1975–2003	Youths, high school seniors	Changes in real price* (1975 US$)	Smoked in past 30 days	Coeff. (t-statistic): −0.12 (−5.23); $P < 0.05$
Tauras and Chaloupka, 1999 [14]	US (MTF)	Longitudinal study	1976–1993	Youths, high school seniors	Changes in real price* (1982–1984 US$)	Smoked in past 30 days	Coeff (t-ratio): −0.03 (−2.38); $P < 0.05$ Elasticity: −0.10
Kostova et al., 2011 [15]	17 LMIC (GYTS)	Before/after w/comparison	1999–2006	Youths, age 13–15	Change in real price (2000 US$)	Smoked in the past month	Elasticity for local brands: −0.74 Elasticity for foreign brands: −1.09
White et al., 2011 [16]	Australia (cross-sectional surveys of secondary schools)	Before/after w/comparison	1990–2005	Youths, age 12-17	Change in state-specific cigarette prices (2005 AU$)	Smoked in the past month	aOR = 0.98 (95% CI: 0.97; 0.99) (1 cent increase in change in price per stick)

Table 3: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population (n)	Intervention (currency)	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Carpenter and Cook, 2008 [17]	US (YRBS)	Before/after w/o comparison	1991–2005	Youths, grades 9–12	Changes in real price* (2005 US$)	Smoked in past 30 days	Coeff. (se): −0.286 (0.101); $P < 0.01$ Elasticity: −0.56
Ding, 2003 [18]	US (MTF)	Before/after w/o comparison	1976–1998	Youths, high school seniors	Changes in real price* (US$)	Smoked in past 30 days	Elasticity (se): −1.41 (0.83); $P = 0.10$ *Males* Elasticity (se): 0.29 (1.03), $P = 0.78$ *Females* elasticity (se): −2.98 (0.69); $P < 0.05$
Waller et al., 2003 [19]	Canada (OSDUS)	Before/after w/o comparison	1977–2001	Youths, grades 7, 9, 11, and 13	Before and after a decrease of C$10 in taxes (C$)	Smoked > 1 cigarette in past 12 months	Overall results for smoking prevalence showed a significant discontinuity effect with a negative slope until 1993 and upward jump at the discontinuity point and leveling off after 1993
Gruber, 2000 [20]	US (MTF)	Before/after w/o comparison	1991–1997	Youths, grades 8, 10 and 12	Changes in real price* (1982 US$)	Smoked in past 30 days	Coeff. (se): −0.955 (0.034); $P > 0.05$ Elasticity: −0.31 *8th and 10th graders* Coeff. (se): −0.03 (0.035); $P > 0.05$ Elasticity: −0.21 *12th graders* Coeff. (se): −0.148 (0.078); $P < 0.05$ Elasticity: −0.67
Chaloupka and Pacula, 1998 [21]	US (MTF)	Before/after w/o comparison	1975–1994	Youths, grades 8, 10 and 12; mean age = 16.3	Changes in real price* (1982–1984 US$)	Smoked in past 30 days	Coeff. (t-ratio): −0.004 (−2.62); $P < 0.05$ Elasticity: −0.62
Smoking prevalence among adults							
Wakefield et al., 2008 [27]	Australia (Roy Morgan Single Source)	Time series	1995–2006	Adults, age 18+	Cigarette costliness‡ (NR)	Smoke factory-made cigarettes	Coeff. (se): −8.802 (2.891); $P < 0.003$

Table 3: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population (n)	Intervention (currency)	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Azagba and Sharaf, 2011 [28]	Canada (National Population Health Survey)	Longitudinal	1999–2009	Adults, ages 12–65 (56,770) mean age = 38 50% male	Changes in real tax (2000 C$)	Daily and occasional smokers	Elasticity: −0.23 *Males* elasticity: −0.32; $P < 0.01$ *Females* elasticity: −0.12; $P > 0.1$
Lance et al., 2004 [29]	China (CHNS); Russia (RLMS)	Longitudinal study	China: 1993–1997; Russia: 1996–2000	Adults, age 13+; 100% male	Change in nominal price (China: yuan; Russia: ruble)	NR	*China* coeff. (se): −0.123 (0.165); $P > 0.05$ Elasticity = −0.045 *Russia* coeff. (se): −0.011 (0.003); $P < 0.01$ Elasticity = −0.101
Bogdanovica et al., 2011 [38]	European Union (Euro-barometer Surveys)	Before/after w/o comparison	2006–2009	Adults, age 15+	Change in cigarette affordability	Smoking prevalence	Correlation: −0.06; $P = 0.77$
Siahpush et al., 2009 [30]	Australia (Roy Morgan Single Source)	Before/after w/o comparison	1991–2006	Adults, age 18+; ages 18–29: 21%; ages 30–49: 41%; ages 50+: 38%; 48% male	Changes in real price‡ (2006 AU$)	Do you now smoke factory-made cigarettes? In the last month, have you smoked any roll-your-own cigarettes?	aRR (95% CI) = 0.974 (0.951 to 0.997) *Price × income* Price × medium income: 1.024 (1.015 to 1.023) Price × high income: 1.025 (1.016 to 1.035)
Gospodinov and Irvine, 2009 [144]	Canada (CTUMS)	Before/after w/o comparison	2000–2005	Adults, age 20+	Changes in real price, based on Canadian Socioeconomic Information Management system (2001 C$)	Occasional or daily smoker	Coeff.: −0.0008 (se = 0.0006); $P > 0.05$ Elasticity: −0.299 (se = 0.224) (95% CI: 0.133–−0.760)
DeCicca and McLeod, 2008 [31]	US (BRFSS)	Before/after w/o comparison	2000–2005	Adults, aged 45–65	Several state cigarette tax increases* (2001 US$)	Daily smoker	*Daily smoking* Coeff.: −0.0098 (se = 0.0036); $P < 0.05$ Elasticity: −0.21: *smoked on some days* Coeff.: −0.0110 (se = 0.0032); $P < 0.05$ Elasticity: −0.20
Jimenez-Ruiz et al., 2008 [39]	Mexico (ENIGH)	Before/after w/o comparison	1994–2005	Adults, age 15+	Until 1999, 40% for filter and 15% for unfiltered; in 2005, 45.5% for both filtered and unfiltered (NR)	Household spent money on cigarettes	Coeff. (t-statistic): −0.0019 (1.77); $P < 0.10$ Elasticity = −0.06

Table 3: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population (n)	Intervention (currency)	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Franz, 2008 [25]	US (BRFSS)	Before/after w/o comparison	1993–2000	Adults, age 18+	Changes in real price* (1995 US$)	Current smoker and smoked more than 100 cigarettes	Baseline: 22.2% Final: 17.9% Coeff.: −0.016; $P < 0.001$ Elasticity = −0.193
Franks et al., 2007 [32]	US (BRFSS)	Before/after w/o comparison	1984–2004	Adults, age 18+	Changes in real price* (2004 US$)	Current smoker	*1984–1996, lowest income quartile* Elasticity: −0.45 (−0.67–−0.22); $P < 0.01$ *1984–1996, other income quartiles* Elasticity: −0.22 (−0.35–−0.10), $P < 0.01$ *1997–2004, lowest income quartile* Elasticity: −0.14 (−0.36–0.08) *1997–2004, other income quartiles* Elasticity: −0.07 (−0.18–0.05)
Sloan and Trogdon, 2004 [33]	US (BRFSS)	Before/after w/o comparison	1990–2002	Adults, age 18+; 35–46% male	Changes in real price* (2002 US$)	Daily or some day smoker	*18 to 20 years old* Coeff. (se): −0.025 (0.012); $P < 0.05$ *21 to 24 years old* Coeff. (se): −0.011 (0.008); $P > 0.05$ *25 to 44 years old* Coeff. (se): −0.009 (0.005); $P < 0.05$ *45 to 64 years old* Coeff. (se): −0.008 (0.007); $P > 0.05$ *65+ years old* Coeff. (se): −0.010 (0.004); $P < 0.05$
Gallus et al., 2003 [34]	Italy	Before/after w/o comparison	1970–2000	Adults, age 15+	Changes in real price, taxes represented 74.7% of cost in 2000 (NR)	NR	Elasticity (se): −0.30 (0.05); $P < 0.001$

Table 3: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population (n)	Intervention (currency)	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Scollo et al., 2003 [35]	Australia (NTC)	Before/after w/o comparison	1997–2000	Adults, ages 18–40	Multiple changes to the taxation structure, including the end of the State franchise fees in Aug 97, a change from a weight to a stick-based system of levying excise duty in Nov 99, and the imposition of the Goods and Services Tax in Jul 00‡ (NR)	NR	Prevalence (May 1997): 29.5% Prevalence (Nov 1998): 27.9% Prevalence (Nov 2000): 26.7% Change percentage from May 1997 to Nov 1998: −5.42% Change percentage from Nov 1998 to Nov 2000: −4.30%
Arunatilake, 2002 [84]	Sri Lanka	Before/after w/o comparison	1991–2000	Age < 20: 40%; age 20–30: 18%; age 30–40: 13%; age 40–50: 12%; age 50–60: 9%; age 60+: 8%; 100% male	Annual increases in tax, ranging from 27.6% of selling price in 1995 to 76.8% in 2000 (NR)	NR	Elasticity: 0.10, $P < 0.1$
van Walbeek, 2002 [36]	South Africa (AMPS)	Before/after w/o comparison	1993–2000	Adults, age 16+; ages 16–24: 28%; ages 25–34: 26%; ages 35–49: 26%; ages 50+: 21%; 48% male	Increases in the real price of cigarettes by 93% (1995 Rand)	Smoking prevalence is defined as the number of respondents who declare cigarette usage expressed as a percentage of the population	1993 Prevalence: 32.6% 2000 Prevalence: 27.1% Change percentage: −16.9% Elasticity: −0.30
Farrelly et al., 2001 [37]	US (NHIS)	Before/after w/o comparison	1976–1993	Adults, age 18+; mean age 43.9; 47% male	Changes in the real price* (1982–1984 US$)	Smoked at least 100 cigarettes during lifetime and currently smoke cigarettes every day or some days	Elasticity: −0.13 *Males* elasticity: −0.03 *Females* elasticity: −0.19

* Data obtained from the tax burden on tobacco.

‡ Data was obtained from the Australian Retail Tobacconist.

Unless otherwise specified, elasticity is price participation elasticity (PPE, percentage change in smoking prevalence for one percentage change in price).

All odds ratios and relative risks can be interpreted as the change in outcome comparing the intervention to control group or after versus before an intervention or a unit increase in the intervention (e.g., 1$ in tax increase).

AMPS: All Media and Products Survey; aOR: adjusted odds ratio; AU$: Australian dollars; BRFSS: Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System; C$: Canadian dollars; CHNS: China Health and Nutrition Survey; CI: confidence interval; Coeff.: coefficient; CTS: California Tobacco Survey; CTUMS: Statistics Canada/Health Canada Canadian Tobacco Use Monitoring Survey; GYTS: Global Youth Tobacco Survey; ENIGH: National Household Income and Expenditure Survey; ITC: International Tobacco Control Policy Evaluation Survey; LMIC: low- and middle-income countries; MS: Master Settlement Agreement; MTF: Monitoring the Future: a Continuing Study of American Youth; NA: not applicable; NELS: 88: National Education Longitudinal Survey of 1988; NHIS: National Health Interview Surveys; NLSY97: National Longitudinal Survey of Youth 1997 Cohort; NR: not reported; NTC: National Tobacco Campaign Evaluation respondent surveys; OR: odds ratio; OSDUS: Ontario Student Drug Use Survey; RLMS: Russian Longitudinal Monitoring Survey; se: standard error; SPST: special production and services tax; US: United States; US$: United States dollars; YRBS: Youth Risk Behavior Survey.

Table 4: Effects of banning smoking in public places on smoking initiation, cessation, and prevalence.

Author, year	Country (data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Smoking initiation							
Hawkins et al., 2011 [41]	England, Scotland (MCS)	Longitudinal	2000–2007	Adults mean age = 29	(I) complete ban, including restaurants and/or bars, 1072 (f) and 632 (m) (C) no smoking ban, 4158 (f) and 2624 (m)	Daily smoking	Initiation rates at followup, females: (I) 6.2% (C) 7.3% aOR = 0.75 (95% CI: 0.58; 0.97) Initiation rates at followup, males: (I) 3.6% (C) 4.5% aOR = 0.81 (95% CI: 0.48; 1.37)
Klein, 2008 [42]	US (MACC)	Longitudinal	2000–2006	Youths, age 12–16	(I) complete ban in restaurants and/or bars (C) smoking areas designated or not restricted	Ever smoked at least a whole cigarette	aOR = 1.08 (95% CI: 1.00;, 1.16)
Smoking cessation							
Hawkins et al., 2011 [41]	England, Scotland (MCS)	Longitudinal	2000–2007	Adults Mean age = 29	(I) complete ban, including restaurants and/or bars, 1072 (f) and 632 (m) (C) no smoking ban, 4158 (f) and 2624 (m)	Not smoking any cigarettes	Quit rates within 1 year after ban, females: (I) 16.0% (C) 24.0% aOR = 0.65 (95% CI: 0.47; 0.89) Quit rates within 1 year after ban, males: (I) 20.5% (C) 28.8% aOR = 0.66 (95% CI: 0.46; 0.93)
Biener et al., 2010 [43]	US (UMass Tobacco Study)	Longitudinal	2001–2006	Adults, age 18+, Age 18–30: 25% Age 31–59: 65% Age 60+: 10%–46% male	(I) change in town's workplace or restaurant smoking ban, 1162 (C) no change, 1473	3-month abstinence	Quit rates within 2 years after ban: (I) 13.1% (C) 13.8% aOR = 0.95 (95% CI: 0.69; 1.31)
Hyland et al., 2009 [44]	UK (ITC)	Longitudinal	2006-2007	Adults, age 18+	(I) complete ban, including restaurants and/or bars, in Scotland, 507 (C) other parts of UK, 828	Smoked at least once/month and smoked at least 100 cigarettes lifetime	Quit rates 1 year after intervention: (I) 19% (95% CI: 9.8; 29%) (C) 21% (95% CI: 14; 28%) aOR = 0.91 (95% CI: 0.47; 1.7)

Table 4: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation, or prevalence
De Chaisemartin et al., 2011 [50]	France (Consultation Dependance Tabagique)	Longitudinal	2004–2008	Adults	(I) complete ban in workplaces, 5963	Smoked 0 cigarettes/day and all expired CO measures <9 ppm	Mean difference in quit rates between employed and unemployed: 7.0%
Bauza-Amengual et al., 2010 [45]	Spain (original data collection)	Longitudinal	2006-2007	Adults, age 18+	(I) complete ban, including restaurants and/or bars††	Quit smoking (self-reported)	Quit rates 1 month after ban: 9.5% Quit rates 6 months after ban: 13.8%
Murphy et al., 2010 [46]	US (original data collection)	Longitudinal	2002–2005	Adults, age 18+, 20% male, mean age = 37 years	(I) complete ban, including restaurants and/or bars, 237	Quit smoking	Quit rate 2 years after ban: 14%
Orbell et al., 2009 [47]	England (original data collection)	Longitudinal	2007	Adults, age 18+, 57% male, Mean age = 36 years	(I) complete ban, including restaurants and/or bars, 84	Quit smoking	Quit rates 3 months after ban: 15.5%
Martinez-Sanchez et al., 2009 [48]	Spain (original data collection)	Longitudinal	2005-2006	Adults	(I) complete ban, including restaurants and/or bars††, 118	Daily or occasional smokers with salivary cotinine concentration ≤35 ng/mL per cigarette smoked	Quit rate 1 year after ban: 5.1%
Fowkes et al., 2008 [49]	Scotland (AAA Trial)	Longitudinal	1998–2007	Adults, age 50–75 33% male mean age = 60.9	(I) complete ban, including restaurants and/or bars, 1141	Self-reported; must have quit for at least 3 months	Change in smoking cessation pattern during 2006, with increase in quit rates (5.1%) in 3-month period prior to ban
Smoking prevalence							
Mackay et al., 2011 [57]	Scotland (Scottish Household Survey)	Time series	1999–2010	NR	(I) complete ban, including restaurants and/or bars	Current smoker	Coeff. for 3–6 mos prior to law: −1.70 (95% CI: −2.38, −1.02), $P < 0.001$ Coeff. for 9 mos after law: −0.08 (95% CI: −0.39, 0.22); $P = 0.59$

Table 4: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Wakefield et al., 2008 [27]	Australia (Roy Morgan Single Source)	Time series	1995–2006	Adults, age 18+	(I) complete ban, restaurants only	Smoke factory-made cigarettes	Coeff. (se): −0.0104 (0.0103); $P = 0.317$
Anger et al., 2011 [63]	Germany (SOEP)	Longitudinal	2002–2008	Adults, mean age = 47 47% male	(I) complete ban, including restaurants and/or bars	Current smoker	Coeff.: −0.004 (se: 0.008); $P > 0.05$
Hawkins et al., 2011 [41]	England; Scotland (MCS)	Longitudinal	2000–2007	Adults, mean age = 29	(I) complete ban, including restaurants and/or bars, 1522 (f) and 904 (m); (C) no smoking ban, 5954 (f) and 3757 (m)	Daily smoking	Smoking prevalence at baseline, females: (I) 31.0% (C) 29.8% Smoking prevalence at followup, females: (I) 30.3% (C) 27.7% aOR = 1.15 (95% CI: 0.95; 1.40) Smoking prevalence at baseline, males: (I) 31.5% (C) 29.5% Smoking prevalence at followup, males: (I) 27.5% (C) 24.2% aOR = 1.24 (95% CI: 0.95; 1.61)
Mullally et al., 2009 [58]	Ireland (All-Ireland Bar Study)	Longitudinal	2004-2005	Adults, age 18+ 71% male Mean age = 33	(I) complete ban, including restaurants and/or bars	Combined self report and cotinine measures	Smoking prevalence prior to law: 56.1% Smoking prevalence 1 year after law: 51.4%; $P = 0.125$
Klein et al., 2009 [54]	US (MACC)	Longitudinal	2000–2006	Youths, age 12–16 49% male	(I) complete ban in restaurants and/or bars, 1028; (C) smoking areas designated or not restricted, 3205	Smoked in the past month	aOR = 1.06 (95% CI: 0.93; 1.21)
Bitler et al., 2011 [65]	US (TUS-CPS)	Before/after w/comparison	1992–2007	Adults, age 18+	Strength of state smoking bans in bars[§]	Daily or someday smoker	OR = 0.78 (95% CI: 0.64 to 0.94)

Table 4: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation, or prevalence
White et al., 2011 [16]	Australia (cross-sectional surveys of secondary schools)	Before/after w/comparison	1990–2005	Youths, age 12–17	Scoring system based on the extent to which policies have been adopted	Smoked in the past month	aOR = 0.93 (95% CI: 0.92; 0.94)
Hahn et al., 2010 [51]	US	Before/after w/comparison	2004–2008	Youths, age 18–24 31–39% male	(I) complete smoking ban, including restaurants and/or bars, 897*, 469** (C) delayed smoking ban, including restaurants and/or bars, 703*, 701**	Smoked in past 30-days	Smoking prevalence (I) before ban: 28.0%; 3.5 years after ban: 19.4%; $P = 0.005$ Smoking prevalence (C) before ban: 21.5%; 8 months after ban: 16.9%; $P = 0.03$
Bitler et al., 2010 [66]	US (TUS-CPS)	Before/after w/comparison	1992–2007	Adults, age 18+	Venue-specific Impact Teen ratings	Smoked at least some days	Coeff. for private workplace SCIAL among private sector workers: 0.001 (se: 0.003); $P > 0.05$ Coeff. for government workplace SCIAL among government workers: 0.011 (se: 0.009); $P > 0.05$ Coeff. for public school SCIAL among school workers: −0.001 (se: 0.003); $P > 0.05$ Coeff. for private school SCIAL among school workers: −0.004 (se: 0.004); $P > 0.05$ Coeff. for restaurant SCIAL among all workers at eating/drinking places: 0.013 (se: 0.014); $P > 0.05$ Coeff. for bar SCIAL among bartenders: −0.058 (se: 0.021); $P < 0.01$
Hahn et al., 2008 [52]	US (BRFSS)	Before/after w/comparison	2001–2005	Adults, age 18+	(I) complete ban, including restaurants and/or bars, 579* and 281** (C) no smoke-free laws, 6560* and 2993**	Daily or some day smoker and smoked at least 100 cigarettes lifetime	Smoking prevalence 40 months prior to law: (I) 25.7% (95% CI: 21.2, 30.1%) (C) 28.4% (95% CI: 26.8, 30.0) Smoking prevalence 20 months after law: (I) 17.5% (11.8, 23.1) (C) 27.6% (25.2, 30.0) aOR = 0.84 (0.72, 0.97)

Table 4: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Lemstra et al., 2008 [53]	Canada (Canadian Community Health Survey)	Before/after w/comparison	2003–2005	Adults	(I) complete ban, including restaurants and/or bars, 1301* and 1244** (C1) Saskatchewan (C2) Canada	NR	Baseline smoking prevalence: (I) 24.1% (95% CI: 20.4, 27.7) (C1) 23.8 (22.6, 25.3) (C2) 22.9 (22.5, 23.3) Smoking prevalence 1 year after law: (I) 18.2% (15.7, 20.9) (C1) 23.8 (C2) 21.3 (20.8, 21.8)
Lee et al., 2011 [61]	England (Health Survey for England)	Before/after w/o comparison	2003–2008	Adults, age 18+	(I) complete ban, including restaurants and/or bars	Current smoker	aOR = 1.02 (95% CI: 0.94, 1.11)
Guerrero et al., 2011 [56]	Spain (National Health Survey for Spain)	Before/after w/o comparison	1993–2009	Adults, age 16–65	(I) complete ban, including restaurants and/or bars††	Smoked at least 100 cigarettes lifetime	Smoking prevalence in 1993: 36.18% Smoking prevalence in 2003: 30.97% Smoking prevalence in 2006 (<1 yr after ban): 29.50% Smoking prevalence in 2009 (3 yrs after ban): 31.47%
Verdonk-Kleinjan et al., 2011 [64]	The Netherlands (Continuous Survey of Smoking Habits)	Before/after w/o comparison	2003-2004	Adults, age 16–65	(I) complete ban in workplaces, 601	Daily smoking	Smoking prevalence prior to ban: 27.5% Smoking prevalence 1 month after ban: 25.5% OR = 0.87 (95% CI: 0.70; 1.08)

Table 4: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Mullally et al., 2009 [58]	Ireland (survey commissioned by the Office of Tobacco Control)	Before/after w/o comparison	2004-2005	Adults, age 18+	(I) complete ban, including restaurants and/or bars	Smoked more than 1 cigarette per week	Smoking prevalence prior to law: 28.3% Smoking prevalence 1 year after law: 24.8%; $P = 0.055$
Elton and Campbell, 2008 [62]	England (original data collection)	Before/after w/o comparison	2007	Adults, age 18+, age 18–24: 7% age 25–34: 12% age 35–44: 16% age 45–54: 18% age 55–64: 20% age 65–74: 14% age 75+: 13% 45% male	(I) complete ban, including restaurants and/or bars, 2054* and 1938**	Currently smoke	Baseline smoking prevalence: 22.4% Smoking prevalence 3 months after law: 22.6%
Haw and Gruer, 2007 [60]	Scotland (original data collection)	Before/after w/o comparison	2005–2007	Adults, age 16–74	(I) complete ban, including restaurants and/or bars, 1815* and 1834**	Self-reported	Baseline smoking prevalence: 35.6% Smoking prevalence after law: 35.1%
Galan et al., 2007 [59]	Spain	Before/after w/o comparison	2005-2006	Adults, age 18–64, Age 18–29: 26% Age 30–44: 40% Age 45–64: 33% 48% male	(I) complete ban, including restaurants and/or bars††, 1750* and 1252**	Self-reported	Baseline smoking prevalence: 31.7% Smoking prevalence after law: 32.7%
Gallus et al., 2006 [55]	Italy (DOXA)	Before/after w/o comparison	2004-2005	Adults, age 15+	(I) complete ban, including restaurants and/or bars†	NR	Baseline smoking prevalence: (I) 26.2% Smoking prevalence 3 months after laws: (I) 25.6%

Table 4: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation, or prevalence
Sloan and Trogdon, 2004 [33]	US (BRFSS)	Before/after w/o comparison	1990–2002	Adults, age 18+; 35–46% male	Categorical variables based on number and type of public places where smoking is banned: none, nominal, basic, moderate, and extensive‡, 1,762,686	Daily or some day smoker	Nominal‡‡: 0.011, 0.001, −0.001, −0.004, and 0.006 Basic‡‡: 0.032, −0.047, 0.009, 0.013, and 0.005 Moderate‡‡: 0.030, −0.015, 0.017, 0.015, and 0.008 Extensive‡‡: 0.013, −0.011, 0.004, −0.005, and −0.007

* Prelaw sample size.
** Postlaw sample size.
† Exceptions were made to the smoking ban for restaurants with separate and regulated smoking areas.
†† There was a partial ban on smoking in restaurants and bars. Establishments of less than 100 square meters were able to decide whether or not to permit smoking. Establishments of more than 100 square meters could provide a separate smoking area with a separate ventilation system that was no larger than 30% of the total area of the premises.
‡ Based on data from the State Legislated Actions on Tobacco Issues, 2002.
‡‡ Results reported by age group: 18 to 20 years, 21 to 24 years, 25 to 44 years, 45 to 64 years, and 65 years and older.
§ Based on data from Robert Wood Johnson's ImpacTeen database.
AAA: Aspirin for Asymptomatic Atherosclerosis; aOR: adjusted odds ratio; BRFSS: Behavioral Risk Factor Surveillance Survey; C: control; CI: confidence interval; CIA: clean indoor air; CO: carbon monoxide; f: females; I: intervention; ITC: International Tobacco Control Policy Evaluation Project; m: males; MACC: Minnesota Adolescent Community Cohort; MCS: Millennium Cohort Study; NR: not reported; ppm: parts per million; SOEP: Socio-Economic Panel Study; TUS-CPS: Tobacco Use Supplement to the Current Population Survey; UK: United Kingdom; US: United States.

due to the small number of changes in state smoking bans during the period of their analysis.

3.4. Banning Advertising and Sponsorship of Tobacco Products. We found insufficient evidence to estimate the impact of implementation of advertising bans or restrictions. We did not identify any studies measuring smoking initiation or cessation as the outcome. Five studies examined prevalence (three among youths and two among adults), comparing rates of smoking before and after implementing advertising bans or restrictions (Table 5). Two of the youth studies showed declines in smoking prevalence; however, inferences regarding the independent effect of advertising bans were limited by the lack of a control group and long time frame between baseline and followup [67, 68]. The other youth study, conducted in Australia, showed an increased smoking prevalence with stronger point-of-purchase and outdoor advertising bans, after adjusting for demographics and other tobacco control policies (adjusted odds ratio: 1.03, 95% CI: 1.01; 1.05) [16].

Other factors influencing findings included the comprehensiveness of the ban, the level of enforcement, and industry response of shifting to indirect means of marketing. One study evaluated price and smoking prevalence in the five largest capital cities in Australia, while adjusting for a tobacco sponsorship ban that "brought two remaining states into line with the three states that had already banned tobacco sponsorship." The authors found no association between the incremental increase in coverage of the ban and prevalence, but noted that after the ban, tobacco companies shifted resources to other outlets (e.g., point of sale) [30]. One US study found that the presence of any advertising restriction at the state level was associated with a nonstatistically significant reduction in smoking prevalence [33].

3.5. Health Warning Labels. We found insufficient evidence to quantify the direct impact of health warning labels on smoking prevalence. No studies examined smoking initiation. Only four studies measured smoking prevalence or cessation, and they were typically not the primary endpoints under study (Table 6).

The limited number of studies is likely due to the fact that health warning labels are implemented at the country-level, and there have been only a limited number of countries introducing new or modified warning labels. In Australia, increasing the text size from 15% to 25% of pack area was associated with a quit rate of 11%, but without a control group it is not possible to determine the net impact [69]. In addition to study design, heterogeneity could be expected as a result of differences in size, content, and design (e.g., text versus pictorial). Borland et al., using data from the International Tobacco Control Policy project, studied the effects of warning labels across four countries over four waves of data collection. Over this time period, the health warning labels on cigarette packs changed in UK (increasing text size and banning misleading product descriptors) and Australia (adding graphic images). However, the timing of these changes relative to data collection did not allow for direct comparisons of cessation behavior before and after implementation [70].

Two other studies evaluated the effects of health warning labels on smoking prevalence [30, 71]. One study reported on the effects of the introduction of 6 rotating text warnings in Australia [30], while the other reported on rotating pictorial health warning labels that covered 50% of the package in Canada [71]. Neither study reported a significant decrease in smoking prevalence.

3.6. Mass Media Campaigns. We found moderate strength of evidence to quantify the independent impact of mass media campaigns. Five, eight, and eight studies examined the independent effects of a mass media campaign on initiation, cessation, and prevalence, respectively (Table 7). The findings for youths were more consistent than adults, with most studies reporting a reduction of 20% to 40% in the odds of smoking initiation [72–75].

In addition to study design, key sources of heterogeneity include differences in content, tone, channels, and reach of campaigns. For example, the two studies which examined a broad campaign focused on cardiovascular disease failed to find consistent evidence of impacts on smoking prevalence [76, 77]. Among US youths, large-scale campaigns focused on tobacco industry manipulation and deception were shown to be effective at reducing initiation [75, 78, 79]. Smaller studies with other types of content were also shown to be effective [72–74]. Less consistent evidence is available for smoking cessation among youths and young adults [74, 80, 81]. Two studies evaluated campaigns that targeted ethnic groups. One, which targeted Spanish-speaking smokers, reported an increased 6-month abstinence rate among those who called into the quit line [82]. The other targeted youths of diverse racial and ethnic backgrounds, but did not report a significant effect on smoking prevalence [83]. Among adults, a mass media campaign focused on hard-hitting, graphic messages with sustained, and high levels of exposure was shown to effectively reduce smoking prevalence. A time series analysis of a mass media campaign in Australia found that an increase in 1,000 gross rating points (a measure of advertising reach and frequency) led to a reduction in adult smoking prevalence of 0.8% within 2 months, after controlling for price [27]. The study also found that the effects dissipated rapidly, suggesting that sustained high levels of exposure are necessary to maximize reductions in smoking prevalence.

4. Discussion

The purpose of this paper was to examine and quantify the independent impact of tobacco control policies on smoking behavior, as measured by initiation, cessation, or prevalence. Although tobacco control policies are often implemented in combination, we focused on studies that attempted to separate out the independent impact of each policy to better inform models for predicting smoking patterns. We also focused on studies that measured smoking behavior before and after policy implementation, to ensure that the proper temporal relationship was met.

Table 5: Effects of advertising and sponsorship of tobacco products on smoking prevalence.

Author, year	Country (Data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking prevalence
Smoking prevalence							
White et al., 2011 [16]	Australia (cross-sectional surveys of secondary schools)	Before/after w/comparison	1990–2005	Youths, age 12–17	Scoring system based on the extent to which policies have been adopted	Smoked in the past month	aOR: 1.03 (95% CI: 1.01; 1.05)
Sloan and Trogdon, 2004 [33]	US (BRFSS)	Before/after w/o comparison	1990–2002	Adults, age 18+; 35–46% male	Any advertising restrictions*, 1,762,686	Daily or some day smoker	18 to 20 years old Coeff. (se): −0.016 (0.012); $P > 0.05$ 21 to 24 years old Coeff. (se): −0.017 (0.010); $P > 0.05$ 25 to 44 years old Coeff. (se): −0.005 (0.007); $P > 0.05$ 45 to 64 years old Coeff. (se): −0.004 (0.006); $P > 0.05$ 65+ year olds Coeff. (se): −0.006 (0.006); $P > 0.05$
Galduróz et al., 2007 [67]	Brazil (original data collection)	Before/after w/o comparison	1997–2004	Youths, age 11–18; 42% male	Advertising ban on the following media: billboard, print, radio, sponsorship, sporting or cultural activity, TV, 15,501† and 21,172‡	Lifetime use of tobacco	Baseline prevalence: 32.7% Smoking prevalence 4 years after ad ban: 25.0%
Fielding et al., 2004 [68]	Hong Kong (original data collection)	Before/after w/o comparison	1990–2001	Youths, aged 8–10	Advertising ban on the following media: broadcast media (1990), billboards, print (1999), 824	Ever smoked	Baseline prevalence: 7.8% Follow-up smoking prevalence: 3.8%
Siahpush et al., 2009 [30]	Australia (Roy Morgan Single Source)	Before/after w/o comparison	1991–2006	Adults, age 18+; ages 18–29: 21%; ages 30–49: 41%; ages 50+: 38%; 48% male	National ban on tobacco sponsorship, bringing 2 remaining states into line with the 3 states that had already banned tobacco sponsorship at the state level (December, 1995), 515,866	Do you now smoke factory-made cigarettes? In the last month, have you smoked any roll-your-own cigarettes?	aRR = 1.00, $P = 0.90$

* Based on data from the Centers for Disease Control and Prevention's State Tobacco Activities Tracking and Evaluation (STATE) System.
† Preban sample size.
‡ Postban sample size.
aRR: adjusted rate ratio; aOR: adjusted odds ratio; BRFSS: Behavioral Risk Factor Surveillance Survey; CI: confidence interval; coeff.: coefficient; se: standard error.

Table 6: Effects of health warning labels on smoking cessation and prevalence.

Author, year	Country (data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking cessation, or prevalence
				Smoking cessation			
Borland et al., 2009 [70]	Australia, Canada, UK, and US (ITC)	Longitudinal	2002–2006	Adults, age 18+	*Australia* (B) 6 rotating, text labels, 25% of front, 33% of back; (I) 14 rotating, graphic labels, 30% of front, 90% of back*, 2305; *Canada* (B) 16 rotating, graphic labels, 50% of pack, 2214; *UK* (B) 6 rotating, text labels, 6% of front; (I-1) 16 rotating, text labels, 30% of front, 40% of back; (I-2) banned use of "light", "mild", 2401; *US* (B) 4 rotating, text labels on side, 2138	Made a quit attempt lasting more than 24 hours since previous survey, and among those who did, whether quit attempt lasted at least 1 month	*Australia* F1 quit rate: 14.99% F2 quit rate: 22.93% F3 quit rate: 25.15% F4 quit rate: 25.90% *Canada* F1 quit rate: 19.84% F2 quit rate: 23.96% F3 quit rate: 22.81% F4 quit rate: 21.34% *United Kingdom* F1 quit rate: 16.83% F2 quit rate: 22.68% F3 quit rate: 28.93% F4 quit rate: 23.94% *United States* F1 quit rate: 14.42% F2 quit rate: 19.23% F3 quit rate: 20.31% F4 quit rate: 20.36%

Table 6: Continued.

Author, year	Country (data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking cessation, or prevalence
Borland, 1997 [69]	Australia (original data collection)	Longitudinal	1994-1995	Adults, age 16+; 51% male	(B) 4 rotating, text-only labels covering 15% of front and back of package, 510; (I) 6 rotating, text-only labels covering 25% of front and 33% of back of package, 243	Quit smoking at followup for at least 1 week	Quit rate: 11%
				Smoking prevalence			
Siahpush et al., 2009 [30]	Australia (Roy Morgan Single Source)	Before/after w/o comparison	1991–2006	Adults, age 18+; ages 18–29: 21%; ages 30–49: 41%; ages 50+: 38%; 48% male	(I) 6 rotating, text-only labels covering 25% of front and 33% of back of package, 515,866	Do you now smoke factory-made cigarettes? In the last month, have you smoked any roll-your-own cigarettes?	aRR = 1.00; $P = 0.96$
Gospodinov and Irvine, 2004 [71]	Canada (CTUMS)	Before/after w/o comparison	2000-2001	Adults, age 15+; 46% male	(B) text only, 9729; (I) 16 rotating, graphic labels, 50% of pack, 10447	Current cigarette smoking	Smoking prevalence: (B) 25.0% (I) 23.4% Marginal effect prevalence rate ratio: −0.0034 (95% CI: −0.029, 0.021; se = 0.01)

* Health warning label also included the quitline phone number.

aRR: adjusted rate ratio; B: baseline; CI: confidence interval; CTUMS: Canadian Tobacco Use Monitoring Surveys; F: followup period; I: intervention; ITC: International Tobacco Control Policy Research Survey; se: standard error; UK: United Kingdom; US: United States.

Table 7: Effects of antitobacco mass media campaigns on smoking initiation, cessation, and prevalence.

Author, year	Country (Data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation or prevalence
Smoking initiation							
Bauman et al., 1991 [145]	US (original data)	Cluster RCT	1985–1987	Youths, ages 12–14	(I) 8 30-second radio messages focused on 7 expected consequences of smoking broadcasted over 3 1-month periods; (C) no mass media campaign*, 951 total nonsmokers at baseline	Ever puffed a cigarette	Among nonsmokers at baseline, differences relative to comparison group at 11–17 months after broadcasts ended (i) Smoking experimentation: 1% (P = NS) (ii) Regular smoking: 2% (P = NS) (iii) Recent smoking: 1% (P = NS)
Farrelly et al., 2009 [75]	US (NLSY97)	Longitudinal study	1997–2004	Youths, ages 12–17	(I) TV campaign with cumulative exposure between 2000–2004 of 3096–32137 GRPs across 210 media markets, 8904	Ever smoked a cigarette	HR = 0.8 (95% CI: 0.71–0.91; P = 0.001) (per 10,000 GRP cumulative exposure)
Linkenbach and Perkins, 2003 [72]	US (original data)	Longitudinal study	2000–2001	Youths, junior and senior high school students; mean age = 14.6; 50% male	(I) 1500 GRPs (broadcast TV); 78,000 print and promotional items distributed in schools; 4 theater slides were run over 1 month at 2 movie theaters; 1 billboard design appeared in 4 locations for 1 month, 299; (C) control, 314	Having tried cigarette smoking	12-month follow-up smoking prevalence: (I) 10% (C) 17% Relative measure: 41% lower rate of initiation in intervention group ($P < 0.05$)
Flynn et al., 1997 [73]	US (original data)	Longitudinal study	1985–1991	Youths, grades 4–6	(I) 540 TV and 350 radio broadcasts per year for 4 years plus school intervention; (C) school intervention	Smoked >0 cigarettes in past week	4-year follow-up smoking prevalence: (I) 7.5% (C) 13.0% 6-year followup smoking prevalence: (I) 15.9% (C) 20.2% OR = 0.73

Table 7: Continued.

Author, year	Country (Data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation or prevalence
Hafstad et al., 1997 [74]	Norway (original data)	Longitudinal study	1992–1995	Youths, ages 14-15	(I) 3 annual campaigns of 1 TV and cinema ad 167 times, 3 full-page ads in 5 newspapers, 1 poster in each location run for 3 weeks; (C) control county	Weekly smoking	*Males* 1-year initiation rate (I) 10.2% (C) 14.5% OR = 0.67 (95% CI: 0.53; 0.85) *Females* 1-year initiation rate (I) 14.6% (C) 25.6% OR = 0.77 (95% CI: 0.63; 0.95)
Smoking cessation							
Solomon et al., 2009 [80]	US (original data)	Cluster RCT	2001–2004	Youths, grades 7–10; 45% male	(I) radio and TV campaign with 380 GRPs/week over 9 months each year for 3 years, 531; (C) no intervention, 601	Not smoking one cigarette in past 30 days	12-month quit rate (I) 18.1% (C) 14.8% 24-month quit rate (I) 14.5% (C) 12.6% 36-month quit rate (I) 16.0% (C) 12.8% Relative measure: no significant time trend or interaction between condition and time
Terry-McElrath et al., 2011 [81]	US (MTF)	Longitudinal	2001–2008	Adults, age 20–30	24-month sum of antitobacco TV advertising measured in GRPs, 7997	Smoked 0 cigarettes/day in past 30 days	*<52 GRPS* (ref) *52–103 GRPs* aOR: 1.15 (95% CI: 0.91; 1.45) *104–155 GRPs* aOR: 1.40 (95% CI: 1.07; 1.83) *156–207 GRPs* aOR: 1.21 (95% CI: 0.90; 1.63) *208+ GRPs* aOR: 1.22 (95% CI: 0.90; 1.66)

Table 7: Continued.

Author, year	Country (Data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation or prevalence
Burns and Levinson, 2010 [82]	US (original data collection)	Longitudinal	2007	Adults, age 18+ 41–50% male	(I) Spanish-language TV campaign with 1387.4 GRPs for 1 month, radio ads, and 1900 30-second spots on movie screens, 117 (C) non-Spanish speaking population, 193	6-month abstinence	Quit rate prior to campaign (I) 9.6% (C) 16.5% Quit rate post campaign (I) 18.8%; $P < 0.05$ (C) 8.8%; $P = 0.01$
Durkin et al., 2009 [146]	US (UMass Tobacco Study)	Longitudinal	2001–2004	Adults mean age = 41 45% male	24-month GRPs	1-month abstinence	Quit rate, 16%
Hyland et al., 2006 [147]	US (COMMIT)	Longitudinal study	1988–2001	Adults, ages 24–64	(I) TV campaign above 1218 GRPs in 1999-2000 (C) TV campaign below 1218 GRPs in 1999-2000	NR	24-month quit rate (I) 12.9% (C) 11.0% RR = 1.1 (95% CI: 0.98–1.24) (per increase in 5000 GRPs of exposure)
Ronda et al., 2004 [76]	Netherlands (original data)	Longitudinal study	1998–2001	Adults, ages 18+ 39–47% male; Mean age: 46–50 years	(I) Billboard, print, radio, TV, posters and postcards in waiting rooms and public buildings; 4 months spread over 2 years[†]	Not having smoking any tobacco in last 7 days	24-month quit rate (I) 12.3% (C) 14.3% 36-month quit rate (I) 18.7% (C) 18.6% relative measure: no association between intervention and smoking outcome in regression models (not reported)
McVey and Stapleton, 2000 [148]	England (original data)	Longitudinal study	1992–1994	Adults, ages 16+ 41-42% male; Mean age: 46 years	(I) 18-month TV campaign, 1744; (C) no intervention, 719	No smoking at all nowadays	18-month quit rate (I) 9.7% (C) 8.7% OR = 1.27 (95% CI: 0.77–2.08; $P = 0.35$)

Table 7: Continued.

Author, year	Country (Data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation or prevalence
Hafstad et al., 1997 [74]	Norway (original data)	Longitudinal study	1992–1995	Youths, ages 14-15	(I) 3 annual campaigns of 1 TV and cinema ad 167 times, 3 full-page ads in 5 newspapers, 1 poster in each location run for 3 weeks, 1061; (C) control county, 1288	Weekly smoking	*Males* 1-year quit rate (I) 12.7% (C) 19.1% OR = 0.63 *Females* 1-year quit rate (I) 25.6% (C) 17.6% OR = 1.9
Smoking prevalence							
Flynn et al., 2010 [83]	US (original data collection)	Cluster RCT	2001–2005	Youths, grades 7–12, 46% male	(I) 380 GRPs from TV ads per week, 215 GRPs from radio ads, 10,412; (C) no intervention, 9544	Smoking in past 30 days	Baseline smoking prevalence (I) 18.9% (C) 17.8% Smoking intervention at 4 year followup (I) 16.9% (C) 15.5%; $P = 0.95$
Wakefield et al., 2008 [27]	Australia (Roy Morgan Single Source)	Time series	1995–2006	Adults, age 18+	138-month TV campaign, 288.5 mean monthly GRPs, 343,835	Smoke factory-made cigarettes	Prevalence percentage point change two months later (i.e., 2 month lag) per 1 GRP per month increase:−0.00077 (95% CI: −0.00144, −0.0001; $P = 0.025$)
Hafstad et al., 1997 [74]	Norway (original data)	Longitudinal study	1992–1995	Youths, ages 14-15	(I) 3 annual campaigns of 1 TV and cinema ad 167 times, 3 full-page ads in 5 newspapers, 1 poster in each location run for 3 weeks, 2742; (C) control county, 3438	Weekly smoking	OR = 0.74 (95% CI: 0.64; 0.86) *Males* Baseline prevalence (I) 6.9% (C) 9.9% 1-year prevalence (I) 13.7% (C) 20.4% *Females* Baseline prevalence (I) 10.1% (C) 11.4% 1-year prevalence (I) 18.7% (C) 23.8%

Table 7: Continued.

Author, year	Country (Data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation or prevalence
Flynn et al., 1995 [149] Worden et al., 1996 [150] Flynn et al., 1992 [151] Flynn et al., 1994 [152] Worden and Flynn, 2002 [153] Flynn et al., 1997 [73]	US (original data)	Longitudinal study	1985–1991	Youths, grades 4–6; mean age: 10.6 years, 48–54% male	(I) 540 TV and 350 radio broadcasts per year for 4 years plus school intervention; (C) school intervention	Smoked >0 cigarettes in past week	Baseline prevalence (I) 1% (C) 1.6% 6-year prevalence (I) 16.5% (C) 24% OR = 0.62 (95% CI: 0.49; 0.78) *Females* 4-year prevalence (I) 12.7%; $P < 0.01$ (C) 21.1% 6-year prevalence (I) 16.5% (C) 29.4%; $P < 0.01$ *Males* 4-year prevalence (I) 9.8%;, $P = 0.16$ (C) 14.4% 6-year prevalence (I) 13.0% (C) 17.1%; $P = 0.23$
Steenkamp et al., 1991 [77]	South Africa (original data)	Longitudinal study	1979–1983	Adults, ages 15–64 46% male	(I) 48-month billboard, print, poster, and mailing campaign‡, 1531; (C) control, 1308	Smoking an average of at least 1 cigarette or 1 gram of tobacco per day	Baseline prevalence (I) 28.1% (C) 29.5% 4-year prevalence (I) 18.8% (C) 19.9% percentage Reduction (I) −32.6% (C) −33.3% Net percentage change in smoking prevalence relative to control Males: 2.0% Females: −19.2%
Meshack et al., 2004 [154]	US (original data)	Before/after with comparison	Spring 2000–December 2000	Youths, grade 6 52% male	(I) 3 × 3 media and community program; media programs involved TV, radio, billboard, and print; $0.50 per capita in low-intensity group; $1.00 per capita in high-intensity group, 3618	Tobacco use in past 30 days	Percent change in prevalence at 8.5 months (among groups with no community program): High intensity: −20.8% Low intensity: −45.3% Comparison: −28.3%

Table 7: Continued.

Author, year	Country (Data source)	Study design	Dates of data collection	Population	Intervention, *n*	Smoking measure	Effect on smoking initiation, cessation or prevalence
Sly et al., 2001 [79]	US (original data)	Before/after with comparison	1998-1999	Youths, ages 12–17	(I) 12-month campaign with TV, radio, billboard, display ads, promotional items (stickers, lanyards, hats, t-shirts, etc.), 1600 GRPs per quarter, 1800; (C) control, 1000	At least a puff or two in the past 30 days	Baseline prevalence (I) 13.8% (C) 12.6% 12-month prevalence (I) 12.6% (C) 14.1% Percentage change (I) −8.9% (C) 11.9% $P < 0.05\%$
Farrelly et al., 2005 [78]	US (MTF)	Before/after w/o comparison	1997–2002	Youths, grades 8, 10, and 12	(I) 24-month TV campaign with 3867–20367 GRPs (cumulative exposure over 2-year period for the lowest and highest quintiles of exposure)	Any smoking in past 30 days	Percentage annual change in prevalence at 0–2 years *prior* to intervention: Total: −3.2% (−3.8, −2.6) 8th: −3.4% (−4.6, −2.1) 10th: −4.6% (−5.6, −3.6) 12th: −1.8% (−2.7, −1.0) Percentage annual change in prevalence at 0–2 years *after* intervention: Total: −6.8% (−7.5, −6.1) 8th: −9.0% (−10.4, −7.6) 10th: −8.7% (−9.8, −7.5) 12th: −5.1% (−6.1, −3.9)

* Additionally, there were 2 other intervention groups that included sweepstakes. Since sweepstakes are not a focus of this paper, they are not included here.
† This was part of a cardiovascular disease prevention campaign.
‡ This was part of a coronary risk factor campaign.
C: control group; CI: confidence interval; COMMIT: Community Intervention Trial for Smoking Cessation; GRPs: gross rating points; HR: hazard ratio; I: intervention group; MTF: Monitoring the Future: a Continuing Study of American Youth; NLSY97: National Longitudinal Survey of Youth 1997; NR: not reported; NS: not significant; OR: odds ratio; RCT: randomized controlled trial; RR: relative risk; TV: television; US: United States.

4.1. Increasing Taxes. We found evidence that increases in tobacco pricing independently reduced smoking prevalence among youths and adults. More limited data were available for low- and middle-income countries, with some studies finding an association with decreased smoking prevalence [29, 36] and others finding no difference [29, 39, 84]. Another review found that low- and middle-income countries tended to be more price sensitive than high-income countries [85]. Based on tobacco consumption data (from estimates of cigarette sales), they estimated a price elasticity of demand of −0.8 for low- and middle-income countries versus −0.4 for high-income countries. Many factors contribute to the heterogeneity in findings, including cigarette affordability, product substitution due to wide price ranges, industry activity to reduce price for consumers, opportunities for tax avoidance, smuggling, and smokers' level of addiction.

4.2. Banning Smoking in Public Places. We found evidence that smoking bans can have an impact on prevalence in the general population, with greater reductions found in smaller geographic areas with limited previous legislation, compared with studies conducted at the national level. Smoking bans likely impact general population behaviour through reducing smoking opportunities and denormalizing smoking [86]. The timing of a smoking ban relative to the underlying tobacco control environment may influence its effectiveness. For example, in settings with limited tobacco control activities, the implementation of a comprehensive ban may trigger a greater shift in social norms. In other settings, implementation may represent an incremental change in the coverage of smoke-free places after years of social norm change and prevalence declines. Different impacts on smoking behaviour would be expected under these scenarios. The effectiveness of a smoking ban also depends on the strength of prior legislation, comprehensiveness of legislation, level of enforcement, and public support [87]. Public support tends to be high and increases after implementation [86].

The International Agency for Research on Cancer (IARC) found sufficient or strong evidence that smoke-free workplaces reduce cigarette consumption and increase cessation rates and that smoke-free policies reduce youth tobacco use [86]. The authors also concluded that a greater decline in smoking could be expected when the policy was part of a comprehensive tobacco control program. In the present paper, we excluded studies that examined specific workplace policies on employee behavior, in order to estimate impacts across the entire population. The studies in the IARC review were all conducted in high-income countries. With the increased adoption of smoking bans in low- and middle-income countries, more evaluation is needed.

4.3. Banning Advertising and Sponsorship of Tobacco Products. We found insufficient evidence to estimate the direct impact of advertising bans or restrictions on smoking initiation, cessation, or prevalence in the general population. The youth studies suggest that advertising bans may play a role in reducing smoking; however, methodological limitations restrict inferences that can be drawn.

Despite limited direct evidence of the impact of advertising bans, the role of tobacco advertising on smoking initiation is well established [88–91]. Advertising increases positive user imagery of tobacco, distorts the utility of tobacco use, increases curiosity about tobacco use [91], and influences normative beliefs and perceptions of tobacco use prevalence [92], all predictive of future smoking experimentation. Youth exposure to tobacco marketing has been associated with a doubling of the chances of initiation [93]. Comprehensive bans are the only effective way to eliminate tobacco marketing exposure, as the tobacco industry subverts restrictions by substituting marketing channels are not covered by existing laws [94].

4.4. Health Warning Labels. We found insufficient evidence describing the direct impact of introducing or strengthening cigarette warning labels on smoking initiation, cessation, or prevalence. The few studies that were identified were not designed specifically to address the impact of warning labels on these outcomes.

Cigarette health warning labels are a means for delivering messages about health risks from smoking and resources for obtaining help to quit. Warning labels can be implemented with little cost to governments, in comparison with mass media campaigns [95, 96]. Despite the limited direct evidence, indirect evidence describes the impact of warning messages on knowledge, salience, and cognitive processing (reading, thinking about, and discussing the warning labels) and the association between these intermediate outcomes and quit intentions, quit attempts, or cessation behavior [97]. Health warnings increase knowledge of health effects [95, 98] and have been cited as a motivating factor among quitters [99]. Studies evaluating graphic, pictorial warning labels in Canada and Australia have shown high levels of cognitive processing [96, 98, 100] and an association between cognitive processing and quitting intention and behavior [70, 98, 100, 101]. In Malaysia, a country with small, text-based warnings, a cross-sectional association was observed between cognitive processing of warning labels and intention to quit and self-efficacy among male smokers [102]. These studies provide indirect evidence for a role of health warning labels in smoking behavior.

4.5. Mass Media Campaigns. We found evidence that mass media campaigns can have an independent effect on reducing initiation of smoking in youths and prevalence in adults [73–75]. Differences observed in the impact of mass media campaigns are likely due, in part, to differences in content, tone, and reach. Although it is not clear which types of messages work best, behavioral research has suggested that adult audiences are most likely to respond to graphic depictions of the health consequences of smoking, and that youth audiences are more likely to respond to messages about tobacco industry deception and manipulation [103–105]. Conversely, messages focusing on smoking as an adult

choice, commonly used in tobacco industry sponsored campaigns, have been shown to be ineffective or even increase youth tobacco use [103, 104, 106]. Campaign messages need to be sufficiently funded to ensure enough exposure [103, 104], tailored to the audience, and varied and rotated to keep them salient [88, 104, 105].

Our findings are consistent with prior evidence. A recent National Cancer Institute monograph concluded that mass media campaigns, even those independent of other community-wide programs, are effective at reducing smoking prevalence [103]. Several reviews have concluded that mass media campaigns are effective in reducing youth tobacco use, specifically when combined with other tobacco control programs [104, 107]. A Cochrane review, however, concluded that tobacco control programs with mass media components can be effective in reducing adult smoking, but the evidence is based on studies of "variable quality" and the "specific contribution of the mass media component is unclear" [108].

4.6. Limitations. Our paper had several limitations. First, we only included studies that evaluated the independent impact of a policy or intervention, thereby excluding studies of multicomponent tobacco control programs. Many studies have demonstrated the effectiveness of multicomponent tobacco control programs [109–111]. Policies are most often implemented in combination with others. Even if they are not implemented on the same date, it is often not possible to analytically separate out their independent contributions. However, evaluation of multicomponent interventions inherently captures the potential synergistic or duplicative effects of policies implemented in combination and provides a range of achievable impacts at the population level.

By limiting our paper to the effects of tobacco control interventions on smoking prevalence, initiation, and cessation, we excluded several other intermediate outcomes, such as tobacco consumption. Tobacco consumption data (i.e., cigarette sales data) is routinely collected in many countries, whereas prevalence data requires conducting surveys. Many studies have demonstrated that increased tobacco prices lead to lower per capita cigarette consumption in low-, medium-, and high-income countries [94, 112–142]. Additionally, studies evaluating per capita consumption have generally found an association between comprehensive advertising bans and reduced cigarette consumption in both developed and developing countries [94, 126]. Including tobacco consumption, data could have strengthened our conclusions on the effectiveness of these interventions. However, tobacco consumption data does not allow us to distinguish between reduced smoking prevalence and reduced consumption among smokers. Policies and interventions can affect outcomes beyond smoking behavior [143]. As mentioned earlier, health warning labels can impact on knowledge, salience, and cognitive processing, which can influence behavior. Inclusion of these other outcomes could have strengthened our results.

Many tobacco control interventions affect entire communities or countries. Complex social and cultural contexts often limit the ability to identify comparable groups of individuals or regions of study. As a result, comparison groups may vary on characteristics related to smoking behavior in the population [103]. In the absence of comparable control groups, time series or pre-/post- studies provide useful evidence for effectiveness. Information on prior trends is preferred to a single estimate before and after an intervention [103], but this requires rich surveillance data which may not be available in all settings. In longitudinal studies, participant attrition leads to the potential for selection bias and a reduction in statistical power.

Most studies included in this paper were from high-income countries, in part because they are more likely to have implemented policies. However, they may not necessarily predict the impact in low- and middle-income countries. With global expansion of tobacco control efforts through the FCTC, a wide range of programs and policies are being implemented across the world. Rigorous evaluation of these programs is needed to determine the effectiveness in reducing tobacco use. Previous studies have suggested that lower income populations may be more sensitive to demand-side tobacco control activities. For example, it is well established that low-income populations are more sensitive to changes in price [85]. In addition, Blecher found a greater association between strength of advertising bans and per capita cigarette consumption in developing compared with developed countries [126]. The author suggested that the lower level of awareness of tobacco-related harm increases the public's susceptibility to tobacco marketing. Similarly, introduction of health warning labels may have a greater impact in settings with fewer other sources of antitobacco information. In addition, implementation of smoking bans could produce a greater change in social norms than in settings, where smoking has been declining for years due to concerted tobacco control efforts.

5. Conclusion/Recommendations

Estimates of the impact of tobacco control policies are critical for setting achievable targets for reductions in smoking prevalence. For several of the policies, we found high or moderately strong evidence that these interventions can independently reduce smoking prevalence in the general population. However, a wide range of impacts were observed. Factors influencing the observed impact likely include the strength of the policy and level of enforcement; promotion around its implementation; the content, tone, and reach of a mass media campaign; the underlying tobacco control environment; strategic activities of the tobacco industry to dampen the effect of policies and programs. Future studies should attempt to characterize these factors to understand the variation in impacts.

Simulation models should account for this uncertainty by incorporating sensitivity analyses or probabilistic approaches to evaluate a possible range of effectiveness. For some policies, indirect evidence can be incorporated with simplifying assumptions, such as studies using per capita consumption or shorter-term outcomes that have

been shown to predict subsequent smoking behavior change. Finally, given the number of studies evaluating comprehensive, multicomponent programs, models could be developed to incorporate this evidence, rather than assuming that individual interventions implemented in combination will act independently. Any approach to predict future smoking patterns will require some simplifying assumptions, but modeling can provide critical tools to inform decision-making and priority setting and to set realistic goals for reducing smoking prevalence and improving public health.

Appendix

PubMed Search Strategies

The following Search Strings were used.

Search Number 1. (("Smoking/epidemiology"[mh] OR "Smoking/prevention and control"[mh] OR "Smoking/economics"[mh] OR smoking[tiab] OR smoker*[tiab] OR smoked[tiab] OR cigarette*[tiab] OR tobacco[tiab] OR cigar[tiab] OR bidi*[tiab] OR hooka*[tiab] OR waterpipe*[tiab] OR kretek*[tiab] OR shisha*[tiab]) AND (price[tiab] OR prices[tiab] OR tax[tiab] OR taxes[tiab] OR taxation[tiab])) NOT (animals[mh] NOT humans[mh]).

Search Number 2. (("Smoking/epidemiology"[mh] OR "Smoking/prevention and control"[mh] OR "Smoking/psychology"[mh] OR "Smoking/legislation and jurisprudence"[mh] OR smoking[tiab] OR smoker*[tiab] OR smoked[tiab] OR cigarette*[tiab] OR tobacco[tiab] OR cigar*[tiab] OR bidi*[tiab] OR hooka*[tiab] OR waterpipe*[tiab] OR kretek*[tiab] OR shisha*[tiab]) AND (((bars[tiab] OR pubs[tiab] OR (employee*[tiab] AND (polic*[tiab] OR program*[tiab])) OR indoor*[tiab] OR restaurant*[tiab] OR workplace*[tiab] OR workplace*[tiab] OR office*[tiab] OR hospital*[tiab]) AND (smoke-free[tiab] OR smokefree[tiab] OR "smoke free"[tiab] OR anti-smoking[tiab] OR antismoking[tiab] OR no-smoking[tiab] OR "no smoking"[tiab] OR non-smoking[tiab] OR nonsmoking[tiab] OR (smoking[tiab] AND employee*[tiab]) OR ban[tiab] OR bans[tiab] OR banning[tiab] OR law[tiab] OR legislation[tiab] OR prohibiti*[tiab] OR "smoking restriction"[tiab] OR "smoking restrictions"[tiab] OR "tobacco restriction"[tiab] OR ordinance*[tiab])) OR ((smoke-free[tiab] OR smokefree[tiab] OR "smoke free"[tiab] OR anti-smoking[tiab] OR antismoking[tiab] OR no-smoking[tiab] OR "no smoking"[tiab] OR non-smoking[tiab] OR nonsmoking[tiab] OR "smoking ban"[tiab] OR "smoking bans"[tiab]) AND (ban[tiab] OR bans[tiab] OR banning[tiab] OR law[tiab] OR legislation[tiab] OR prohibiti*[tiab] OR "smoking restriction"[tiab] OR "smoking restrictions"[tiab] OR ordinance*[tiab])))) NOT (animals[mh] NOT humans[mh]).

Search Number 3. (("Smoking/epidemiology"[mh] OR "Smoking/prevention and control"[mh] OR "Smoking/psychology"[mh] OR "Smoking/legislation and jurisprudence"[mh] OR smoking[tiab] OR smoker*[tiab] OR smoked[tiab] OR cigarette*[tiab] OR tobacco[tiab] OR cigar*[tiab] OR bidi*[tiab] OR hooka*[tiab] OR waterpipe*[tiab] OR kretek*[tiab] OR shisha*[tiab]) AND ((advertis*[tiab] OR brand*[tiab] OR marketing[tiab] OR ordinance*[tiab] OR message*[tiab] OR television[tiab] OR tv[tiab] OR televised[tiab] OR "motion pictures"[tiab] OR radio[tiab] OR newspaper*[tiab] OR movie*[tiab] OR "in-store"[tiab] OR "in store"[tiab] OR magazine*[tiab] OR email[tiab] OR "e-mail"[tiab] OR internet[tiab] OR web[tiab] OR print[tiab] OR campaign*[tiab] OR commercial[tiab] OR commercials*[tiab] OR ((display[tiab] OR displays[tiab]) AND (retail[tiab] OR store[tiab] OR "point of purchase"[tiab] OR "point-of-purchase"[tiab OR "point of sale"[tiab] OR "point-of-sale"[tiab] OR "self-service"[tiab] OR "self service"[tiab] OR "self-serve"[tiab] OR "self serve"[tiab])) OR sponsor*[tiab]) AND ((adolescent*[tiab] OR children[tiab] OR minor*[tiab] OR teenager*[tiab] OR teens[tiab] OR "under-age"[tiab] OR young[tiab] OR youth*[tiab] OR kids[tiab]) OR (ban[tiab] OR bans[tiab] OR banning[tiab] OR law[tiab] OR laws[tiab] OR legislation*[tiab] OR sale[tiab] OR sales[tiab] OR purchas*[tiab] OR initiat*[tiab] OR behav*[tiab] OR restrict*[tiab] OR forbid*[tiab] OR prohibit*[tiab])))) NOT (animals[mh] NOT humans[mh]).

Search Number 4. (("Smoking/epidemiology"[mh] OR "Smoking/prevention and control"[mh] OR "Smoking/psychology"[mh] OR "Smoking/legislation and jurisprudence"[mh] OR smoking[tiab] OR smoker*[tiab] OR smoked[tiab] OR cigarette*[tiab] OR tobacco[tiab] OR cigar*[tiab] OR bidi*[tiab] OR beedi*[tiab] OR hooka*[tiab] OR waterpipe*[tiab] OR kretek*[tiab] OR shisha*[tiab] OR chutta*[tiab] OR dhumti*[tiab] OR hookli*[tiab] OR chillum*[tiab]) AND ((health[tiab] AND (warning*[tiab] OR label*[tiab])) OR (warning*[tiab] AND label*[tiab]) OR ((mild[tiab] OR light[tiab] OR "low tar"[tiab]) AND (packs[tiab] OR packet*[tiab] OR package*[tiab] OR label*[tiab])) OR (("mass media"[tiab] OR television[tiab] OR tv[tiab] OR televised[tiab] OR "motion pictures"[tiab] OR radio[tiab] OR newspaper*[tiab] OR movie*[tiab] OR "in-store"[tiab] OR "in store"[tiab] OR magazine*[tiab] OR email[tiab] OR "e-mail"[tiab] OR internet[tiab] OR web[tiab] OR print[tiab] OR advertis*[tiab] OR campaign*[tiab] OR promotion*[tiab] OR marketing[tiab] OR commercial*[tiab] OR packs[tiab] OR package*[tiab] OR packet*[tiab]) AND (initiat*[tiab] OR cessation[tiab] OR quit[tiab] OR quitting[tiab] OR stop[tiab] OR stopping[tiab] OR antismoking[tiab] OR "anti-smoking"[tiab] OR antitobacco[tiab] OR antitobacco[tiab])))) NOT (animals[mh] NOT humans[mh]).

Search Number 5. Number 1 OR Number 2 OR Number 3 OR Number 4.

Conflict of Interests

The authors declare that they have no conflict of interests.

Authors' Contribution

E. A. Tang, G. Chander, H. E. Hutton, O. A. Odelola, J. L. Elf, B. M. Heckman-Stoddard, E. B. Bass, E. A. Little, and E. B. Haberl B. J. Apelberg contributed equally to this paper.

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Research Article

Exploring the Next Frontier for Tobacco Control: Nondaily Smoking among New York City Adults

Rachel Sacks, Micaela H. Coady, Ijeoma G. Mbamalu, Michael Johns, and Susan M. Kansagra

Bureau of Chronic Disease Prevention and Tobacco Control, New York City Department of Health and Mental Hygiene, CN-18, Queens, NY 11101, USA

Correspondence should be addressed to Rachel Sacks, rachel.sacks.mph@gmail.com

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Objective. Among current smokers, the proportion of Nondaily smokers is increasing. A better understanding of the characteristics and smoking behaviors of Nondaily smokers is needed. *Methods*. We analyzed data from the New York City (NYC) Community Health Survey to explore Nondaily smoking among NYC adults. Univariate analyses assessed changes in Nondaily smoking over time (2002–2010) and identified unique characteristics of Nondaily smokers; multivariable logistic regression analysis identified correlates of Nondaily smoking in 2010. *Results*. The proportion of smokers who engage in Nondaily smoking significantly increased between 2002 and 2010, from 31% to 36% ($P = 0.05$). A larger proportion of Nondaily smokers in 2010 were low income and made tax-avoidant cigarette purchases compared to 2002. Smoking behaviors significantly associated with Nondaily smoking in 2010 included smoking more than one hour after waking (AOR = 8.8, 95% CI (5.38–14.27)); buying "loosies" (AOR = 3.5, 95% CI (1.72–7.08)); attempting to quit (AOR = 2.3, 95% CI (1.36–3.96)). *Conclusion*. Nondaily smokers have changed over time and have characteristics distinct from daily smokers. Tobacco control efforts should be targeted towards "ready to quit" Nondaily smokers.

1. Introduction

Nondaily smoking, also referred to as intermittent or occasional smoking, represents a new challenge for tobacco research and control, both nationally and in New York City (NYC). Expanding smoke-free environments and higher cigarette taxes have been associated with declines in daily smoking nationwide and on a state-by-state basis [1–4]. However, alongside this downward trend in daily smoking, Nondaily smoking has risen. Between 2002 and 2010, the proportion of Nondaily smokers within the US adult smoker population rose [5, 6].

A better understanding of the Nondaily smoking population is needed in order to inform the development of educational efforts and cessation interventions that address this shift in the smoking population [7–10]. Previous studies have characterized Nondaily smoking as either an indicator of a tobacco initiation period common among college students and young adults [11, 12], a transition stage among daily smokers that precedes cessation [13–15], or a stable, long-term smoking behavior [1, 13]. Due to their high rates of quit attempts [8, 16], Nondaily smokers are also seen as a "ready to quit" subgroup of smokers that could benefit from cessation advice [7, 17]. Yet tobacco control programs and healthcare providers may be overlooking these smokers, either because Nondaily smokers do not self-identify as "smokers" [1, 2, 13], do not perceive themselves at risk for the negative health consequences of smoking [1, 7, 17], or may be ineligible for cessation programs that provide pharmacotherapy [18].

Communicating the dangers of smoking to Nondaily smokers is further complicated by the existence of subgroups within this population. Previous studies have described Nondaily smokers as younger, predominantly female, better educated, and wealthier than daily smokers [14, 19]. Research has also found greater representation of racial/ethnic minorities among Nondaily smokers as compared to daily smokers [7, 17, 20], and particularly high levels of Nondaily smoking among Hispanics [21]. However, these broad demographic categories may not provide sufficient

information to inform targeted cessation interventions for Nondaily smokers, especially considering the diversity of smoking behaviors seen in this population [1, 7]. The so-called social smokers who smoke primarily in social situations have been the subject of exploratory research that has identified associations between smoking and binge drinking, especially among college students [11, 22, 23]. By contrast, former daily smokers who have reduced their smoking in response to tax increases or smoke-free air laws represent a different subgroup of the Nondaily smoking population that may be older and more sensitive to tobacco control policies than social smokers [24–26].

NYC provides an ideal environment in which to examine a diverse population of smokers to both assess Nondaily smoking over time and more closely examine the demographic and smoking characteristics of Nondaily smokers. In 2002, NYC launched a comprehensive tobacco control plan that included (1) taxation, including four cigarette tax increases since 2002; (2) legislation, which rendered workplaces smoke-free, including restaurants and bars; (3) expansion of treatment options for smokers via provision of nicotine replacement therapy for daily smokers; (4) intensive antitobacco education via various media channels. After implementing this plan, the prevalence of adult smoking in NYC dropped significantly from 22% in 2002 to 16% in 2009 [27].

Using a population-based survey of NYC adults, our objectives were threefold: (1) to assess whether the proportion and characteristics of Nondaily smokers have changed between 2002 and 2010; using the 2010 data only, (2) to compare the demographic characteristics, and smoking behaviors of different types of smokers (Nondaily, light daily and heavy daily); (3) to explore characteristics associated with Nondaily smoking.

2. Materials and Methods

2.1. Data Collection and Sample. Nondaily smoking data were collected using the NYC Community Health Survey (CHS), a population-based, random-digit-dialed telephone survey of approximately 10,000 NYC adults, aged 18 or older. The NYC DOHMH has conducted the CHS annually since 2002. The survey is available in multiple languages, including Spanish, Russian, and Chinese. All interviews were conducted by trained interviewers.

In 2002, eligible households were contacted using landlines only. A total of 9,674 interviews were conducted, representing a 36% response rate and a 69% cooperation rate among contacted households [28]. In 2010, landlines and cell phone numbers were used to contact potential respondents, resulting in 8,665 interviews. Response and cooperation rates of 34% and 88% for landline users and 46% and 96% for cell phone users were achieved among those contacted.

2.2. Instrument. The NYC CHS instrument was adapted from the Centers for Disease Control's Behavioral Risk Factor Surveillance System (BRFSS) [29]. The tobacco module includes questions related to current smoking, secondhand smoke exposure, responses to increases in taxation of tobacco products, and smoking cessation.

Current smoking was defined as presently smoking on all or some days and having smoked at least 100 cigarettes in a lifetime; "Nondaily" smoking was defined as smoking on some days. Daily smokers were classified as "heavy" or "light" depending on the number of cigarettes smoked per day (CPD). Heavy smoking was defined as 11 or more CPD; light smoking as 10 or less CPD. Respondents who reported smoking 11 or more CPD on some days were classified as heavy smokers (19 cases in 2002 and 4 cases in 2010).

Missing CPD data was imputed (40 cases in 2002, 69 cases in 2010) using mean replacement. In 2002, the mean number of cigarettes per day was calculated using only everyday smokers. In 2010, respondents were first asked how many cigarettes they smoked on the days they smoked and then asked how many days per month they smoked. When the number of cigarettes smoked was available but number of days smoked was missing, the days smoked were replaced with the mean of days smoked for all Nondaily smokers. If both the number of cigarettes smoked and days smoked were missing, then values were imputed based on the mean for Nondaily smokers.

A quit attempt was defined as intentional cessation for at least 24 hours in the past year [30]. Binge drinking was defined as having more than five drinks (males) or more than four drinks (females) on a single occasion within the last 30 days [31].

The survey was modified between 2002 and 2010. Questions about the location of cigarette purchases produced a large number of missing responses. The instrument was subsequently modified to include specific modes of tax-avoidant purchase (internet/mail, another person/street in NYC, in New York State (NYS) outside NYC, other state, Indian reservation, outside USA, duty free).

The household measure of income has also changed. In 2002, respondents were asked to provide their yearly household income. For 2010, respondents' poverty level was measured based on federal poverty level (FPL) thresholds (<200% FPL, 200–<400% FPL, ≥400% FPL), annual income thresholds used to estimate the number of people in poverty nationwide. To enable comparisons between 2002 and 2010, a new poverty variable for 2002 was created and estimated from the income variable. The estimation incorporated observations with partial information on income and corrects for observations with insufficient information to assign an income category.

The 2010 survey also included items to measure how many days per week and month cigarettes were smoked to more accurately measure CPD. To assess a key dimension of nicotine dependency, the 2010 survey asked "how soon after waking up do you smoke your first cigarette?"

Because the CHS uses a complex sampling design, analyses require the use of a stratifying variable and a weighting variable. The stratifying variable has 34 strata that represent neighborhoods derived from the United Hospital Fund (UHF) classification system [32]. An additional stratum was added in 2010 to represent the cell phone only sample. The weighting variable adjusts for probability of selection

and poststratification. Poststratification is accomplished by weighting each record up to the population of the neighborhood (as defined by UHF), while taking into account the respondent's age, gender, and race. Starting in 2009, responses were also weighted to account for the distribution of the adult population comprising three telephone usage categories (landline only, landline and cell, cell only) using data from the 2008 New York City Housing and Vacancy Survey.

For each survey year, cases were required to have nonmissing values for at least three or more of the following variables in order to meet BRFSS guidelines for completeness: age, Hispanic status, race/ethnicity, marital status, education, employment, and phone (do you have more than one telephone in your household?). From the base sample of complete interviews in 2002 ($N = 9,674$) and in 2010 ($N = 8,665$), our final analytic sample included 2,113 smokers in 2002 and 1,141 smokers in 2010.

2.3. Statistical Analysis. Changes in the number and proportion of Nondaily, light, and heavy smokers were assessed by comparing 2002 and 2010 data. Additionally, to compare characteristics and behaviors that were associated with being a Nondaily smoker, proportions were calculated for each variable of interest using the 2002 and 2010 datasets. Variables included were selected based on *a priori* knowledge of characteristics and behaviors associated with Nondaily smoking [1, 7, 14, 24]: age, race/ethnicity, gender, borough of residence, education level, and income; we also examined quit attempts, healthcare professional advice regarding cessation, having a smoke-free home policy, time to first cigarette after waking, source of last cigarette purchased (carton, pack, or loose single), and location of last cigarette purchase. Source and location of last cigarette were used to assess smokers' purchasing patterns for evidence of tax-avoidant purchases. Chi-square tests were used to identify significant variation between 2002 and 2010 among the stratifying variables. Significant chi-squares were followed up with pairwise comparisons between 2002 and 2010 prevalence estimates using t tests. A multivariable analysis was used to test the significance of changes in characteristics of the Nondaily smoker population between 2002 and 2010. Variables found to be significant in bivariate analysis ($P < 0.05$) were included in the multivariable model.

Next, using 2010 data, we compared demographic and smoking-related characteristics of Nondaily smokers to those of light smokers and heavy smokers, separately, in order to identify significant differences in these populations. Chi-square tests were used to identify significant variation between groups; significant chi-square tests were followed up with pairwise comparisons using t-tests. All differences were considered significant at $P < 0.05$.

A multivariable logistic regression model was used to identify characteristics associated with Nondaily smoking in 2010. The dependent variable was a dichotomous indicator of Nondaily (coded as 1) versus daily smoking (coded as 0). Independent variables found to be significant in bivariate analysis ($P < 0.05$) were considered candidates in the multivariable model. Potential confounding variables were also included in the model based on *a priori* knowledge of characteristics and behaviors associated with Nondaily smoking [1, 7, 12, 14].

To assess effect modification, we also included interaction terms derived from previous research. Several studies suggest that the relationship between Nondaily smoking and education may be modified by sex, and the association between Nondaily smoking and binge drinking may be modified by race [11, 17, 23]. Thus, we included terms for these interactions in the model. An interaction term between tax-avoidant purchasing behavior and smoking rules in the home was also included to help explain the relationship between Nondaily smoking and home smoking rules, which has been found in previous research [7]. The final model included three interaction terms: sex x education level; racial/ethnicity X binge drinking; and having a smoke-free home policy X tax-avoidant purchasing behavior. Significant effects were retained in the final model. Model fit was assessed using the likelihood ratio test. Adjusted odds ratios (AORs) and corresponding 95% confidence intervals (CIs) and P values were derived from the final models.

All analyses were conducted using the survey procedures in SAS v.9.1 (SAS Institute Inc., Cary, NC) and SAS-callable SUDAAN v.10 (Research Triangle Institute, Research Triangle Park, NC) to account for the complex survey design, incorporate the survey weights and age standardize estimates. In the descriptive analyses, all estimates were standardized to the US 2000 standard population using four age strata (18–24; 25–44; 45–64; 65+). All analyses (descriptive and multivariable) were weighted to the NYC adult population.

3. Results

3.1. Changes in Nondaily Smoking over Time. Between 2002 and 2010, NYC saw a 35% overall decline in adult smoking prevalence in NYC, from 22% to 14% (data not shown). Since 2002, the number of heavy smokers in NYC has declined by more than half, from an estimated 490,000 in 2002 (representing 8% of the adult population) to about 226,000 in 2010 (representing 4% of the adult population) (Figure 1). The number of Nondaily smokers declined by about one-quarter from an estimated 410,000 in 2002 (representing 7% of the adult population) to about 311,000 in 2010 (representing 5% of the adult population). The decrease in the number of light smokers was similar to that of Nondaily smokers. In 2002 and 2010, the majority of current smokers was either Nondaily or light smokers (62% and 73%, resp.).

In 2002, about one-third (31%) of adult smokers in NYC reported smoking only on some days (Table 1); that percentage significantly increased to 36% in 2010 ($P = 0.050$). Across both years (2002 and 2010), Nondaily smokers were most likely to be between 25 and 44 years old (range of 52-53% across years), white (41% in both years), and have at least some college education (55–61%). The majority of participants reported making a quit attempt in the last

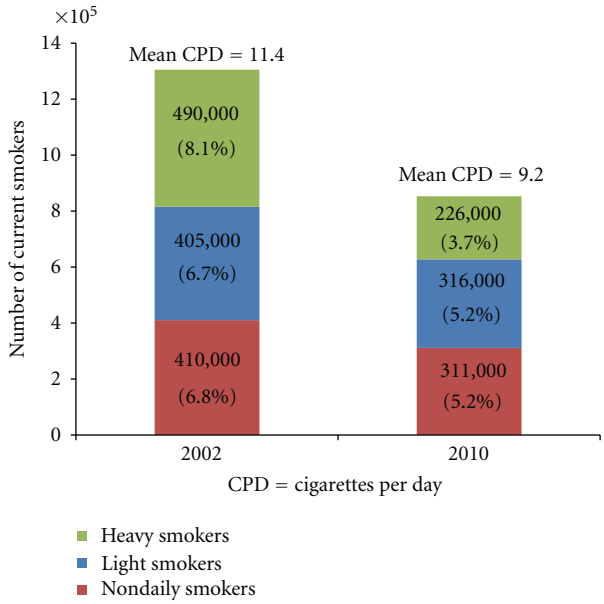

Figure 1: *Types of smokers, 2002 versus 2010.* Source: Community Health Survey 2002, 2010. Data are age-standardized to the US 2000 Standard Population. Estimated number and proportions are among the total NYC population aged 18 years and older.

12 months (range of 73-74% across years) and 27–29% engaged in binge drinking. Nondaily smokers were more likely to make tax-avoidant purchases in 2010 (29%) than in 2002 (12%).

Two demographic characteristics of Nondaily smokers differed across years (Table 1). While the proportion of Nondaily smokers living in the borough of Manhattan declined from 29% in 2002 to 16% in 2010 ($P < 0.001$), the proportion that resides in Queens increased (23% in 2002 versus 32% in 2010, $P = 0.022$). Finally, the proportion of Nondaily smokers in the lowest income category increased from 2002 to 2010 (33% versus 46%, $P = 0.004$), while the proportion in the middle income category declined (34% versus 22%, $P = 0.004$). The proportion of Nondaily smokers who did not allow smoking in the home increased (41% versus 52%, $P = 0.001$).

Multivariable logistic regression analyses designed to test if the changes in these characteristics were significant between 2002 and 2010 showed that only the decrease in residents in Manhattan remained significant after controlling for demographic characteristics and smoking behaviors (AOR = 0.3, 95% CI (0.10, 0.89); data not shown). Thus, there were fewer Nondaily smokers in Manhattan in 2010 than in 2002.

3.2. Characteristics Associated with Nondaily Smoking in 2010. Several significant differences in demographic and smoking characteristics were found between Nondaily, and light or heavy smokers in 2010 (Table 2). Whites were less likely to be Nondaily smokers than heavy smokers (41% versus 54%, $P < 0.05$), while blacks were more likely to be Nondaily smokers than heavy smokers (25% versus 10%, $P < 0.05$). Males were also more likely to be Nondaily smokers than heavy smokers (51% versus 66%, $P = 0.029$). The highest rate of quit attempts was among Nondaily smokers, while the percent of smokers advised to quit by a healthcare professional was lowest among Nondaily smokers in comparison to light and heavy smokers (44% versus 60% and 65%; Ps < 0.01). Compared to heavy smokers, more Nondaily smokers reported having rules about smoking in the home (52% versus 27%, $P < 0.001$). Most Nondaily smokers (79%) reported smoking their first cigarette of the day more than one hour after waking, in comparison to light smokers (41%) and heavy smokers (15%), $P < 0.001$. Significantly fewer Nondaily smokers smoked their last cigarette from a carton, as compared to heavy smokers (8% versus 35%, $P < 0.001$), and from a pack, as compared to light smokers (66% versus 77%, $P < 0.001$).

3.3. Correlates of Nondaily Smoking. The results of the multivariable model are reported in Table 3. In the adjusted model, Nondaily smokers were more likely to smoke their first cigarette of the day more than one hour after waking (AOR = 8.8, 95% CI (5.38–14.27)). Other variables associated with being a Nondaily smoker included buying single loose cigarettes (AOR = 3.5, 95% CI (1.72–7.08)), and making a quit attempt in the last year (AOR = 2.3, 95% CI (1.36–3.96)). Our results further suggest that the relationship between Nondaily smoking and having rules limiting smoking in the home varies as a function of cigarette purchasing behavior (AOR = 6.57, 95% CI (1.96–22.01)). Among smokers who try to avoid NYC cigarette taxes, Nondaily smoking was more common among those with rules limiting smoking in the home (AOR = 3.51, 95% CI (2.76–4.47)) but not for non-tax-avoidant smokers (AOR = 0.54, 95% CI (0.20–1.41)). Similarly, race moderated the relationship between binge drinking and Nondaily smoking (OR = 4.62, 95% CI (1.59–13.48)). The odds of being a Nondaily smoker was higher for racial/ethnic minorities who engage in binge drinking (AOR = 2.06, 95% CI (1.61–2.64)) but this did not hold for whites (AOR = 0.45, 95% CI (0.20–1.01)). There was also evidence that sex moderated the relationship between Nondaily smoking and educational attainment (OR = 2.49, 95% CI (0.91–6.82), $P = .08$). Males with at least some college education had more than twice the odds of being a Nondaily smoker (AOR = 2.6, 95% CI (1.23–5.43)), while the odds of being a Nondaily smoker among females did not vary by education (AOR = 1.03, 95% CI (0.80–1.35)). Income was collinear with education and excluded from the model.

4. Discussion

4.1. Key Results and Main Conclusions. Nondaily smokers now account for more than one-third of all adult smokers in NYC, and this proportion is much higher than the proportion seen nationally [6]. We noted a significantly higher proportion of Nondaily smokers were Queens residents in 2010 than in 2002, and rates of Nondaily smoking rose faster among New Yorkers in the lowest income

Table 1: Characteristics of Nondaily adult smokers aged 18 years and older, by select demographics—New York City Community Health Survey 2002 versus 2010.

	2002		2010		Chi-square test
	%	95% CI (LCI, UCI)	%	95% CI (LCI, UCI)	*P* value
Nondaily smokers overall	30.6	(28.1, 33.3)	35.6	(31.5, 40.0)	0.049
Age group					
18–24	17.4	(13.8, 21.7)	14.6	(9.5, 22.0)	
25–44	53.3	(48.4, 58.2)	52.0	(44.8, 59.1)	
45–64	23.6	(19.8, 27.9)	26.8	(21.4, 32.9)	0.723
65+	5.7	(4.0, 8.0)	6.6	(4.5, 9.6)	
Race/Ethnicity					
White non-Hispanic	40.7	(35.8, 45.9)	41.3	(34.6, 48.4)	
Black non-Hispanic	24.5	(20.4, 29.2)	25.0	(20.0, 30.8)	
Hispanic	24.3	(20.5, 28.6)	27.2	(21.5, 33.6)	0.516
Other non-Hispanic	10.4	(7.4, 14.4)	6.6	(3.8, 11.1)	
Male	49.0	(44.0, 54.1)	50.6	(43.8, 57.3)	0.955
Borough of residence					
Bronx	16.4	(12.9, 20.6)	16.7	(12.3, 22.2)	
Brooklyn	26.6	(22.5, 31.2)	30.2	(24.7, 36.5)	
Manhattan	28.7	(24.3, 33.5)	15.6*	(11.3, 21.1)	0.005
Queens	23.0	(18.6, 28.0)	32.4*	(26.2, 39.2)	
Staten Island	5.4	(3.8, 7.5)	5.1^	(2.7, 9.4)	
HS Graduate or Less (among adults aged 25+)	45.1	(40.0, 50.3)	39.2	(32.8, 46.0)	0.348
Income From All Sources (% federal poverty level)					
<200 FPL	33.4	(28.2, 39.0)	46.4*	(39.4, 53.5)	
200–<400 FPL	33.7	(28.4, 39.3)	21.6*	(16.2, 28.4)	0.016
≥400 FPL	33.0	(28.1, 38.3)	32.0	(25.5, 39.2)	
Smoking Cessation (past 12 months)					
Tried to quit smoking	73.9	(69.1, 78.3)	73.4	(67.1, 79.0)	0.776
Received provider advice to quit smoking	43.9	(38.9, 48.9)	43.5	(37.1, 50.1)	0.566
Smoking is not allowed in the home	40.9	(35.8, 46.2)	52.3	(46.0, 58.6)	0.001
Last cigarette purchased from tax-avoidant location	12.1	(9.1, 16.0)	29.3	(22.7, 36.8)	<.001
Binge drinking (last 30 days)	27.2	(23.1, 31.7)	28.7	(23.0, 35.1)	0.774

* Significant difference between 2002 and 2010, $P < .05$; indicated on variables with more than two levels.
^ Estimate's Relative Standard Error (a measure of estimate precision) is greater than 30% or the sample size is too small, making the estimate potentially unreliable.
n/c: not calculated because one or more estimates is unreliable.
We present only one category for dichotomous variables to eliminate redundancy in the table.

category during that period. Together these trends suggest an increase in Nondaily smoking among lower-income New Yorkers—a departure from earlier studies that have associated Nondaily smoking with higher income and education levels [19, 24, 33]. Alongside these demographic shifts, there was an increase in purchasing behaviors associated with tax avoidance between 2002 and 2010. Price increases on cigarettes resulting from higher taxes seem the most plausible explanation for this shift. Within the context of NYC's tobacco control efforts, this trend suggests that low-income and price-sensitive smokers may be consuming fewer cigarettes in response to higher prices.

Binge drinking has been explored in previous studies, particularly as it relates to college students and social smoking [9, 11, 12, 23]. The small sample size of 18–24-year olds in our study prevents us from detecting and exploring trends among this age group. However, we documented that nearly one-third of Nondaily smokers have engaged in binge drinking and found that Nondaily smokers were more likely to be racial/ethnic minorities in comparison to heavy smokers.

Our results suggest that Nondaily smokers may be a "ready to quit" population that is less nicotine dependent than other groups of smokers [1, 7, 26]. Compared to light and heavy smokers, Nondaily smokers were more likely to have tried to quit smoking and to wait longer to smoke their first cigarette, suggesting a lower level of nicotine dependency [34]. Nondaily smokers were also more likely to purchase

Table 2: Characteristics of Nondaily, light and heavy smokers, current adult smokers aged 18 years and over—New York City Community Health Survey, 2010.

	Nondaily smoker %	Light smoker %	Heavy smoker %	*P* value
Overall	35.6	37.0	27.4*	0.009
Mean cigarettes per day (SE)	1.8 (0.1)	7.1 (0.2)*	23.4 (1.0)*	<.001
Age group				
18–24	14.6	16.4	5.0^	0.061
25–44	52.0	45.4	47.5	
45–64	26.8	30.5	36.3	
65+	6.6	7.7	11.2	
Race/Ethnicity				
White non-Hispanic	41.3	31.3*	54.0*	<.001
Black non-Hispanic	25.0	23.0	10.4*	
Hispanic	27.2	36.8	24.0	
Other non-Hispanic	6.6	9.0	11.6	
Male	50.6	47.1	66.4*	0.029
Borough of residence				
Bronx	16.7	18.5	15.5	0.428
Brooklyn	30.2	27.6	29.6	
Manhattan	15.6	22.7	19.3	
Queens	32.4	27.3	28.3	
Staten Island	5.1^	3.9	7.2	
HS graduate or less (among adults aged 25+)	39.2	44.3	48.5	0.020
Income (% federal poverty level)				
<200 FPL	46.4	53.6	49.4	0.207
200–<400 FPL	21.6	16.8	13.5*	
≥400 FPL	32.0	29.7	37.1	
Smoking Cessation (past 12 months)				
Tried to quit smoking	73.4	51.4*	54.8*	0.001
Received provider advice to quit	43.5	59.6*	64.8*	<.001
Smoking is not allowed in the home	52.3	44.2	27.1*	<.001
Time to first cigarette				
Within 60 minutes	21.5	59.0*	85.5*	<.001
More than 1 hour	78.5	41.0	14.5	
Source of last cigarette				
Carton	7.8	10.4	35.4*	<.001
Pack	66.1	76.6*	60.2	
Single/loosie/bummed/roll own	26.1	13.0*	4.4^	
Last cigarette purchased from tax-avoidant location	70.7	85.3*	60.8	<.001
Binge Drinking (last 30 days)	28.7	24.9	38.0	0.503

* Significantly different from Nondaily smokers, $P < .05$. See Section 2 for descriptions and definitions of smoker types.
^Estimate's Relative Standard Error (a measure of estimate precision) is greater than 30% or the sample size is too small, making the estimate potentially unreliable.
We present only one category for dichotomous variables to eliminate redundancy in the table.

single loose cigarettes, and those who banned smoking in the home appear to comprise a price-sensitive subsgroup. Healthcare providers appear to be overlooking this group; however, Nondaily smokers were less likely to be advised to quit smoking by a healthcare professional.

Many researchers have noted that Nondaily smoking may increase as a result of expanding tobacco control legislation and cigarette price increases [2, 4, 35, 36]. The Chaiton and Cohen hypothesis regarding the "softening" of the smoking population may be a useful framework for

Table 3: Multivariable logistic analyses predicting Nondaily smoking versus daily smoking among current smokers, aged 18 years and over—New York City, 2010.

	Main effects model		Interaction effects model	
	Adjusted odds ratio	(95% CI) LCI, UCI	Adjusted Odds Ratio	(95% CI) LCI, UCI
Age Group				
18–44	0.83	(0.49, 1.40)	0.87	(0.51, 1.50)
45+	Ref.		Ref.	
Borough of Residence				
Brooklyn	1.10	(0.55, 2.22)	1.06	(0.52, 2.19)
Manhattan	0.66	(0.30, 1.48)	0.63	(0.27, 1.47)
Queens	1.03	(0.48, 2.22)	1.00	(0.45,2.20)
Staten Island	1.17	(0.42, 3.23)	1.02	(0.32, 3.20)
Bronx	Ref.		Ref.	
Time to first cigarette of the day				
More than 1 hour after waking up	8.32*	(2.05, 13.70)	8.76*	(5.38, 14.27)
Within 60 minutes of waking up	Ref.		Ref.	
Last cigarette purchased				
Carton	0.39*	(0.17, 0.91)	0.41*	(0.19, 0.90)
Single/loosie/bummed/rolled-your-own	3.61*	(1.79, 7.28)	3.49*	(1.72, 7.08)
Pack	Ref.		Ref.	
Cessation attempts in the past year				
Tried to quit smoking	2.15*	(1.28, 3.60)	2.32*	(1.36, 3.96)
Did not try to quit smoking	Ref.		Ref.	
Sex				
Male	0.87	(0.53, 1.40)	0.51	(0.22, 1.16)
Female	Ref.		Ref.	
Race/ethnicity				
All other races	1.11	(0.64, 1.91)	0.66	(0.3, 1.24)
White	Ref.		Ref.	
Rules about smoking in home				
Smoking is not allowed	1.10	(0.68, 1.79)	0.74	(0.43, 1.28)
Smoking is allowed in some or all areas	Ref.		Ref.	
Education (among adults aged 18+)				
Some college or more	1.75*	(1.06, 2.91)	1.03	(0.80, 1.35)
High school grad or less	Ref.		Ref.	
Last cigarette purchased				
Outside NYC/tax-avoidant	1.51	(0.80, 2.84)	0.54	(0.20, 1.41)
In New York City/nontax-avoidant	Ref.		Ref.	
Binge drinker				
Yes	1.06	(0.60, 1.88)	0.45*	(0.20, 1.01)
No	Ref.		Ref.	
Smoking not allowed in the home X tax-avoidant	—	—	6.57*	(1.96, 22.01)
All other race X binge drinker	—	—	4.62*	(1.59, 13.48)
Sex X some college or more education	—	—	2.49†	(0.91, 6.82)

†$P < .10$, *$P < .05$.

interpreting our findings in this regard [37]. Although more research is needed to measure nicotine addiction among Nondaily smokers in NYC, our results are consistent with the "softening" hypothesis. We saw a shift among the smoking population away from heavy daily smoking toward Nondaily smoking; we noted that low-income New Yorkers comprised a larger proportion of the Nondaily smoking population in 2010 as compared to 2002; we saw that Nondaily smokers were more likely than daily smokers to purchase single cigarettes than a pack. These factors point to the possibility

that NYC's smoking population may be reducing their cigarette consumption in response to NYC's comprehensive tobacco control plan and transitioning toward becoming persistent Nondaily smokers.

4.2. Limitations. The NYC CHS is a population-based survey of smokers that relies upon self-reported data. Its cross-sectional design limits our ability to draw causal inferences. However, the surveys were large, conducted in multiple languages, and weighted to ensure they are representative of the NYC population; respondent opinions correlate well with both observed declines in smoking and predictions from the literature [5, 6]. In our analyses, a small number of smokers who reported smoking on some days only were classified as heavy smokers due to their high levels of consumption (23 cases total between 2002 and 2010). However, results from an exploratory analysis in which the 23 cases were classified as Nondaily smokers did not differ from the results presented here; thus, this classification did not impact our results. Finally, the change in the CPD imputation method between 2002 and 2010 could have contributed to decreases in mean CPD between 2002 and 2010.

4.3. Future Directions. New York has a greater percentage of Nondaily smokers than the US as a whole—a trend also seen in California, another jurisdiction with a strong tobacco control program [38]. This shift in smoking trends indicates that as tobacco control efforts spread around the nation, the phenomenon of Nondaily smoking may increase. Accordingly, new cessation policies and educational messaging may need to be tailored to this growing subpopulation of Nondaily smokers. NYC now has the highest cigarette excise taxes in the nation and comprehensive smoke-free air laws that prohibit smoking in bars, restaurants, and other public spaces. These distinctive environmental aspects may render our findings unique to NYC. Further research is needed to assess whether other jurisdictions with less comprehensive tobacco control policies are experiencing similar trends.

In bivariate analysis, we found that among Nondaily smokers a higher proportion were Queens residents in 2010 compared to 2002. Queens is home to many recent immigrants; 48% of the population is foreign-born, compared to 22% of the NYC population as a whole [39]. Because previous research has documented that Nondaily smoking is common among this group, particularly among Hispanic immigrants [21, 40], increasing rates of Nondaily smoking in Queens could reflect recent immigration in that borough. It should be noted that the changes in Queens were not significant in the full multivariable model, suggesting the decline was confounded by another predictor. However, our data do not allow us to identify immigration trends. Further research will be needed to explore this hypothesis in more detail.

Our findings also identified low levels of cessation advice by healthcare providers in this population, indicating that new questions may be necessary to screen effectively for Nondaily smoking in this setting. The question "are you a smoker?" may not resonate with Nondaily smokers; it may be more effective to ask if a patient smokes cigarettes every day, some days, or not at all. New Joint Commission guidelines, scheduled to take effect in 2012, encourage a similar approach, stipulating that healthcare providers screen patients for tobacco use in the past 30 days to assess and document their patients' smoking status [41]. Providers should adopt these new guidelines to better identify and treat Nondaily smokers.

Because Nondaily smokers may perceive themselves at lower risk for adverse health effects [40], and in view of findings here and in other studies that healthcare providers may not be routinely advising Nondaily smokers to quit [7], more research is needed on how to effectively assess and convey the health risks of Nondaily smoking. Furthermore, because common cessation aids may not be indicated for Nondaily smokers, incorporating assessments of nicotine dependency would be instrumental to future studies.

Many of the studies that have sought to categorize different subgroups of Nondaily smokers have often relied on qualitative studies that have been limited to specific populations, such as college students [16, 24–26]. Clear definitions of subgroups that account for both the smoking characteristics and behaviors documented in these smaller studies as well as broader trends seen in population-based studies [7, 40] would allow for better tailoring of antitobacco efforts toward the needs of Nondaily smokers. Price-sensitive smokers may be one such group; however, identifying the psychosocial characteristics of price-sensitive smokers could allow for better targeting of antitobacco interventions to their needs. Additional studies focusing on social smoking, particularly among young people, and on the prevalence of Nondaily smoking among recent immigrants to NYC would assist in the development of more effective interventions.

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Research Article

Pilot Study Results from a Brief Intervention to Create Smoke-Free Homes

Michelle C. Kegler,[1,2] Cam Escoffery,[1,2] Lucja Bundy,[2] Carla J. Berg,[1,2] Regine Haardörfer,[2] Debbie Yembra,[2] and Gillian Schauer[2]

[1] *Department of Behavioral Sciences and Health Education, Emory Prevention Research Center, Rollins School of Public Health, Emory University, 1518 Clifton Road NE, Atlanta, GA 30322, USA*
[2] *Emory Prevention Research Center, Rollins School of Public Health, Emory University, 1518 Clifton Road NE, Atlanta, GA 30322, USA*

Correspondence should be addressed to Michelle C. Kegler, mkegler@emory.edu

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Very few community-based intervention studies have examined how to effectively increase the adoption of smoke-free homes. A pilot study was conducted to test the feasibility, acceptability, and short-term outcomes of a brief, four-component intervention for promoting smoke-free home policies among low-income households. We recruited forty participants (20 smokers and 20 nonsmokers) to receive the intervention at two-week intervals. The design was a pretest-posttest with follow-up at two weeks after intervention. The primary outcome measure was self-reported presence of a total home smoking ban. At follow-up, 78% of participants reported having tried to establish a smoke-free rule in their home, with significantly more nonsmokers attempting a smoke-free home than smokers ($P = .03$). These attempts led to increased smoking restrictions, that is, going from no ban to a partial or total ban, or from a partial to a total ban, in 43% of the homes. At follow-up, 33% of the participants reported having made their home totally smoke-free. Additionally, smokers reported smoking fewer cigarettes per day. Results suggest that the intervention is promising and warrants a rigorous efficacy trial.

1. Introduction

Exposure to secondhand smoke (SHS) has a broad range of serious health consequences. SHS exposure increases the risk of lung cancer, stroke, and coronary heart disease [1–6]. Exposure to SHS can exacerbate asthma and underlying lung disease, contribute to respiratory problems, and reduce lung function in adults [5, 7]. Exposure is particularly dangerous to children, increasing the risk of respiratory infections, including asthma, bronchitis, and pneumonia, severity of asthma symptoms, middle ear infections, and sudden infant death syndrome [2, 8–13]. Risk for adverse health effects in children increases as the number of adult smokers in the household increases [2].

Due in large part to the increasing adoption of smoke-free environments in the USA, the home is currently a primary source of exposure to SHS for both children and nonsmoking adults [2]. The prevalence of smoke-free homes, defined as no smoking any place at any time, has increased rapidly in recent years [14]. These increases are associated with an expansion of smoke-free policies at the state and local level [14–16]. In 2008, an estimated 78% of homes in the USA were smoke-free [17]. However, rules that limit smoking in the home are less common in households in which at least one person smokes and in African American and low-income households [18–20].

Smoke-free homes have been shown to reduce exposure to SHS for both nonsmokers and children [12, 21–25]. Additionally, both longitudinal and cross-sectional studies show that smokers who have implemented smoke-free home rules are significantly more likely to make a quit attempt, be abstinent and smoke fewer cigarettes per day [19, 26–31].

Household smoking bans are also an important component of antismoking socialization and are linked to reduced likelihood of adolescent smoking [32, 33].

Few community-based intervention studies have examined how to effectively increase the adoption of smoke-free homes, particularly with the primary message focused on household smoking bans as opposed to smoking cessation [12]. Clinic-based interventions, often with a combined message of smoking cessation and reduced smoking in the home, have typically consisted of brief interventions with a verbal recommendation to reduce SHS exposure along with printed educational materials [12]. Home-based interventions have tended to be more intensive, usually involving 5–7 half-hour sessions over several months [12]. A review of home and clinic-based interventions reported mixed results in the clinic-based interventions and greater success in the more intensive home-based interventions [12]. However, little research has focused on brief and practical strategies for addressing SHS exposure through interventions focused explicitly on creating a smoke-free home [34]. Given the concentration of smoking in low-income households, the current study aimed to test the feasibility, acceptability, and short-term outcomes of a brief intervention for promoting smoke-free home policies among low-income households. We hoped to learn if smoking and nonsmoking members of low-income households would be interested in participating, whether they would participate in the full intervention and whether the intervention would motivate them to take steps to create a smoke-free home. We were also interested in their feedback on the intervention and suggestions for improvement.

2. Methods

2.1. Sample and Recruitment. We recruited participants from a county health department clinic in the metro Atlanta area. Participants were recruited in person by research staff and through fliers posted at the health department. Interested participants called our research office and were screened for eligibility. Eligible participants had to be 18 years or older, speak and understand English, be a smoker living with at least one other person in the household or a nonsmoker living with a smoker, and not have a total smoking ban. Only one participant per household was eligible. Approximately 300 fliers were distributed and 91 participants called the study office to express interest in participating. The study purpose and procedures were explained to eligible participants (21 were ineligible) and the first 20 smokers and first 20 non-smokers who agreed to participate provided verbal consent over the telephone and were enrolled ($n = 40$). Thirty-six participants completed the entire study.

2.2. Description of the Intervention. The smoke-free homes intervention consisted of four components: three mailings of print materials and one coaching call, aimed at increasing household smoking bans and reducing secondhand smoke exposure. The materials were designed to target both smokers and nonsmokers who allow smoking in the home. The conceptual model (Figure 1) is based on social cognitive theory [35–37] and the transtheoretical model's stages of change [38–40]. Social cognitive theory was selected because of its emphasis on both cognitive and environmental determinants of behavior and the interplay between them known as reciprocal determinism [37]. The intervention targets proximal determinants of behavioral capacity, self-efficacy, and outcome expectations related to creating a smoke-free home and smoking behaviors. Although not well studied with respect to smoke-free homes, these variables have been shown as important in a wide range of behavioral interventions based on social cognitive theory [37]. Through the use of persuasion, role modeling, goal setting, environmental cues and reinforcement—change strategies tied to social cognitive theory—participants were encouraged to work through the five steps of creating a smoke-free home. These include (1) deciding to create a smoke-free home, (2) talking to household members about making a home smoke-free, (3) setting a date for going smoke-free, (4) actually making a home smoke-free, and (5) keeping the home smoke-free. Because the five steps aligned quite well with stages of change as articulated in the transtheoretical model, we also included stages of change in the conceptual model [38]. This allowed us to focus the coaching component of the intervention on the appropriate step (or stage) for each participant.

The five steps emerged from our prior qualitative work on creating smoke-free homes (e.g., factors influencing the decision to go smoke-free, the need to talk to household members about a possible rule, challenges in enforcing the rule), combined with existing smoke-free home campaigns by the U.S. Environmental Protection Agency and Health Canada [41, 42]. Our earlier formative work on smoke-free homes included qualitative interviews with 102 households in rural Georgia with varying degrees of household smoking restrictions [43, 44]. Briefly, this work documented that family discussions about smoking bans focused heavily on protecting children. In homes with at least one nonsmoker, the smell and dangers of secondhand smoke and an aversion to breathing smoke were also frequently discussed. Conversations about a smoke-free home were usually initiated by women and/or nonsmokers. Conflict over the issue was rare, although challenges with enforcement and compliance were described by some participants [43, 44]. This formative research helped us develop intervention messages, for example, on common reasons to create a smoke-free home. Participant ideas for promoting a smoke-free home, which included environmental strategies such as posting no smoking signs in the home, helping the smoker find a comfortable place outside to smoke, and removing ashtrays and lighters, were also included in the educational materials. Finally, we asked about barriers to enforcing a ban. These barriers, such as feeling uncomfortable or concern over showing disrespect to a visitor or older relative were acknowledged in the materials as well, along with potential solutions.

All print materials were designed around the theme of "Some Things are Better Outside." The first component, mailed after completion of the baseline survey, was a "tool-kit" for creating a smoke-free home. The tool-kit included a "*Five-Step Guide to a Smoke-Free Home*" which described

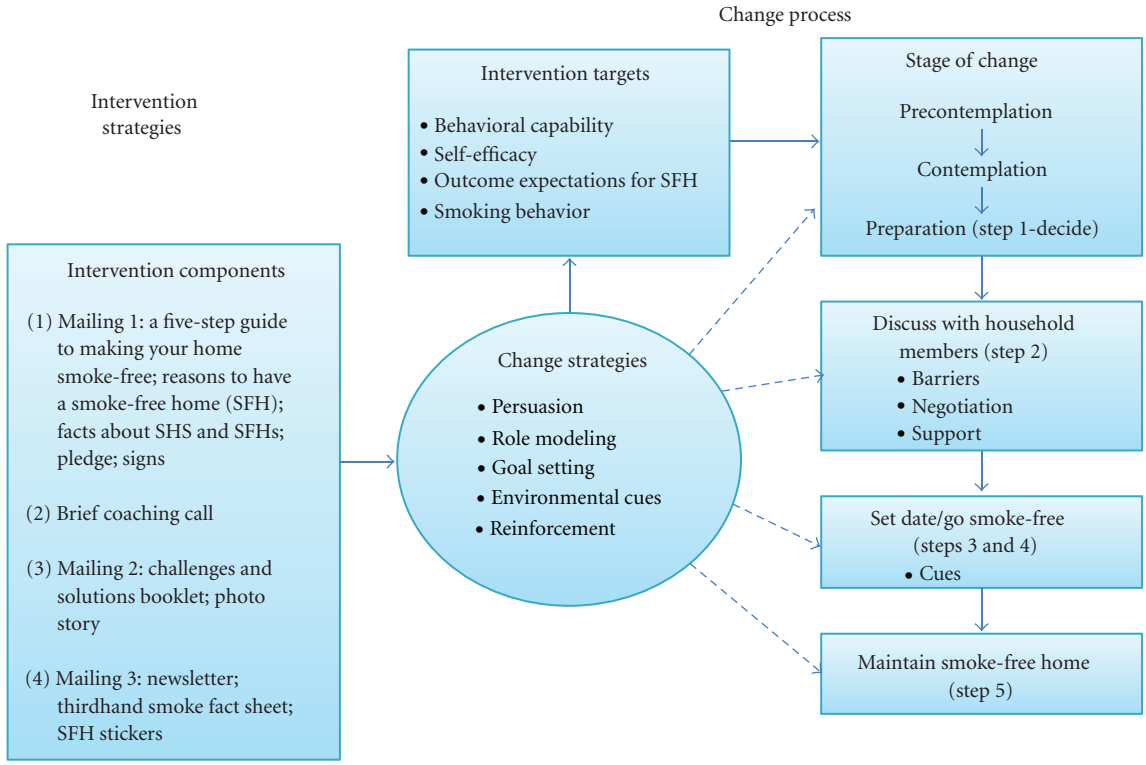

Figure 1: Model of behavior change: brief intervention to create smoke-free home policies in low-income households.

the steps, tips, and strategies to plan for, make, and keep a smoke-free home. The guide was packaged in a 9″× 12″ mailer that folds out to 18″× 24″ when opened. The mailer was designed to be interactive and educational. It included definitions of secondhand smoke and smoke-free homes, a list of reasons to have a smoke-free home, truths about secondhand smoke, a tear-off pledge participants and household members could sign after deciding to make their home smoke-free, and two tear-off smoke-free home signs with adhesive tape strips.

The second component of the intervention was a coaching call. The coaching script incorporated the five steps as described in the "*Five-Step Guide to a Smoke-Free Home.*" The semistructured script elicited responses on the progress of making the home smoke-free, benefits of a smoke-free home, and challenges and barriers to setting a smoke-free home rule. A stage of change assessment was performed (i.e., have no interest in making home smoke-free, are thinking about making home smoke-free, decided to make home smoke-free, or already have a smoke-free home) to prompt the coach to provide stage-based messages. The coaching session ended with a summary of the call and goals for making and/or keeping a smoke-free home.

The third component included additional educational information in the form of a photo story which depicted a household comprising a mother, grandmother, and a child going through the process of making their home smoke-free. It provided information on secondhand smoke and its dangers, tips on having a conversation with the smoker in the home, ways to make smoking outside easier, and wants to celebrate being smoke-free. Also included in this mailing was a "*Challenges and Solutions: Keeping your Home Smoke-Free*" booklet. It provided ten commonly reported challenges derived from our formative research (e.g., you are not the head of the household and you cannot make the rules in your home; you live in an apartment and there is no porch or yard to use as a smoking area, etc.) and offered easy-to-implement solutions.

The fourth component included a newsletter with testimonials and success stories portraying families and their reasons for having a smoke-free home, as well as examples of ways to keep their home smoke-free. This mailing also included a thirdhand smoke fact sheet and six smoke-free home stickers that could be used as reminders to smoke outside (i.e., placed on bathroom mirrors, cigarette packs, ashtrays, etc.).

In addition to the formative research described above, we pretested our intervention materials, including the "Some Things are Better Outside" theme, through six focus groups (3 smokers and 3 non-smokers). Participants gave us feedback about each intervention component, and overall, had very positive comments about the intervention components (e.g., 5-step guide, pledge, signs, stickers). We also learned that there was little knowledge about thirdhand smoke, which prompted the inclusions of a small educational piece on this concept.

2.3. Procedures. We used a simple pretest posttest design with follow-up at two weeks after the intervention. After

enrollment, participants were asked to complete a baseline survey by telephone which lasted approximately 30–45 minutes. All participants received the four intervention components at two-week intervals. Intervention components included three mailings and one coaching call. The first set of print materials was mailed after completion of the baseline survey, followed by a coaching call at week two, with the remaining print materials mailed at weeks four and six. A follow-up survey was conducted eight weeks after baseline. Each participant was compensated with a $25 gift card for completing each follow-up survey. Telephone surveys and coaching sessions were recorded for quality assurance. The study protocol was approved by the Emory University Institutional Review Board.

2.4. Measures. The baseline survey included questions related to smoking history, secondhand smoke exposure, cigarette consumption, cessation attempts, household composition and smoking status, beliefs about secondhand smoke, stage of readiness to restrict smoking in the home, self-efficacy to restrict smoking in the home, prior smoke-free home attempts, and secondhand smoke reduction behaviors.

2.4.1. Process Evaluation. Process measures were collected at the eight-week follow-up to assess the receipt of mailed materials, the proportion of materials read, the usefulness and relevance of materials, satisfaction with the coaching session, and utilization of intervention materials such as posting signs, signing and/or posting the pledge, coming up with a list of reasons for making the home smoke-free, having the family talk, or calling the smoking cessation quitline telephone number provided in the materials.

2.4.2. Outcome Measures (Primary)

Smoke-Free Home Ban. The primary outcome measure was self-reported presence of a total home smoking ban and was assessed at baseline and again through the 8-week follow-up survey using the item, "*Which statement best describes the rules about smoking inside your home?*" Participants were asked to select one of the following response options: *smoking is not allowed anywhere inside your home; smoking is allowed in some places or at some times; smoking is allowed anywhere inside your home; there are no rules about smoking inside your home* [45].

Prior Smoke-Free Home Attempts. We examined smoke-free home attempts by asking, "*In the last two months, has anyone tried to establish a smoke-free rule in your current home? By smoke-free, we mean that smoking is not allowed at any time or any place within your home*" [46].

Secondhand Smoke Exposure. Secondhand smoke exposure was measured using two items: "*How often does anyone smoke inside your home?*" with response options ranging from *daily* to *never* and "*During the past 7 days, how many days have people smoked in your home in your presence?*" [47].

2.4.3. Outcome Measures (Secondary). Three of our secondary outcomes were asked of smokers only: stage of change for quitting, cessation attempts, and number of cigarettes smoked per day.

Stage of Change for Quitting Smoking. Participants self-reported their smoking status both at baseline and at follow-up. Readiness to quit smoking among those who reported either "everyday" or "some days" of smoking at baseline was assessed using two additional items adapted from Velicer et al. [48]. In a yes/no format, we asked participants at baseline and eight-week follow-up, *"Are you thinking about quitting smoking within the next six months/30 days?"*

Cessation Attempts. Occurrence of quit attempts was assessed using the item, "*How many times during the past 2 months have you stopped smoking for more than one day because you were trying to quit smoking?*" adapted from the Behavioral Risk Factor Surveillance System [45].

Cigarette Consumption. One item was used to assess cigarette consumption per day, *"On average, on the days you smoke, how many cigarettes do you smoke in a day?"* [31].

Smoking Restrictions in Cars. An item adapted from Norman et al. [20] was used to assess smoking restrictions in cars. Participants were asked "*Now, what about smoking in your car or cars, would you say. . .*" and were provided the following response options: *there are no rules about smoking in the cars; smoking is sometimes allowed in some cars; smoking is never allowed in any car; there is no car.*

Demographics. Demographic information on the participant's ethnicity/race, age, gender, educational level, marital status, household income, and employment status was collected at baseline. Measures were adapted from the 2005 Behavioral Risk Factor Surveillance System [49].

2.5. Data Analysis. Results for primary and secondary outcomes were summarized using simple descriptive statistics including arithmetic mean, standard deviation, and percentage. Process evaluation measures were tested for differences in responses between smokers and nonsmokers with paired samples t-tests, Wilcoxon Mann Whitney tests, chi-squared tests of independence, and Fisher's exact tests depending on the nature of data collected. Changes in outcomes between baseline and follow-up were evaluated across all participants, as well as among smokers and non-smokers living with a smoker, using paired t-tests for continuous variables and the Wilcoxon signed rank sum test for ordinal variables. SPSS and SAS 9.3 were used to conduct descriptive as well as inferential analyses.

3. Results

3.1. Description of Study Participants. Most of the participants were African American (95%), and the majority were

Table 1: Demographics of enrolled study participants.

Age	($n = 40$)
18–39	38%
40–49	38%
50–60	25%
Race	
White	3%
African American	95%
Other	3%
Gender	
Female	70%
Education	
Less than high school	3%
Some high school	28%
High school graduate or GED	33%
Vocational or technical school	8%
Some college	30%
Employment status	
Employed	35%
Unemployed	65%
Annual household income	
$10,000 or less	35%
$10,001 to $15,000	13%
$15,001 to $20,000	18%
$20,001 to $25,000	13%
More than $25,000	18%
Home ownership	
Own	18%
Rent	80%
Other	3%
Type of housing	
Single-unit/detached home	58%
Townhome/duplex	8%
Apartment/condo/multiunit	35%
Number of children in the home	
None	43%
1	15%
2	15%
3	15%
4 or more	13%
Health care coverage	
No health care coverage	25%
Coverage through employer	18%
Medicaid or medical assistance	45%
Military (CHAMPUS, TIRCARE, or VA)	5%
Other	10%

women (70%) (Table 1). Study participants had varying degrees of education, but none of the participants had completed college. Most participants were unemployed (65%), and of the 35% employed, less than half were employed full time. A large percentage (35%) of participants reported an annual household income of $10,000 or less and 58% lived with children under the age of 18. One quarter of the participants had no health care coverage, and 45% received Medicaid or Medical Assistance. Most homes (80%) were rented. The majority of participants (58%) lived in single-unit or detached homes, but 35% lived in an apartment, a condominium, or a multiunit complex.

3.2. Process Evaluation. Table 2 shows selected process evaluation findings by smoking status of the participant. A majority of participants read most or all of the materials (75%), with no significant difference between smokers and nonsmokers. Most participants (86%) reviewed the materials sometimes or even often, with smokers looking at the materials more than non-smokers ($P = .03$). In addition, participants found the materials relevant and useful. Notably, 89% reported the materials were very relevant and 95% reported they were very useful, with no differences by smoking status. Most liked the *5-Step Guidebook* best and did not like any of the materials least. Of the 36 participants who completed the follow-up survey, 81% came up with a list of reasons for making the home smoke-free and 97% had a talk with their family about making the home smoke-free. In addition, five participants (14%) reported calling smoking cessation services for support in quitting smoking. More than half (53%) signed the smoke-free home pledge, and more than 60% of participants posted the pledge, put up the signs, and used the stickers. A large majority of participants reported that the coaching call was very relevant to them (88%) and provided very useful information (85%), again with no significant differences by smoking status (not shown). General satisfaction with the call was high (94% very satisfied). Across all process measures, the smokers were as or more engaged with the intervention materials than the non-smokers.

3.3. Primary Outcomes. Table 3 reports the impact of the intervention on smoking in the participants' homes. At follow-up, 78% of participants reported having tried to establish a smoke-free rule in their home, with significantly more non-smokers (94%) attempting a smoke-free home than smokers (63%) ($P = .03$). These attempts led to increased smoking restrictions, that is, going from no ban to a partial or total ban, or from a partial to a total ban, in 43% of the homes. At follow-up, 33% of the participants reported having made their home smoke-free ($P < .0001$), including 32% of smokers ($P < .04$) and 35% of nonsmokers ($P < .004$). The improvement in the smoke-free home status also resulted in a significant reduction of days on which smoking occurred in the home in the past week. Mean days of smoking in the home during the past week decreased from 5.3 days (SD = 2.4) to 2.6 days (SD = 2.7) ($P < .0001$).

3.4. Secondary Outcomes. Smokers ($n = 20$) showed a significant improvement in readiness to quit smoking as assessed by the stages of change model (Table 4). At baseline, 35% planned to quit in the next 30 days and at follow-up

Table 2: Process evaluation results for smoke-free home intervention.

	Total		Smokers		Non smokers		
	N	%	*N*	%	*N*	%	*P* value
	N = 36		*N* = 19		*N* = 17		
How much of the 1st mailing did you read? The mailing includes the 5-step guide to making your home smoke-free.							
Did not read any of it	1	3%	—	—	1	6%	
Read some of it	8	22%	4	21%	4	24%	
Read most of it	5	14%	1	5%	4	24%	.16
Read all of it	22	61%	14	74%	8	47%	
How often do you review/look at the materials?							
Never	2	6%	—	—	2	12%	
Rarely	3	8%	1	5%	2	12%	.03
Sometimes	19	53%	9	47%	10	59%	
Often	12	33%	9	47%	3	18%	
How relevant were the materials to you personally?							
Not at all	—	—	—	—	—	—	
A little	3	8%	1	5%	2	12%	
Somewhat	1	3%	1	5%	—	—	.81
Very/a lot	32	89%	17	89%	15	88%	
How useful or helpful was the information in the materials?							
Not at all	—	—	—	—	—	—	
A little	2	6%	1	5%	1	6%	
Somewhat	—	—	—	—	—	—	.99
Very/A lot	34	95%	18	95%	16	94%	
Did you (or someone in your home) any of the following? "Yes" reported.							
…come up with a list of reasons for making your home smoke-free?	29	81%	15	79%	14	82%	1.00
…have a talk with your family or household members about making your home smoke-free?	35	97%	18	95%	17	100%	1.00
…sign the pledge?	19	53%	14	74%	5	29%	.008
…post the pledge?	23	64%	13	68%	10	59%	.55
…put up the signs?	24	67%	14	74%	10	59%	.30
…use the stickers?	25	69%	17	90%	8	47%	.005
…call smoking cessation services?	5	14%	3	16%	2	12%	1.00

Table 3: Intervention impact on smoking rules in the home.

	All participants			Smokers			Non-Smokers		
	Baseline	Follow-up	*P* value	Baseline	Follow-up	*P* value	Baseline	Follow-up	*P* value
	N = 40	*N* = 36		*N* = 20	*N* = 19		*N* = 20	*N* = 17	
Smoking ban inside home									
Total ban	—	33%		—	32%		—	35%	
Partial ban	70%	58%	.0001	75%	58%	.04	65%	59%	.004
No ban	30%	8%		25%	11%		35%	6%	
Improvement in SFH status	N/A	43%		N/A	40%		N/A	45%	
SFH attempts	N/A	78%		N/A	63%		N/A	94%	
Smoking inside the home									
Daily	83%	53%		75%	53%		90%	53%	
Weekly	13%	14%		20%	11%		5%	18%	
Monthly	3%	6%	.0015	—	11%	.06	5%	—	.02
Less than monthly	3%	11%		5%	11%		—	12%	
Never	—	17%		—	16%		—	18%	
	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)	
Days smoking occurred in the home last week	5.3 (2.4)	2.6 (2.7)	<.0001	5.4 (2.5)	1.8 (2.6)	<.0001	5.2 (2.4)	2.7 (2.8)	.002

Table 4: Intervention impact on smoking behaviors and stage of change for quitting.

	Baseline ($n = 20$)	Follow-up ($n = 19$)	P value
Stages of Change: quitting smoking			
Precontemplation	20%	5%	
Contemplation	45%	32%	0.01
Preparation	35%	58%	
Action	—	5%	
Smokers with quit attempts	N/A	65%	
	Mean (SD)	Mean (SD)	
Cigarettes per day	10.2 (5.7)	6.9 (6.0)	0.04

58% were in the preparation stage ($P < .01$). While only one individual reported quitting, 65% of the participating smokers reported at least two quit attempts during the two prior months. Moreover, cigarette consumption decreased significantly over the same time period, from 10.2 to 6.9 cigarettes per day ($P < .04$). Participation in this study also prompted participants to change their rules regarding smoking in the car. Among those with cars ($n = 26$), the proportion of smoke-free cars went from 20.0% to 38.9%, a significant increase ($P < .005$).

4. Discussion

Assisting low-income households to go smoke-free has the potential to reduce exposure to SHS, help smokers to quit, and potentially disrupt the smoking initiation process in children and adolescents [31–33]. This study examined the feasibility, acceptability, and short-term outcomes of a brief intervention that explicitly targeted the creation of smoke-free homes. Results were promising for both smokers and non-smokers. We had no difficulty recruiting for the study, and retention was high. Participants reported high levels of interaction with the intervention materials and felt they were both relevant and helpful. Moreover, a relatively large percentage of participants engaged in the actions recommended through the intervention, such as talking with household members about going smoke-free and posting no-smoking signs.

Short-term outcomes were promising, with about 1/3 of participants creating total smoking bans and over 40% tightening their household smoking restrictions in some way. These results are comparable or better than those from many intensive counseling interventions [12, 50]. A review of home and clinic-based interventions to reduce SHS exposure in the home reported an average effect size of .34 [12]. A more recent review of interventions to create smoke-free homes during pregnancy or the neonatal period, typically based on counseling, was inconclusive due to poor study quality and the heterogeneity of outcomes reported [50]. Allmark and colleagues [51] reported evaluation results from an intervention similar to the one reported here, in which families who signed up for the program received a booklet and support materials. Although limited by no comparison group and a modest response rate, they found that among households that permitted some smoking at home before the initiative, about 78% became smoke-free after receiving the intervention program.

Given the short follow-up period in our pilot study, we are uncertain whether participants will maintain their smoke-free homes. Even if long-term maintenance of smoke-free homes decreases to 10%, however, because of the ease of intervention delivery, this intervention has the potential to have a significant impact if widely disseminated. Most interventions to date have involved a more intensive counseling protocol; additional research is needed to establish whether brief interventions may be effective [12, 34, 50, 52]. Our next step is to conduct a randomized controlled trial of this brief intervention with follow-up at six months.

There are several limitations to this study. This was a pilot study to test the feasibility a brief intervention of mailed print materials and coaching on making homes smoke-free. We evaluated the effectiveness of our intervention with only 40 families using a nonexperimental design; there was no control group. It is possible that social desirability, reactivity to the survey questions about smoke-free homes and/or other external factors are responsible for the positive outcomes. In addition, the sample for this study was predominantly urban, African American, and low income. The results may not be generalizable to other populations. The study also had a short follow-up period; future studies should examine the extent of relapse in home smoking bans. Finally, these data on home smoking bans were based on self-report and may not accurately reflect actual rules about smoking in the home. Future studies should use air nicotine monitors or other objective measures to validate self-reports of smoke-free homes.

5. Conclusions

Results from the pilot study found that a brief educational intervention with families can increase smoke-free home policies and lower exposure to smoking in the home. In addition, this preliminary study suggests that the intervention can also help smokers reduce the number of cigarettes they smoke. Further research is needed to rigorously test the effectiveness of this brief intervention for increasing smoke-free homes, as well as its effects on other populations. We plan to conduct efficacy and effectiveness trials with large samples of low-income populations in several states. Because the home is a substantial source of SHS for

children and nonsmoking adults, strategies to successfully eliminate exposure to smoke indoors are needed. Evaluating community-level interventions to create smoke-free homes can greatly reduce the impact of secondhand smoke on children and nonsmoking adults.

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Research Article

Heterogeneity in Past Year Cigarette Smoking Quit Attempts among Latinos

Daniel A. Gundersen,[1] Sandra E. Echeverria,[2] M. Jane Lewis,[3] Gary A. Giovino,[4] Pamela Ohman-Strickland,[5] and Cristine D. Delnevo[3]

[1] *School of Nursing, University of Medicine & Dentistry of New Jersey, 65 Bergen Street, Room GA-225, Newark, NJ 07101-2012, USA*
[2] *Department of Epidemiology, School of Public Health, University of Medicine & Dentistry of New Jersey, 683 Hoes Lane West, Piscataway, NJ 08854, USA*
[3] *Department of Health Education and Behavioral Science, School of Public Health, University of Medicine & Dentistry of New Jersey, 683 Hoes Lane West, Piscataway, NJ 08854, USA*
[4] *Department of Community Health and Health Behavior, School of Public Health and Health Professions, University at Buffalo, The State University of New York, 310 Kimball Tower, Buffalo, NY 14214-8028, USA*
[5] *Department of Biostatistics, School of Public Health, University of Medicine & Dentistry of New Jersey, 683 Hoes Lane West, Piscataway, NJ 08854, USA*

Correspondence should be addressed to Daniel A. Gundersen, gunderda@umdnj.edu

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Objective. Examine the association between English language proficiency (ELP) and immigrant generation and having made a cigarette smoking quit attempt in the past 12 months among Latinos. Examine if gender moderates the association between acculturation and quit attempts. *Methods*. Latino past year smokers from the 2003 and 2006/07 Tobacco Use Supplement to the Current Population Survey were analyzed. Logistic regression was used to examine the association between quit attempt and ELP and immigrant generation, controlling for demographics and smoking characteristics. *Results*. Latinos with poor ELP were more likely to have made a quit attempt compared to those with good ELP (adjusted odds ratio [AOR] = 1.22, confidence interval [CI]: 1.02–1.46) after controlling for demographic and smoking characteristics. First (AOR = 1.21, CI: 1.02–1.43) and second generation immigrants (AOR = 1.36, CI: 1.12–1.64) were more likely than third generation immigrants to have made a quit attempt in the past 12 months. *Conclusion*. Quit behaviors are shaped by differences in language ability and generational status among Latinos. This underscores the need to disaggregate Latinos beyond racial/ethnic categories to identify subgroup differences relevant for smoking and smoking cessation behaviors in this population.

1. Introduction

Research on cigarette smoking among Latinos has explored differences with respect to acculturation [1–14], that is, "the process by which groups or individuals integrate the social and cultural values, ideas, beliefs, and behavioral patterns of their culture of origin with those of a different culture" [15]. Acculturation has been conceptualized and measured several ways, but public health research has typically included items on language preference and proficiency and the extent of contact with coethnic members, although more recent work has challenged this limited view of acculturation processes [16]. In general, this research has demonstrated that Latinas with higher levels of acculturation are more likely to smoke than Latinas with lower levels of acculturation [1, 3, 4, 6, 8–12, 14], though two studies found no association [7, 13]. Among men, however, the evidence generally finds no association [4, 7, 9, 12–14], and among the studies where a significant association was found the results were inconsistent [6, 8, 10].

The research on patterns of cigarette smoking among Latinos has largely focused on current smoking and differences in prevalence. However, prevalence is influenced by both initiation and cessation, and it is imperative for public

health to understand the patterns of these behaviors as well. In particular, calls have been made to better understand cessation behaviors among racial/ethnic minorities [17, 18]. While some research has examined differences relative to non-Latino whites [19–24], very few studies have examined the role of acculturation in cessation behaviors. The research that has been published has relied on community or intervention studies based on nonprobability samples, and have produced inconsistent findings [17, 25, 26]. Moreover, ignored in the studies of acculturation and tobacco use and cessation is an examination of intermediate cessation behaviors, including quit attempts.

The lack of knowledge of the patterns of cessation behaviors among Latinos is cause for concern, particularly given the growth of this population in recent decades [27]. Additionally, Latinos are a heterogeneous population with varying health profiles. One striking characteristics is that roughly 40% is foreign born (approximately 30% excluding Puerto Rico) [28], a feature the tobacco industry has already recognized and incorporated it into their marketing practices [29]. Moreover, the USA Census Bureau estimates Latinos to be the fastest growing racial/ethnic group in the U.S.-projecting it will comprise about 25% of the total population by 2050, and net migration likely will play an important role in this growth [27, 30]. As such, it is crucial for tobacco behavior research to focus on all aspects of tobacco use behaviors and not just prevalence in this population.

The aim of this paper is to describe population level differences in cigarette smoking quit attempts among Latinos, with a focus on two measures often included in acculturation research-English language proficiency (ELP) and immigrant generation. In addition, we explore whether gender moderates the association between quit attempts and ELP or immigrant generation.

2. Methodology

2.1. Data Sources and Sampling Design. Data from the 2003 and 2006/07 Tobacco Use Supplement (TUS) to the Current Population Survey (CPS) were analyzed [31–34]. Details on the TUS-CPS methodology are described elsewhere [31–34]. Briefly, the TUS-CPS is a national survey of tobacco behaviors which employs a multistage probability sampling design [34]. The self-response rates ranged from 61% to 65.8% for the waves analyzed in this paper [32, 33]. The analysis was restricted to 4,589 adult (≥18 years of age) Latino current smokers and smokers who quit in the past 12 months (i.e., past year smokers). Proxy responses, persons under the age of 18, and those indicating they have never been regular smokers were excluded.

2.2. Variable Selection and Operationalization

2.2.1. Outcome. The outcome was having made a quit attempt in the past 12 months (yes = 1, no = 0). Quit attempts were operationalized as, in the last 12 months, having stopped smoking for 1 day or longer because he/she was trying to quit smoking, having made a serious attempt to stop smoking because he/she was trying to quit even if he/she stopped for less than one day or having successfully stopped smoking.

2.2.2. Focal Independent Variables. English language proficiency was dichotomized into "poor" versus "good" English ability. Respondents who conducted the interview in Spanish or another non-English language were assumed to have poor English language proficiency, while those who conducted the interview in English were assumed to have good English language proficiency. This is a proxy measure of language proficiency that has shown good agreement with the acculturation scale in the National Alcohol Survey (kappa = .71) [35].

Immigrant generation was categorized to contrast first generation (foreign born individuals), second generation (USA born, with at least one foreign born parent), and third generation or higher (USA born, with 2 USA born parents; hereafter referred to as third generation).

2.2.3. Control Variables. Control variables were selected based on previous empirical evidence in the tobacco control literature or the literature on Latino health. Sociodemographic control variables include education (less than high school, high school or GED, some college, or bachelor's degree or higher), annual household income (less than $25 K, $25 K to less than $50 K, $50 K to less than $75 K, and $75 K or more), and gender.

Age of smoking initiation and time to first cigarette in the morning were included to account for smoking behaviors and dependence. Age of initiation was categorized as "before 18," "18 to 24," and "25 years and older." Time to first cigarette after waking was categorized as "less than 30 minutes," "30 minutes or more," and "varies." Having received advice from a health care provider to stop smoking in the past 12 months was coded as "yes" versus "no". Respondents without a health care visit in the past 12 months were regarded as not having received advice to stop smoking. Lastly, per capita tobacco control expenditures were included to control for the tobacco control context in which the respondents live. Following Farrelly et al. [36, 37] tobacco expenditures were computed to include 100% of the current year (i.e., year of data collection) per capita funding while discounting the three most previous years by 25% per year.

In addition to the variables described above, race, country of origin, and occupation type were included in the multivariable models if they met the criteria suggested by Hosmer and Lemeshow [38].

2.3. Statistical Analysis. Overall associations were estimated by fitting multivariable logit models, where log-odds of a quit attempt in the last 12 months was regressed on the focal independent variables and a set of control variables, with separate models for ELP and immigrant generation. Fitting separate models for ELP and immigrant generation was done to recognize that language proficiency is likely an intermediate variable between immigrant generation and the outcome, rather than the two focal independent variables being treated as confounders. Age was centered at the mean

in the sample and cumulative per capita tobacco control funding was centered at the mean among states. Additionally, an interaction term for age of initiation and age was included to control for the differing effect age of initiation may have by age of respondents.

To assess whether gender moderates the focal relationships, product terms for gender and ELP and gender and immigrant generation were added to the respective models. The interactions were examined using the approach described by Norton et al. [39] and Ai and Norton [40]. However, the conclusion of the interaction analyses was consistent across the range of predicted probabilities. As such, for succinctness only the exponentiated logit coefficient for the interaction terms are presented and discussed in this paper.

The CPS is released with pre-imputed demographic information for some variables with missing values. The imputation methods for these variables are described elsewhere [34]. Categorical variables that were not pre-imputed were coded to include an "unknown" category and included in the models. One exception is for ELP, which had less than half a percent of observations missing.

All analyses were conducted in Stata 11 [41]. Sampling weights and balanced repeated replication weights (240 replicates) with Fay's adjustment factor were used to adjust the point and interval estimates for the complex survey design. Because the objective of the analysis was to describe population level patterns in quit attempts, 95% confidence intervals are presented and discussed rather than *P*-values. This allows for an assessment of the range of plausible values rather than using a testing approach for between group differences. Readers interested in assessing statistical significance can do so using the conservative approach of judging non-overlapping confidence intervals between groups [42].

3. Results

3.1. Sociodemographic Description. Table 1 provides univariate and bivariate descriptive statistics of the sociodemographic characteristics of Latino past year smokers in the study sample. Overall, about three out of four Latino past year smokers had good ELP and almost half were first generation immigrants. Nearly two-thirds of the respondents were male, and the mean age was 38 years. Less than ten percent had a bachelor's degree or higher while seven out of ten had either less than a high school education or a high school diploma or equivalent. About one in ten had an annual household income of $75,000 or more while over four in ten reported a household income of less than $25,000 annually. Almost three out of ten reported having a manual labor occupation, less than one in ten were unemployed, and two in ten were not in the labor force. Nearly six in ten reported Mexico as their Latino origin, while fifteen percent reported Puerto Rico, less than five percent reported Cuba. Finally, nine out of ten were white, while the rest were black or some other race.

Compared to Latinos with good ELP, those with poor ELP were more likely to be first generation immigrants, slightly older, male, have less than a high school education, have an annual household income less than $25,000, report Mexico as their country of origin, and identify themselves as white. Those with poor ELP were less likely than those with good ELP to have a management occupation and report Puerto Rico as their country of origin.

First generation immigrants were less likely than second and third generation immigrants to have good ELP, and have annual household income of at least $75,000. However, first generation immigrants were more likely than second and third generation immigrants to be male and have less than a high school education.

3.2. Smoking Characteristics of Latino Past Year Smokers. Table 2 presents univariate and bivariate descriptive statistics of the smoking characteristics of the Latino past year smoker population. Overall, just over half had made a quit attempt in the past year, about half began smoking regularly before their 18th birthday, two out of ten smoked their first cigarette within 30 minutes of waking in the morning, and three of ten reported having received advice to stop smoking from a health care provider in the past 12 months. Lastly, over half were current daily smokers, three in ten current someday smokers, and just over one in ten had stopped smoking in the 12 month period prior to the time of data collection.

Those with poor and good ELP were about equally likely to have made a quit attempt in the past 12 months. Second generation immigrants were more likely than third generation immigrants to have made a quit attempt. Those with poor ELP were less likely than those with good ELP to start smoking regularly before age 18, smoke their first cigarette within 30 minutes, and have received advice to stop smoking from a health care provider in the past 12 months. First generation immigrants were less likely than second and third generation immigrants to report beginning smoking regularly before 18 years of age, have their first cigarette within 30 minutes, and report having received advice to stop smoking from a health care provider in the last 12 months.

Those with poor ELP were slightly less likely to be daily smokers than those with good ELP but were equally likely to be former smokers. First generation immigrants were less likely than third generation immigrants to be daily smokers, while they were more likely than second and third generation immigrants to be someday smokers.

3.3. Multivariable Models. Table 3 presents unadjusted odds ratios (UOR) based on univariable logit regressions and adjusted odds ratios (AOR) with 95% confidence intervals (CI) of making a quit attempt in the past year by ELP, immigrant generation, and control variables. Overall, those with poor ELP were more likely to have made a quit attempt relative to those with good ELP (AOR = 1.22, CI: 1.02–1.46) after controlling for demographic and smoking characteristics. Similarly, first (AOR = 1.21, CI: 1.02–1.43) and second generation immigrants (AOR = 1.36, CI: 1.12–1.64) were more likely than third generation or higher immigrants to have made a quit attempt in the past 12 months.

Table 4 presents the models with interactions for gender and ELP and gender and immigrant generation. The AOR

Table 1: Sociodemographic characteristics of Latino past year smokers.

	Overall		English language proficiency				Generational status					
	(N = 4,589)		Good (N = 3,597)		Poor (N = 971)		1st (N = 2,016)		2nd (N = 879)		≥3rd (N = 1,694)	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
ELP[†]												
Good	75.6	(73.8, 77.3)					52.2	(49.3, 55.0)	92.3	(89.2, 94.6)	98.5	(97.7, 99.0)
Poor	24.4	(22.7, 26.2)					47.8	(45.0, 50.7)	7.7	(5.4, 10.9)	1.5	(1.0, 2.3)
Immigrant generation												
1st generation	47.8	(45.9, 49.6)	33.0	(31.1, 35.0)	93.8	(92.0, 95.3)						
2nd generation	11.5	(10.4, 12.6)	13.9	(12.6, 15.3)	3.6	(2.5, 5.1)						
≥3rd generation	40.8	(38.9, 42.6)	53.1	(51.0, 55.3)	2.6	(1.7, 3.8)						
Mean age in years	38.0	(37.5, 38.4)	37.2	(36.7, 37.7)	40.3	(39.3, 41.2)	39.1	(38.5, 39.8)	35.8	(34.3, 37.3)	37.2	(36.6, 37.9)
Gender												
Male	64.8	(63.3, 66.2)	60.9	(59.1, 62.6)	76.9	(74.2, 79.5)	74.2	(72.4, 75.9)	57.1	(52.4, 61.7)	55.9	(53.6, 58.2)
Female	35.2	(33.8, 36.7)	39.1	(37.4, 41.9)	23.1	(20.5, 25.8)	25.8	(24.1, 27.6)	42.9	(38.3, 47.6)	44.1	(41.8, 46.5)
Education												
<HS	40.8	(38.9, 42.7)	32.7	(30.8, 34.8)	66.0	(62.5, 69.3)	53.7	(51.0, 56.4)	32.4	(27.8, 37.3)	28.0	(25.3, 30.8)
HS/GED	30.0	(28.4, 31.7)	33.3	(31.4, 35.3)	19.7	(16.9, 22.8)	23.7	(21.4, 26.1)	33.1	(28.6, 37.4)	36.5	(34.1, 39. 1)
Some college	21.7	(20.5, 23.0)	25.8	(24.3, 27.3)	8.7	(7.0, 10.7)	14.2	(12.7, 15.9)	28.9	(24.7, 33.5)	28.4	(26.2, 30.8)
BS[+]	7.5	(6.7, 8.5)	8.1	(7.2, 9.3)	5.7	(4.3, 7.5)	8.4	(7.2, 9.8)	5.6	(3.8, 8.3)	7.1	(5.9, 8.4)
Household income[*]												
<25 K	44.0	(42.2, 45.8)	40.7	(38.6, 42.7)	54.5	(50.8, 58.2)	46.1	(43.5, 48.7)	39.5	(35.7, 43.5)	43.7	(40.4, 47.1)
25 K to <50 K	33.1	(31.4, 34.9)	33.0	(30.1, 35.0)	33.5	(30.1, 37.1)	34.7	(32.2, 37.4)	33.1	(29.8, 36.6)	30.7	(27.8, 33.7)
50 K to <75 K	12.9	(11.6, 14.4)	14.2	(12.7, 15.9)	9.1	(6.8, 11.9)	11.3	(9.5, 13.5)	13.5	(11.0, 16.6)	14.9	(12.7, 17.3)
≥75 K	10.0	(9.0, 11.1)	12.2	(10.9, 13.7)	2.9	(1.7, 4.9)	7.8	(6.5, 9.3)	13.8	(11.3, 16.8)	10.8	(9.0, 12.9)
Occupation type												
Management	10.4	(9.4, 11.5)	12.7	(11.6, 13.9)	3.2	(2.2, 4.6)	7.5	(6.3, 9.0)	15.1	(11.8, 19.0)	12.4	(10.9, 14.2)
Service	15.4	(14.3, 16.6)	14.4	(13.1, 15.7)	18.6	(13.1, 21.4)	17.0	(15.3, 18.8)	12.0	(9.3, 15.4)	14.5	(12.9, 16.2)
Sales/Office	14.2	(13.1, 15.4)	16.8	(15.4, 18.3)	6.3	(4.9, 8.1)	9.3	(8.0, 10.8)	18.1	(14.3, 22.6)	18.9	(17.0, 21.0)
Manual labor	29.4	(27.9, 31.1)	25.0	(23.4, 26.8)	43.2	(39.8, 46.6)	39.0	(36.4, 41.7)	20.0	(16.5, 24.0)	20.8	(18.8, 23.0)
Unemployed	8.3	(7.4, 9.2)	8.8	(7.7, 10.1)	6.6	(5.1, 8.5)	6.8	(5.6, 8.1)	11.8	(8.8, 15.7)	9.0	(7.7, 10.5)
Not in labor force	22.3	(21.0, 23.7)	22.3	(20.7, 23.9)	22.1	(19.2, 25.3)	20.5	(18.5, 22.5)	23.0	(19.3, 27.2)	24.3	(22.2, 26.5)
Race												
White	90.6	(89.6, 91.5)	89.1	(87.9, 90.2)	95.3	(93.7, 96.6)	92.9	(91.5, 94.1)	89.6	(86.1, 92.4)	88.2	(86.4, 90.0)
Black	3.7	(3.1, 4.4)	4.1	(3.4, 4.9)	2.5	(1.6, 3.9)	3.3	(2.5, 4.3)	6.4	(4.3, 9.4)	3.4	(2.6, 4.6)
Other	5.7	(4.9, 6.5)	6.8	(5.9, 7.9)	2.2	(1.4, 3.4)	3.8	(2.9, 4.8)	4.0	(2.5, 6.3)	8.4	(7.0, 10.0)
Country of origin												
Mexico	59.2	(57.3, 61.0)	57.2	(55.1, 59.3)	65.3	(61.3, 69.1)	55.8	(53.1, 58.5)	42.9	(38.1, 47.7)	67.7	(64.8, 70.5)
Puerto Rico	15.1	(14.0, 16.3)	17.9	(16.5, 19.4)	6.4	(4.6, 8.8)	12.5	(11.0, 14.3)	39.0	(34.4, 43.6)	11.4	(9.8, 13.3)
Cuba	4.7	(4.0, 5.6)	3.1	(2.5, 3.9)	9.8	(7.6, 12.4)	7.1	(5.9, 8.6)	6.2	(4.3, 8.8)	1.6	(1.0, 2.5)
Other	21.0	(19.5, 22.5)	21.8	(20.1, 23.7)	18.6	(15.8, 21.8)	24.6	(22.5, 26.8)	12.1	(8.9, 16.2)	19.3	(17.0, 21.7)

[*]>5% missing; [†]<1% missing; 95%CI = 95% confidence interval.

Table 2: Smoking characteristics of Latino past year smokers, overall and by English language proficiency and immigrant generation.

	Latino ($N = 4,589$)		Good ELP ($N = 3,597$)		Poor ELP ($N = 971$)		1st Generation ($N = 2,016$)		2nd Generation ($N = 879$)		≥3rd Generation ($N = 1,694$)	
	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI	%	95% CI
Quit attempt, past 12 months	51.3	(49.6, 53.0)	51.3	(49.4, 53.3)	51.4	(47.8, 55.0)	51.0	(48.5, 53.5)	57.1	(53.5, 60.7)	48.2	(45.4, 51.1)
Age smoked regularly[†]												
<18	51.9	(50.3, 53.5)	53.3	(51.5, 55.1)	47.5	(43.8, 51.2)	48.0	(45.5, 50.6)	56.3	(53.4, 60.1)	54.8	(52.4, 57.1)
18–24 years	38.8	(37.1, 40.4)	37.9	(36.1, 39.8)	41.4	(37.7, 45.2)	41.2	(38.7, 43.6)	37.6	(33.8, 41.5)	36.0	(33.4, 38.7)
25 years or older	9.4	(8.5, 10.3)	8.8	(7.8, 9.8)	11.1	(9.0, 13.7)	10.8	(9.3, 12.6)	6.1	(4.7, 8.1)	9.2	(7.6, 11.1)
Time to first cigarette[*]												
<30 minutes	20.7	(19.3, 22.2)	22.8	(21.2, 24.4)	14.4	(12.1, 17.1)	16.9	(14.9, 19.1)	22.4	(19.3, 26.0)	25.3	(22.9, 28.0)
≥30 minutes	76.1	(74.6, 77.6)	74.8	(73.2, 76.7)	79.8	(76.5, 82.6)	78.9	(76.5, 81.2)	75.1	(71.4, 78.5)	72.6	(69.9, 75.2)
Varies	3.2	(2.5, 4.0)	2.3	(1.7, 3.1)	5.8	(4.2, 8.0)	4.2	(3.2, 5.5)	2.5	(1.4, 4.2)	2.1	(1.4, 3.1)
Advice to quit[‡]												
Yes	32.5	(30.9, 34.1)	35.9	(34.1, 37.8)	21.7	(19.0, 24.7)	27.4	(25.1, 29.7)	38.3	(35.0, 41.8)	36.4	(33.6, 39.2)
No	67.6	(65.9, 69.2)	64.1	(62.2, 65.9)	78.3	(75.3, 81.0)	72.6	(70.3, 74.9)	61.7	(58.2, 65.1)	63.7	(60.9, 66.4)
Smoking status at time of survey												
Current daily	57.0	(55.3, 58.7)	58.7	(56.8, 60.6)	51.8	(48.3, 55.2)	53.9	(51.5, 56.3)	57.4	(53.3, 61.3)	61.4	(58.5, 64.3)
Current someday	30.4	(28.8, 32.0)	28.7	(26.9, 30.5)	36.0	(32.9, 39.2)	33.5	(31.3, 35.8)	27.8	(24.4, 31.4)	27.5	(24.9, 30.2)
Quit in past year	12.6	(11.4, 13.8)	12.6	(11.3, 14.1)	12.2	(10.2, 14.7)	12.6	(11.0, 14.4)	14.9	(12.4, 17.8)	11.1	(9.3, 13.1)

95%CI = 95% confidence interval.
[*]>5% missing; [†]>1% missing; [‡]<1% missing.

Table 3: Odds ratios for making a quit attempt in the past 12 months, by ELP, immigrant generation, and covariates ($N = 4,589$).

	Univariable logit regressions		Multivariable model: English language proficiency		Multivariable model: immigrant generation	
	UOR	95%CI	AOR	95%CI	AOR	95%CI
ELP						
Poor	1.00	(0.85, 1.18)	1.22	(1.02, 1.46)		
Good	1.00	Referent	1.00	Referent		
Immigrant generation						
1st generation	1.12	(0.96, 1.30)			1.21	(1.02, 1.43)
2nd generation	1.43	(1.20, 1.71)			1.36	(1.12, 1.64)
≥3rd generation	1.00	Referent			1.00	Referent
Gender						
Female	1.00	Referent	1.00	Referent	1.00	Referent
Male	0.87	(0.75, 1.00)	0.94	(0.81, 1.09)	0.94	(0.81, 1.09)
Per cap tob control exp	1.01	(1.00, 1.03)	1.02	(1.00, 1.03)	1.02	(1.00, 1.03)
Race						
White	1.00	Referent	1.00	Referent	1.00	Referent
Black	1.40	(0.96, 2.04)	1.39	(0.96, 2.03)	1.32	(0.90, 1.94)
Other	0.90	(0.68, 1.18)	0.80	(0.61, 1.06)	0.82	(0.62, 1.08)
Age (centered)						
Age	0.98	(0.98, 0.99)	0.98	(0.97, 0.99)	0.98	(0.97, 0.99)
Age of initiation						
<18	1.00	Referent	1.00	Referent	1.00	Referent
18–24	1.12	(0.97, 1.28)	1.12	(0.94, 1.33)	1.13	(0.95, 1.34)
25+	1.05	(0.82, 1.34)	1.26	(0.96, 1.67)	1.27	(0.96, 1.67)
Unknown	0.41	(0.23, 0.72)	0.32	(0.15, 0.68)	0.36	(0.18, 0.73)
Age age of initiation*						
18–24 *age	1.00	(0.99, 1.01)	1.00	(0.99, 1.01)	1.00	(0.99, 1.01)
25+ *Age	0.99	(0.97, 1.01)	0.99	(0.98, 1.01)	0.99	(0.97, 1.01)
Unknown *age	0.99	(0.95, 1.03)	0.99	(0.93, 1.04)	0.99	(0.95, 1.04)
Education						
<High school	0.83	(0.70, 0.99)	0.88	(0.74, 1.05)	0.90	(0.75, 1.07)
High school/GED	1.00	Referent	1.00	Referent	1.00	Referent
Some college	1.10	(0.91, 1.32)	1.04	(0.86, 1.25)	1.02	(0.85, 1.23)
≥Bachelor	1.11	(0.85, 1.46)	1.01	(0.76, 1.33)	0.99	(0.75, 1.31)
Household income						
<25 K	1.00	Referent	1.00	Referent	1.00	Referent
25 K to <50 K	1.03	(0.87, 1.22)	0.95	(0.79, 1.14)	0.94	(0.78, 1.12)
50 K to <75 K	1.06	(0.84, 1.35)	0.88	(0.70, 1.12)	0.87	(0.69, 1.11)
≥75 K	1.41	(1.07, 1.86)	1.24	(0.93, 1.65)	1.18	(0.89, 1.57)
Unknown	0.83	(0.64, 1.09)	0.76	(0.56, 1.02)	0.76	(0.56, 1.01)
Time to first cigarette						
<30 minutes	1.00	Referent	1.00	Referent	1.00	Referent
≥30 minutes	1.25	(1.06, 1.47)	1.20	(1.01, 1.42)	1.20	(1.01, 1.44)
Varies	1.11	(0.72, 1.71)	1.15	(0.72, 1.83)	1.22	(0.77, 1.93)
Unknown	17.00	(9.55, 30.18)	17.55	(10.11, 30.48)	17.93	(10.35, 31.04)
Advice from HCP						
Yes	1.41	(1.23, 1.62)	1.58	(1.36, 1.83)	1.55	(1.34, 1.80)
No	1.00	Referent	1.00	Referent	1.00	Referent
Unknown	0.85	(0.39, 1.86)	0.65	(0.22, 1.91)	0.64	(0.25, 1.69)
Mean residual goodness of fit statistic			$F_{(9,231)} = 1.01, P > .05$		$F_{(9,231)} = 1.80, P > .05$	

AOR = adjusted odds ratio; UOR = unadjusted odds ratio; 95%CI = 95% confidence interval.
ELP = English language proficiency; HCP = health care provider.

Table 4: Adjusted odds ratios for making a quit attempt in the past 12 months by ELP, immigrant generation, gender, and interactions for ELP ∗ gender and immigrant generation ∗ gender ($N = 4,589$).

	Multivariable model: English language proficiency[a]		Multivariable model: immigrant generation[a]	
	AOR	95%CI	AOR	95%CI
ELP				
Poor	1.47	(1.08, 2.00)		
Good	1.00	Referent		
Immigrant generation				
1st generation			1.35	(1.04, 1.76)
2nd generation			1.10	(0.84, 1.44)
≥3rd generation			1.00	Referent
Gender				
Female	1.00	Referent	1.00	Referent
Male	0.99	(0.84, 1.17)	0.92	(0.73, 1.16)
Interactions				
ELP ∗ gender	0.78	(0.54, 1.13)		
1st generation ∗ gender			0.86	(0.62, 1.20)
2nd generation ∗ gender			1.43	(0.96, 2.13)

[a] Controls for cumulative per capita tobacco control expenditures, race, education, income, time to first cigarette, cessation advice from healthcare provider, age, age of initiation, interaction of age and age of initiation.
AOR = adjusted odds ratio.
95%CI = 95% confidence interval.

contrasting poor relative to good ELP is smaller by a factor of 0.78 (CI: 0.54–1.13) among males than among females. Similarly, the AOR contrasting 1st and 3rd generation immigrants is smaller by a factor of 0.86 (CI: 0.62–1.20) among males than among females, and the contrast between 2nd and 3rd generation immigrants is larger by a factor of 1.43 (CI: 0.96–2.13) among males than among females.

Predictive margins for quit attempts by ELP and immigrant generation is presented in Figure 1. Latinos with good ELP (50.3%) had lower predictive margin of past 12 month quit attempt than Latinos with poor ELP (54.8%). First (52.2%) and second generation immigrants (54.9%) had higher predictive margins than third generation immigrant Latinos (47.9%).

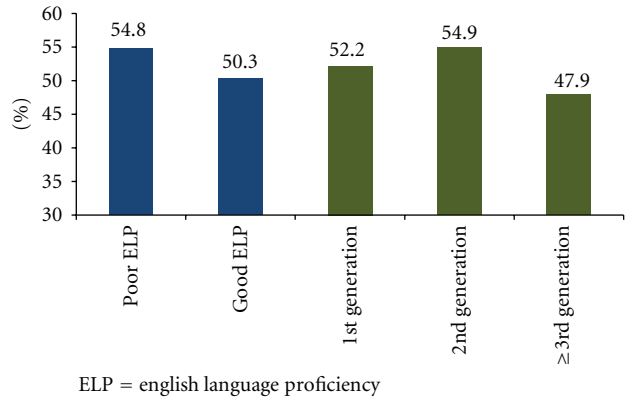

Figure 1: Predictive margins for making a quit attempt in the past 12 months by English language proficiency and immigrant generation among Latino past year smokers ($N = 4,589$). ELP = English language proficiency.

4. Discussion

The present analyses found that Latinos with poor ELP and those of a more recent immigrant generation were more likely to have made a quit attempt. Interestingly, third generation Latino immigrants had similar predictive margin of quit attempt as the overall non-Latino white estimate of quit attempts (46.4%, data not shown in tables or figure). These findings are consistent with past research, which suggests that those with more exposure to USA culture adopt the prevailing tobacco behaviors, at least as compared to non-Latino whites, which is the comparison most often made in the tobacco control acculturation literature [1, 6, 8–10, 17]. Our findings demonstrate that disaggregating Latinos based on language and immigrant generation are warranted in future studies of smoking cessation attempts.

The analysis did not find reliable evidence that that gender moderates the associations between quit attempts and ELP or immigrant generation. However, it is noteworthy that the direction of the interaction observed in these data is consistent with much of the research in the cigarette smoking literature in that there appears to be a stronger acculturation effect among women than there is among men [2, 4, 5, 9, 12]. In contrast, our findings are inconsistent with an analysis by Castro et al., who found an acculturation effect only among men and not among women [17]. Comparative population data has shown that the smoking prevalence in many Latin American countries is much lower compared to the USA rates among women but much more similar among men, and that has been the case over the last several years [43–45]. As such, the larger acculturation effect among females might be expected for smoking simply because there

is more room for overt behavior change. However, there is little comparative population data from Latin American countries for cessation behaviors, which to an extent hinders interpretation of the findings from the present analysis. To date, only Mexico, through the Global Adult Tobacco Survey (GATS), has comparative population level cessation behavior data available [46]. The GATS data show that 57% of female past year smokers in Mexico had made a quit attempt compared to 47% among men [46]. This compares to 49% for females and 44% for males in the non-Latino white sample of the TUS-CPS (data not shown in tables). If the Mexico data roughly extend to other Latin American countries, it is consistent with acculturation to see a stronger association among women than among men for quit attempts. As comparative population level data become more widely available as global tobacco control surveillance grows, this information should be incorporated in future analyses to aid in interpretation of other tobacco use and cessation behaviors.

4.1. Strength and Limitations. The major strength of this paper is that it examined a relationship that has not previously been reported in the published literature. Moreover, it did so using a large nationally representative dataset with rich data on current and past tobacco behaviors and sociodemographic information on the Latino population. However, our paper also has some limitations. First, due to the cross-sectional design we do not have the longitudinal data to support conclusions about changes in smoking behavior patterns over time. Second, the analysis was limited by the variables that were available in the TUS-CPS dataset. As such, variables such as smoking cessation cognitions and other psychological measurements that may be related to cessation could not be controlled for. Third, the concept of acculturation involves multiple aspects to identity formation and adaptation that are inherently dynamic and complex. We used measures commonly applied in the literature, but in recent years Latino health researchers have increasingly called attention to the need for theoretically based measures of acculturation and studies that begin to capture the full range of the Latino experience in the United States, particularly socioeconomic and racially/ethnically-based disadvantage [16, 47–49]. Lastly, the data in the TUS are self-reported and are subject to recall error, which may be differential with respect to current versus former smokers and ELP or immigrant generation.

5. Conclusion

In summary, our study adds to the growing literature on the heterogeneity of Latino health and extends prior work by presenting data on quit attempts. These findings underscore the need to disaggregate Latinos beyond racial/ethnic categories to identify subgroup differences relevant for smoking and smoking cessation behaviors in this population.

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Research Article

Concurrent Use of Cigarettes and Smokeless Tobacco among US Males and Females

Nasir Mushtaq, Mary B. Williams, and Laura A. Beebe

Department of Biostatistics and Epidemiology, University of Oklahoma Health Sciences Center, 801 NE 13th Street, CHB-309, Oklahoma City, OK 73104, USA

Correspondence should be addressed to Nasir Mushtaq, nasir-mushtaq@ouhsc.edu

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Background. The current study describes concurrent use of cigarettes and smokeless tobacco (CiST) among males and females and evaluates factors associated with CiST use. *Methods*. Cross-sectional data were drawn from the 2010 Behavioral Risk Factor Surveillance System (BRFSS). Weighted stratified analyses were performed to find associations between CiST use and sociodemographic factors by gender. CiST users were compared to three different tobacco use groups: nonusers, exclusive smokers, and exclusive ST users. *Results*. Younger age and heavy alcohol consumption were consistently associated with increased odds of CiST use among both males and females, and regardless of comparison group. Among males, education was inversely related to CiST use, and these findings were consistent in all three comparisons. Among women, those unable to work or out of work were more likely to be CiST users, which was consistent across comparisons. American Indian females had higher odds of CiST use than White females when nontobacco users or smokers were the comparison group. *Conclusion*. This study identified sociodemographic characteristics associated with CiST use, and differences in these associations among women and men. Additionally, this study highlights the need to carefully consider what comparison groups should be used to examine factors associated with CiST use.

1. Introduction

Tobacco use is widely considered the most preventable cause of illness and death in the United States. Although the consumption of cigarettes and some other forms of tobacco have decreased in the last decade [1, 2], the consumption of smokeless tobacco has recently increased [3]. In addition, traditional cigarette companies, such as Reynolds America and Altria, the parent company of Phillip Morris, have extended their product lines to include many types of smokeless tobacco [4]. Not only are tobacco companies moving into the smokeless tobacco market, they are marketing smokeless tobacco products as alternatives to smoking when there are bans or restrictions [5]. These conditions encourage the dual use of cigarettes and smokeless tobacco.

The combined use of any tobacco products may increase exposure to potentially harmful chemicals and subsequently increase risk of disease [6, 7]; however, evaluating the concurrent use of cigarettes and smokeless tobacco (ST) is especially important for four reasons. First, tobacco marketing of smokeless tobacco as an alternative when smoking is restricted may increase the prevalence of concurrent use. Second, these two forms of tobacco are the most prevalent forms of tobacco used, and a higher proportion of both groups use tobacco daily compared to users of other forms of tobacco [8, 9]. Third, increased health risks of concurrent use have been demonstrated, such as, an increased risk of acute myocardial infarction among concurrent users beyond the risk of only smoking or solely using smokeless tobacco [7]. Finally, concurrent users may be less likely than cigarette smokers to report intentions to quit in the next 6 months [10].

Although concurrent tobacco use has been previously examined in specific populations in the United States since 1999 [11–15], there is limited research describing concurrent use in the general US adult population. Prevalence of concurrent use among men did not significantly change from 1992 (1.0% 95% CI: 1.0–1.1) to 2002 (0.9% 95% CI: 0.8–1.0) [16, 17]. However, the most recent Federal Trade Commission report on smokeless tobacco (ST) found that snuff sales have recently risen [3]. The increased ST sales may reflect an increased uptake of ST by cigarette smokers, especially

in light of tobacco companies' marketing ST products to smokers [5]. Recent studies have reported higher prevalence of concurrent use from national surveys. One study utilizing Behavioral Risk Factor Surveillance Survey (BRFSS) from 2008 for selected states reported a prevalence of concurrent use of 1.5% [18], while a nationwide consumer-based survey found that an overall prevalence of concurrent use was 1.1% [10]. Another recent study of 2009 BRFSS data found that concurrent use ranged by state from 0.9% in Puerto Rico to 13.7% in Wyoming and differed among men and women [19].

Other studies have evaluated ST use among cigarette smokers and cigarette smoking among ST users, which can provide important information given the changing patterns in tobacco use. One such study reported that 6.1% of adult smokers used ST, and 41.3% of ST users smoked cigarettes [10]. Furthermore, Tomar and colleagues found among men 2.3% of daily smokers and 4.3% of someday smokers also used snuff, while 15% of daily snuff users and 45% of someday snuff users also smoked cigarettes [4].

A limited number of studies have examined correlates of concurrent tobacco use. The consumer-based study found that prevalence of concurrent use was higher among young, men, lower income (< $15,000), and White respondents [10]. A study of Air Force recruits found that ST use among smokers was associated with age (17–20 years), sex (males), race (Whites), and alcohol consumption (at least once per week) [20]. In a similar recent study, concurrent use among active duty military personnel found factors associated with a higher prevalence of concurrent use compared to nontobacco use included: male gender, younger age (21–34 years old), less than a college education, and not being married [21].

These studies highlight the need for ongoing surveillance of concurrent use, and although some have provided information regarding the prevalence of concurrent tobacco use in different populations, questions remain regarding factors associated with concurrent use among women. To increase our understanding of the concurrent use of cigarettes and ST (CiST) in various groups, the current study examined CiST prevalence and factors associated with CiST use by gender. Furthermore, questions remain regarding the appropriate comparison group for CiST users. Most previous studies have compared concurrent users to cigarette smokers and/or smokeless tobacco users; [4, 10, 20, 21] however, it may be of interest to also compare CiST users to nontobacco users (nonusers). Therefore, CiST users were compared to: exclusive smokers, exclusive ST users, and nonusers.

2. Methods and Materials

Cross-sectional data were drawn from the Behavioral Risk Factor Surveillance System (BRFSS) survey for the year 2010. Centers for Disease Control and Prevention (CDC) in collaboration with state health departments conduct BRFSS to obtain state-level data related to various behavioral risk factors, sociodemographic characteristics, and health conditions. BRFSS employs telephone interviews by random digit dialing to collect information from noninstitutionalized residents18 years and older. When combined across states, BRFSS data provide national estimates which are comparable to those obtained from other national surveys [22–24]. The ability of BRFSS to provide valid national estimates and across state comparisons is well established [25]. A number of studies in the past have used BRFSS data to study different behavioral risk factors including smoking at national level.

2.1. Measures

2.1.1. Tobacco Use. Tobacco use status was categorized into four categories: exclusive cigarette smoking, exclusive smokeless tobacco (ST) use, concurrent use of cigarettes and ST (CiST), and no current tobacco use. Cigarette smoking was defined as respondents who smoked at least 100 cigarettes in their lifetime and currently smoke cigarettes. Exclusive smokers were those who smoked cigarettes someday or everyday and did not currently use ST. Respondents currently using ST products, someday or everyday but not currently smokers, were defined as exclusive ST users. Nontobacco users were those who were not current cigarette smokers or ST users.

2.1.2. Concurrent Cigarette and Smokeless Tobacco (CiST) Use. The outcome variable for this study, CiST use, was characterized as the use of both ST and cigarettes irrespective of the frequency of use. Therefore, both daily and someday users of ST products and cigarettes were considered CiST users.

2.1.3. Sociodemographic Factors. These variables included age, gender, race/ethnicity, education level, income level, occupation, marital status, and alcohol consumption. Age was categorized as 18–24, 25–34, 35–44, 45–54, 55–64, and 65 years or older.; race/ethnicity was divided into six categories, non-Hispanic white, non-Hispanic African American, non-Hispanic American Indian or Alaska Native, Hispanic, multiracial, and other. Education had four levels, less than high school, high school, some college, and college graduate or more. Participants were assigned into the following occupational categories: employed for wages, self-employed, homemaker, out of work, student, retired, and unable to work. Annual household income was categorized as less than $10,000, $10,000 to $14,999, $15,000 to $19,999, $20,000 to $24,999, $25,000 to $34,999, $35,000 to $49,999, $50,000 to $74,999, and more than $75,000. Marital status was divided into two categories: married (i.e., married and member of an unmarried couple) and single (i.e., divorced, widowed, separated, and never married). Alcohol use is a social factors routinely associated with tobacco use [26, 27]. Alcohol consumption was divided into two categories heavy drinking and no low or moderate drinking. Heavy drinking was defined by BRFSS as more than two drinks per day for men and more than one drink per day for women.

2.2. Statistical Analysis. Descriptive statistics were calculated for the variables in the study. Gender stratified weighted prevalences were calculated for all the variables including

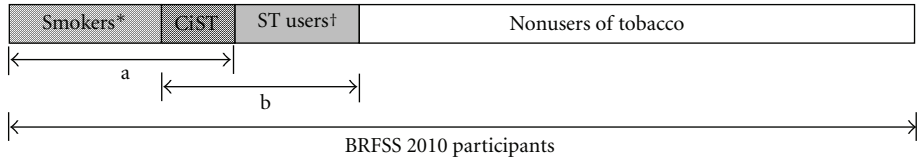

Figure 1: Analysis framework for different comparison groups. Comparisons: (1) CiST versus nonusers of tobacco, (2) within subgroup "a" (CiST versus exclusive smokers), and (3) within subgroup "b" (CiST versus exclusive ST users). *Exclusive smokers (daily or someday), †exclusive ST users (daily or someday), CiST: concurrent users of cigarettes, and ST a: all smokers (exclusive and dual users) and b: all ST users (exclusive and dual users).

tobacco use patterns and sociodemographic characteristics. Weighted stratified analyses were performed to examine associations between CiST use and sociodemographic factors by gender. CiST users were compared to three different tobacco use groups: nonusers, exclusive smokers, and exclusive ST users (Figure 1).

Chi-square goodness of fit tests and logistic regression models were used to determine bivariate associations between CiST use and sociodemographic variables. The variables found to be associated at a significance level of 0.05 with CiST use from simple logistic regression models were used in multivariate regression analysis. Adjusted odds ratios (ORs) and 95% confidence intervals were calculated as the measure of association. All analyses were conducted using SAS v 9.2 and "FINALWT" variable, recommended by BRFSS, was used as a weighting variable. Weighted analyses addressed any imbalances in the sampling design and also provided the unbiased estimates for the general population. An alpha level of 0.05 was used for statistical significance.

3. Results

The prevalence of CiST use was higher among males (1.6%) compared to females (0.3%). The majority of male CiST users were non-Hispanic Whites (79%), employed for wages (54%), and had some college or less education (87%). Similarly, most female CiST users were non-Hispanic Whites (73%) and attained some college or less education (84%); however, 38% of female CiST users were employed for wages. A higher proportion of male CiST users (64%) than female CiST users (47%) had an annual income more than $25,000. Sociodemographic characteristics of the participants are described in Table 1.

3.1. CiST Use among Males. Among men CiST use was reported by 1.6% of participants, while more than 17.4% were exclusive smokers, and 4.2% were exclusive ST users. The prevalence of CiST use among men was higher among American Indian/Alaska Natives, those reporting multiple races, less than 35 years old, those out of work or unable to work, had a high school education or less, had less income, and were single and heavy drinkers. Sociodemographic characteristics of male respondents are described in Table 2.

The multivariate logistic regression analyses using male nontobacco users as the comparison was conducted to obtain association of individual sociodemographic variable with CiST use while controlling for all other variables. Table 3 summarizes the associations between sociodemographic factors and CiST use among males compared to exclusive smokers, exclusive ST users, and nonusers. The likelihood of CiST use increased as age decreased among men. Native American men and those reporting multiple races were about 20% more likely to be CiST users compared to white men. As educational attainment decreased the odds of being a CiST user increased with men having less than a high school education being more than seven times as likely as those with a college degree to be a CiST user. Similarly, as men's household incomes rose above $20,000, the odds of CiST use decreased. Men with incomes between $10,000 and 14,999 were also less likely to be CiST users than those making less than $10,000. Men who were out of work or were unable to work were more likely to be CiST users than men employed for wages. On the other hand, men who were self-employed, students, homemakers, or retired were less likely to be CiST users than men employed for wages. Men who also drank heavily were more than four times as likely to be CiST users as men who drank less than two drinks per day.

3.1.1. Smokeless Tobacco Use among Male Smokers. CiST use was reported by 8.5% of male smokers. Results of the multiple logistic regression models comparing CiST use to exclusive smokers indicated that CiST use was higher among Whites than any other racial/ethnic group. White smokers were 1.3 times more likely to be CiST users than American Indian/Alaska Native smokers, and 2.5 times more likely than African American male smokers after adjustment. There was an inverse association between CiST use and education attained among male smokers. Compared to those who were employed for wages, other occupations were less likely to be CiST users. Similarly, heavy alcohol use increased the odds of CiST use by 1.2 times among male smokers.

3.1.2. Cigarette Smoking among Male ST Users. Twenty-eight percent of the male ST users also smoked cigarettes. Male ST users who were White were less likely to also smoke cigarettes compared to any other race/ethnic group, except American Indian/Alaska Native ST users. Men who graduated from college were less likely to be CiST users compared to those with some college or high school education, and less than half as likely to be CiST users than those with less than high school education. CiST use was also higher among male ST users with annual incomes less than $10,000 compared to those earning more than $10,000. CiST use among male ST

Table 1: Sociodemographic characteristics of CiST users by gender—BRFSS 2010.

Variable	Male (weighted %)	Female (weighted %)
Age		
18–24	22.19	14.11
25–34	32.45	19.33
35–44	18.96	18.96
45–54	14.52	22.35
55–64	8.00	13.81
65 or older	3.88	11.43
Race ethnicity		
White	79.52	72.93
African American	5.76	9.26
American Indian/Alaska Native	2.22	3.67
Hispanic	7.07	11.09
Multiracial	2.85	2.41
Other	2.57	0.65
Education		
Less than high school	18.08	19.77
High school	43.69	37.22
Some college	25.38	26.60
College graduate or more	12.85	16.41
Occupation		
Employed for wages	53.67	38.37
Self-employed	10.61	3.87
Out of work	17.98	14.40
Homemaker	0.23	9.88
Student	5.47	5.12
Retired	4.40	9.31
Unable to work	7.64	19.06
Income		
Less than $10,000	7.16	14.90
$10,000–$14,999	6.05	10.65
$15,000–$19,999	10.44	14.96
$20,000–$24,999	12.12	12.49
$25,000–$34,999	15.14	12.21
$35,000–$49,999	13.53	10.41
$50,000–$74,999	15.35	6.60
$75,000 or more	20.21	17.79
Marital status*		
Married	67.94	62.26
Single	32.06	37.74
Alcohol drinking		
Light, moderate, or no drinking	84.69	88.78
Heavy	15.31	11.22

*Married: married or member of an unmarried couple; Single: divorced, widowed, separated, and never married.

users was 1.7 times higher among heavy drinkers compared to nonheavy alcohol drinkers.

3.2. CiST Use among Females. CiST use was reported by 0.3% of the female participants, while 14.8% were exclusive smokers, and 0.5% were exclusive ST users. AI/AN women had the highest prevalence of CiST use (1.5%) and smoking (29.8%). Like men, CiST use among women increased with decreasing education level. Similarly, CiST prevalence among women decreased with increasing income level. A higher proportion of women who were unable to work were CiST users (1.1%) followed by those who were out of work (0.7%). Sociodemographic characteristics of the female respondents stratified by their tobacco use status are summarized in Table 4.

Results of multivariate logistic regression analyses (Table 5) using female nontobacco users as the comparison indicated after controlling for all other variables, AI/AN females were almost twice likely to be CiST users compared to White women. The likelihood of women being CiST users compared to nonusers increased as education level decreased. Women with less than a high school education were more than four times as likely to be CiST users as women with a college education. Similarly, women who were unable to work were almost three times as likely to be CiST users as those employed for wages, and those out of work were 75% more likely to use both products. As the household income of women rose above $20,000, the odds of CiST use decreased compared to those with incomes less than $10,000. Heavy alcohol drinking was associated with more than four times the odds of CiST use among women after adjustment for other covariates.

3.2.1. Smokeless Tobacco Use among Female Smokers. CiST use was reported by 2.3% of the female smokers. Age, race/ethnicity, education level, income level, occupation, and heavy alcohol consumption were significantly associated with CiST use among female smokers. Among female smokers, AI/AN were 1.6 times more likely to be CiST users than White, and Hispanic smokers were 1.4 times as likely as Whites to be CiST users. Conversely, African American, multiracial, and those reporting other race had lower odds of ST use compared to white female smokers. Female smokers having less than high school education were 1.2 times more likely to be CiST users compared to college graduates, whereas women with high school or some college education were less likely to be CiST users than college graduates. Compared to female smokers employed for wages, smokers who were out of work, students, or unable to work had increased likelihood of CiST use but self employed, retired, and homemaker female smokers had decreased odds of CiST use. CiST use was 1.3 times more likely among female smokers who were also heavy drinkers compared to those who consumed less than one drink per day.

3.2.2. Cigarette Smoking among Female ST Users. Among female ST users, 42.4% also smoked cigarettes. Multivariate logistic regression analysis showed that White female ST users were more likely to be CiST users compared to ST users of any other racial ethnic group and were 7.1 times as likely as African American female ST users to report CiST use. Female ST users who had less than high school

Table 2: Prevalence of tobacco use by sociodemographic characteristics among males—BRFSS 2010.

Variable	Unweighted sample size	CiST user (weighted %)	Exclusive smoker (weighted %)	Exclusive ST user (weighted %)
Age				
18–24	5795	3.17	19.25	4.55
25–34	12675	3.10	24.13	4.73
35–44	22437	1.45	16.87	6.03
45–54	33851	1.19	18.98	3.88
55–64	41306	0.86	16.68	2.66
65 or older	54050	0.40	8.42	2.54
Race ethnicity				
White	134692	1.86	16.64	5.20
African American	11049	1.02	22.39	1.85
American Indian/Alaska Native	2515	2.78	31.08	6.69
Hispanic	11382	0.81	18.03	1.20
Multiracial	3024	2.64	27.17	5.45
Other	4642	0.85	11.70	1.63
Education				
Less than high school	15951	2.86	29.10	3.92
High school	48900	2.50	24.51	5.43
Some college	41238	1.69	18.91	4.81
College graduate or more	63389	0.56	7.89	2.85
Occupation				
Employed for wages	71785	1.63	15.66	4.83
Self-employed	20369	1.58	17.15	4.21
Out of work	11589	2.95	32.94	3.32
Homemaker	456	0.97	30.36	4.41
Student	2629	1.80	11.61	3.85
Retired	51632	0.44	10.27	2.55
Unable to work	10827	2.43	34.24	4.48
Income				
Less than $10,000	6398	2.56	32.54	3.07
$10,000–$14,999	7569	2.20	29.66	3.41
$15,000–$19,999	10224	2.57	28.72	3.43
$20,000–$24,999	13557	2.34	25.24	4.31
$25,000–$34,999	17385	2.43	21.98	4.30
$35,000–$49,999	23607	1.61	18.35	4.46
$50,000–$74,999	25191	1.54	14.28	4.68
$75,000 or more	47655	0.89	9.81	4.25
Marital status				
Married	111209	1.22	13.75	4.34
Single	58178	2.43	25.31	3.82
Alcohol drinking				
Light, moderate, or no drinking	155113	1.45	16.07	3.99
Heavy	8718	4.51	36.84	6.90
Total		1.62	17.45	4.16

education were also less likely to be CiST users compared to college graduates. However, high school graduates or those with some college education were more likely to be CiST users than college graduates. Similarly, female ST users who were self-employed, out of work, homemaker, students, or unable to work had increased odds of CiST use compared to female ST users who were employed for wages. Women using ST and having household incomes between $10,000

Table 3: Association between sociodemographic factors and CiST use among males.

Variable	Nonuser OR (95% CI)	Exclusive smoker OR (95% CI)	Exclusive ST user OR (95% CI)
Age			
18–24	6.75 (6.67, 6.83)	3.14 (3.11, 3.18)	2.72 (2.68, 2.76)
25–34	10.54 (10.43, 10.66)	2.44 (2.42, 2.47)	4.00 (3.94, 4.05)
35–44	4.50 (4.45, 4.55)	1.38 (1.36, 1.39)	1.49 (1.47, 1.51)
45–54	3.19 (3.15, 3.23)	1.04 (1.03, 1.06)	1.96 (1.93, 1.98)
55–64	2.14 (2.12, 2.17)	0.86 (0.85, 0.87)	2.05 (2.02, 2.07)
65 or older	Referent		
Race/ethnicity			
White	Referent		
Af Am	0.28 (0.27, 0.28)	0.40 (0.40, 0.41)	1.21 (1.19, 1.22)
AI/AN	1.21 (1.19, 1.22)	0.78 (0.77, 0.79)	0.89 (0.88, 0.90)
Hispanic	0.15 (0.15, 0.15)	0.32 (0.32, 0.32)	1.71 (1.69, 1.72)
Multiracial	1.23 (1.22, 1.24)	0.81 (0.80, 0.82)	1.19 (1.17, 1.20)
Other	0.43 (0.43, 0.43)	0.62 (0.62, 0.63)	1.89 (1.87, 1.92)
Education			
Less than high school	7.53 (7.48, 7.58)	1.50 (1.49, 1.51)	2.52 (2.50, 2.54)
High school	4.39 (4.37, 4.42)	1.30 (1.29, 1.31)	1.60 (1.59, 1.61)
Some college	2.92 (2.91, 2.94)	1.19 (1.18, 1.20)	1.33 (1.32, 1.33)
College graduate or more	Referent		
Occupation			
Employed for wages	Referent		
Self-employed	0.99 (0.98, 1.00)	0.92 (0.91, 0.92)	0.91 (0.91, 0.92)
Out of work	1.20 (1.20, 1.21)	0.74 (0.74, 0.74)	1.50 (1.49, 1.51)
Homemaker	0.65 (0.63, 0.67)	0.39 (0.38, 0.40)	1.02 (0.99, 1.06)
Student	0.45 (0.44, 0.45)	0.99 (0.98, 0.99)	0.81 (0.80, 0.82)
Retired	0.59 (0.59, 0.60)	0.66 (0.65, 0.66)	0.72 (0.71, 0.73)
Unable to work	1.35 (1.34, 1.36)	0.96 (0.95, 0.96)	1.10 (1.09, 1.11)
Income			
Less than $10,000	Referent		
$10,000–$14,999	0.84 (0.83, 0.85)	0.90 (0.89, 0.90)	0.76 (0.75, 0.77)
$15,000–$19,999	1.04 (1.04, 1.05)	1.05 (1.05, 1.06)	0.99 (0.98, 1.01)
$20,000–$24,999	0.99 (0.99, 1.00)	1.01 (1.00, 1.02)	0.80 (0.79, 0.81)
$25,000–$34,999	0.99 (0.98, 1.00)	1.08 (1.07, 1.09)	0.90 (0.89, 0.91)
$35,000–$49,999	0.65 (0.65, 0.66)	0.91 (0.90, 0.92)	0.62 (0.62, 0.63)
$50,000–$74,999	0.61 (0.60, 0.61)	1.11 (1.10, 1.12)	0.63 (0.62, 0.63)
$75,000 or more	0.44 (0.44, 0.44)	0.94 (0.93, 0.95)	0.46 (0.46, 0.47)
Marital status			
Married	Referent		
Single	1.41 (1.41, 1.42)	0.93 (0.93, 0.94)	1.67 (1.66, 1.68)
Alcohol consumption			
Nondrinker, light, or moderate	Referent		
Heavy	4.26 (4.24, 4.28)	1.16 (1.15, 1.16)	1.69 (1.68, 1.70)

Odds ratios are adjusted for all other variables under study.

and 49,999 had higher odds of CiST use compared to female ST users with incomes less than $10,000. Conversely, female ST users earning more than $50,000 were less likely to use CiST compared to those earning less than $10,000.

4. Discussion

Previous studies have used a variety of terms to refer to the use of multiple forms of tobacco, and some terms had

Table 4: Prevalence of tobacco use by sociodemographic characteristics among females—BRFSS 2010.

Variable	Unweighted sample size	CiST user (weighted %)	Exclusive smoker (weighted %)	Exclusive ST user (weighted %)
Age				
18–24	6826	0.56	14.72	0.63
25–34	22236	0.41	18.21	0.61
35–44	36206	0.33	15.64	0.38
45–54	52887	0.40	18.25	0.39
55–64	64731	0.31	14.83	0.38
65 or older	98075	0.20	7.67	0.53
Race ethnicity				
White	217259	0.36	16.00	0.33
African American	25166	0.30	15.41	1.16
American Indian/Alaska Native	3519	1.46	29.76	1.37
Hispanic	20528	0.28	9.18	0.46
Multiracial	4664	0.50	22.90	0.37
Other	6264	0.06	5.12	0.97
Education				
Less than high school	27344	0.68	21.14	1.26
High school	85570	0.47	20.08	0.59
Some college	78152	0.33	17.38	0.34
College graduate or more	88921	0.16	6.84	0.25
Occupation				
Employed for wages	107128	0.30	14.57	0.42
Self employed	16743	0.23	14.16	0.38
Out of work	15543	0.67	26.22	0.59
Homemaker	33692	0.23	11.88	0.43
Student	4506	0.38	11.92	0.30
Retired	80711	0.19	8.29	0.46
Unable to work	21212	1.11	31.00	0.95
Income				
Less than $10,000	15946	0.83	24.22	1.37
$10,000–$14,999	17242	0.67	22.90	0.56
$15,000–$19,999	21391	0.71	23.03	0.62
$20,000–$24,999	25277	0.48	20.02	0.54
$25,000–$34,999	29411	0.41	17.70	0.43
$35,000–$49,999	34984	0.27	16.40	0.26
$50,000–$74,999	35304	0.16	12.92	0.30
$75,000 or more	55437	0.21	8.16	0.25
Marital status				
Married	147693	0.28	12.43	0.39
Single	131848	0.45	18.75	0.60
Alcohol drinking				
Light, moderate, or no drinking	262219	0.31	13.95	0.47
Heavy	11298	0.89	31.10	0.43
Total		0.35	14.79	0.47

multiple meanings in the literature, so Klesges and colleagues called for common operational definitions but did not offer specific definitions [20]. In the present study, we have introduced "CiST" and defined it as the combined use of cigarettes and smokeless tobacco at any frequency to differentiate it from other concurrent tobacco use. We examined CiST use among males and females and identified sociodemographic factors associated with CiST use. Comparisons were made

Table 5: Association between sociodemographic factors and CiST use among females.

Variable	Nonuser OR (95% CI)	Exclusive smoker OR (95% CI)	Exclusive ST user OR (95% CI)
Age			
18–24	3.12 (3.06, 3.18)	1.08 (1.06, 1.09)	1.06 (1.03, 1.09)
25–34	3.75 (3.69, 3.81)	0.76 (0.75, 0.77)	2.43 (2.38, 2.50)
35–44	3.31 (3.26, 3.37)	0.72 (0.71, 0.73)	2.56 (2.50, 2.62)
45–54	3.04 (2.99, 3.08)	0.68 (0.67, 0.69)	2.58 (2.52, 2.64)
55–64	1.90 (1.87, 1.93)	0.66 (0.65, 0.67)	1.84 (1.80, 1.88)
65 or older	Referent		
Race/ethnicity			
White	Referent		
Af Am	0.39 (0.39, 0.40)	0.76 (0.75, 0.77)	0.14 (0.14, 0.14)
AI/AN	1.82 (1.78, 1.86)	1.58 (1.55, 1.61)	0.35 (0.34, 0.36)
Hispanic	0.32 (0.31, 0.32)	1.40 (1.38, 1.41)	0.35 (0.35, 0.36)
Multiracial	1.08 (1.06, 1.11)	0.99 (0.97, 1.01)	0.60 (0.58, 0.62)
Other	0.15 (0.14, 0.16)	0.51 (0.49, 0.53)	0.05 (0.05, 0.05)
Education			
Less than high school	4.69 (4.62, 4.75)	1.18 (1.16, 1.19)	0.84 (0.83, 0.86)
High school	2.91 (2.88, 2.94)	0.95 (0.94, 0.96)	1.11 (1.09, 1.13)
Some college	1.87 (1.85, 1.89)	0.74 (0.73, 0.75)	1.38 (1.35, 1.40)
College graduate or more	Referent		
Occupation			
Employed for wages	Referent		
Self-employed	0.81 (0.80, 0.83)	0.86 (0.84, 0.87)	1.69 (1.65, 1.74)
Out of work	1.75 (1.73, 1.77)	1.19 (1.18, 1.21)	2.98 (2.92, 3.03)
Homemaker	0.70 (0.69, 0.71)	0.94 (0.92, 0.95)	1.11 (1.09, 1.13)
Student	0.76 (0.75, 0.78)	1.22 (1.20, 1.24)	2.01 (1.94, 2.08)
Retired	0.85 (0.83, 0.86)	0.94 (0.93, 0.96)	0.93 (0.91, 0.95)
Unable to work	2.99 (2.96, 3.02)	1.90 (1.88, 1.92)	2.55 (2.50, 2.59)
Income			
Less than $10,000	Referent		
$10,000–$14,999	0.89 (0.88, 0.90)	0.88 (0.87, 0.89)	2.75 (2.68, 2.81)
$15,000–$19,999	1.01 (1.00, 1.03)	0.99 (0.98, 1.00)	1.77 (1.73, 1.80)
$20,000–$24,999	0.63 (0.62, 0.64)	0.69 (0.68, 0.70)	1.14 (1.12, 1.16)
$25,000–$34,999	0.65 (0.64, 0.66)	0.81 (0.80, 0.82)	1.40 (1.38, 1.43)
$35,000–$49,999	0.43 (0.42, 0.44)	0.61 (0.60, 0.62)	1.34 (1.31, 1.37)
$50,000–$74,999	0.25 (0.24, 0.25)	0.47 (0.46, 0.48)	0.68 (0.66, 0.70)
$75,000 or more	0.32 (0.32, 0.33)	0.92 (0.91, 0.94)	0.95 (0.93, 0.97)
Marital status			
Married	Referent		
Single	1.23 (1.22, 1.24)	0.93 (0.92, 0.93)	1.49 (1.47, 1.51)
Alcohol consumption			
Nondrinker, light, or normal	Referent		
Heavy	4.44 (4.39, 4.49)	1.27 (1.26, 1.28)	3.23 (3.16, 3.30)

Odds ratios are adjusted for all other variables under study.

between CiST users and nontobacco users, exclusive smokers and exclusive ST users separately. This is the first study to evaluate CiST use patterns among females and factors associated with CiST using these three comparison groups.

Some characteristics of CiST users identified in the current study were similar to those found in previous research, such as a higher prevalence of CiST use in younger age groups compared to smokers and ST users [10, 20]. Likewise,

our findings that lower education levels are associated with CiST use are consistent with previous work reported by the two studies conducted among military groups [20, 21]. However, our study found a stronger relationship between education and CiST use compared to nontobacco users for both genders, and the strength of this relationship is stronger among men than among women. Further, the association we found between alcohol consumption and CiST use among smokers is comparable to that reported by Klesges among Air Force recruits [20]. Although Spangler and colleagues described CiST use among the Lumbee tribe in North Carolina in 2001 [11], there are no other studies we are aware of describing CiST use among Native Americans. Our findings provide a national perspective regarding CiST use among Native Americans and come at an important time as many Native American tribes are developing tobacco control programs in their communities, and these findings suggest CiST use should be monitored among Native Americans.

Approaches used by previous researchers to compare concurrent tobacco use have been inconsistent and insufficient. Most previous work investigated ST use among smokers to better understand CiST use in this smoking subgroup [4, 10, 20, 21]. These analyses can be helpful in identifying groups of smokers at higher risk of CiST use; however, other information may be lost if this is the only comparison group used. Demographic and other factors related to CiST use may also be related to smoking, so using smokers as the comparison group may distort the relationships between CiST use and those factors. For example, this study found that CiST use was more prevalent among Native American men (2.8%) compared to White men (1.9%); however, when CiST use was evaluated among male smokers, the odds of CiST use was lower among Native Americans than Whites. In contrast, when nontobacco users were the comparison group, the odds of CiST use among Native American men was higher than White men. Comparing CiST users to nontobacco users provides information regarding factors associated with CiST use without distortion of the relationship. On the other hand, examining CiST use among tobacco using subgroups (smokers or ST users) offers insight regarding tobacco users who may be at higher risk of CiST use within the respective tobacco using group. With the recent tobacco industry marketing of smokeless tobacco to cigarette smokers [5], it is indeed important to understand groups of smokers who may be at risk for CiST use. Nevertheless, it may be equally important to understand other avenues of initiation to CiST use since information is currently lacking regarding how CiST use develops.

In addition to considering that CiST use may begin when monotobacco users adopt the other tobacco product, we need to consider another possible path to CiST use: the initiation of both forms of tobacco simultaneously. More information is needed regarding the development of CiST use among smokers, smokeless tobacco users, and in general. Until more is known about the development of CiST use, we recommend using more than one comparison group for surveillance of CiST use to enable a comprehensive examination of trends in CiST use.

Another important feature of the present study is the stratified analysis by gender. Although most of this study's findings for male tobacco users agree with past studies, this study also identifies sociodemographic characteristics associated with CiST use among women. A few previous studies of concurrent tobacco use have included women in their analyses [10, 19–21]; however, none examined CiST use among women separately. Even though the prevalence of CiST use is less than one percent of the female population, based on the results of current study, an estimated 500,000 women in USA are CiST users. Our findings show that certain groups of women are more likely to be CiST users, including AI/AN women, those with lower education, out of work, and heavy drinkers. In addition, CiST use is an emerging public health problem and its use among women may increase in the future since tobacco companies are marketing smokeless tobacco to smokers when smoking is restricted [5].

Using BRFSS data enabled the evaluation of CiST use patterns among males and females and the use of multiple comparison groups, with sufficient sample size and adequate power for the statistical analyses. Additionally, these data provide valid national estimates and the results are more generalizable to the US population. Unlike past studies, the large sample also enabled evaluation of more detailed categories within each sociodemographic factor, and a number of important categories were identified.

There are a few limitations of this study which are primarily inherent to BRFSS. The tobacco use prevalence estimates reported in current study are less than the estimates based on 2010 National Health Interview Survey (NHIS). BRFSS is a telephone-based survey that does not include households without landline phones, and this limitation of the sampling frame of the survey results in noncoverage bias. Similarly, estimates obtained from BRFSS are potentially biased due to low response rates which are associated with underrepresentation of certain subgroups of population such as, women, racial/ethnic minorities, younger adults, and low-income individuals [28]. These limitations may make it more difficult to estimate tobacco use in these underrepresented groups. Some previous studies have reported significant relationship between CiST use and tobacco use characteristics, such as age at smoking initiation, number of days (per month) of tobacco use, and quantity used per day; [20, 21] however, BRFSS lacks this information so these characteristics could not be examined. Validity of self-reported cigarette smoking has been assessed using biochemical specimens in the past; however, there are no such validation studies for ST use [29, 30]. There may be some misclassification bias due to self-reported tobacco use in the current study. Finally, BRFSS did not collect information regarding other forms of tobacco, such as pipes, cigars, bidis, or hookahs. Therefore, the nontobacco users category may include some users of these forms of tobacco.

5. Conclusions

This study identified a number of sociodemographic characteristics associated with CiST use and differences in

these associations among women and men by factors such as employment status, educational attainment, and race. Hence, CiST use should be monitored and studied further in women and the high-risk groups in both genders identified in this study. This study also provided more detailed information of CiST use in specific categories not well studied previously, such as AI/AN, and various employment and income categories. Future monitoring of CiST use should continue to determine if CiST use changes over time, especially among high-risk groups. Finally, this study highlights the need to carefully consider what comparison groups should be used to examine factors associated with CiST use. Since information is currently lacking regarding how CiST use develops, and associations of CiST use vary with different comparison groups, tobacco surveillance systems should monitor a wide range of tobacco consumption and researchers should cautiously select comparison groups that are most appropriate for their investigation.

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Research Article

Patterns of Tobacco Use and Dual Use in US Young Adults: The Missing Link between Youth Prevention and Adult Cessation

Jessica M. Rath,[1] Andrea C. Villanti,[2,3] David B. Abrams,[2,3,4] and Donna M. Vallone[1]

[1] *Department of Research and Evaluation, Legacy, Washington, DC 20036, USA*
[2] *The Schroeder Institute for Tobacco Research and Policy Studies, Legacy, Washington, DC 20036, USA*
[3] *Department of Health, Behavior and Society, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD 21205, USA*
[4] *Department of Oncology, Georgetown University Medical Center and Lombardi Comprehensive Cancer Center, Washington, DC 20007, USA*

Correspondence should be addressed to Jessica M. Rath, jrath@legacyforhealth.org

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Few studies address the developmental transition from youth tobacco use uptake to regular adulthood use, especially for noncigarette tobacco products. The current study uses online panel data from the Legacy Young Adult Cohort Study to describe the prevalence of cigarette, other tobacco product, and dual use in a nationally representative sample of young adults aged 18–34 ($N = 4,201$). Of the 23% of young adults who were current tobacco users, 30% reported dual use. Ever use, first product used, and current use were highest for cigarettes, cigars, little cigars, and hookah. Thirty-two percent of ever tobacco users reported tobacco product initiation after the age of 18 and 39% of regular users reported progressing to regular use during young adulthood. This study highlights the need for improved monitoring of polytobacco use across the life course and developing tailored efforts for young adults to prevent progression and further reduce overall population prevalence.

1. Introduction

In 2010, young adults aged 18–25 reported the highest prevalence of current use of a tobacco product (40.8%) compared to youth (ages 12–17) or adults (ages 26 and older) [1]. Although young adult (aged 18–24) cigarette smoking prevalence decreased overall (24.4% to 20.1%) from 2005 through 2010 [2], the highest prevalence of smoking among all adults was reported among this age segment in 2005 and 2006 [3, 4]. Since the Master Settlement Agreement, which restricted tobacco marketing to youth [5], young adults have become an increasingly important target audience for tobacco industry attention [6]. Young adulthood marks an important developmental period for leaving home and school, increased stress and pressure, identity exploration, and the establishment of health behaviors that will persist throughout adulthood [7]. It has also been shown to be a particularly salient time for progression to regular tobacco use [8]. The transition from youth smoking initiation (and its primary prevention) to adult established smoker (and cessation treatment interventions) is an understudied developmental period along the trajectories and pathways of progression to regular tobacco use, nicotine dependence, and difficulty quitting [9, 10]. Understanding the role tobacco use behavior plays during this critical life stage can offer important opportunities to significantly reduce tobacco use prevalence and its preventable harms.

Several studies indicate that this age group is also at increased risk for using other noncigarette tobacco products. The National College Health Assessment survey (NCHA-II) reported that 14.8% of college students used cigarettes in the past 30 days, 7.8% used cigars, little cigars, or clove cigarettes in the past 30 days, and 3.9% used smokeless tobacco [11]. Research also highlights the prevalence of hookah use in the young adult population, particularly among college students [11–15]. For example, more than a quarter of college students have smoked tobacco from a hookah or water pipe, with 8.5% reporting past 30-day use [11]. In 2007, an estimated 200–300 hookah cafés/bars operated in the USA, usually near college campuses, with more appearing

every day [16]. Although limited data is available on the trial of snus, young adults indicate a high level of interest in these products [17]. New electronic nicotine delivery devices (ENDS), erroneously called electronic or e-cigarettes, may also be especially appealing to young adults, providing aerosolized doses of nicotine with appealing flavors [18]. Two recent studies also reported on use of electronic cigarettes, e-cigarettes, or electronic nicotine delivery systems (ENDS) in the young adult population; one study showed the highest prevalence of ever use in 18–24 year olds at 10.1% [19] and the other suggests an inverse relationship between use of ENDS and age, with higher use among younger adults [20]. Additionally, rates of dual use and polytobacco use in the young adult population are of increasing concern. In a nationally-representative sample, young adults aged 18–24 reported the highest prevalence of polytobacco use, defined as concurrent use of more than one tobacco product, compared to those adults ≥25 years [21]. In Minnesota, more than 24% of young adult current cigarette smokers reported current use of other non-cigarette products [22], and in a Canadian sample, more than 26% of young adults reported lifetime polytobacco use [23].

Since 1992, smoking patterns for young adults have shifted to reflect an increase in light and intermittent smoking [24]. However, tobacco use surveillance measures have not been modified to detect these changes in tobacco use behavior. A recent study by Foldes et al. [22] demonstrated that using the adolescent measure of current smoking (i.e., have you smoked a cigarette in the past 30 days?) resulted in a 7% increase in smoking prevalence among young adults, 18.7% of which were considered previously unrecognized smokers. Twenty-eight percent of these previously unrecognized light and intermittent smokers reported initiating smoking after age 18 years and 35.5% reported starting to smoke regularly between the ages of 18 and 24 [22].

In a rapidly changing landscape of tobacco use patterns across an increasingly diversified offering of tobacco products, the need for rapid and reliable surveillance is even more critical. The passage of the 2009 FDA Family Smoking Prevention and Tobacco Control Act (FSPTCA) provides a new set of regulatory tools to reduce the harms of tobacco use [25]. The new FDA regulation has also coincided with the introduction of a number of new products to deliver nicotine to the human brain (e.g., snus, dissolvables, and e-cigarettes) that may be especially attractive to youth and young adults [17, 18, 20]. All major cigarette companies worldwide are positioning themselves in the market for snus, the Swedish name for snuff. Most of the new products are smokeless, spitless, low nitrosamine tobacco and use existing major cigarette brand names to market the products [26–28]. Companies are using advertising such as "Fits Alongside Your Smokes" to promote these products for dual use [29, 30]. Moreover, it is likely that new innovations of ENDS will be marketed in the near future [18, 31]. Thus, it is even more imperative that surveillance of young adults keep up with and measure changing trends as rapidly and rigorously as possible to serve as an early warning tool (i.e., the "canary in the coal mine") for regulators and policymakers. The current study uses data from a large, nationally representative sample of young adults to describe prevalence, patterns, and predictors of cigarette, other tobacco product, and dual use in this population.

2. Methods

2.1. Participants. The Legacy Young Adult Cohort Study is designed to understand the trajectories of tobacco use in a young adult population using a longitudinal cohort sample ($N = 4,215$). The 18–34-year age range was selected in order to be consistent with other Legacy research. For example, previous publications by the Legacy research group demonstrate differences between younger (18–24) and older (25–34) young adults [32]. Baseline data from the cohort were used to estimate prevalence of cigarette and other tobacco product use in this nationally representative sample of young adults aged 18–34 drawn from the Knowledge Networks' KnowledgePanel®. KnowledgePanel® is a commercial online panel of adults aged 18 and older that covers both the online and offline populations in the U.S (http://www.knowledgenetworks.com/knpanel/index.html). The cohort was recruited via address-based sampling, a probability-based random sampling method which provides statistically valid representation of the USA population, including cell-phone-only households, African Americans, Latinos, and younger adults. Knowledge Networks also provides households without internet access with a free netbook computer and internet service to reduce response bias in typical online survey samples. The baseline survey was fielded for one month in the summer of 2011 and African American and Hispanic respondents were oversampled to ensure sufficient samples for subgroup analysis. The household recruitment rate for this study was 14.8% and, in 65% of these households, one member completed a survey. For this particular study, only one panel member per household was selected at random to be part of the study sample and no members outside the panel were recruited. The study completion rate was 56.9% and thus, the cumulative response rate was 5.5%. Appendix A provides a demographic comparison of panel members to the overall USA population aged 18–34 and demonstrates the representativeness of the Knowledge Networks sample (see Supplementary Material available online at doi:10.1155/2012/679134). Poststratification adjustments were used to offset any nonresponse or noncoverage bias by weighting the data. Observations were deleted for those respondents where data was missing on the item which assessed ever tobacco use ($N = 14$). This study was approved by the Independent Investigational Review Board, Inc. Immediately upon completion of the survey, points were awarded to each respondent. This survey incentive was 10,000 points which is the equivalent of $10. When panel respondents reach 25,000 points by completing numerous surveys, they receive a check for $25.

2.2. Measures. Demographic items included age (grouped as 18–24 and 25–34), gender, and race/ethnicity (White, non-Hispanic; Black, non-Hispanic; other, non-Hispanic; and

Hispanic). Educational attainment (less than high school, high school, some college, Bachelor's degree, and graduate or professional degree), current employment status, and self-described financial situation (live comfortably, meet needs with a little left, just meet basic expenses, and do not meet basic expenses) were also included.

Tobacco use was assessed with measures of ever tobacco use, first tobacco product tried, past 30-day use, every day or someday use, and number of cigarettes smoked per day for each day of the week. For ever use, first product tried, and past 30-day use, response categories included cigarettes, cigars, pipe (with tobacco), little cigars/cigarillos/bidis (like Black & Milds, Swisher Sweets, Phillies Blunt, or Captain Black), e-cigarettes (like BLU or NJOY), chewing tobacco (like Levi Garrett, Red Man, or Beech Nut), dip/snuff (like Skoal or Copenhagen), snus (like Camel Snus), dissolvable tobacco products (like Ariva, Stonewall, Camel Orbs, Sticks or Strips), and hookah/shisha (hookah tobacco); for first product tried, participants were able to fill in an "other" category. Ever use and first product used also captured consumption of nicotine replacement products (like gum, patches, lozenges). Participants were asked to recall their age at tobacco product initiation and at progression to regular use, defined as monthly use. Given the rising prevalence of hookah use, participants were also asked whether they had ever visited a hookah bar or restaurant.

Tobacco use was categorized as respondents who reported current "every day" or "some days" use of cigarettes or tobacco products. Categories included "cigarettes only," "cigarettes and other tobacco products," and "other tobacco products only." Individuals who reported no current tobacco product use, including those who never used a product, were classified as "neither." Individuals who reported using both cigarettes and other tobacco products "every day" or "some days" were classified as dual users.

2.3. Data Analysis. All analyses were performed using Stata IC 11.0 [33] and data were weighted to produce nationally representative prevalence estimates. Univariate analyses were conducted to describe the distribution of sociodemographic variables and bivariate analyses estimated the prevalence of tobacco use by product and the prevalence of dual use across sociodemographic and socioeconomic variables. Differences in means or prevalence estimates were assessed by nonoverlapping 95% confidence intervals and P values were estimated using the design-based F statistic. Multinomial multivariate logistic regression models were used to calculate the adjusted relative risk ratios (RRRs) in Table 3 for current cigarette-only use, dual use, and other tobacco-product-only use compared to no tobacco use for all covariates in the model accounting for survey weights.

3. Results

Participants ranged in age from 18 to 34 years ($N = 4201$), 50% were males (CI: 48%–52%), and 50% were females (CI: 48%–52%). Sixty percent of the population was White (CI: 58%–62%), 13% Black (CI: 12%–15%), 7% other (CI: 6%–9%), and 19% Hispanic (CI: 18%–21%). The majority of participants (43%) had some college education (CI: 41%–45%) while 16% had a Bachelor's degree (CI: 15%–18%), 7% had a graduate degree (CI: 6%–8%), and 34% had a high school education or less (CI: 32%–36%). The majority of the sample works full time (47%; CI: 45%–49%), 22% work part time (CI: 20%–23%), and 32% does not currently work for pay (CI: 30%–34%). Financial situation was assessed by the following categories: live comfortably (23%; CI: 21%–25%), meet needs with a little left (35%; CI: 33%–37%), just meet basic expenses (32%; CI: 30%–34%), and do not meet basic expenses (9%; CI: 8%–11%).

More than half of the sample had ever smoked cigarettes (51%), 31% had ever smoked cigars, and 26% had ever smoked little cigars/cigarillos/bidis (Table 1). First product used followed the same order: 73% initiated with cigarettes, 11% with cigars, 5% with little cigars/cigarillos/bidis, and 4% with hookah. Of those who reported every day or someday smoking, 87% had smoked in the past 30 days (mean number of days of cigarette use in the past 30 = 23 days), 19% currently smoke cigars (mean = 6 days of past 30), and 16% currently smoke little cigars/cigarillos/bidis (mean = 11 days of past 30). In addition, 8% of persons reporting every day or someday use of cigarettes or other tobacco products reported hookah use in the past 30 days (17% ever use of hookah), with a mean of 7 hookah uses in the past 30 days. Ever use and current use of e-cigarettes, chewing tobacco, pipes, dip, snus, dissolvable products, and nicotine products were all at 10% or less (Table 1). Twenty-three percent of the full sample reported current use of cigarettes and/or other tobacco products, with 7% reporting dual use. This corresponds to a 30% prevalence of dual use among current tobacco users.

Bivariate correlations were assessed between selected demographics and current tobacco product use (Table 2). There were no statistically significant differences in tobacco product use among those aged 18–24 years versus those aged 25–34 years. Females were significantly less likely than males to use cigarettes and other tobacco products (5% versus 9%; $P < .001$) as well as other tobacco products only (1% versus 6%; $P < .001$). A significantly higher proportion of Hispanics reported use of neither cigarettes or other tobacco products (83% versus 75%; $P = .017$), compared to Whites and Black participants were significantly less likely to use other tobacco products only compared to Whites (2% versus 4%; $P = .017$). Participants with at least some college education, compared to high school education or less, were significantly more likely to be nonsmokers and nonusers of other tobacco products with 93% of those with a graduate or professional degree not using tobacco products versus 68% of participants with high school educations only ($P < .001$). Twenty-three percent of persons reporting that they do not meet their basic expenses are cigarette smokers and 12% use cigarettes and other tobacco products. This is significantly different than those reporting living comfortably (5% smokers; 4% smoking and using other tobacco products; $P < .001$).

In the group of dual users, the highest prevalence of past 30-day use was reported for the following products: cigarettes (98%), cigars (23%), little cigars (26%), hookah (17%), dip or snuff (12%), chewing tobacco (12%), and e-cigarettes

Table 1: Prevalence of tobacco product by first use, ever use, and past 30-day use, using poststratification weights for the full sample.

	Ever use ($N = 4201$)		Tobacco product first used ($N = 2493$)		Mean age at initiation			Past 30-day use[a]			Mean no. of days used in past month[b]		
	Prevalence	95% CI	Prevalence	95% CI	*N*	Mean	95% CI	*N*	Prevalence	95% CI	*N*	Mean	95% CI
Cigarettes	0.51	(0.49–0.53)	0.73	(0.71–0.76)	1799	15.17	(14.94–15.40)	819	0.87	(0.83–0.90)	710	22.93	(21.76–24.10)
Cigars	0.31	(0.29–0.33)	0.11	(0.09–0.13)	283	17.19	(16.63–17.74)	666	0.19	(0.15–0.24)	132	5.88	(4.03–7.72)
Pipe (with tobacco)	0.09	(0.08–0.11)	0.01	(0.00–0.01)	15	16.34	(11.22–21.46)	629	0.05	(0.03–0.09)	24	10.14	(2.62–17.66)
Little cigars/cigarillos/bidis (like Black & Milds, Swisher Sweets, Phillies Blunt, or Captain Black)	0.26	(0.24–0.28)	0.05	(0.04–0.07)	158	16.92	(16.14–17.71)	648	0.16	(0.12–0.21)	117	10.52	(7.40–13.64)
E-cigarettes (like BLU or NJOY)	0.06	(0.05–0.07)	***	***	3	20.00	(14.51–25.43)	627	0.07	(0.05–0.11)	44	9.04	(4.38–13.69)
Chewing tobacco (like Levi Garrett, Red Man, or Beech Nut)	0.07	(0.06–0.09)	0.01	(0.01–0.02)	25	12.65	(10.18–15.11)	625	0.05	(0.03–0.09)	24	11.11	(4.88–17.34)
Dip/snuff (like Skoal or Copenhagen)	0.10	(0.09–0.11)	0.03	(0.02–0.04)	60	14.80	(13.73–15.88)	627	0.11	(0.08–0.16)	49	15.14	(9.77–20.51)
Snus (like Camel Snus)	0.06	(0.05–0.07)	***	***	3	19.25	(16.33–22.17)	626	0.05	(0.03–0.08)	36	10.96	(4.90–17.02)
Dissolvable tobacco products (like Ariva, Stonewall, Camel Orbs, Sticks or Strips)	0.01	(0.00–0.01)	—	—	—	—	—	619	0.01	(0.00–0.04)	7	16.29	(−4.87–37.46)
Hookah/shisha (hookah tobacco)	0.17	(0.16–0.19)	0.04	(0.03–0.05)	122	19.32	(18.50–20.15)	631	0.08	(0.05–0.12)	63	6.97	(1.97–11.96)
Nicotine products (like gum, patches, lozenges)	0.07	(0.06–0.08)	***	***	1	22	***						
Other[c]			***	***	3	17.85	(14.68–21.02)						
Unsure/decline to state refused			0.01	(0.00–0.02)	18	14.07	(9.61–18.52)						
			***	***									

Note. In all columns, *N* represents the unweighted denominator for prevalence estimates.
[a]Among those who report every day or someday use of cigarettes or other tobacco products.
[b]Among those who used at least one day in the past 30 days.
[c]All participants responding "other" identified "clove cigarettes" as the first product used.
***Insufficient precision to report.
—No responses.

Table 2: Demographics by current tobacco product use, using poststratification weights for the full sample (unweighted $N = 4,201$).

	Not tobacco users		Cigarettes only		Cigarettes and other tobacco products		Other tobacco products only		
	Prevalence	95% CI	Prevalence	95% CI	Prevalence	95% CI	Prevalence	95% CI	P value
Overall	0.77	(0.75–0.79)	0.12	(0.11–0.14)	0.07	(0.06–0.08)	0.04	(0.03–0.05)	—
Age									
18–24	0.78	(0.75–0.81)	0.11	(0.09–0.13)	0.06	(0.05–0.08)	0.05	(0.03–0.07)	0.129
25–34	0.77	(0.74–0.79)	0.13	(0.11–0.15)	0.07	(0.06–0.09)	0.03	(0.02–0.04)	
Gender									
Male	0.75	(0.72–0.78)	0.10	(0.08–0.12)	0.09	(0.07–0.11)	0.06	(0.05–0.08)	<0.001
Female	0.80	(0.77–0.82)	0.14	(0.12–0.16)	0.05	(0.04–0.06)	0.01	(0.01–0.02)	
Race/ethnicity									
White, non-Hispanic	0.75	(0.73–0.78)	0.13	(0.11–0.15)	0.07	(0.06–0.09)	0.04	(0.03–0.06)	
Black, non-Hispanic	0.75	(0.68–0.80)	0.13	(0.09–0.19)	0.11	(0.07–0.16)	0.02	(0.01–0.03)	0.017
Other, non-Hispanic	0.84	(0.76–0.90)	0.10	(0.06–0.17)	0.03	(0.01–0.08)	0.03	(0.01–0.11)	
Hispanic	0.83	(0.79–0.87)	0.09	(0.06–0.12)	0.06	(0.04–0.08)	0.03	(0.01–0.05)	
Education									
Less than high school	0.68	(0.60–0.74)	0.20	(0.14–0.27)	0.12	(0.08–0.17)	0.01	(0.00–0.05)	
High school	0.68	(0.62–0.72)	0.19	(0.15–0.24)	0.09	(0.06–0.13)	0.04	(0.02–0.07)	<0.001
Some college	0.78	(0.75–0.81)	0.10	(0.08–0.12)	0.07	(0.05–0.09)	0.05	(0.04–0.07)	
Bachelor's degree	0.89	(0.86–0.92)	0.05	(0.03–0.08)	0.03	(0.02–0.05)	0.02	(0.01–0.05)	
Graduate or professional degree	0.93	(0.90–0.96)	0.04	(0.02–0.08)	0.02	(0.01–0.04)	0.01	(0.00–0.01)	
Current employment status									
Work full-time (35 hours/week or more)	0.78	(0.75–0.81)	0.11	(0.09–0.13)	0.07	(0.05–0.09)	0.05	(0.03–0.06)	
Work part-time (15–34 hours/week)	0.78	(0.73–0.83)	0.11	(0.08–0.15)	0.07	(0.05–0.10)	0.04	(0.02–0.07)	0.218
Work part-time (less than 15 hours/week)	0.70	(0.61–0.78)	0.16	(0.11–0.23)	0.11	(0.06–0.21)	0.02	(0.01–0.09)	
Do not currently work for pay	0.77	(0.74–0.81)	0.13	(0.11–0.17)	0.07	(0.05–0.09)	0.02	(0.01–0.04)	
Financial situation									
Live comfortably	0.86	(0.82–0.89)	0.05	(0.04–0.08)	0.04	(0.03–0.07)	0.04	(0.03–0.07)	
Meet needs with a little left	0.81	(0.78–0.84)	0.10	(0.08–0.12)	0.06	(0.04–0.08)	0.03	(0.02–0.05)	<0.001
Just meet basic expenses	0.72	(0.69–0.76)	0.16	(0.13–0.19)	0.08	(0.06–0.11)	0.04	(0.02–0.06)	
Do not meet basic expenses	0.63	(0.55–0.71)	0.23	(0.17–0.32)	0.12	(0.08–0.19)	0.01	(0.01–0.03)	

Table 3: Relative risk ratios (RRRs)[1] of tobacco product use compared to no tobacco use (weighted $N = 4,157$).

	Cigarettes-only versus no tobacco use		Cigarettes and other tobacco products versus no tobacco use		Other tobacco products only versus no tobacco use	
	RRR	(95% CI)	RRR	(95% CI)	RRR	(95% CI)
Age						
18–24	Ref.		Ref.		Ref.	
25–34	1.48	(1.07–2.06)*	1.60	(1.03–2.49)*	0.84	(0.47–1.50)
Gender						
Male	Ref.		Ref.		Ref.	
Female	1.29	(0.96–1.73)	0.51	(0.34–0.76)**	0.17	(0.08–0.35)**
Race/ethnicity						
White, non-Hispanic	Ref.		Ref.		Ref.	
Black, non-Hispanic	0.74	(0.45–1.20)	1.06	(0.60–1.90)	0.39	(0.20–0.78)*
Other, non-Hispanic	0.84	(0.44–1.61)	0.42	(0.14–1.25)	0.67	(0.14–3.27)
Hispanic	0.38	(0.25–0.59)**	0.45	(0.25–0.79)*	0.56	(0.26–1.23)
Education						
Less than high school	2.42	(1.53–3.83)**	2.00	(1.05–3.81)*	0.24	(0.04–1.47)
High school	2.06	(1.44–2.95)**	1.41	(0.87–2.29)	1.04	(0.52–2.08)
Some college	Ref.		Ref.		Ref.	
Bachelor's degree	0.42	(0.25–0.73)*	0.34	(0.16–0.68)*	0.27	(0.12–0.58)**
Graduate or professional degree	0.32	(0.16–0.63)**	0.19	(0.07–0.51)**	0.09	(0.03–0.26)**
Current employment status						
Work full time (35 hours/week or more)	Ref.		Ref.		Ref.	
Work part time (15–34 hours/week)	0.78	(0.48–1.24)	1.02	(0.57–1.85)	0.88	(0.42–1.87)
Work part time (less than 15 hours/week)	1.18	(0.70–1.99)	1.74	(0.80–3.81)	0.56	(0.13–2.46)
Do not currently work for pay	0.71	(0.50–1.01)	0.87	(0.52–1.45)	0.71	(0.35–1.42)
Financial situation						
Live comfortably	0.61	(0.38–0.98)*	0.80	(0.44–1.46)	1.26	(0.63–2.49)
Meet needs with a little left	Ref.		Ref.		Ref.	
Just meet basic expenses	1.67	(1.20–2.33)*	1.25	(0.76–2.08)	1.15	(0.57–2.33)
Do not meet basic expenses	2.79	(1.72–4.51)**	2.06	(1.03–4.14)*	0.65	(0.22–1.90)

* $P < 0.05$, ** $P < 0.001$.
[1]Relative risk ratios were calculated using multinomial logistic regression and are adjusted for survey weights and all other variables in the model.

(9%). Past 30-day use of snus in this group was 7% and dissolvable tobacco product use was 3%. Individuals who reported using cigarettes only had a mean daily use of 9.20 cigarettes per day (CI: 8.18–10.23) and those who reported using cigarettes and other tobacco products reported 8.73 cigarettes per day (CI: 6.66–10.80). These mean values for these two groups were not significantly different as judged by overlapping 95% confidence intervals. The groups of nontobacco users and other tobacco products only also reported daily cigarette use at low levels: 1.52 cigarettes per day in the "not tobacco users" group and 1.69 cigarettes per day in the "other tobacco products only" group. Twenty-three percent (CI: 22%–25%) of the sample reported ever visiting a hookah bar or restaurant, 32% (CI: 29%–34%) of ever tobacco users reported trying their first tobacco product after age 18 and of those who became regular tobacco users, 39% (CI: 35%–43%) became a regular tobacco user after age 18.

In the multivariate model (Table 3), older young adults (aged 25–34) were significantly more likely to use cigarettes only or cigarettes and other tobacco products compared to those aged 18–24 (RRR = 1.48; CI: 1.07–2.06 and RRR = 1.60, CI: 1.03–2.49, respectively) and females were less likely to be dual users (RRR = 0.51; CI: 0.34–0.76) or to use other tobacco products only (RRR = 0.17; CI: 0.08–0.35) compared to males. Hispanics were less likely to use cigarettes or to be dual users and Blacks also had 61% reduced risk of other-tobacco product-only use compared to whites. Across all tobacco use categories, those with a Bachelor's degree or greater were significantly less likely to use tobacco products compared to those with some college education. Those with less than a high school education had a twofold increase in cigarette-only use (RRR = 2.42, CI: 1.53–3.83) and dual use (RRR = 2.00, CI: 1.05–3.81) compared to those with some college education. This pattern was similar for cigarette only

use among those with a high school education compared to some college education (RRR = 2.06, CI: 1.44–2.95). Similar to the results from the bivariate analyses, individuals who reported that they "just meet" or "do not meet" basic expenses were more likely to use cigarettes only compared to those who reported "[meeting] needs with a little left" and participants reporting that they "do not meet" basic expenses were also twice as likely to be dual users (RRR = 2.06, CI: 1.03–4.14), after controlling for all other variables in the model.

4. Discussion

This study provides a unique focus on tobacco use patterns among young adults. It is the first paper in a series that presents baseline information on this population in the context of a longitudinal cohort designed to track the patterns, transitions, and trajectories of tobacco use behavior in this understudied age group. Young adults experience a significant developmental transition from living mostly at home or protected school environments to the freedoms and responsibilities of adulthood. Results of this study are intended to offer a clear understanding of tobacco product use prevalence in a young adult population and are reasonably consistent with national data, showing that more than half of the sample had ever smoked cigarettes and 19% of ever tobacco users aged 18–24 reported current cigarette use compared to the 20% national average for 18–24-year olds [2]. Findings from our study are also consistent with other recent studies which document the increasing prevalence of cigarette initiation after age of 18 and the high rates of transition to regular smoking in young adulthood [1, 22].

This study demonstrates a 30% dual use rate among current tobacco users, supporting previous studies indicating that 24–26% of young adult smokers are polytobacco users [22, 23]. It also shows that 64% of individuals who use other tobacco products smoke cigarettes concurrently. Interestingly, recent studies indicate that snus was introduced to test markets in 2006 [17], dissolvable tobacco products (including orbs, sticks, and strips) were introduced to test markets in 2008 [34], and some form of electronic cigarette has been on the market since at least 2006 [35]. The integration from test market to market suggests that the 4–6% increase in dual use found in this 2011 study as compared to the 2009 and 2010 data [22, 23] may be due to the increase in the array of available alternative tobacco products and/or tobacco company marketing efforts over time. In this study, dual users (cigarette smokers who also use one or more other tobacco products) report the same levels of smoking as cigarette-only users (8.73 cigarettes per day versus 9.20 cigarettes per day). This finding suggests that the use of other tobacco products does not replace cigarette smoking or decrease the mean number of cigarettes smoked daily among young adults. Additionally, the high prevalence of dip/snuff and chewing tobacco use among young adult cigarette smokers is consistent with a previous study showing high rates of smokeless tobacco and cigarette use among young males [26]. While a lower proportion of adults report dual use of smokeless tobacco and cigarettes in other national samples [26, 36], a longitudinal study showed that the quit rate was significantly lower for cigarette smoking compared to smokeless tobacco use and that there was little switching from cigarettes to smokeless tobacco in the USA (0.3% in one year) [36]. In a study of young adult military personnel, initiation of smokeless tobacco use was associated with harm escalation (i.e., smoking to dual use or smokeless to smoking or dual use) rather than harm reduction (i.e., smoking to smokeless only) [37]. Despite tobacco industry arguments that smokeless tobacco products provide a bridge to cessation [38], marketing of new smokeless tobacco products like snus in the USA encourages dual use by advertising these products as a substitute when cigarette smoking is unacceptable or prohibited [29]. Further, Camel Snus was test-marketed in some college communities, suggesting the targeting of these products for young adult smokers [29]. Our study confirms the high proportion of young adults reporting dual use of smokeless and combustible tobacco products, and supports concerns raised in previous studies about the role of smokeless tobacco use and dual use in smoking trajectories of young adults [26, 29, 37]. It also identifies differences in patterns of tobacco use and dual use by age, gender, race/ethnicity and socioeconomic status that could have long-term implications for tobacco-related health disparities.

Our study emphasizes the need for effective interventions to reduce the number of young adult smokers who progress from experimentation to regular use of tobacco products, change social norms about emerging tobacco products, and facilitate cessation of tobacco products in this age group. Recent studies suggest that media interventions may serve a key function in addressing all of these gaps [39], but these will need to be complemented with tailored and targeted strategies at the individual and community levels. Moreover, federal regulation of new tobacco products and their marketing also presents an unprecedented opportunity to reduce combusted cigarette and other forms of tobacco product consumption in this vulnerable age group via policy change and regulation of claims made by new and modified risk/reduced harm products and by use of targeted public education campaigns. In order to inform the regulatory process, rapid and reliable data will be needed [25]. This is especially important as new products using noncombustible forms of nicotine delivery are introduced that could have unintended consequences by delaying or negating cessation motivation or attracting new users, especially if the industry continues to target young adults by introducing appealing new products like ENDS, snus, and dissolvables into the marketplace [18].

4.1. Strengths/Limitations. This study harnesses the strengths of an existing online panel of adults to recruit a large, nationally-representative sample of young adults, a group typically identified as hard to reach. Smokers were over-sampled for the purpose of this study in order to describe trajectories of cigarette, other tobacco product, and dual use in this population. Although the current analysis is limited to cross-sectional data from the baseline survey,

future analyses will utilize longitudinal data to assess trends in young adult tobacco use over time. This study has several limitations: first, all tobacco product use is self-reported and may be subject to recall bias. The online nature of this panel study does not allow for biochemical validation of smoking status. Second, the survey was administered in English and Spanish and individuals who do not speak or are not literate in English or Spanish were unable to participate in this study. In addition, validity data is not available for the self-described financial situation measure. Finally, the small sample sizes for product use resulted in insufficient precision to report results for initiation of ENDS, snus, nicotine replacement products, and other tobacco products for certain population subgroups. This may be due to the overall low prevalence of use of these emerging products; thus, as emerging tobacco products gain attention in the marketplace, initiation with these products is likely to increase. We expect that future waves of data will have larger numbers of individuals initiating with emerging tobacco products as they gain popularity in the USA marketplace.

5. Conclusion

This study uses data from a large, nationally representative sample of young adults aged 18–34 to describe prevalence, patterns, and predictors of cigarette and dual use in this population. Of the 23% percent of young adults who were current tobacco users, 30% reported dual use. Similar levels of cigarette use were observed among cigarette-only users and dual users, indicating that dual use does not lead to harm reduction among young smokers. Further, nearly one-third of ever tobacco users in our study reported tobacco product initiation after the age of 18 and nearly 40% of regular users reported progressing to regular use during young adulthood. Due to the increased morbidity and mortality associated with tobacco use, disrupting transitions to regular smoking in young adults will result in tremendous benefits in terms of lives saved and disease prevented at the population level [40, 41]. This study highlights the need for improved monitoring of polytobacco use across the life course and development of tailored smoking prevention and cessation interventions for young adults. It also argues for the need to have rigorous but rapid surveillance in place to serve as an early warning sentinel system to inform regulation of new, emerging, and existing tobacco products by the FDA to protect the health of USA young adults [25]. Since smoking prevalence overall in the adult population (≥18 years) has stalled to around 20% in the past 5 years [42], interventions focused on the prevention and cessation of tobacco and polytobacco use in young adults can be critical to reversing the slowed decline in tobacco use among U.S. adults.

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Research Article

Trends in Roll-Your-Own Smoking: Findings from the ITC Four-Country Survey (2002–2008)

David Young,[1] Hua-Hie Yong,[1] Ron Borland,[1] Lion Shahab,[2] David Hammond,[3] K. Michael Cummings,[4] and Nick Wilson[5]

[1] *Tobacco Control Unit, Cancer Council Victoria, 100 Drummond Street Carlton, VIC 3053, Australia*
[2] *Cancer Research UK, Health Behaviour Unit, Department of Epidemiology and Public Health, University College, London WC1E6XA, UK*
[3] *Department of Psychology, University of Waterloo, 200 University Avenue West, Waterloo, ON, Canada N2L 3G1*
[4] *Department of Health Behavior, Roswell Park Cancer Institute, Elm and Carlton Streets, Buffalo, NY 14263, USA*
[5] *Department of Public Health, University of Otago Wellington, P.O. Box 7343, Wellington South 6242, New Zealand*

Correspondence should be addressed to David Young, david.young@cancervic.org.au

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Objective. To establish the trends in prevalence, and correlates, of roll-your-own (RYO) use in Canada, USA, UK and Australia, 2002–2008. *Methods*. Participants were 19,456 cigarette smokers interviewed during the longitudinal International Tobacco Control (ITC) Four-Country Survey in Canada, USA, UK, and Australia. *Results*. "Predominant" RYO use (i.e., >50% of cigarettes smoked) increased significantly in the UK and USA as a proportion of all cigarette use (both $P < .001$) and in all countries as a proportion of any RYO use (all $P < .010$). Younger, financially stressed smokers are disproportionately contributing to "some" use (i.e., ≤ 50% of cigarettes smoked). Relative cost was the major reason given for using RYO, and predominant RYO use is consistently and significantly associated with low income. *Conclusions*. RYO market trends reflect the price advantages accruing to RYO (a product of favourable taxation regimes in some jurisdictions reinforced by the enhanced control over the amount of tobacco used), especially following the impact of the Global Financial Crisis; the availability of competing low-cost alternatives to RYO; accessibility of duty-free RYO tobacco; and tobacco industry niche marketing strategies. If policy makers want to ensure that the RYO option does not inhibit the fight to end the tobacco epidemic, especially amongst the disadvantaged, they need to reduce the price advantage, target additional health messages at (young) RYO users, and challenge niche marketing of RYO by the industry.

1. Introduction

This paper explores patterns of roll-your-own (RYO) use in four developed countries (USA, UK, Canada, and Australia). RYO cigarettes are an important component of the tobacco market in many countries, with wide variation in use. For example, a majority of smokers use RYO at least some of the time in New Zealand (NZ) (53%) [1] and Thailand (58%) [2], compared with 7% in the USA [3]. In 2002, the other three countries in the study reported here had intermediate prevalence with 28% in UK, 24% in Australia, and 12% in Canada [3].

The 2002 cross-sectional study [3] found that RYO use was associated with lower income, male sex, greater nicotine addiction, lower intention to quit, and greater likelihood to believe RYO tobacco is less harmful to health. In NZ [1] there was a strong interaction between age and socioeconomic status (SES), with use amongst younger smokers increasing more as SES declined, relative to older smokers, suggesting uptake of RYO is a strategy of younger, poorer smokers. SES is also important in middle income countries; in Malaysia and Thailand RYO smoking was associated with low income, low education, and being unemployed [2].

The primary driver for RYO is the price differential between factory-made (FM) and RYO cigarettes, due in part to differences in how these products are taxed [1, 2]. Not only is RYO tobacco subject to lower taxation in many countries, but

it is also much easier to control the amount of tobacco used by rolling thinner cigarettes [4]. Evidence from previous ITC Project RYO studies [3, 5] also indicates that RYO smokers have a disproportionate tendency to believe RYO tobacco is less harmful and 20–30% cite "it (RYO) is not as bad for your health" as a reason for smoking RYO [1, 6], even though research suggests that RYO cigarettes are at least as harmful, and if anything more harmful, than FM cigarettes [7–10].

It has been reported elsewhere [11] that the prevalence of RYO use is increasing in some countries. There is evidence that use has increased in the UK [12], and it has been argued that this is due to both the tax differential between RYO and FM in the UK and easy access to duty-free rolling tobacco in continental Europe [13]. To the extent that its cheaper cost is a prime motive, the Global Financial Crisis (GFC) could be driving any increases in RYO use identified in the study being reported here, especially in the USA and UK, where there was evidence of deteriorating economic conditions since 2005 [14–16] and where the impact has been particularly severe and long lasting.

In addition, industry documents reveal that the UK has been subject to a systematic campaign to change the image of RYO from a low-cost, down-market, product to a "cool," "natural" choice [3]. On-pack advertising in Australia also reflects this strategy, and there is some anecdotal evidence that the myth that RYO tobacco is more "natural" (and by implication "safer") is widespread in that country [17].

On the other hand, in Canada, the ease of access to cheaper contraband cigarettes [18] and the prevalence of discounting FM cigarettes are factors that would make the use of RYO for economic reasons less likely.

In an effort to extend the findings of our earlier work [3] based on data from the first wave of the ITC Four-Country Study, this study used six additional waves of data, a total of 7 waves covering the period from late 2002 to the end of 2008, specifically:

(1) to examine trends in RYO use relative to FM cigarette smoking,

(2) to determine if RYO prevalence has been rising in the UK and the USA, relative to Canada, given the different circumstances applying in those jurisdictions,

(3) to examine whether RYO use was greater and/or has been increasing disproportionately among young, financially disadvantaged smokers, given the results of the NZ study,

(4) to examine the prevalence of the reason that "RYO is less harmful" for smoking RYO and to determine if the importance of this reason has changed relative to other reasons for using RYO.

2. Methods

2.1. The ITC Project. The ITC Project is a multicountry study on tobacco use and tobacco control policy evaluation. Detailed descriptions of the project's conceptual framework and methods have been published elsewhere [19–21].

Participants were adult (18 years of age and older) cigarette smokers (who currently smoked at least once a month) from Canada, USA, UK, and Australia. The survey was designed as a longitudinal study to simultaneously evaluate several leading tobacco control policies subject to implementation over the time period of the study. The survey was conducted annually at around the same time of the year as much as possible with any variation in timing mainly for the purpose of enabling pre/posttests of policy changes (e.g., banning the term "lights" in the UK, labeling changes in Australia and Canada) [22]. The total number of participants was 19,456, a sample of approximately 2000 respondents per country per year (2002–2008), a retention rate of around 70% each year with 30% replenishment. Although ex-smokers are retained in the cohort, they are not included in the analyses reported here.

The survey field work was conducted using computer-assisted telephone interviews (CATIs). The survey was conducted in English or in French if desired in the Francophone areas of Canada. Strict protocols were developed and implemented to ensure equivalence of methods.

The study protocol was cleared for ethics by the Institutional Review Boards or Research Ethics Boards in each of the countries: the University of Waterloo (Canada), Roswell Park Cancer Institute (USA), University of Illinois-Chicago (USA), University of Strathclyde (UK), and The Cancer Council Victoria (Australia).

2.2. Measures

2.2.1. RYO Use. All respondents were asked if they smoked "FM cigarettes only," "mainly FM," "FM and RYO similar," "mainly RYO," or "only RYO." Based on these responses, RYO use was categorized in three ways: "Sometime RYO use" (mainly FM, FM & RYO similar); "Predominant RYO use" (mainly or only RYO, i.e., >50% of cigarettes smoked); and "Any RYO" use (i.e., either "sometime" or "predominant").

2.2.2. Sociodemographic Measures. Age (corrected for time in the sample), sex, income and education were measured the same way as previously reported [3, 17, 21]. From Wave 4 onwards smokers were also asked if they had been experiencing financial stress in the last 12 months ("unable to pay important bills on time"; yes/no), a single-item measure that has been used successfully in previous studies [23].

2.2.3. Smoking Behaviors. They were heaviness of Smoking Index [24] (a combination of number of cigarettes per day with time to first cigarette), intention to quit (yes/no), and number of friends who smoke (out of a total of 5 closest friends).

2.2.4. Reasons for Smoking RYO. This was a multiple response variable and has only been asked from Wave 5 onwards. Respondents were asked to identify up to four reasons from a list: because they are cheaper; because of the taste; because they help you reduce the amount smoked; because they are not as bad for your health.

Table 1: Prevalence (%) of exclusive factory-made (FM) use, sometime ("Some") RYO use, and predominant ("Pred") RYO use by country and across waves (weighted data).

Wave (year)	Canada			United States			United Kingdom			Australia		
	FM	Some RYO	Pred RYO	FM	Some RYO	Pred RYO	FM	Some RYO	Pred RYO	FM	Some RYO	Pred RYO
1 (2002)	81.6	6.2	12.2	92.9	5.1	2.1	69.6	8.8	21.6	73.1	12.6	14.3
2 (2003)	83.0	5.9	11.5	93.4	4.4	2.3	68.2	7.4	24.4	75.2	9.9	14.9
3 (2004)	83.7	6.1	10.2	93.1	4.7	2.2	68.7	6.8	24.5	76.4	9.3	14.3
4 (2005)	83.9	5.1	11.0	91.2	5.9	2.8	67.6	6.2	26.2	77.5	7.8	14.7
5 (2006)	85.0	4.5	10.5	90.2	6.4	3.3	63.2	7.4	29.4	74.9	9.0	16.1
6 (2007)	87.3	4.2	8.6	90.3	4.5	5.2	62.3	6.1	31.5	77.3	7.7	15.0
7 (2008)	87.9	3.3	8.8	89.1	5.2	5.7	62.0	6.6	31.5	78.2	6.4	15.4
P value for trend	*.001*	*.006*	.080	.078	.677	*<.001*	*<.001*	*.039*	*<.001*	*.055*	*<.001*	.131

2.3. Weighting and Statistical Analyses. All analyses were carried out using version 18.0.1 of the PASW (previously SPSS) statistical package. Weights have been designed to make the data representative of smokers in each of the four countries. There was no between-countries weighting. Weighted data are reported for the univariate and bivariate analyses, including self-reported prevalence. We used general estimating equations (GEEs) for multivariate analysis, since this technique allows for correlated data sets across the waves.

3. Results

3.1. Trends in the Prevalence of RYO Use. The prevalence of FM and RYO use by country across waves are presented in Table 1. The proportion of smokers using any RYO was highest in the UK and lowest in the USA in every wave. The prevalence of any RYO use relative to FM increased significantly in the UK ($P < .001$), while there was a nonsignificant increase in the USA ($P = .078$). It decreased significantly in Canada ($P = .001$) and marginally in Australia (albeit, not significantly; $P = .055$). These overall trends were supported by within-subjects data (i.e., data from those who were present across all 7 waves); there was more switching from exclusive FM to any RYO use in the UK, and the USA, and the reverse applied in Canada and Australia.

Over the study period, predominant use rose significantly in the UK and the USA, while there was a near-significant decline in Canada and Australia was flat. The prevalence of predominant RYO use as a proportion of any RYO use increased in all four countries (all $P < .010$).

3.2. Correlates of Predominant RYO Use. Because of the increasing relative and/or absolute prevalence of predominant use we decided to focus on predominant RYO use as a proportion of all cigarette use. The GEE analysis revealed that country was the variable most strongly associated with predominant use of RYO compared with all other forms of smoking ($P < .001$) (data not shown). There were also main effects of sex, income, heaviness of smoking, age, intention to quit (all $P < .001$), and number of smokers in their social network ($P = .002$). We also included the "financial stress" in the four Waves where it was measured, but it was not significant. We found significant interactions of country by sex, country by wave, country by age (all $P < .001$), and country by income ($P = .007$). Because of the strong by-country interactions, we carried out separate GEE analyses for each country (see Table 2).

The common correlates of predominant RYO use (compared with all other cigarette use) were *(low) income* and *(older) age*. However the age effect was weaker in Canada. Similarly, *males* reported more RYO use, but this trend was also smaller, and nonsignificant, in Canada. In the UK and Australia predominant users were significantly *less likely to intend to quit* than were other smokers. There was a similar trend in Canada, but not in the USA. In addition, predominant RYO users in Canada and Australia tended to be *heavier smokers*.

3.3. Comparison of Sometime Users with Predominant Users of RYO. A GEE analysis was carried out comparing sometime users with predominant users of RYO. The significant correlates of sometime use (rather than predominant use), using the seven waves of data were country, age, income, sex, (all $P < .001$), and wave ($P = .019$). A greater proportion of RYO smokers were sometime users in the USA (OR = 3.14; $P < .001$) compared with the UK (OR = .57; $P < .001$), and compared with Wave 1, the relative prevalence of sometime use showed significant falls in Waves Four (OR = .90; $P = .047$), Six (OR = .86; $P = .034$) and Seven (OR = .75; $P < .001$). Compared with predominant RYO users, sometime users were *more likely to have higher incomes* (OR = 1.27; $P < .001$) and, importantly, sometime users were *younger* than predominant RYO users, and the difference increased with age group (18–24 = reference, 25–39: OR = .58; $P < .001$, 40–54: OR = .39; $P < .001$, 55+ OR = .29; $P < .001$). Compared with predominant users, they were also *less likely to be male* (OR = .79; $P < .001$) and were marginally *more likely to intend to quit* (OR = 1.08; $P = .054$).

Given the large by-country interactions, results are presented separately by country. Sometime RYO smokers were *younger* than predominant RYO smokers in all four countries. In addition, Canadian sometime users smoked less, US sometime users were significantly less likely to be in the low income bracket, and UK and Australian sometime users were significantly less likely to be male. In addition, there was

Table 2: Multivariate results of GEE analyses by country for predominant use of RYO compared to all other smoking patterns (factory-made cigarettes or "some" RYO).

	Canada			United States			United Kingdom			Australia		
	OR	CI	*P* value	OR	CI	*P* value	OR	CI	*P* value	OR	CI	*P* value
Wave (year)			*.005*			*.006*			*.054*			*.157*
1 (2002)	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
2 (2003)	.99	.87–1.12	ns	1.10	.80–1.52	ns	1.04	.99–1.11	ns	1.06	.99–1.40	ns
3 (2004)	.99	.84–1.18	ns	1.12	.73–1.73	ns	1.07	.99–1.15	ns	1.09	.99–1.20	ns
4 (2005)	.97	.79–1.20	ns	1.17	.72–1.88	ns	1.09	.99–1.19	ns	1.04	.93–1.17	ns
5 (2006)	.79	.65–.97	.024	1.21	.66–2.22	ns	1.19	1.07–1.33	.001	1.12	.99–1.23	ns
6 (2007)	.59	.44–.79	<.001	2.08	1.37–3.15	.001	1.16	1.01–1.34	.035	1.05	.92–1.20	ns
7 (2008)	.57	.37–.87	.010	1.91	.87–4.20	ns	1.21	1.04–1.41	.014	1.10	.94–1.29	ns
Sex			*.875*			*.020*			*<.001*			*<.001*
Female	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
Male	1.05	.61–1.83	ns	2.15	1.13–4.10	.020	2.93	2.53–3.38	<.001	1.93	1.64–2.28	<.001
Income			*<.001*			*<.001*			*<.001*			*<.001*
Low	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
Medium	.64	.42–.99	.046	.46	.28–.78	.004	.89	.72–1.07	ns	.80	.70–.90	<.001
High	.16	.06–.42	<.001	.16	.09–.31	<.001	.70	.58–.84	<.001	.55	.46–.65	<.001
Age (years)			*.513*			*.173*			*.061*			*.005*
18–24	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
25–39	1.07	.38–3.02	ns	1.47	.88–2.45	ns	1.57	1.00–2.50	.048	1.17	.94–1.46	ns
40–54	1.31	.42–4.02	ns	2.04	1.06–3.96	.034	1.64	1.07–2.53	.025	1.45	1.15–1.84	.002
55+	1.64	.52–5.16	ns	1.14	.57–2.28	ns	1.32	.86–2.04	ns	1.28	.98–1.68	ns
Intend to quit			*.356*			*.148*			*.022*			*.035*
No	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
Yes	.88	.66–1.16	ns	2.01	.78–5.19	ns	.88	.79–.98	.022	.91	.83–.99	.035
HSI	1.26	1.12–1.4	<.001	.99	.86–1.16	ns	1.03	.99–1.08	ns	1.04	1.01–1.08	.019
No. of friends	.99	.90–1.07	ns	1.01	.87–1.16	ns	.99	.97–1.03	ns	1.02	.99–1.04	ns

* HIS: heaviness of smoking index, CI: 95% confidence interval, OR: adjusted odds ratio.

Table 3: Self-reported reasons for smoking RYO (all RYO users; Wave 7 in 2008, weighted data, multiple responses allowed).

Reason given	Percentage of respondents			
	Canada	US	UK	Australia
Cheaper than FM	93.2	94.3	95.4	85.4
Reduce amount smoked*	46.6	52.4	49.6	53.1
Taste	41.2	42.0	62.7	63.3
Healthier	24.5	28.3	26.9	39.6

* More specifically "because they help you reduce the amount smoked."

a significant interaction effect in Australia between age and wave with two clear age segments for sometime use emerging over the seven Waves (18–39 increasing prevalence and 40+ low prevalence).

The relationship with "financial stress" was again tested using data from Waves 4–7. In this case, unlike the situation with respect to predominant use, significant interactions between age group and financial stress ($P = .031$) and wave and financial stress ($P = .010$) emerged. Figure 1 shows the interaction between age and financial stress. This effect was independent of country, so we present the combined data. It is clear from the graph that young (18–24) smokers experiencing financial stress are not only disproportionate sometime RYO users across all four waves, and their level of sometime use has increased from 2005 (Wave 4). While those 55+ who are experiencing financial stress also show a rise in prevalence from Wave 5, their highest level of prevalence is lower than the lowest level of 18–24 year olds.

3.4. Reasons for Using RYO. The most common reason cited for using RYO (Table 3) was relative cost. From Waves 5 to 7, believing that RYO cigarettes are healthier increased

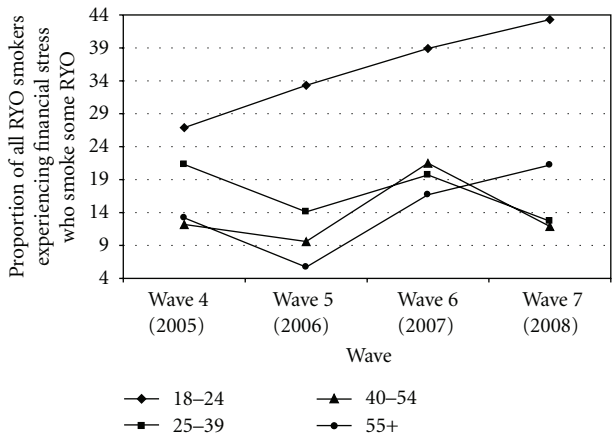

Figure 1: Proportion of all RYO users experiencing financial stress who smoke some RYO, by age group (4 country data, 2005–2008).

significantly as a reason for using RYO in Canada (15.3% → 24.4%; $P = .021$), but no clear trend emerged in the other three countries. Australian RYO smokers identified health as a reason for smoking RYO more than RYO smokers from other countries. It is noteworthy that while those who predominantly use RYO, and those who are sometime users, give equal weight to saving money and the assumed health advantages, predominant RYO smokers are disproportionately inclined to cite "they taste better" as a reason for smoking RYO compared with sometimes users (64% versus 35%).

4. Discussion

We found the highest level of any RYO use is in the UK, followed by Australia, Canada and the USA, confirming and extending our earlier findings [3]. Consistent with our hypotheses, any use of RYO is increasing in the UK and probably in the USA, but is falling in Canada. RYO use relative to FM use is changing in quite different ways in the four countries under study, albeit with some core similarities. Understanding such a complex dynamic requires a systemic approach to the issue [25–29] to elucidate the dynamic relationships between countries, economic drivers, cultural norms, tobacco industry strategies, access to alternatives to RYO, tobacco control policies, and other factors.

Predominant use of RYO increased as a proportion of any RYO use in all four countries, most markedly in the USA, and increased as a proportion of total cigarette smoking in the USA and the UK. Compared to sometime RYO users, predominant users were more likely to have low-income, tended to be older, were disproportionately male and far more likely to cite "taste" as a reason for smoking RYO. However, young smokers experiencing financial stress were more likely to be sometime users than predominant users, and this interaction was independent of country.

We analysed the results to establish the extent to which they are consistent with price and financial need being the primary drivers of RYO use. Smokers themselves say that saving money is the main reason for RYO use, as this and other studies have found [1, 3, 5]. Further, use is highest in low income groups, especially predominant use. We assume that the typical pattern is for smokers to start using RYO on an occasional basis and only progress to predominant use if there are sufficient reasons for doing so (e.g., financial stress). Once this happens they begin to espouse different rationales for their RYO use (e.g., taste).

The clearest increases in predominant use were in the USA and UK: the two countries that arguably have been hardest hit by the GFC [14–16]. It is noteworthy that in Waves Six (2007) and Seven (2008), RYO smokers in the USA were more likely than FM smokers to say they were experiencing financial stress. One could speculate that in light of the financial pressures, in the USA smokers may have switched to RYO to reduce expenditure. The high, and increasing, level of UK RYO use reported by other studies [11, 12] was replicated. It is clear that RYO is a stable, mainstream market segment in the UK and easy access to duty-free RYO as well as a favourable tax regime [13] makes it relatively easy to reduce tobacco-related expenditure via RYO use.

Even before the GFC, the US industry was forecasting growth in the RYO segment, with cigarette manufacturers moving to take over existing niche manufacturers like Lane and Santa Fe. By 2004 Reynolds/Brown & Williamson thereby controlled 36% of the market, with Republic controlling an equivalent proportion [30]. Furthermore, as economic conditions deteriorated, manufacturers introduced tubes with longer filters (saving tobacco), and extra slim rolling papers, filter tips, and rolling machines [31].

The predominant use of RYO in Australia is relatively stable, but is increasing as a proportion of all RYO smoking, with use of sometime RYO falling substantially from Wave One to Wave Seven. The GFC affected Australia less than the USA and the UK and this may be partially responsible for the flat profile of predominant use compared to the clear increases in prevalence observed in the latter two countries.

The pattern of RYO use in Canada was the most distinct. Both predominant and sometime RYO use fell significantly (although sometime use fell proportionally more). The use of cheap contraband FM cigarettes among Canadians, especially the young [18], and the burgeoning share of discounted or cheap brands of cigarettes in that country, which had risen from 2% of the total market in 2002 to 42.8% in 2005 [32], are all factors that could help explain the decline. The net prevalence of RYO smokers (relative to FM smokers) saying they have been experiencing financial stress has been falling. It is likely that many of those experiencing substantial financial stress are using contraband tobacco or other low-cost alternatives that are available in Canada.

RYO cigarettes are an effective way of continuing to smoke at lower cost. This results in less revenue to government, made worse when the RYO tobacco is smuggled or otherwise taxed at lower rates. Of particular concern is the likelihood that this low-cost tobacco reduces incentives for smokers to quit. Similarly, there are concerns that RYO smoking might incur greater harm to health [7–9]. All these are good reasons for governments to act to reduce RYO use as part of an overall tobacco control strategy which could also

include initiatives to support disadvantaged smokers (e.g., augmented programs of smoking cessation assistance and transfer of additional tax revenues to the poorest sectors of society).

Even though the proportion believing that RYO is healthier than FM use is a minority, that any group of smokers should hold such misconceptions is concerning. From a public health perspective, there is no justification for allowing tobacco companies to add "value" to RYO tobacco through messages about it being "natural" and "less harmful."

In light of the prevalence of the health reason, we would argue that RYO smokers (especially the young) should not only be subject to the same health messages as other smokers but in addition, warnings on packaging and elsewhere should also stress that smoking RYO is at least as harmful as smoking FM. However, this needs to be qualified by the observation that peer-group pressure among young people is strong, and where a young peer group regularly uses RYO and reinforces use with myths about relative safety, health messages will need to be carefully framed. Clearly, research with such groups should be a prerequisite as part of adopting such a strategy.

Consideration also needs to be given to raising taxes on RYO to make its cost-point more comparable to FM cigarettes. This has been recommended previously [1] and a differentially higher one-off increase in excise tax on RYO tobacco has been imposed in New Zealand to help to stem rising RYO usage in that country (i.e., a tax of 24% on RYO versus 10% for FM cigarettes). This went some way toward equalizing RYO and FM cigarettes, but not entirely in terms of cost per cigarette, based on what is known about the weight of RYO cigarettes in NZ [4].

However, price-related interventions need to acknowledge that smokers will try to maximize the amount of nicotine they get from their delivery device, and research is needed to see if smokers respond by smoking their RYO cigarettes harder, something with the potential to increase harms. In considering tax equalization strategies, evidence from the UK that RYO tobacco is easier to smuggle means that such suggestions need to be carefully researched and backed up by increased resources to undermine trafficking of illicit tobacco.

Finally, trying to stop for-profit companies attempting to value-add to their products in search of increased sales is a futile exercise unless well-designed and enforced regulation is used. Governments need to confront the contradiction that allows companies to market products for profit that it is their avowed policy to discourage [33, 34] and do this for all forms of smoked tobacco. They should also do so in ways that minimize smuggling and other illicit supply, recognizing that this may be harder to stop for RYO tobacco than for FM cigarettes.

This study has several limitations. First, the relatively small number of RYO smokers in any given wave, especially in the USA, meant that following those smokers who stayed in the sample to monitor their choices of RYO versus FM cigarettes was impractical. In this situation the GEE technique enabled us to monitor aggregate changes in tobacco use and, at the same time, allow for interwave correlation. Second, it is extremely difficult, if not impossible, to quantify the links between exogenous drivers (e.g., the GFC, access to contraband, state/provincial tax regimes) using regression-based models like GEE.

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Research Article

Use of Emerging Tobacco Products in the United States

Robert McMillen,[1,2] Jeomi Maduka,[3] and Jonathan Winickoff[2,4]

[1] *Department of Psychology and Social Science Research Center Research Boulevard, Suite 103, Starkville, MS 39759, USA*
[2] *Julius B. Richmond Center of Excellence, American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, IL 60007, USA*
[3] *University of Texas Southwestern Medical School, 5323 Harry Hines Boulevard, Dallas, TX 75390, USA*
[4] *Massachusetts General Hospital, GH Center for Child and Adolescent Health Policy, 50 Staniford Street, Suite 901, Boston, MA 02114, USA*

Correspondence should be addressed to Robert McMillen, rcm19@msstate.edu

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This paper provides the first nationally representative estimates for use of four emerging products. Addressing the issue of land-line substitution with cell phones, we used a mixed-mode survey to obtain two representative samples of US adults. Of 3,240 eligible respondents contacted, 74% completed surveys. In the weighted analysis, 13.6% have tried at least one emerging tobacco product; 5.1% snus; 8.8% waterpipe; 0.6% dissolvable tobacco products; 1.8% electronic nicotine delivery systems (ENDS) products. Daily smokers (25.1%) and nondaily smokers (34.9%) were the most likely to have tried at least one of these products, compared to former smokers (17.2%) and never smokers (7.7%), $P < .001$. 18.2% of young adults 18–24 and 12.8% of those >24 have tried one of these products, $P < .01$. In multivariable analysis, current daily (5.5, 4.3–7.6), nondaily (6.1, 4.0–9.3), and former smoking status (2.7, 2.1–3.6) remained significant, as did young adults (2.2, 1.6–3.0); males (3.5, 2.8–4.5); higher educational attainment; some college (2.7, 1.7–4.2); college degree (2.0, 1.3–3.3). Use of these products raises concerns about nonsmokers being at risk for nicotine dependence and current smokers maintaining their dependence. Greater awareness of emerging tobacco product prevalence and the high risk demographic user groups might inform efforts to determine appropriate public health policy and regulatory action.

1. Introduction

Recently, snus, dissolvable tobacco products, and electronic nicotine delivery systems (sometimes called "e-cigarettes" or ENDS) have been introduced to the US market, while waterpipes (hookah), especially in group social settings, have gained popularity [1]. Snus, dissolvables, ENDS, and waterpipes are often promoted as safer alternatives to traditional cigarettes and a potential way to decrease the harm caused by tobacco [2–4]. However, people who may never have smoked a cigarette or who had been addicted to nicotine in the past may be enticed to use tobacco by these alternative products, posing an individual and public health risk. Once in a tobacco using culture and exposed to nicotine, individuals may be at higher risk of regular cigarette use [5]. There is also the potential that current smokers may use these products as an alternative to cessation [6]. Polytobacco use among current smokers may increase levels of nicotine exposure and risk of persistent tobacco dependence relative to the exclusive use of cigarettes [7]. Despite these concerns, little is known about the use of these products among US adults. Although substantial research has examined other alternative tobacco products [8, 9], this is the first nationally representative study to examine the prevalence rates for these new emerging products. Data on the use of these emerging products is urgently needed as the FDA considers regulation of these products.

Snus is a smokeless tobacco product that does not require the user to spit. The tobacco in some snus has low concentrations of nitrosamines [2] and is marketed to smokers as a reduced harm product. Snus is also marketed in airports as a tobacco product that can be used in places where smoking is not allowed. If snus was to replace cigarette smoking entirely for an individual, it would be less harmful than cigarettes [3], but its most significant health risks may be in maintaining

dependence to cigarettes and as a starter product for other forms of tobacco [10]. Proponents of the promotion of snus as a harm reduction policy look to the Swedish experience where studies have found that while snus use is increasing, smoking prevalence is declining [7]. However, promoting snus in the United States for harm reduction may reduce smoking cessation [11], perhaps because the USA already has ongoing tobacco control programs. Additionally, US tobacco companies market dual usage of both snus and cigarettes with slogans like: "When you cannot smoke, snus" [12].

Dissolvable tobacco products are also smokeless spitless tobacco products. These products are typically flavored forms of finely milled tobacco and dissolve in the mouth. Like snus, these products are frequently marketed as forms of tobacco that can be used in places where smoking is prohibited or that are tobacco-free. To illustrate, one producer claims, "dissolvable tobacco has no boundaries, there are no locations or situations where you cannot use it, and nobody can tell you're using it" [13]. These products may also appeal to adolescents, due to the attractive packaging, flavoring, and dissolvable delivery system.

ENDS are a category of products that deliver a vapor of nicotine and flavoring on inhalation [14]. These products are very new and are marketed as both cessation devices and an alternative to cessation [6]. ENDS come in a variety of tobacco, fruit, and food flavors, and, although they do not actually burn tobacco, some ENDS contain a light-emitting diode at the tip that resembles the burning end of a cigarette [6]. Because of their recent emergence, little research exists on their attractiveness.

Developed in India during the 1700s [15], a waterpipe is an instrument for inhaling charcoal tobacco smoke that has been cooled by passing through water. Although users may think that smoke inhaled from a waterpipe is safer than smoke from a cigarette, studies show that waterpipe use produces concentrations of carbon monoxide, nicotine, tar, and heavy metals at levels similar to, or higher than, cigarettes [1]. There is also the risk of infectious disease transmission, including herpes, from waterpipe mouthpieces [1]. Due to misperceptions that waterpipes are safe, and the use of these waterpipes in social settings, there is also the risk that nonsmokers might be attracted to waterpipe smoking. Most waterpipe users are intermittent cigarette smokers [16], which facilitates an opportunity in a tobacco-friendly environment for nonsmokers to become initiated to the cigarette smoking social culture as well [17].

The purpose of this study is to assess the prevalence of use of snus, waterpipe, dissolvable tobacco products, and ENDS. The prevalence of lifetime use and current use of these products by cigarette smoking status are examined, as well as other correlates of lifetime use. Results from this study can inform regulatory decisions about these products, while the identification of potential high risk demographic groups can guide clinical counseling efforts regarding the risks of any tobacco use. Finally, the use of these products among former smokers is examined to determine whether former smokers used these products as an acute form of nicotine replacement therapy to aid in cessation or used these products years after successfully quitting cigarettes.

2. Methods

2.1. Respondents. The Social Climate Survey of Tobacco Control (SCS-TC) is a nationally representative annual cross-sectional survey that contains items pertaining to normative beliefs, practices/policies, and knowledge regarding tobacco control. Previously, this survey has utilized a random-digit-dialing (RDD) frame of households with landline telephones [18, 19]. However, substitution of cell phones for landlines continues to increase and 27.8% of US households are currently wireless only [20]. Moreover, wireless substitution is particularly problematic for surveys of tobacco use, as smoking status, as well as age, region, and several other demographic factors vary by telephone status [20]. In order to reduce noncoverage issues arising from wireless substitution, mixed-mode, mixed-frame surveys representing national probability samples of adults were administered in 2010. The design included an RDD (mode 1) frame and an internet panel (mode 2) frame developed from a probability sample. The Institutional Review Board at Mississippi State University approved this study on July 30, 2010.

The mode 1 frame included households with listed and unlisted landline telephones. Telephone interviews with respondents were conducted in October and November 2010. Household telephone numbers were selected using RDD sampling procedures. Once a household was contacted, the adult to be interviewed was selected by asking to speak with the person in the household who is 18 years of age or older and who will have the next birthday. Five attempts were made to contact those selected adults who were not home.

The mode 2 frame included an online survey, administered in September and October of 2010 to a randomly selected sample from a nationally representative pre-established 50,000 member research panel [21, 22].

The 50,000 panel members were randomly recruited by probability-based sampling, and households were provided with access to the Internet and hardware if needed in order to develop a panel that is representative of the entire US population [21]. This panel is based on a sampling frame which includes both listed and unlisted numbers, those without a landline telephone, and does not accept self-selected volunteers [21, 22]. Probability-based recruitment for the panel includes two frames. The RDD frame uses list-assisted RDD sampling techniques and the Address-Based Sampling (ABS) frame from the US Postal Service's Delivery Sequence File, which includes all households serviced by the US Postal Service [21]. The use of RDD and ABS frames for recruiting panel members provides sample coverage for 99% of US households [23]. A recent study examining this probability panel revealed that the panel's primary demographics are representative of the US Census [24]. Moreover, more than a hundred peer-reviewed papers have applied this survey methodology [25], including articles published in health journals [26–29].

Overall weights were computed in two steps. First, the two modes were weighted based upon 2009 US Census estimates to be representative of the US population. Second, three adjustments to these initial weights were computed to account for the overlap in the two samples. Weights from

the mode 1 frame were multiplied by .818 to adjust for the overlap (81.8% of households in the mode 2 frame had a landline). Composite adjustments were then computed to combine the two sampling frames. According to AAPOR [30], observations from two sampling frames with overlap may be combined using composite weights. Two compositing factors that sum to one are typically selected. Given that the effective sample sizes of the mode 1 frame and mode 2 frame are similar, the two compositing factors were set to 0.5. The weights of respondents who were represented in both sampling frames (i.e., landline owners) were multiplied by the compositing factor. In the final adjustment, a restandardized weight was computed so that the weighted sample size matched the sum for effective sample size for both independent frames.

2.2. Measures. Results are from data on a subset of the measures included in the SCS-TC. To assess current cigarette smoking status of respondents, respondents were asked, "Have you smoked at least 100 cigarettes in your entire life?". Respondents who reported that they had were then asked, "Do you now smoke cigarettes every day, some days, or not at all?". Respondents who reported that they have smoked at least 100 cigarettes and now smoke every day or some days were categorized as daily and nondaily smokers; respondents who had not smoked at least 100 cigarettes were categorized as never smokers; and respondents who reported that they have smoked at least 100 cigarettes, but no longer smokers were categorized as former smokers.

One set of items assessed lifetime use of emerging tobacco products. Which of the following products have you tried, even just one time? (1) Smokeless tobacco, (2) snus, such as Camel or Marlboro snus, (3) roll-your-own cigarettes, (4) smoking tobacco from a hookah or a waterpipe, (5) dissolvable tobacco products like Ariva/Stonewall/Camel/Camel Orbs/Camel sticks, (6) electronic cigarettes or E-cigarettes, such as Ruyan or NJOY. Respondents who had tried a product were asked if they had used that product in the past 30 days. Those who had were considered to be current users (analyses in this paper were limited to products that are new to the US market or that have recently gained popularity).

Sociodemographic variables included four categories for region (determined by the US Census regions), three categories for self-reported race (white, single race; black, single race; and all other responses), two categories for age (18–24 and 25+), and sex. The two age categories were selected in order to determine if younger adults were the most susceptible to using these emerging products.

2.3. Analyses. Chi-square tests were used to examine smoking status and sociodemographic characteristics among lifetime and current users of these nicotine-containing products. For the analyses by smoking status, post hoc multiple comparisons of never smokers versus former smokers and nondaily smokers versus daily smokers were conducted with an adjusted alpha level set at 0.05/6 or 0.008.

Multivariable analysis was applied to assess the relationship of smoking status, age, and other sociodemographic characteristics with lifetime use. To explore the possibility that adults were using these products as a form of nicotine replacement therapy, chi-square analyses were used to compare use of at least one of these products among former smokers by the length of time since cessation.

In order to address the possibility that former smokers used one of these emerging products prior to cessation, chi-square tests were used to examine use of these products among former smokers who quit less than a year ago, one to five years ago, five to 10 years, and more than 10 years. Although our data do not allow us to directly determine whether use of these emerging products occurred before or after smoking cessation, these analyses will provide insight into whether smoking cessation or use of an emerging product occurred first. It is doubtful that someone who quit smoking more than five years ago used one of these emerging products prior to cessation.

3. Results

In mode 1, of 2,128 eligible respondents contacted, 1,504 (70.7%) completed surveys [30]. For the mode 2 frame, 2,272 panelists were randomly drawn from the probability panel [31]; 1,736 responded to the invitation, yielding a final stage completion rate [26] of 67.5% percent. Length of time on the panel for the mode 2 frame ranged from 0.09 to 11.08 years, with a median length of time on the panel of 2.29 years. Table 1 shows the demographic characteristics of the overall sample.

3.1. Lifetime Users of Emerging Tobacco Products. Although most adults have not tried any of these tobacco products (86.4%), some adults have tried a waterpipe (8.8%) or snus (5.1%). Fewer adults have tried an ENDS product (1.8%) or dissolvable tobacco products (0.6%). Nondaily (34.9%) and daily smokers (25.1%) were the most likely to have tried each of these tobacco products ($P < .001$); however, some nonsmokers had tried at least one of these products (see Table 2). Among the nonsmokers, former smokers (17.2%) were more likely than never smokers (7.7%) to have used at least one of these tobacco products ($P < .001$). Use of these products also varied across nondaily and daily smokers. Although daily smokers (12.9%) were more likely to have tried snus than nondaily smokers (4.1%), $P = .003$, ever use of waterpipe was higher among nondaily smokers 26.0% than daily smokers (12.9%), $P < .001$.

Age, sex, region, race, and education were also significantly associated with lifetime use for at least one of these products (see Table 2). Younger adults were more likely than older adults to have tried snus and water pipe (8.0% versus 4.6%, 12.3% versus 8.2%, resp., $P < .01$); males were more likely than females to have tried each of these products (see Table 2), with the exception of electronic cigarettes.

Table 3 presents the odds ratios from a logistic regression of lifetime use of at least one of these emerging products on smoking status, region, race, age, education, and sex (the pattern of results did not change when this logistic regression model was replicated with sample frame included

Table 1: Demographic characteristics of respondents (unweighted $N = 3,240$).

Demographic variable	Overall N	Overall weighted percent	Mode 1 frame unweighted percent	Mode 2 frame unweighted percent
Smoking status				
Never smoker	1,802	56.9%	56.9%	52.3%
Former smoker	787	24.8%	28.3%	28.3%
Nondaily smoker	146	4.6%	1.6%	4.0%
Daily smoker	434	13.7%	13.2%	15.4%
Region				
Northeast	404	12.6%	18.7%	18.9%
Midwest	589	18.4%	25.5%	22.4%
South	1,203	37.6%	39.5%	37.0%
West	1,007	31.4%	16.4%	21.7%
Race				
White	2,346	74.2%	87.2%	73.8%
African American	364	11.5%	10.0%	8.5%
Other	454	14.3%	2.7%	17.7%
Age				
18–24	440	13.7%	8.3%	8.1%
25+	2,763	86.3%	91.7%	91.9%
Education				
Not a high school graduate	291	9.2%	5.6%	11.2%
High school graduate	903	28.5%	28.6%	29.0%
Some college	929	29.3%	25.9%	28.0%
College graduate	1,044	33.0%	40.0%	31.7%
Sex				
Female	1,523	52.3%	36.2%	46.7%
Male	1,675	47.6%	63.8%	53.3%

as a predictor). Most notable was the strong association between use of emerging tobacco products with young age, male gender, and higher education when controlling for smoking status.

3.2. Current Users of Emerging Tobacco Products. Current use of these tobacco products was rare (current use did not exceed 1% for any of these products). However, current use among adults who had ever used these products was nontrivial, snus (14.4%), waterpipe (11.4%), and ENDS (19.7%). Conversely, current use of dissolvable tobacco products among ever users was less than one percent.

3.3. Cessation and Use of Emerging Tobacco Products. Of significant concern is the use of these products by former smokers after they had successfully quit smoking cigarettes. However, it is possible that some former smokers used these emerging tobacco products as a form of nicotine replacement therapy to help them quit, or simply tried one of these products before they quit smoking cigarettes. To address this possibility, we compared the use of these products among former smokers who quit smoking less than 1 year ago (7.2%), one to five years ago (17.1%), five to 10 years (14.6%), and more than 10 years (61.0%). People who had quit smoking more recently (<1 year ago) were the most likely to report having tried one of these products 32.1%; 27.1%; 14.9%; 13.5%, respectively ($P < .001$ for trend). However, the distant former smokers, defined as >5 years quit, accounted for 59.7% of those who had every tried one of these products.

4. Discussion

There are many concerns regarding emerging tobacco products; this is the first study to examine use of these products in a nationally representative sample. Our findings demonstrate that more than one in 10 US adults have tried at least one emerging tobacco product. Although overall current use of these products was low, a nontrivial percentage of people who had tried snus, waterpipe, or ENDS were current users. More people have tried a waterpipe than snus or ENDS, however ENDS and snus are newer to the US market. Daily and nondaily smokers were the most likely to have tried each of these products. Furthermore, nondaily smokers are the most likely to have tried a waterpipe.

Our study also demonstrates that lifetime use of these products is more common among males than females and younger adults than older adults, whereas lifetime use is

Table 2: Ever use of nicotine products by respondent characteristics.

	Snus	Waterpipe	Dissolvable tobacco products	ENDS	At least one of these products
Overall	5.1% ($n = 162$)	8.8% ($n = 281$)	0.6% ($n = 20$)	1.8% ($n = 56$)	13.6% ($n = 435$)
Smoking status	$P < .001$	$P < .001$	$P = .001$	$P < .001$	$P < .001$
Never smokers	2.7% ($n = 48$)	5.4% ($n = 97$)	0.2% ($n = 3$)	0.3% ($n = 6$)	7.7% ($n = 139$)
Former smokers	6.5% ($n = 51$)	11.4% ($n = 90$)	1.1% ($n = 9$)	1.5% ($n = 12$)	17.2% ($n = 135$)
Nondaily smokers	4.1% ($n = 6$)	26.0% ($n = 38$)	2.7% ($n = 4$)	8.2% ($n = 12$)	34.9% ($n = 51$)
Daily smokers	12.9% ($n = 56$)	12.9% ($n = 56$)	0.9% ($n = 4$)	6.2% ($n = 27$)	25.1% ($n = 109$)
Region	$P = .076$	$P < .001$	$P = .520$	$P = .396$	$P < .001$
Northeast	3.2% ($n = 13$)	12.6% ($n = 51$)	0.2% ($n = 1$)	2.7% ($n = 11$)	15.6% ($n = 63$)
Midwest	6.5% ($n = 38$)	10.0% ($n = 59$)	0.5% ($n = 3$)	1.4% ($n = 8$)	15.1% ($n = 89$)
South	4.5% ($n = 54$)	4.8% ($n = 58$)	0.6% ($n = 7$)	1.6% ($n = 19$)	9.5% ($n = 114$)
West	5.7% ($n = 57$)	11.2% ($n = 113$)	0.9% ($n = 9$)	1.9% ($n = 19$)	16.9% ($n = 170$)
Race	$P = .372$	$P = .006$	$P = .786$	$P = .971$	$P = .002$
White	5.3% ($n = 124$)	9.5% ($n = 222$)	0.6% ($n = 15$)	1.7% ($n = 41$)	14.6% ($n = 343$)
Black	3.6% ($n = 13$)	4.4% ($n = 16$)	0.8% ($n = 3$)	1.9% ($n = 7$)	7.7% ($n = 28$)
Other	4.8% ($n = 22$)	9.5% ($n = 43$)	0.4% ($n = 2$)	1.8% ($n = 8$)	13.2% ($n = 60$)
Age	$P = .003$	$P = .005$	$P = .626$	$P = .195$	$P = .002$
18–24	8.0% ($n = 35$)	12.3% ($n = 54$)	0.5% ($n = 2$)	2.5% ($n = 11$)	18.2% ($n = 80$)
25+	4.6% ($n = 128$)	8.2% ($n = 227$)	0.7% ($n = 18$)	1.6% ($n = 45$)	12.8% ($n = 355$)
Sex	$P < .001$	$P < .001$	$P < .001$	$P = .087$	$P < .001$
Males	8.5% ($n = 130$)	13.6% ($n = 208$)	1.2% ($n = 18$)	2.2% ($n = 33$)	20.8% ($n = 317$)
Females	2.0% ($n = 33$)	4.4% ($n = 74$)	0.1% ($n = 2$)	1.4% ($n = 23$)	7.0% ($n = 118$)
Education	$P < .001$	$P < .001$	$P = .107$	$P < .001$	$P < .001$
Less than HS	3.8% ($n = 11$)	8.2% ($n = 24$)	0.0% ($n = 0$)	0.7% ($n = 2$)	10.3% ($n = 30$)
High school	7.8% ($n = 70$)	4.9% ($n = 44$)	0.3% ($n = 3$)	1.7% ($n = 15$)	12.7% ($n = 115$)
Some college	4.8% ($n = 45$)	12.8% ($n = 119$)	1.1% ($n = 10$)	3.7% ($n = 34$)	18.2% ($n = 169$)
College degree	3.2% ($n = 33$)	8.9% ($n = 93$)	0.7% ($n = 7$)	0.5% ($n = 5$)	11.3% ($n = 118$)

lowest among adults living in the southern region of the US Contrary to cigarette use patterns, higher levels of education are associated with higher use of at least one of these emerging products. This relationship is the inverse of the trend toward decreased cigarette use in the higher educated demographic groups, suggesting that emerging products may have the capacity to "re-normalize" tobacco use in a demographic that has had significant denormalization of tobacco use previously.

All forms of tobacco are potentially harmful but the use of these emerging products is concerning for at least four additional reasons. First, the use of these products by people who have never smoked cigarettes may lead to desensitization to the concept of using tobacco products in general. Tolerance to tobacco and less normative resistance to tobacco could lead to future use of cigarettes. In addition, these products contain nicotine and will therefore start the upregulation of nicotine receptors in the reward centers of the brain, setting up the potential for nicotine addiction and a facilitated leap to the cigarette [5]. Second, people who have quit smoking may relapse to nicotine addiction after using these products. Recent former smokers are particularly susceptible to relapse early on, whereas distant former smokers may still relapse back to smoking cigarettes especially when using other tobacco products [32]. Third, current smokers may use these products as an alternative to cessation [33]. Although replacing cigarettes with these other tobacco delivery devices might be beneficial, the risk of relapse to cigarette smoking may be elevated compared to people who overcome their addition without continuing the behavioral act of cigarette use itself. And fourth, the lifetime prevalence of using waterpipe among nondaily smokers is more than 25% and substantially higher than among daily smokers and nonsmokers. Polytobacco use among these nondaily smokers may also increase levels of nicotine exposure and risk of persistent tobacco dependence relative to the exclusive use of cigarettes [7].

The higher lifetime prevalence rate for use of these products among young adults, males, more educated adults, and residents outside of the southern region suggest that public health strategies should prioritize preventing additional or further use of these products in these populations, while maintaining lower lifetime prevalence rates in other groups. Almost 20% of young adults have tried at least one of these emerging tobacco products.

There are at least two unique strengths of this study. These are the first nationally representative data on the prevalence of use of these emerging products. This information can help to inform efforts to determine the need for regulatory protections. Furthermore, these findings are based

Table 3: Final logistic regression model showing odds of having tried a waterpipe, snus, or ENDS (N = 3,158).

Predictors	Have tried one of these products adjusted OR (95% confidence interval)
Smoking status	
Former smoker	2.71 (2.06, 3.56)
Nondaily smoker	6.13 (4.02, 9.33)
Daily smoker	5.53 (4.03, 7.58)
Region	
Northeast	1.68 (1.16, 2.42)
Midwest	1.65 (1.20, 2.28)
West	1.80 (1.36, 2.39)
Age	
18–24	2.18 (1.60, 2.97)
Sex	
Males	3.51 (2.77, 4.45)
Education	
High school	1.58 (.99, 2.51)
Some college	2.67 (1.69, 4.22)
College degree	2.04 (1.26, 3.30)

Model also included race, not significant. Reference groups were as follows: never smokers, south region, 25 years of age and older, females, and no high school degree.

on a nationally-representative sample of US adults obtained from a mixed-mode frame that substantially reduces concerns of the increasing bias in RDD surveys arising from noncoverage due to wireless substitution. However, this study is subject to at least five limitations.

First, although the mixed-mode design substantially reduced noncoverage bias compared to an RDD design by including respondents who did not have a landline telephone in their home, it is possible that the dual sampling frame did not entirely eliminate noncoverage issues. The use of the internet panel raises some concern about the representativeness of the sample. However, several comparison studies have demonstrated that this approach yields results comparable to well-designed RDD surveys, in terms of demographics and outcome variables [24, 34]. Chang and Krosnick compared findings from this internet panel, an RDD survey, and a nonprobability internet survey (Harris Interactive Internet Panel). The RDD and internet panel probability samples were found to be more representative than the nonprobability internet sample. Compared to the RDD sample, this internet probability panel demonstrated less evidence of survey satisficing and social desirability than the RDD survey, frequent concerns with tobacco use survey research [34]. More recently, Yeager and colleagues conducted a similar comparison study that also included benchmarks from the National Health Interview Survey and the Current Population Survey [24]. Again, this internet panel probability sample was comparable to these large government surveys in terms of demographic, behavioral, and attitudinal benchmarks and were found to be more representative than seven different nonprobability internet surveys [24].

Second, ongoing engagement might lead to panel conditioning, and thereby reduce data reliability if respondents develop a "time-in-sample bias" due to increased experience with completing surveys. However, results from the primary analyses did not change with the inclusion of a variable that measured time on the panel. (For the mode 2 frame, analyses presented in Tables 2 and 3 were replicated with the inclusion of a variable that measured length of time on the panel. The pattern of results did not change, and no evidence of a "time-on-panel bias" was detected.)

Third, the cumulative response rate for the mode 2 frame is significantly lower than the response rate from mode 1. However, it is important to note the differences between an RDD telephone sample and a probability-based internet panel. An online panel is composed of people recruited at different times and, more importantly, committed to answer many surveys for a period of time and not just that single survey. Further, panelists must also complete profiling surveys in order to become members of the panel. These differences are reflected in the recruitment and profile rates reported above. These differences make directly comparing response rates between one-time surveys and panel surveys difficult and perhaps not illuminating.

When considering the first three limitations, it is worth comparing estimates from the 2010 SCS-TC to those from a large-scale national survey. Both the SCS-TC and the National Health Interview Survey (NHIS) [35] assess current smoking status using the same survey items, and produced very similar estimates (SCS-TC, 18.3%, NHIS, 19.4%). Thus this prevalence estimate from the SCS-TC is comparable to that from one of the principal sources of information about the health of the US population.

The fourth limitation relates to whether any of the recent former smokers had quit cigarettes because of these emerging tobacco products, or, rather, had used these products after successfully quitting. Obviously those former smokers who quit before these products emerged in the US market did not use these products as a cessation strategy, but this is an area for future study among people who have recently quit smoking.

The fifth limitation concerns the cross-sectional nature and scope of these data. As noted above, it is not possible from this survey to determine when adults, particularly former smokers, tried these products. Moreover, an expanded pool of survey items that assessed when and under what scenarios people used these products would provide more conclusive insight into the risks that these products pose. Further studies should include more detailed items to examine perceptions and use of these emerging products among adolescents and young adults who are closer to the median age of cigarette smoking initiation.

An expanding pool of tobacco products with little or no regulation may increase the overall number of individuals who become nicotine dependent and later use cigarettes. This study demonstrates that some young adults, distant former, and never cigarette smokers have used these emerging nicotine-containing tobacco products, suggesting a need to

restrict how and to whom these products are marketed, sold, and used. Furthermore, clinicians need to be aware of emerging tobacco products, both to better screen high risk demographic groups, and to offer counseling about the risks of these products as another form of tobacco use.

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Research Article

The Impact of State Preemption of Local Smoking Restrictions on Public Health Protections and Changes in Social Norms

Paul D. Mowery,[1] Steve Babb,[2] Robin Hobart,[3] Cindy Tworek,[4] and Allison MacNeil[2]

[1] *Biostatistics Inc., 228 East Wesley Road, NE, Atlanta, GA 30305, USA*
[2] *CDC Office on Smoking and Health, 4770 Buford Highway, NE, MS-K50, Atlanta, GA 30341-3717, USA*
[3] *ICF International, Denver, CO 80223, USA*
[4] *Department of Pharmaceutical Systems and Policy, West Virginia University, Morgantown, WV 26506, USA*

Correspondence should be addressed to Paul D. Mowery, pzm4@cdc.gov

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Introduction. Preemption is a legislative or judicial arrangement in which a higher level of government precludes lower levels of government from exercising authority over a topic. In the area of smoke-free policy, preemption typically takes the form of a state law that prevents communities from adopting local smoking restrictions. *Background*. A broad consensus exists among tobacco control practitioners that preemption adversely impacts tobacco control efforts. This paper examines the effect of state provisions preempting local smoking restrictions in enclosed public places and workplaces. *Methods*. Multiple data sources were used to assess the impact of state preemptive laws on the proportion of indoor workers covered by smoke-free workplace policies and public support for smoke-free policies. We controlled for potential confounding variables. *Results*. State preemptive laws were associated with fewer local ordinances restricting smoking, a reduced level of worker protection from secondhand smoke, and reduced support for smoke-free policies among current smokers. *Discussion*. State preemptive laws have several effects that could impede progress in secondhand smoke protections and broader tobacco control efforts. *Conclusion*. Practitioners and advocates working on other public health issues should familiarize themselves with the benefits of local policy making and the potential impact of preemption.

1. Introduction

Preemption is a legislative or judicial arrangement in which a higher level of government strips lower levels of government of their authority over a specific subject matter [1–3]. In the area of smoke-free policy, preemption typically takes the form of a state law or court ruling prohibiting adoption of local smoking restrictions that are more stringent than the state standard. State preemptive laws can also prohibit other local tobacco control measures, such as restrictions on youth access to tobacco products and restrictions on marketing and promotion of these products. Some state preemptive provisions apply to several or all of these domains. In this study, we focus on the impact of state laws that preempt local laws regulating smoking in enclosed public places and workplaces, including restaurants. We set out to document the effect of state provisions preempting local smoking restrictions on three specific outcomes: the number of local smoke-free ordinances in a state, the proportion of indoor employees covered by 100% smoke-free workplace policies, and public support for smoke-free policies in various settings. We selected December 31, 2001 as the time point for our analysis because it provides a relatively large number of data points in the preemption category for analysis. In addition, as of December 31, 2001, no states had enacted comprehensive statewide smoke-free laws.

A broad consensus exists among public health practitioners and tobacco control advocates that preemption has an adverse impact on tobacco control efforts [4, 5]. The *Healthy People 2020* Tobacco-Use Objective TU HP2020-16 seeks the elimination of state laws that preempt stronger local tobacco control laws [6]. Preemptive state laws prevent local governments from taking action to protect residents from the

well-documented dangers of tobacco use and secondhand smoke exposure [7]. This is a significant loss, as the strongest and most innovative smoking restrictions—and tobacco control policies in general—have traditionally emerged first at the local level before ultimately being adopted at the state level [8, 9]. The tobacco industry's difficulty in influencing local policy making and the greater influence it is typically able to exercise at the state level have led the industry to lobby forcefully for preemption of smoke-free laws [10–15]. In internal documents, the tobacco industry has expressed concern that strong smoke-free laws will lead to reduced social acceptability of smoking and decreased cigarette sales, while in public the industry has argued, usually indirectly through third-party organizations, that preemption is necessary to ensure a "level playing field" among businesses in different communities, to preserve business proprietors' ability to set their own smoking policies and to prevent local smoke-free laws from adversely impacting restaurant and bar business [8, 13]. In fact, preemptive legislation has often appeared to be a direct response to local smoke-free policy progress. The tobacco industry and its allies have often introduced such legislation shortly after the adoption or consideration of the first local smoke-free ordinances in a state [8, 13].

Successful efforts to impede the adoption of local smoke-free laws have the potential for repercussions beyond reduced protections for nonsmokers. Research, including some conducted by the tobacco industry, has demonstrated that smoke-free policies can also contribute to increased quit attempts and increased success in quitting among adult smokers as well as reduced cigarette consumption among smokers who continue to smoke [13, 16–19]. Tobacco control practitioners believe that preemptive laws have other negative effects, including loss of opportunities for the public debate and education that typically accompany consideration of local smoke-free laws, less vigorous local enforcement efforts, and lower levels of compliance [8, 14, 20–22]. The number of state laws preempting stronger local smoking restrictions increased sharply in the 1990s [14, 15]. In many states, provisions preempting local smoking restrictions were coupled with weak statewide smoking restrictions that contained many exemptions. While some states' preemptive provisions applied only to certain settings (e.g., restaurants in Michigan), allowed local policy making in a limited number of local jurisdictions (e.g., Illinois), or grandfathered local ordinances enacted before a certain date (e.g., Oregon), most states' preemptive provisions were comprehensive in scope, applying to all settings and all local jurisdictions in the state, and effectively blocking any local action in this regard [14].

After peaking in the mid-1990s, the pace of adoption of new state measures preempting local tobacco control policy making leveled off after 1996 [14]. As the pitfalls of preemption became apparent, advocates have pushed for inclusion of explicit non-preemption clauses in state-legislation restricting smoking [1, 20]. In 2002, Delaware became the first state to successfully repeal a provision preempting local smoking restrictions, and eight other states—Illinois, Louisiana, Mississippi, Nevada, New Jersey, Oregon, Iowa, and North Carolina (which rescinded its preemption provisions for some settings, but not for others)—have followed suit, either in conjunction with adoption of a statewide smoke-free law or as a stand-alone action [23]. In other states, such as Kentucky [24] and South Carolina [25] state courts have ruled that state statutes—once widely thought to be preemptive—do not prohibit passage of local smoke-free laws [26]. Although progress is clearly being made toward achieving the *Healthy People 2020* goal of no preemptive state smoke-free laws, as of December 31, 2011, 12 states are still considered to preempt local smoking restrictions in at least one of three major settings (government workplaces, private workplaces, or restaurants) [27].

A comprehensive literature review found just one published study to date that has sought to quantify the impact of state laws preempting local smoking restrictions. Stark and colleagues examined the effect of an Oregon law which preempted local smoking restrictions in conjunction with the establishment of partial statewide smoking restrictions. The law grandfathered in existing local ordinances that were stronger than the state standard. The authors found that nonsmoking restaurant and bar employees working in the preempted communities had elevated levels of a tobacco-specific carcinogen compared to their counterparts working in the grandfathered communities [28].

The current study attempts to quantify the effect of state laws that preempt stronger local smoking restrictions, on a national basis. We examined the number of local ordinances in each state, comparing states with preemption with states that did not have preemption. We also compared the percentage of indoor workers who reported working in a smoke-free worksite, and attitudes about smoke-free laws, between residents of preemption and non-preemption states.

2. Methods

2.1. Data Sources. We used the 2001-2002 Tobacco Use Supplement to the Current Population Survey (TUS/CPS) to assess the proportion of indoor workers protected by 100% smoke-free workplace policies, public support for smoke-free policies in various settings, and self-reported current smoking status. The TUS/CPS is a nationally representative survey of persons aged 15 years and older conducted by the US Census Bureau and sponsored by the National Cancer Institute and the Centers for Disease Control and Prevention [29]. The national sample is stratified by state, and respondents from all states and the District of Columbia are represented in the sample. The TUS/CPS response rate—which includes response to both the parent CPS survey and the TUS supplement—was 64.0%. Data were weighted to account for probability of selection and nonresponse. Weights were adjusted so that the weighted sample represents the demographic distribution of the US population.

The Centers for Disease Control and Prevention (CDC) State Tobacco Activities Tracking and Evaluation (STATE) System database (http://www.cdc.gov/tobacco/statesystem/),

the University of Illinois at Chicago/Robert Wood Johnson Foundation ImpacTeen database (http://www.impacteen.org/), and the American Lung Association's State Legislated Actions on Tobacco Issues (SLATI) database (http://slati.lungusa.org/) were used to assess state smoke-free and preemption laws in effect as of the 4th quarter of 2001. The Americans for Nonsmokers' Rights Foundation US Tobacco Control Laws Database (http://www.no-smoke.org/document.php?id=313) of local tobacco control ordinances was used to determine the number of local laws restricting smoking in effect, by state, as of the 4th quarter of 2001. Data on state funding for tobacco control and state cigarette excise taxes were obtained from the CDC STATE System database.

2.2. Measures. Self-reported individual-level outcomes examined in this analysis include whether respondents who work indoors are covered by smoke-free workplace policies, and public support for smoke-free policies in various venues, stratified by smoking status. Smoking status was assessed by two questions: "have you smoked at least 100 cigarettes in your entire life?" and "do you now smoke cigarettes every day, some days, or not at all?" Current smokers were defined as respondents who had smoked 100 cigarettes in their lifetimes and who now smoke every day or some days.

The TUS/CPS assessed workplace smoking policy among indoor workers using two questions: "which of these best describes your place of work's smoking policy for indoor public or common areas, such as lobbies, rest rooms, and lunch rooms?" and "which of these best describes your place of work's smoking policy for work areas?" Smoke-free workplaces were defined as workplaces in which smoking is prohibited in both public and work areas. Public support for smoke-free policies in various settings was assessed based on responses to the question: "in ⟨venue⟩, do you think that smoking should be allowed in all areas, allowed in some areas, or not allowed at all?" The question was asked for six venues—restaurants, hospitals, indoor work areas, bars and cocktail lounges, indoor sporting events, and indoor shopping malls. Support for smoke-free policies in each venue was defined as a response of "smoking should not be allowed at all." We constructed an index of public support by summing the six responses. Respondents who thought that smoking should not be allowed at all in at least four of the six venues were categorized as supporting smoke-free policies. This index is similar to one used by Gilpin et al. [30].

The presence of a state preemptive provision was measured by creating dichotomous variables for state legislation precluding local smoking restrictions in government worksites, private worksites, and restaurants. Preemption in each of these three locations received one point. Points were summed to create a worksite/restaurant preemption index. We also constructed a preemption score for other public places, including health facilities, recreational facilities, cultural facilities, public transit, malls, public schools, and private schools. Preemption of local smoking restrictions in one or more of these other locations received a score of one point. This score was added to the worksite/restaurant score. Thus, the total preemption index for each state covering worksites, restaurants, and other public places could range from 0 to 4. A preemption score was calculated by multiplying the preemption index by the number of years the preemptive law had been in effect.

A strength of state smoke-free laws index was constructed as the sum of values for state smoking restrictions covering government worksites, private worksites, restaurants, bars, and other public places. For each of these venues, state smoking restrictions were rated as follows: 0: no smoking restrictions, 1: law prohibiting smoking but allowing separately ventilated areas or size exemptions, and 2: 100% smoke-free. Laws that provided for exemptions other than separately ventilated areas or size exemptions were assigned to the "no smoking restrictions" category. Other public places where state smoking restrictions were assessed included hospitals, public transportation, enclosed arenas, grocery stores, shopping malls, prisons, and hotels/motels. For other public places, only the venue with the greatest strength of protection from secondhand smoke was included in the score (values were not summed for each location). The venue-specific scores were summed over the five venues to create the index, yielding a possible range of 0 to 10 for each state's total score.

State funding for tobacco control was calculated as total state funding for tobacco control in fiscal year 2001 divided by the state population. The total includes state cigarette excise tax appropriations for tobacco control, master settlement appropriations for tobacco control, appropriations from other state funding sources, CDC funding, funding for tobacco control activities from the Substance Abuse and Mental Health Services Administration, Robert Wood Johnson Foundation funding, and American Legacy Foundation funding. The excise tax on cigarettes in each state was measured by the inflation-adjusted state cigarette excise tax averaged over the years 1995 to 2001. Taxes were obtained as of the 4th quarter of each year. The state excise tax was averaged over seven years to reflect the cumulative impact that state to state differences in cigarette prices might have on differences in tobacco attitudes and beliefs.

2.3. Statistical Analysis. We used a multivariate hierarchical model relating whether the respondent worked in a smoke-free workplace and support for smoke-free policies in various settings to the preemption score for each state, adjusted for other covariates. At the state level, the preemption and smoke-free scores were modeled as continuous variables. US region, state funding for tobacco control, and state cigarette excise taxes were modeled as categorical variables. At the individual level, additional covariates in the model included age, gender, race, and marital status.

3. Results

3.1. States with Preemption, Venues Affected, and Duration of Preemptive Laws, 2001. As of December 31, 2001, a total of 18 states had provisions preempting local smoking restrictions in at least one of the three major settings considered (Table 1). All but two of these state laws preempted local

Table 1: States with preemption of local smoke-free laws and preemption score, 2001.

State	Number of major public venues in which local smoke-free laws are preempted (out of 3)[a]	Preemption of local smoke-free laws in at least one other public place?[b]	Number of years preemption in effect	Preemption score[c]
FL	3	Yes	16	64
NJ	3	Yes	15	60
OK	3	Yes	14	56
PA	3	Yes	13	52
IA	3	Yes	11	44
IL	3	Yes	11	44
SC	3	Yes	11	44
VA	3	Yes	11	44
NV	3	Yes	10	40
CT	3	Yes	8	32
LA	3	Yes	8	32
NC	3	Yes	8	32
DE	3	Yes	7	28
TN	3	Yes	7	28
SD	3	Yes	6	24
UT	3	Yes	6	24
MI	1	No	18	18
MS	1	No	1	1

[a]Major venues: government worksites, private worksites, and restaurants.
[b]Preemption of local smoking bans in one or more of these locations: health facilities; recreational facilities; cultural facilities; public transit; malls; public schools; private schools.
[c]Preemption score equals the sum of preemptive restrictions in government worksites, private worksites, restaurants, and other public places (one point for each location) times the number of years the preemptive law had been in effect.

smoking restrictions in all three major settings as well as in other public places. Only the preemption laws in Michigan and Mississippi applied to fewer than 3 venues. The Michigan law preempted local laws regulating smoking in restaurants; the Mississippi law pertained only to government worksites. These two states did not preempt local smoking restrictions in other public places. Many of the state preemptive laws had been passed during the 1990s. State preemptive laws had been in effect for a median period of 10.5 years. Mississippi's preemptive law had been in effect for the shortest time—only 1 year. Michigan's preemptive law had been in effect for the longest time (18 years), followed by Florida's law (16 years).

3.2. Number of Local Ordinances in Preemption And Non-Preemption States. By 2001, 3,292 US municipalities had ordinances in effect restricting smoking in one or more public places and workplaces [31]. The mean number of local ordinances of this kind in effect in preemption states was 34.8. The mean number of local ordinances in effect in non-preemption states was 80.8. This difference was not statistically significant ($P > 0.05$) due to the large variability in numbers of local laws within both preemption and non-preemption states (Figures 1 and 2). California had the most local laws in place restricting smoking (706), followed by Massachusetts (471), Texas (283), and North Carolina (193), a preemption state that grandfathered local smoke-free laws adopted before a certain date. All but one state, including

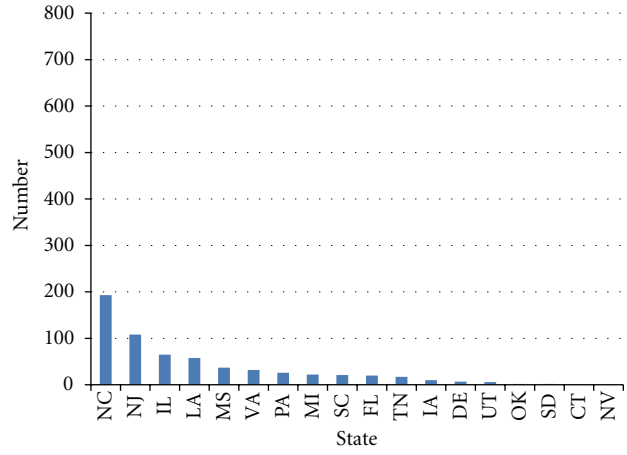

Figure 1: Cumulative number of smoke-free ordinances, preemption states, as of December 31, 2001.

preemption states, had at least one local law restricting smoking in effect. Six out of 18 preemption states and ten out of 33 non-preemption states had enacted fewer than 10 local smoke-free ordinances.

3.3. State Preemption Score. The state preemption score (Table 1) measures both the number of venues in which local governments are preempted from regulating smoking and

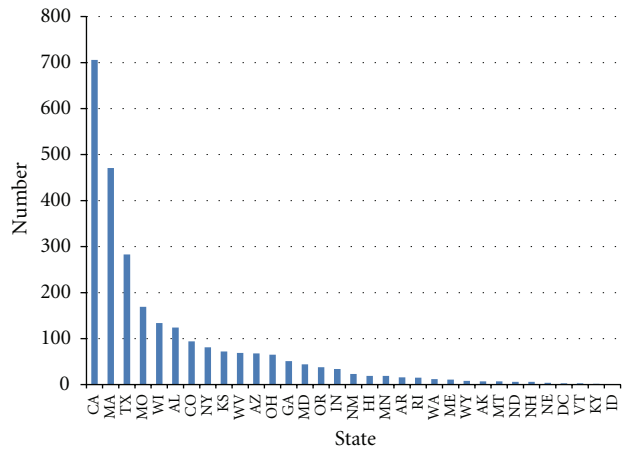

Figure 2: Cumulative number of smoke-free ordinances, non-preemption states, as of December 31, 2001.

the number of years the preemptive law had been in effect as of 2001. The Florida law received the highest (i.e., most restrictive) preemption score of 64, followed by New Jersey (60), Oklahoma (56), and Pennsylvania (52). Mississippi (1) had the lowest score. The mean preemption score for all 18 preemption states was 37.1 (standard error 3.7).

3.4. Comparison of Smoke-Free Workplaces and Attitudes about Smoke-Free Policies among Adults Living in Preemption and Non-Preemption States. The percentage of indoor workers who reported working in 100% smoke-free workplaces was higher in non-preemption states than in states with preemption. In a multivariate analysis, the attained significance level for this difference, adjusted for state smoke-free laws, funding for tobacco control, state cigarette excise taxes, US region, and individual covariates, was $P = 0.06$ (Table 2).

Support for smoke-free policies was higher among respondents living in states without preemption than among respondents in preemption states. This difference was observed for current, former, and never smokers. The difference in support for smoke-free policies between non-preemption and preemption state residents was largest among current smokers. In a multivariate analysis adjusted for covariates, this difference was statistically significant among current smokers ($P < 0.05$), but not among former and never smokers ($P > 0.05$).

4. Discussion

To our knowledge, this is only the second study to attempt to quantify the effect of state laws that preempt stronger local smoking restrictions and the first study to document the effect of state preemptive laws on a national level and to assess multiple outcomes of these laws.

The most striking finding of the study is that state preemptive laws are associated with reduced support for smoke-free environments in indoor settings among current smokers. (A similar effect was found among former and never smokers, but it was not significant.) In other words, current smokers in states with preemption were less likely

Table 2: Percentage of indoor workers with smoke-free workplaces, and percentage of adults who favor bans on indoor smoking, by state preemption status, USA, 2001.

Outcome	State Preemption Status	Percent (95 CI)	(P value)[a]
Indoor workers—work in a 100% smoke-free workplace	No	72.4 (72.0, 72.9)	($P = 0.06$)
	Yes	69.1 (68.5, 69.7)	
Never smokers—favor bans on smoking in indoor places	No	77.8 (77.4, 78.2)	($P = 0.12$)
	Yes	72.6 (72.1, 73.2)	
Current smokers—favor bans on smoking in indoor places	No	44.1 (43.3, 44.8)	($P = 0.02$)
	Yes	35.6 (34.7, 36.5)	
Former smokers—favor bans on smoking in indoor places	No	68.7 (68.0, 69.4)	($P = 0.06$)
	Yes	62.8 (62.0, 63.7)	
Overall—favors bans on smoking in indoor places	No	68.8 (62.8, 74.9)	($P = 0.05$)
	Yes	62.2 (59.8, 64.6)	

[a] F-test for the hypothesis that average outcomes are the same in preemption and non-preemption states, as estimated from a multivariate hierarchical linear model. In addition to state preemption score, state-level covariates in the multivariate model include smoke-free score, funding for tobacco control programs, state cigarette excise tax, and US region. Individual-level covariates: age, gender, race, and marital status.

to express support for smoke-free environments than their counterparts in states without preemption. State preemption could have this effect by preventing or delaying shifts in social norms that may be generated in part by the discussion, adoption, and implementation of local smoke-free laws.

The discussion and debate that typically occur when communities are considering adopting smoke-free ordinances may raise public awareness regarding the health effects of secondhand smoke and the need for smoke-free policies and contribute to changes in public attitudes regarding the social acceptability of smoking [8, 13]. This discussion also generates news media coverage [32, 33]. Studies have suggested that increased news media coverage of tobacco issues, in turn, is associated with decreases in annual per capita cigarette consumption, decreases in weekly cigarette sales, and increases in adult tobacco use cessation [32, 34–36]. Increased news coverage of secondhand smoke issues may also be associated with increased adoption of local smoke-free laws [37].

In addition to losing opportunities for discussion, residents in preemption states also lose the opportunity to live under smoke-free ordinances. This is a significant loss, as a number of studies have reported that public support for smoke-free environments increases after smoke-free laws go into effect [18, 38, 39]. Studies have found that this effect is especially pronounced among smokers, in part because their baseline levels of support are typically lower than those of nonsmokers [18, 39, 40]. It may be that having the

experience of actually living under a smoke-free law dispels concerns about potential adverse effects of such laws and provides firsthand evidence of their benefits. It may also be that people, and smokers in particular, simply adjust to and become accustomed to these laws.

Evidence from a number of states' experiences suggests that the shifts in social norms that occur when smoke-free laws are being considered, adopted, and implemented foster a climate that supports smoking cessation, reduced adult tobacco use, and reduced youth tobacco use initiation [13, 17–19, 41–43]. Evidence also indicates that these shifts lead to increased efforts to reduce secondhand smoke exposure even in settings which are not covered by smoke-free laws, for example, increased adoption of voluntary smoke-free home rules [18, 39]. In fact, the evidence indicates that such changes in public attitudes, which are largely generated by smoke-free laws and other tobacco control policies, are one of the single most important mechanisms through which state and local tobacco control programs reduce tobacco use [44–46]. One of the most significant, although indirect, effects of state preemptive laws may be their denial to state residents of the opportunity to have these experiences during the discussion, adoption, and implementation of smoke-free ordinances, and to undergo the resulting shifts in social norms. This may perpetuate disparities among states in tobacco control policies and tobacco use by freezing local policies and norms in place, thus impeding the efforts of these states to "catch up" with states that have achieved greater progress in reducing tobacco use.

The study also demonstrates that state preemptive provisions are associated with a reduced level of worker protection from secondhand smoke. Indoor workers in states with preemption provisions are less likely to be covered by smoke-free workplace policies than their counterparts in states without preemption.

The implementation of smoke-free laws and smoke-free workplace policies is associated with increased cessation among adult smokers and reduced adult smoking prevalence [13, 17–19]. Several studies have suggested that smoke-free laws and policies are also associated with reduced youth smoking initiation [41, 42]. These effects could operate through several mechanisms, including reduced opportunities to smoke, reduced cues prompting smoking, and shifts in public attitudes regarding the social acceptability of smoking.

This analysis also suggests that state preemptive provisions are associated with fewer local ordinances restricting smoking. This is in keeping with the findings of previous reviews [7, 8, 13].

It should be noted that there are some exceptions to this finding. Some states with preemption have local ordinances in place. This can be due to a number of factors. For example, North Carolina provided a window of opportunity for local jurisdictions to adopt ordinances restricting smoking before the state preemption provision took effect. Other states, such as Illinois, preserved local control in some communities which had already adopted local smoking restrictions before the preemptive state law took effect (i.e., these communities could revisit and strengthen their ordinances). Some states, such as Michigan, preempt local smoking restrictions only in certain venues, while allowing such restrictions in other venues. In other states, such as Florida, local smoking restrictions adopted before the preemptive state law remain in the books, but are not enforced. And in some states local jurisdictions may have passed smoking restrictions, unaware of potential impediments to such action posed by state statutes and legal precedents. However, the data bear out the common sense proposition that the absence of preemption is in most cases a necessary, though not sufficient, condition for the adoption of local smoking restrictions.

This study has some noteworthy strengths, including nationally representative data and control for a variety of state policy and individual-level variables. The study is also subject to several limitations. In particular, because the study is cross-sectional and examines the relationship between state preemption laws and the three outcomes of interest at a single point in time, it cannot establish the causality of the observed associations.

Opponents of smoke-free legislation have not abandoned the use of preemption to impede the adoption of comprehensive local smoking restrictions. In recent years, tobacco control advocates have noted instances in several states of legislation that carves out exemptions for specific venues (e.g., cigar bars and outdoor seating in restaurants) while preempting local governments from restricting smoking in these venues.

In conclusion, this study suggests that state provisions preempting local smoking restrictions affect several outcomes in ways that could impede progress in advancing secondhand smoke protections and broader tobacco control efforts. The issue of the implications of preemption is not unique to tobacco control. Preemption of stronger restrictions at lower jurisdictional levels has surfaced with regard to a number of other public health issues, including alcohol control, and, most recently, menu labeling requirements for restaurants. Because it is somewhat a technical issue and can initially appear to be innocuous, preemption can easily be overlooked, but it can have profound implications. It took tobacco control practitioners and advocates several years to reach consensus on the dangers of preemption—years during which several additional states enacted preemptive laws. It is important that practitioners and advocates working on other public health issues fully understand the benefits of local policymaking and the potential impact of preemption.

There is a need for additional studies replicating the findings of this analysis, especially longitudinal studies. In addition, there is a need for studies exploring the effects of the repeal of state provisions preempting local smoking restrictions on the outcomes we have considered—a type of study that to our knowledge has yet to be attempted.

5. Conclusions

This study supports the widely held belief that state provisions preempting local smoking restrictions may impede progress in advancing secondhand smoke protections and broader tobacco control efforts. This underlines the critical importance of preserving local authority in this area.

Preemption of stronger restrictions at lower jurisdictional levels has surfaced with regard to a number of other public health issues, most recently regarding menu labeling requirements for restaurants. It took tobacco control practitioners and advocates several years to reach consensus on the dangers of preemption—years during which several additional states enacted preemptive laws. It is important that practitioners and advocates working on other public health issues fully understand the benefits of local policymaking and the potential impact of preemption in order to avoid repeating this experience.

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Research Article

Adult Current Smoking: Differences in Definitions and Prevalence Estimates—NHIS and NSDUH, 2008

Heather Ryan,[1] Angela Trosclair,[2] and Joe Gfroerer[3]

[1] *Division of Cancer Prevention and Control, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Atlanta, GA 30341, USA*
[2] *Office on Smoking and Health, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Atlanta, GA 30341, USA*
[3] *Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality, Rockville, MD 20857, USA*

Correspondence should be addressed to Heather Ryan, hryan@cdc.gov

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Objectives. To compare prevalence estimates and assess issues related to the measurement of adult cigarette smoking in the National Health Interview Survey (NHIS) and the National Survey on Drug Use and Health (NSDUH). *Methods*. 2008 data on current cigarette smoking and current daily cigarette smoking among adults ≥18 years were compared. The standard NHIS current smoking definition, which screens for lifetime smoking ≥100 cigarettes, was used. For NSDUH, both the standard current smoking definition, which does not screen, and a modified definition applying the NHIS current smoking definition (i.e., with screen) were used. *Results*. NSDUH consistently yielded higher current cigarette smoking estimates than NHIS and lower daily smoking estimates. However, with use of the modified NSDUH current smoking definition, a notable number of subpopulation estimates became comparable between surveys. Younger adults and racial/ethnic minorities were most impacted by the lifetime smoking screen, with Hispanics being the most sensitive to differences in smoking variable definitions among all subgroups. *Conclusions*. Differences in current cigarette smoking definitions appear to have a greater impact on smoking estimates in some sub-populations than others. Survey mode differences may also limit intersurvey comparisons and trend analyses. Investigators are cautioned to use data most appropriate for their specific research questions.

1. Introduction

Cigarette smoking continues to be the single greatest preventable cause of disease and death in the United States [1]. The US federal government's first nationally-representative survey of cigarette smoking and other tobacco use behaviors took place in 1955 as a supplement to the US Census [2]. Since then federally sponsored tobacco surveillance has grown to include several established data collection systems routinely implemented at the national level, some of which have been adapted, sponsored, and implemented at the state level [3–5]. As one of the World Health Organization (WHO) MPOWER package's six proven tobacco prevention and control policies [6], tobacco prevention and control monitoring systems and their maintenance and enhancement are an essential part of public health practice [7]. Specifically, WHO calls for monitoring systems that track multiple anti- and protobacco attitude, behavior, and policy indicators; disseminate findings to facilitate utilization; provide overall as well as demographic subpopulation data at the national, state, and, where practicable, local levels; maximize system sustainability through cross-discipline collaboration, strong management and organization, and sound funding [6].

Understanding, documenting, and quantifying the characteristics of the tobacco user, or potential user, have been key to tobacco control efforts [4]. A variety of existing monitoring, research, and evaluation systems are available to collect such information [4], with increasing demand for surveillance data to inform evidence-based public health tobacco initiatives necessitating their periodic review [5]. At the national level, the National Health Interview Survey (NHIS) has been the data source used to measure progress on

Healthy People adult tobacco-use prevalence objectives since the first ever release of national health objectives (Healthy People 1990) [8, 9]. Adult tobacco-use prevalence can be estimated from other national surveys as well [3], allowing evaluation of any differences in prevalence magnitude or in trends over time between data sources; however, there have been few studies comparing their smoking prevalence estimates [10]. A comparison of estimates from the 1997 NHIS and national estimates from the 1997 Behavioral Risk Factor Surveillance System (BRFSS) surveys [11] found current smoking prevalence to be significantly higher in NHIS than in BRFSS (24.7% versus 23.1%). Differences were also observed in a Substance Abuse and Mental Health Services Administration (SAMHSA) report [12] that described smoking prevalence estimates from the 2005 National Survey on Drug Use and Health (NSDUH). SAMHSA reported that estimates from NSDUH were higher (26.5%) than estimates obtained from the 2005 NHIS (20.9%), even after applying the NHIS current smoking definition to NSDUH data limiting smokers only to those who reported smoking ≥100 cigarettes in their lifetime (24.7% in NSDUH using NHIS definition). In a 2009 report comparing NHIS and NSDUH current smoking prevalence for the period 1998–2005, Rodu and Cole [10] describe an increasingly divergent picture of smoking prevalence in the USA between 1999 and 2005. Rodu's secondary analysis of NHIS and NSDUH data indicated that by 2005 NHIS prevalence had declined to approximately 21% while the NSDUH estimate was approximately 25%, with the latter but not the former suggesting a plateau in smoking prevalence. This pattern then reversed with a 2010 report using NHIS data that indicated a stall in the prevalence of adult smoking from 2005 (20.9%) to 2009 (20.6%) [13] while SAMHSA's primary analysis of NSDUH data suggested a continuing decline from 26.5% to 24.9% during the same period [12].

Key methodological issues, such as sampling design, survey mode and setting, and survey question standardization and context, have the potential to influence data quality and comparability [4]. Differences in the survey questions used to define current smoking are thought to be one of the probable methodological sources of discrepancy between NHIS and NSDUH smoking estimates. Most notably, NHIS limits its question of current smoking to respondents who on a previous question reported smoking ≥100 cigarettes in their lifetime (i.e., NHIS "ever smokers," with "never smokers" then defined as respondents with lifetime smoking anywhere between 0 and 99 cigarettes). NSDUH also limits its current smoking definition based on reported ever smoking behavior; however, other than an implicit zero, it does not designate a cut-point for number of lifetime cigarettes smoked for categorizing "ever smokers" versus "never smokers."

Levels of cigarette consumption—such as number of cigarettes smoked per day, number of days smoked per month, and amount of lifetime cigarette use—have often served as a proxy for other key tobacco control indicators, such as secondhand smoke exposure, nicotine addiction, and health risk [14]. This, however, may not necessarily be advisable practice. A review by Husten (2009) [14] concluded that consumption is a crude measure of both toxin exposure and nicotine dependence and, with respect to toxin exposure, likely inaccurate as well. Likewise, with respect to health risk, the review concluded that no level of consumption could be considered "safe," and thus used to demarcate a risk threshold. Research specific to whether 100 lifetime cigarettes is a discriminating cut-point for distinguishing ever smokers versus never smokers—and, subsequently, for defining who is, ever has been, or may become a current smoker—is limited [15] but indicates that it too may be unsuitable. In a study of craving patterns, tolerance, and subjective responses to the pharmacological effects of smoking, findings from Pomerleau et al. (2004) [16] indicated 20 cigarettes per lifetime may be a more prudent marker than 100 for such a differentiation. Others have proposed that liability for dependence and subsequent uptake of smoking may even be distinguishable after an individual's very first puff [17]. Additionally, non-daily and light daily smoking—behaviors consistent with current cigarette smoking but lifetime smoking <100 cigarettes—have been found to significantly vary across racial/ethnic subpopulations [18–24]. Findings from Trinidad et al. (2009) [24] indicated non-Hispanic black, Asian/Pacific Islander, and Hispanic/Latino smokers were more likely to be nondaily and light daily smokers compared with non-Hispanic whites, even after controlling for age, gender, and education level. This was particularly true of Hispanic/Latino smokers, who were 3.2 times more likely to be non-daily smokers and 4.6 times more likely to be daily smokers who smoke ≤5 cigarettes per day as compared with non-Hispanic white smokers. Furthermore, Hispanic/Latino non-daily smokers smoked fewer days per month and smoked fewer cigarettes per day on the days they did smoke compared with non-Hispanic whites.

Infrequent smoking and smoking trajectories among adults remain open research issues. Youth data emerging over the past decade, however, have consistently concluded the trajectory of smoking begins with the loss of autonomy that occurs during infrequent use [25–30]. Among adults who have adopted the practice of infrequent smoking, research not only suggests it can remain a stable pattern lasting long periods of time [31–33] but that it also poses substantial health risk with adverse outcomes paralleling dangers observed among daily smoking, especially for cardiovascular disease [34]. Such results have notable implications for the understanding of tobacco dependence and the development of prevention and cessation strategies, especially for racial/ethnic minorities.

While differences in current smoking estimates between NHIS and NSDUH have been previously reported [10, 12], more in-depth examination directed specifically at methodology and how differences may affect comparability with other surveys is needed [10, 35]. Therefore, the current report makes comparisons between NHIS and NSDUH prevalence estimates using, for NHIS data, the standard NHIS definition of current smoking, which includes a screener question for a level of lifetime smoking ≥100 cigarettes and, for NSDUH data, using both the standard NSDUH definition of current smoking, which does not use the screener question, and a modified definition that applies the NHIS

current smoking definition (i.e., with 100-cigarette restriction) to NSDUH data. Specifically, the following research questions are addressed: (1) how and for what subpopulations and smoking behaviors might the ≥100 lifetime cigarettes criterion affect adult prevalence estimates? and (2) what subpopulations are most likely to have smoked during the past 30 days but not meet the ≥100 lifetime cigarettes criterion? Findings are presented by sociodemographic characteristics for current smoking and for daily smoking among current smokers.

2. Materials and Methods

2.1. Surveys. We used data from the 2008 NHIS and 2008 NSDUH public data files for prevalence comparisons between surveys. Combined 2006–2008 NSDUH public data files were used to examine subpopulation characteristics of respondents who had smoked during the past 30 days but did not meet the ≥100 lifetime cigarettes criterion.

2.2. NHIS. The NHIS is a multipurpose national health survey conducted by the National Center for Health Statistics (NCHS) at the Centers for Disease Control and Prevention (CDC) and is designed to provide information about a wide range of health topics for the noninstitutionalized US household population aged 18 years and older. The survey uses multistage, cluster sampling. It is primarily administered as a direct in-person interview, with interviews that either cannot be conducted or fully completed in person administered by telephone. The percentage of completed 2008 NHIS sample adult interviews that were administered either in part or in whole by telephone was 25% (S. Jack, NCHS, personal communication, Oct. 19, 2011). Interviews are conducted by field representatives using computer-assisted personal interviewing (CAPI). The CAPI data collection method employs computer software that presents the questionnaire on a computer screen and guides the interviewer through the questionnaire, automatically routing them to appropriate questions based on answers to previous questions. Interviewers enter survey responses directly into the computer, and the CAPI program determines if the selected response is within an allowable range, checks it for consistency against other data collected during the interview, and saves the responses into a survey data file. The nationally representative survey sample and subsequent data weighting permit calculation of national estimates. In 2008, the design oversampled non-Hispanic black, Hispanic, and Asian populations to allow for more precise estimates in these groups. The 2008 household response rate was 84.9%, and the interview response rate was 74.2%, yielding an overall response rate of 62.9%. Further details about the sampling and survey methodology used in the NHIS can be found elsewhere [36].

2.3. NSDUH. The NSDUH is a national health survey sponsored by SAMHSA and is designed to provide information about the use of alcohol, tobacco, and illegal drugs in the non-institutionalized US household population aged 12 years and older [37]. The survey sample design is a stratified, multistage, area probability design. Since 1999, the survey has been administered through confidential, anonymous, face-to-face interviews in the household by trained interviewers using a combination of direct CAPI and audio computer-assisted self-interviewing (ACASI) in which the respondent reads questions on a computer screen or listens to questions through headphones and then records answers into a computer, to increase honest reporting of sensitive behaviors. The tobacco-use section was conducted via self-administered ACASI. The representative survey sample and subsequent data weighting permit calculation of national estimates. The design oversamples youth and young adults to allow for more precise estimates in these groups. There is no oversampling of racial/ethnic groups. The 2006 household response rate was 90.6%, and the interview response rate for adults ≥18 years [38] was 72.9%, yielding an adult overall response rate of 66.0%. The household, adult interview [39], and adult overall response rates were 89.5%, 72.7%, and 65.0%, respectively, for the 2007 survey and 89.0%, 73.3%, and 65.3%, respectively, for the 2008 survey. Further details about the sampling and survey methodology used in the NSDUH can be found elsewhere [37, 40, 41].

2.4. Variable Definitions. For both NHIS and NSDUH, we examined current smoking status and, among current smokers, daily smoking. For NSDUH, we also examined level of lifetime cigarette use among current smokers. Definitions for each measure follow.

2.5. Current Smoking

2.5.1. NHIS. The standard NHIS current smoking definition (hereafter simply termed the "NHIS definition") has comprised of two questions [42] since 1965 (J. Madans, NCHS, personal communication, Nov. 10, 2011), with the present wording in use since 1992 [43]. The first question, asked of all respondents, is "have you smoked at least 100 cigarettes in your entire life?" Respondents answering "yes" are classified as ever smokers, and those who answer "no" are classified as never smokers and excluded from subsequent cigarette use questions. Ever smokers are then asked a second question: "do you now smoke cigarettes every day, some days or not at all?" Respondents who answer "every day" or "some days" are classified as current smokers (Figure 1).

2.5.2. NSDUH. Our analysis used two different definitions of current smoking for NSDUH: the standard current smoking definition (NSDUH-S) established in 1993 and a modified definition (NSDUH-M) constructed to be comparable to the NHIS definition. The NSDUH-S current smoking definition uses two questions to measure smoking prevalence [44]. The first, asked of all respondents, is "have you ever smoked part or all of a cigarette?" Respondents answering "yes" are classified as ever smokers, and those who answer "no" are classified as never smokers. Ever smokers are then asked a second question: "during the past 30 days, have you smoked part or all of a cigarette?" Respondents who answer "yes" are classified as current smokers (Figure 2).

While NSDUH also contains the question "have you smoked at least 100 cigarettes in your entire life?" identical to

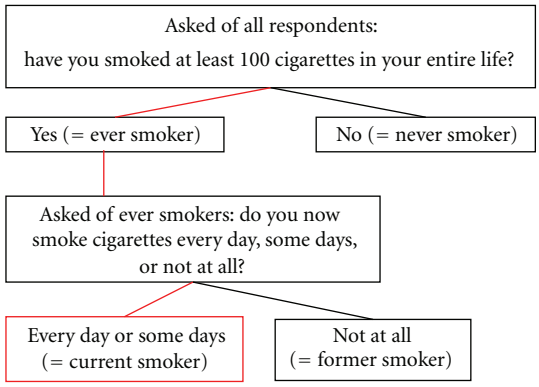

Figure 1: Standard NHIS current cigarette smoking variable definition.

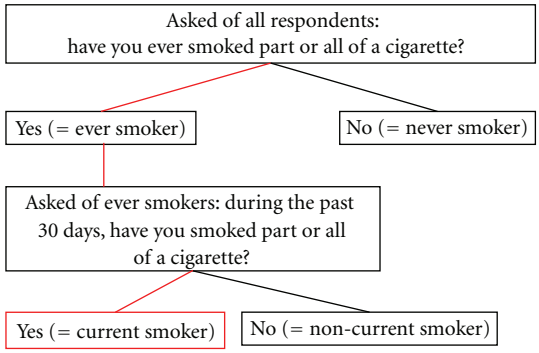

Figure 2: Standard NSDUH current cigarette smoking variable definition (NSDUH-S).

the NHIS and is asked of NSDUH ever smokers, it is not used to define current smoking. We constructed the second, modified NSDUH-M current smoking definition that includes the 100-cigarette lifetime use question, with NSDUH-M current smokers defined as NSDUH ever smokers who both reported smoking part or all of a cigarette during the 30 days preceding the survey and reported lifetime cigarette use ≥100 cigarettes (Figure 3).

2.6. Daily Smoking. For NHIS, daily smoking among current smokers was defined primarily using the question "do you now smoke cigarettes every day, some days, or not at all?", and secondarily using the question "on how many of the past 30 days did you smoke a cigarette?" which is asked of "some day" smokers only. Respondents who answered "every day" to the first question were classified as daily smokers, as were respondents who answered "some days" to the first question but for the second reported smoking a cigarette on all of the preceding 30 days. For NSDUH-S and NSDUH-M, this variable was defined using the question "during the past 30 days, that is, since [DATE], on how many days did you smoke part or all of a cigarette?" Respondents who answered that they smoked on all of the preceding 30 days were classified as daily smokers.

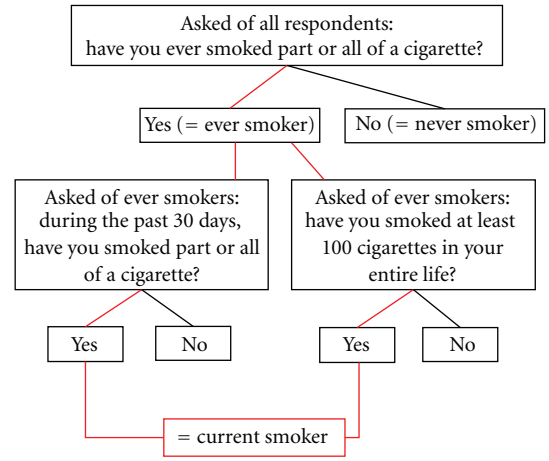

Figure 3: Modified NSDUH current cigarette smoking variable definition (NSDUH-M).

2.7. Lifetime Cigarette Use. For NSDUH-S, level of lifetime cigarette use among current smokers was defined using the question "have you smoked at least 100 cigarettes in your entire life?", with dichotomized "yes/no" response options differentiating those who have smoked ≥100 cigarettes in their lifetime versus those who have smoked <100.

2.8. Demographic Information. For both surveys, smoking status was examined by age group (18–25, 26–34, 35–49, 50–64, ≥65), gender (male, female), race/ethnicity (non-Hispanic white, Non-Hispanic black, Hispanic or Latino, Asian, American Indian/Alaska Native), and education among persons aged ≥26 years (< high school, high school graduate, some college, college graduate).

2.9. Statistical Analyses. For all analyses, respective sample weights were applied to the data to adjust for nonresponse and the varying probabilities of selection, including those resulting from oversampling, yielding nationally representative findings. SUDAAN 10.0 [45], which accounts for the complex survey sample design, was used to generate prevalence estimates and 95% confidence intervals.

For NHIS and NSDUH, 2008 prevalence estimates were calculated, overall and by demographic subgroup, for current smoking and daily smoking among current smokers, and two sets of between-survey comparisons then made. The first comparison was made using the NHIS current smoking definition versus the NSDUH-S definition, and the second using the NHIS current smoking definition versus the NSDUH-M definition. To explore lifetime smoking of <100 cigarettes among current smokers, 2006–2008 NSDUH-S combined prevalence estimates were calculated, overall and by demographic subgroup. Two-sided t-tests were performed for both 2008 NHIS versus 2008 NSDUH comparisons to identify statistically significant differences at an alpha level of 0.05. Adjusted odds ratios with 95% confidence intervals were calculated for the 2006–2008 NSDUH-S combined analysis, controlling for age, gender, race/ethnicity, and education.

3. Results

3.1. Current Cigarette Smoking among Adults. Assessment of the NSDUH-S current smoking definition indicated that the overall prevalence (25.5%, 95%CI 24.7–26.2) was significantly higher than the NHIS overall prevalence (20.6%, 95%CI 19.9–21.4) (Table 1). This same pattern was observed for all subpopulations analyzed except the 50–64- and ≥65-year old age groups, Asians, and American Indians/Alaska Natives. Using the NSDUH-M current smoking definition, overall prevalence remained significantly higher (23.6%, 95%CI 22.8–24.3) than the NHIS overall prevalence. This same pattern was observed for the 18–25 and 26–34 years age groups, males, non-Hispanic whites, and college graduates.

3.2. Daily Cigarette Smoking among Current Smokers. Assessment of smoking frequency using the NSDUH-S current smoking definition indicated that the overall prevalence of daily smoking (63.3%, 95%CI 61.8–64.8) was significantly lower than the NHIS prevalence (79.7%, 95%CI 78.3–81.2) (Table 1). This same pattern was observed for all subpopulations analyzed except the ≥65 year old age group and American Indians/Alaska Natives. Using the NSDUH-M current smoking definition, the prevalence of daily cigarette smoking during the past 30 days remained significantly lower (68.2%, 95%CI 66.8–69.6) than the NHIS prevalence. This same pattern was observed for all subpopulations analyzed except the 26–34- and ≥65-year-old age groups, Hispanics or Latinos, Asians, and American Indians/Alaska Natives.

3.3. <100 Lifetime Cigarettes among Current Smokers. Among NSDUH-S current smokers, younger respondents had significantly greater odds of smoking fewer than 100 cigarettes during their lifetime (Table 2). Using persons aged ≥65 years as the referent, 18–24-year olds had 11.2 times greater odds (aOR, 95%CI: 4.8–26.1) and 25–34-year olds had 3.5 times greater odds (aOR, 95%CI: 1.5–8.7), of having a lifetime smoking level of <100 cigarettes. By gender, females had 1.2 times greater odds (aOR, 95%CI: 1.1–1.4) than males of having a lifetime smoking level <100 cigarettes. As compared to non-Hispanic whites, Hispanic or Latino smokers had 4.8 times greater odds (aOR, 95%CI: 4.2–5.5) of having a lifetime smoking level of <100 cigarettes, followed by American Indians/Alaska Natives (aOR, 95%CI: 3.6, 1.8–7.3), non-Hispanic blacks (aOR, 95%CI: 2.4, 2.0–2.8), and Asians (aOR, 95%CI: 2.2, 1.5–3.3). By education, smokers who graduated from college had 2.5 times greater odds (aOR, 95%CI: 1.9–3.2), and those with some college education had 1.7 times greater odds (aOR, 95%CI: 1.3–2.1), of having a lifetime smoking level of <100 cigarettes than those with less than a high school education.

4. Discussion

In comparisons between NHIS and NSDUH, NSDUH consistently yielded higher national overall and subpopulation estimates of current cigarette smoking among adults than NHIS and, among current smokers, lower estimates of daily smoking. However, with the use of the modified NSDUH-M current smoking variable definition that, like the NHIS definition, is restricted to respondents with lifetime cigarette use ≥100 cigarettes, estimates generally shifted closer to NHIS estimates, and several subgroups differences that were statistically significant for NHIS versus NSDUH-S became comparable for NHIS versus NSDUH-M. Specifically, estimate comparability occurred for the current smoking variable among 35–49-year olds, females, non-Hispanic black respondents, and those with <high school, high school graduate, or some college educational level, and, for the daily smoking variable, among 26–34 year olds and Asian respondents. Among Hispanic respondents, comparability occurred for both the current smoking variable and the daily smoking variable. In these instances, enough NSDUH respondents who reported smoking during the past 30 days had smoked *fewer than* 100 lifetime cigarettes (i.e., NSDUH-M) to negate the significant differences originally observed when level of lifetime cigarette use was not taken into account (i.e., NSDUH-S). The 100 cigarette prerequisite appeared to impact current smoking estimates much more extensively than it did smoking frequency estimates; that is, inclusion of the prerequisite produced comparability in estimates extensively across all four demographic categories for current smoking, whereas comparability occurred only minimally for daily smoking.

Subpopulations most impacted by the restriction of the current smoker variable definition to respondents with lifetime cigarette use ≥100 cigarettes appear to be younger adults and racial/ethnic minorities. The current smoking estimate comparability that occurred with use of the NSDUH-M current smoking definition represents a loss of significant differences originally observed between NHIS and NSDUH-S for the 35–49-years age group, females, non-Hispanic blacks, Hispanics, and the <high school, high school graduate, and some college educational levels. The daily smoking estimate comparability that occurred represents a loss of significant differences originally observed between NHIS and NSDUH-S for the 26–34-years age group, Asians, and Hispanics. Within this, Hispanic smoking prevalence appeared to be the most sensitive to differences in smoking variable definitions as this was the only group for which estimate comparability occurred across both current smoking and daily smoking.

These findings are consistent with other studies showing restriction of the adult current smoking definition to respondents with lifetime cigarette use ≥100 cigarettes leads to lower prevalence estimates [10, 12, 13], especially among minorities [46]. They are also consistent with previous studies that specifically found Hispanic smokers were most likely to be nondaily smokers and to smoke fewer days per month than non-Hispanic respondents [18, 19, 21–24, 31, 47]. It was the tobacco industry itself, however, that showed foresight into the relevance of such nuances and the subsequent opportunities afforded by what it termed "occasional smokers," and during the 1990s took an interest in this group. Indeed, tobacco industry workshop materials from 1996 explained that occasional smokers may or may not self-identify as a smoker [47]. Data collection efforts by Philip

Table 1: Current cigarette smoking among adults[‡§¶] and daily cigarette smoking among adults who currently smoke[**††] by demographic and current smoking variable definition—NHIS and NSDUH, 2008.

	Current cigarette smoking[‡§¶]									Daily cigarette smoking among current smokers[**††]								
	NSDUH-S[‡]			NHIS[§]			NSDUH-M[¶]			NSDUH-S[‡]			NHIS[§]			NSDUH-M[¶]		
	%	LL	UL	%	LL	UL	%	LL	UL	%	LL	UL	%	LL	UL	%	LL	UL
Total	25.5*	24.7	26.2	20.6	19.9	21.4	23.6†	22.8	24.3	63.3*	61.8	64.8	79.7	78.3	81.2	68.2†	66.8	69.6
Demographic																		
Age																		
18–25 years	35.5*	34.6	36.5	21.4	19.4	23.5	28.2†	27.3	29.1	48.1*	46.4	49.8	74.3	70.0	78.7	59.9†	58.1	61.6
26–34 years	33.8*	32.1	35.5	25.2	23.4	27.1	31.5†	29.8	33.1	59.9*	56.7	63.2	72.6	69.2	76.1	64.3	61.2	67.4
35–49 years	27.6*	26.3	28.9	23.4	22.1	24.8	26.4	25.2	27.7	66.9*	64.4	69.4	83.1	80.9	85.4	69.7†	67.2	72.1
50–64 years	22.1	20.2	23.9	21.5	20.2	22.9	21.7	19.8	23.5	72.1*	68.4	75.7	83.6	81.2	86.1	73.3†	69.6	77.0
≥65 years	9.9	8.2	11.7	9.3	8.2	10.4	9.7	7.9	11.4	76.3	68.7	84.0	81.6	77.3	85.9	78.2	71.2	85.3
Gender																		
Male	28.5*	27.4	29.6	23.1	22.0	24.2	26.4†	25.3	27.5	62.2*	60.1	64.2	77.4	75.2	79.6	66.9†	65.0	68.9
Female	22.7*	21.7	23.6	18.3	17.3	19.3	20.9	20.0	21.8	64.7*	62.4	66.9	82.5	80.7	84.3	69.7†	67.4	72.1
Race/ethnicity																		
White non-Hispanic	26.5*	25.6	27.4	22.0	21.1	23.0	25.1†	24.2	25.9	69.0*	67.2	70.8	83.4	81.8	85.0	72.8†	71.1	74.5
Black non-Hispanic	27.2*	25.0	29.4	21.2	19.4	23.1	25.0	22.9	27.2	54.7*	49.6	59.7	76.2	72.4	80.0	58.6†	53.3	63.9
Hispanic or Latino	21.4*	19.6	23.3	15.8	14.2	17.4	17.3	15.6	19.0	39.0*	34.8	43.1	59.2	53.6	64.8	47.7	42.8	52.6
Asian[‡‡]	12.5	9.5	15.6	9.8	7.5	12.1	10.6	7.7	13.5	51.5*	40.3	62.8	79.0	71.6	86.3	60.8	49.2	72.4
American Indian/Alaska Native[§§]	47.2	35.5	58.9	32.4	23.8	41.1	42.7	30.5	54.8	59.2	39.5	78.9	69.2	49.8	88.6	65.1	45.8	84.3
Education[¶¶]																		
<High school	35.0*	32.8	37.1	27.6	25.6	29.5	32.6	30.5	34.8	68.3*	64.5	72.1	83.8	80.9	86.8	72.8†	69.3	76.3
High school graduate	29.7*	28.3	31.1	25.3	23.8	26.8	28.2	26.9	29.6	71.0*	68.6	73.4	83.6	80.8	86.3	74.4†	72.1	76.8
Some college	27.1*	25.6	28.5	22.7	21.3	24.1	24.8	23.4	26.2	61.2*	58.0	64.3	79.9	77.2	82.6	66.6†	63.6	69.5
College graduate	14.0*	12.9	15.2	8.9	8.0	9.8	12.9†	11.7	14.0	47.4*	43.0	51.8	67.1	61.9	72.3	51.8†	47.1	56.4

*Significant difference between NHIS and NSDUH-S, $P < .05$.

†Significant difference between NHIS and NSDUH-M, $P < .05$.

‡NSDUH respondents ≥18 years of age who reported smoking part or all of a cigarette during the preceding 30 days.

§NHIS respondents ≥18 years of age who have smoked ≥100 cigarettes in their lifetime and reported they now smoke cigarettes either every day or some days.

¶NSDUH respondents ≥18 years of age who have smoked ≥100 cigarettes in their lifetime and reported smoking part or all of a cigarette during the preceding 30 days.

**NSDUH current cigarette smokers ≥18 years of age who reported smoking on all of the preceding 30 days.

††NHIS current cigarette smokers ≥18 years of age who reported they now smoke cigarettes every day.

‡‡Non-Hispanic, and does not include Native Hawaiian and Other Pacific Islander.

§§Non-Hispanic. Wide variances in estimates reflect small sample sizes.

¶¶Among respondents ≥26 years of age.

Table 2: Level of lifetime cigarette use* <100 cigarettes among adults who currently smoke cigarettes†, by demographic—NSDUH 2006–2008.

	Level of lifetime smoking <100 cigarettes among current smokers					
	Prevalence estimates			Adjusted odds ratios‡		
	%	LL	UL	aOR	LL	UL
Total	7.1	6.7	7.4			
Demographic						
Age						
18–25 years	19.1	18.3	19.8	11.2	4.8	26.1
26–34 years	6.9	6.1	7.8	3.5	1.5	8.7
35–49 years	3.8	3.1	4.4	2.0	0.9	4.8
50–64 years	1.8	1.2	2.5	1.1	0.4	2.7
≥65 years	1.6	0.3	2.9	1.0	1.0	1.0
Gender						
Male	6.9	6.4	7.4	1.0	1.0	1.0
Female	7.3	6.8	7.8	1.2	1.1	1.4
Race/Ethnicity						
White non-Hispanic	5.0	4.6	5.3	1.0	1.0	1.0
Black non-Hispanic	8.6	7.5	9.7	2.4	2.0	2.8
Hispanic or Latino	17.1	15.3	18.9	4.8	4.2	5.5
Asian§	12.5	8.8	16.2	2.2	1.5	3.3
American Indian/Alaska Native¶	11.8	6.8	16.9	3.6	1.8	7.3
Education**						
<High school	5.5	4.6	6.4	1.0	1.0	1.0
High school graduate	5.0	4.5	5.5	1.1	0.8	1.4
Some college	7.8	7.2	8.5	1.7	1.3	2.1
College graduate	8.3	7.2	9.4	2.5	1.9	3.2

*Among NSDUH respondents ≥18 years of age who reported ever smoking part or all of a cigarette, those who have smoked ≥100 cigarettes in their lifetime versus those who have smoked <100.
†NSDUH respondents ≥18 years of age who reported smoking part or all of a cigarette during the preceding 30 days.
‡Adjusted for age, gender, race/ethnicity, and education.
§Non-Hispanic, and does not include Native Hawaiian and Other Pacific Islander.
¶Non-Hispanic. Wide variances in estimates reflect small sample sizes.
**Among respondents ≥26 years of age.

Morris that took place in the late 1990s specifically focused on those who did *not* identify as a smoker and defined occasional smokers simply to be people who referred to themselves as nonsmokers, responded "yes" when asked if they smoked one or more cigarettes in the past year, and responded "no" when asked if they presently smoke at least a pack a week [48]. Internal communications summarizing the resulting data noted that "Hispanics represent substantially more than their fair share of occasional smokers" [49].

Husten (2009) [14] states that the stability of the behavior within any definitional category or categories of occasional use is an important consideration in determining a definition of the term. We take this line of thought a step further by applying stability criteria *within* a particular variable definition and *across* multiple subpopulations. The current analysis indicates that WHO's call for the provision of overall as well as demographic subpopulation data [6] may not be accurately met if a single current smoking definition is utilized for all subgroups when those same groups are known to differ on a key component of the variable's definition (i.e., occasional use). Like Husten, we reason that levels of consumption may be best left as continuous variables rather than presumptive cut-points, as there do not seem to be clear consumption levels that correlate with the onset of dependence or health risk. As noted, data that definitionally include rather than exclude lower consumption patterns have significant implications for the understanding of tobacco use and addiction and the development of prevention and cessation strategies—such as the extent to which intervention messages do versus do not address non-daily smoking [20], health risks of any smoking [31], motivations other than health effects [20], beliefs about ability to quit [23], situational triggers [31], social and cultural forces [23], and attitude changes [50]—especially for racial/ethnic minorities.

Measures relevant to occasional smokers are needed to be able to adequately monitor and describe their cigarette use, motivations, nicotine dependence, and cessation behaviors [50], underscoring the importance for national surveillance systems to use multiple comparable prevalence measures to capture diverse smoking behaviors, especially among subgroups. Consideration must be taken with regards, but not limited to, any screener questions, skip patterns, or closed data edits that result in a complete drop of certain respondents such that they are unable to be added back in when calculating prevalence estimates. An assumption of dropping respondents from certain questions is that the answers to these questions, had they been asked, would in most cases have been "no" or "not applicable" [15]. Much could thus be gained by maintaining one or two key smoking behavior questions across surveys, allowing researchers to retain rather than relinquish the ability to test this assumption [15] and subsequently capture, assess, and use these data to their fullest capacity. Further investigation of associations between the knowledge, attitudes, and behaviors of true never smokers (i.e., lifetime smoking level = 0) and graded levels of lifetime cigarette use >0 may provide additional help in determining whether a judicious cut-point exists for categorizing a respondent as an ever smoker versus a never smoker and, subsequently, in defining current smokers. In the meantime, investigators should use data most appropriate for addressing their specific research questions and subgroups of interest (e.g., relevant consumption levels, age group, racial/ethnic minority status, etc.).

4.1. Limitations. This paper has described how the use of a modified NSDUH current smoking variable definition that, like the NHIS definition, is restricted to respondents with lifetime cigarette use ≥100 cigarettes negates a notable number of significant differences among subpopulation otherwise observed between the two surveys. However, there are other central methodological differences in addition to question wording that were not assessed in the current analysis—such as survey mode, setting, context, and incentives—that may also contribute to discrepancies in current smoking estimates. In 1994, NSDUH changed from an interviewer administered survey mode for the tobacco questions to a self-administered survey mode for these questions. Findings from a random split sample conducted to measure the impact suggest that the self-administered mode may have resulted in higher reporting of current smoking behavior [51, 52]. NHIS tobacco questions, on the other hand, remain interviewer-administered. Further, NHIS interviews that either cannot be conducted or fully completed in person are administered by telephone, whereas NSDUH interview mode is strictly in person. In a study comparing telephone versus face-to-face interviewing of national probability samples, findings suggest telephone respondents to be more likely to present themselves in socially desirable ways than were face-to-face respondents [53]. More changes in the NSDUH mode of administration took place in 1999 when it shifted from paper and pencil interviews to ACASI. ACASI is thought to provide respondents with an enhanced sense of privacy, thus increasing their willingness to truthfully report their health behaviors. Indeed, a 2004 study comparing the 1999 and 2001 NSDUH and BRFSS prevalence estimates of adult binge drinking reported that—having ruled out other explanations such as differences in survey design, sampling, response rates and question wording—ACASI may have been responsible for the NSDUH estimates that were 2.4 to 9.2 percentage points higher than BRFSS estimates [54].

NHIS and NSDUH also differ in terms of overall survey context and question placement, which may influence respondents' perceptions of smoking itself [10]. NHIS primarily focuses on participants' health status with limited attention given to related licit substance use (cigarette and alcohol use), whereas NSDUH focuses almost entirely on substance-use behaviors, covering both licit and illicit substances, including marijuana, cocaine, crack, hallucinogens, inhalants, and nonmedical use of prescription drugs. In the NHIS context where cigarette use is one of the most serious health behaviors one can report respondents may perceive smoking to be one of the more undesirable behaviors they are being asked about, which may lead to underreporting [35, 55]. Conversely, in the NSDUH context respondents may perceive smoking to comparatively be one of the more socially acceptable behaviors they are being asked about and thus may be more comfortable acknowledging that they smoke [10].

In 2002, the NSDUH began paying respondents a $30 incentive upon completion of the survey, whereas the NHIS remains uncompensated. Although the results of a 2001 experiment indicated that the incentive would have no appreciable impact on prevalence estimates [56], "reality dictated otherwise" according to a SAMHSA report [57]. SAMHSA reports presenting NSDUH's summary of findings in 2001 and 2002 revealed increased prevalence estimates across the majority of substances queried in the survey [57], including cigarettes, alcohol, any illicit drug use, marijuana, and cocaine [58].

Lastly, in addition to survey mode, setting, context, and incentives, there are other factors that may affect prevalence estimates that also fell outside the scope of the current study, such as construct validity and differences in target populations, sampling methods, adjustments for nonresponse, and weighting. While all of the preceding may help explain observed differences in smoking prevalence estimates, more research in these areas is needed [10, 35].

5. Conclusions

Our study provides further information on how different smoking definitions between two national surveys may impact the overall and subpopulation prevalence estimates observed for some smoking behaviors. Our findings can be used to further inform tobacco control research and surveillance with regards to measurement of adult smoking behavior, including current use and frequency of use. Moreover, these findings may also inform how and why estimates differ by demographic subpopulation. Evidence-based, statewide tobacco control programs that are comprehensive, sustained, and accountable have been shown to reduce smoking rates, tobacco-related deaths, and diseases caused by smoking, with

tobacco use monitoring critical to ensuring that program-related effects can be clearly measured [7]. Further research on methodological issues related to differing smoking prevalence estimates across tobacco control monitoring systems is needed, in particular to enhance the capacity of tobacco control surveillance to evaluate progress and further tobacco control efforts. Better understanding of why estimates may vary across data systems and among specific subpopulations, coupled with continued surveillance efforts, permits more accurate assessment of adult smoking prevalence and tobacco use behaviors.

Conflict of Interests

The findings and conclusions in this paper are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the Substance Abuse and Mental Health Services Administration.

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Research Article

The 2009 US Federal Cigarette Tax Increase and Quitline Utilization in 16 States

Terry Bush,[1] Susan Zbikowski,[1] Lisa Mahoney,[1] Mona Deprey,[1] Paul D. Mowery,[2] and Brooke Magnusson[1]

[1] *Alere Wellbeing (Formerly Free & Clear, Inc.), 999 Third Avenue Suite 2100, Seattle, WA 98104-1139, USA*
[2] *Biostatistics, Inc., 228 E Wesley Road Ne, Atlanta, GA 30305-3710, USA*

Correspondence should be addressed to Terry Bush, terry.bush@alere.com

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Background. On April 1, 2009, the federal cigarette excise tax increased from 39 cents to $1.01 per pack. *Methods.* This study describes call volumes to 16 state quitlines, characteristics of callers and cessation outcomes before and after the tax. *Results*. Calls to the quitlines increased by 23.5% in 2009 and more whites, smokers ≥ 25 years of age, smokers of shorter duration, those with less education, and those who live with smokers called after (versus before) the tax. Quit rates at 7 months did not differ before versus after tax. *Conclusions*. Descriptive analyses revealed that the federal excise tax on cigarettes was associated with increased calls to quitlines but multivariate analyses revealed no difference in quit rates. However, more callers at the same quit rate indicates an increase in total number of successful quitters. If revenue obtained from increased taxation on cigarettes is put into cessation treatment, then it is likely future excise taxes would have an even greater effect.

1. Introduction

On February 4, 2009, a 62-cent increase in the federal cigarette tax was enacted, along with increases in other tobacco taxes, to fund expansion of the State Children's Health Insurance Program (SCHIP) [1]. The federal cigarette tax increased to $1.01 per pack on April 1, 2009. Increasing the price of tobacco through excise taxes is an effective way to encourage quit attempts and thus to decrease the prevalence of smoking [2, 3]. It is estimated that a 10% increase in cigarette prices leads to a 4% decrease in cigarette consumption in high-income countries and about 8% in low-to-middle income countries [2, 4]. A 70% increase in current tobacco prices could prevent 25% of all smoking-related deaths globally [4] and higher taxes have a greater impact on the young and low income smokers by deterring smoking initiation and encouraging smokers to quit [2]. Telephone quitlines are an effective population-based form of smoking cessation treatment and their utilization has been shown to be responsive to tobacco control policies [5–9]. Therefore, the study aims were to (1) describe call volumes to 16 state quitlines before and after the tax increase; (2) examine the characteristics of tobacco users who enrolled with quitlines before and after the tax increase and (3) examine the outcomes (quit rates) of tobacco users who enrolled with state quitlines before and after the tax increase. Analyses were conducted to determine whether implementation of the federal tax on April 1, 2009 coincided with (1) increased calls to state quitlines; (2) increased calls from people with low education levels; (3) increased quit rates (the higher cigarette prices may motivate those attempting to quit to remain quit). It was expected that the increase in calls may begin prior to April 1, 2009 and as early as February 2009 as people become aware of the passage of the federal tax increase and in response to preemptive cigarette price increases instituted by the tobacco industry in December 2008 and March 2009 [10, 11].

2. Methods

Two different data sources were used: one is based on administrative data collected from all callers and the other is a seven-month follow-up interview with a random sample of quitline participants. Administrative data comes from

the Free & Clear database for state tobacco quitlines that tracks call volumes, completed counseling calls and caller characteristics obtained during registration with the quitline. This data comes from 16 of the 17 state quitlines operated by Free & Clear, Inc., at the time of this study. The one state that was not included in the analysis had incomplete data for the time period before the tax increase. Participating states include Alaska, Connecticut, Georgia, Hawaii, Indiana, Maine, Maryland, Missouri, North Carolina, Oklahoma, Oregon, South Carolina, Utah, Virginia, Washington and Wisconsin, whose smokers represented 24% of smokers in the United States in 2009 [12]. Data from the seven-month followup comes from four state quitlines and is based on random samples of quitline participants in each state timed to occur seven months from enrollment with the quitline. All 16 states agreed to participate in this study and to contribute their data to the pooled dataset. The 16 state quitlines represent different geographic regions and states with varying state laws (e.g., tobacco control programs with varying resources and programmatic activities). As well, they have a variety of cessation services such as offering free nicotine replacement therapy (NRT) through their quitline during the study period. Since states regularly change their services, we chose to portray a snapshot of offerings during the study period (Table 1). All quitlines provided mailed support materials (Quit Guides), a single reactive (inbound) counseling call to all tobacco users, and three or four additional outbound calls to select groups (e.g., those ready to quit within 30-days). Some state quitlines refer insured tobacco users to cessation benefits offered through their health plan or employer. All but four states offered at least some free NRT (patch or gum) depending on the state-approved eligibility criteria (e.g., insurance status). All of the participating states used the same data collection methods and a common questionnaire [13] to collect demographic and tobacco use data at intake and follow-up thus enhancing data comparability across state quitlines and across study years.

3. Measures

3.1. Total Calls to State Quitlines. Analyses examined both pooled monthly call volume (total calls to quitlines) and pooled daily call volume. State-level data was not examined as this was a descriptive study to assess whether a volume change would be observed in aggregate data from callers to the quitline in 16 states. However, in statistical models of outcomes, "state" was included as a fixed effect to account for unmeasured variability within and between states. Monthly data was examined from December 2008 through August 2009 and from a similar time period the year before for comparison (December 2007 through August 2008) in order to show call volume prior to the tax increase (December 2008, January 2009, February 2009, March 2009), during the months that the tobacco industry increased prices in anticipation of the tax increase (December 2008 through March 2009), during the month the tax increase was passed (February 2009), and after the tax increase took effect (April 2009, May 2009 anticipated to have heavy call volumes). Daily call volume was then examined directly before and after the April 1, 2009 tax increase to determine when the calls began to increase in anticipation of the tax increase and how soon the calls returned to previous levels. The time period selected for this analysis was March-April 2009 (March-April 2008 was also examined for comparative purposes).

3.2. Caller Characteristics. A comprehensive set of variables collected when a person enrolls with a state quitline was used to describe caller characteristics. Variables included participant demographics (age, gender, race/ethnicity, insurance status, educational level), current tobacco use (tobacco type, amount used), duration of smoking, time to first cigarette upon waking, living or working with smokers, and how they heard about the quitline. Chronic disease status was assessed by asking: "have you been diagnosed with any of the following conditions; asthma, chronic obstructive pulmonary disease or emphysema, coronary artery disease or heart disease or diabetes?" Responses were captured with a "yes" or "no" to each chronic disease.

3.3. Seven-Month Quit Rates. Data from the seven-month followup survey was obtained for persons who enrolled from March 2009–May 2009 (and for comparison March 2008–May 2008). This time period was selected for comparisons of demographics and quit rates because this was the period in which the impact of the tax would most likely be observed. The four states with available data (i.e., some did not conduct the seven-month survey during these time periods and others used another organization to conduct the seven-month survey and their data was unavailable) used similar survey sampling protocols and similar questionnaires. Information collected at the seven-month follow-up included use of medications since enrolling with the quitline and current smoking status. Successful cessation was defined as seven-day and 30-day abstinence by asking participants: "when was the last time you smoked a cigarette, even a puff?" Our questionnaire included the standard battery of questions used in the Minimum Data Set (MDS) instrument recommended by the North American Quitline Consortium (NAQC) [13]. The seven-month response rate was 39.3%.

4. Analyses

Data across all states was pooled and presented in aggregate form in graphs and tables. First, the total number of monthly calls to the 16 quitlines was collected and presented in a figure as well as the number of tobacco users who received one or more counseling calls from December 2007 through August 2008 and December 2008 through August 2009. Rao-Scott Chi-square and t-test statistics were used to compare characteristics of callers during the time of the 2009 tax increase and for the same months in the prior year and included state as a fixed variable to account for the variability in services provided across quitlines. A P value of 0.01 was used as a cut-off value for the hypotheses tests because of the large sample size. For the four states with data from the seven-month follow-up, multivariate logistic regression analyses were used

Table 1: Benefits and services offered by the 16 state quitlines participating in the study before and after the federal excise tax increase.[1,2]

State quitline	Mailed materials		1 single, reactive		Single call + 3 additional calls[3]		Single call + 4 additional calls[3]		Free NRT (2 weeks)[3]		Free NRT (4 weeks)[3]		Free NRT (8 weeks)[3]		Free NRT (12 weeks)[3]	
	before	after	before	after	before	after	before	after	before	after	before	after	before	after	before	after
State 1	Y	Y	Y	Y	—	—	Y	Y	Y	—	—	—	—	Y	—	—
State 2	Y	Y	Y	Y	—	—	Y	Y	—	—	—	—	Y	—	—	—
State 3	Y	Y	Y	Y	—	—	Y	Y	—	—	—	—	Y oth	—	—	—
State 4	Y	Y	Y	Y	Y	Y	—	—	Y	—	—	—	—	—	—	—
State 5	Y	Y	Y	Y	Y	Y	—	—	Y	Y	—	—	—	—	—	—
State 6[4]	Y	Y	Y	Y	Y	Y	—	—	—	—	—	—	—	—	—	—
State 7	Y	Y	Y	Y	Y	Y	—	—	—	—	—	—	Y	—	Y	Y
State 8	Y	Y	Y	Y	Y	Y	—	—	—	—	—	Y oth	—	—	—	—
State 9[4]	Y	Y	Y	Y	Y	Y	—	—	—	—	—	—	—	—	—	—
State 10	Y	Y	Y	Y	—	—	Y	Y	Y ins	Y med	—	—	Y unins	Y unins	—	—
State 11	Y	Y	Y	Y	Y	Y	—	—	Y ins	—	—	—	Y unins	—	—	—
State 12[4]	Y	Y	Y	Y	—	—	Y	Y	—	—	—	—	—	—	—	—
State 13	Y	Y	Y	Y	—	—	Y	Y	—	—	Y ins	Y ins	Y unins	Y unins	—	—
State 14[4]	Y	Y	Y	Y	Y	Y	—	—	—	—	—	—	—	—	—	—
State 15	Y	Y	Y	Y	—	—	Y	—	Y ins	—	—	—	Y unins	—	—	—
State 16	Y	Y	Y	Y	—	—	Y	Y	—	—	—	Y oth	—	—	—	—

[1] Restrictions apply: Y ins = NRT provided to insured callers only; Y unins = NRT provided to uninsured callers only; Y med = NRT provided to Medicaid callers only; oth = other restrictions apply; Y = no restrictions. [2] Before: March 1, 2008 through May 31, 2008; After: March 1, 2009 through May 31, 2009. The dash "—" indicates that the information is contained in another mutually exclusive column (e.g., 2 weeks but not 8 weeks of NRT).

[3] Offered only to those ready to quit within 30 days.

[4] States who contributed seven-month follow-up data.

to examine tobacco abstinence outcomes (7-day point prevalence and 30-day point prevalence) comparing callers during the time of the 2009 tax increase to callers during the same time period in the prior year. Again, "state" was included as a fixed variable, as well as case-mix covariates that differed before versus after the tax increase (age, race, education, chronic conditions, how they heard about the quitline, and amount smoked at intake), and gender because it is associated with cessation outcomes [14, 15]. For those who enrolled with the multicall program, utilization of services (number of counseling calls completed) and quit outcomes was also assessed in multivariate and logistic regression analyses. Outcomes were reported in two ways: first among those who completed the survey (respondent analysis) and second using the "intent-to-treat" (ITT) analysis whereby persons with missing outcomes data are assumed to be smoking.

The logistic model was

Logit(probability of abstinence (yes/no)) = overall mean + time indicator variable + individual covariates + state + callprogram + howheard, where time indicator variable = before or after (0 or 1), callprogram = one versus multicall program and howheard = how participant heard about the Quitline.

5. Results

Figure 1 presents the number of calls to the 16 quitlines over time and shows the spike in calls during March-April 2009. Overall, there was a 23.5% increase in total call volume when comparing December 2007–May 2008 (84,541 calls) to December 2008–May 2009 (104,452 calls). In 2009, calls increased beginning in March and began to taper off in May (a 59.1% increase in call volumes comparing March 2008–May 2008 (38,919 calls) to March 2009–May 2009 (61,935 calls)). Comparing each month in 2008-2009 with the corresponding month from the prior year, increases in call volume were observed in December 2008 and February through May 2009, with the largest percent increase (94.1%) occurring in March 2009. Increases during March and April 2009 occurred both in total call volume (calls from tobacco users, friends, family, health care professionals, and the general public seeking information), as well as in the number of tobacco users per month who received at least one counseling call. Data for June, July, and August are not shown in Figure 1 since the tax effect on call volumes had returned to the before tax levels in May. Note that the observed increase in quitline calls (and enrollments) around January 1 for both time periods was expected and is often attributed to New Years' resolutions. Some states also plan promotional events to coincide with this seasonal effect. This was the case in January 2008 whereby the spike in calls corresponds to promotional activities of one large state quitline [16]. In post hoc analyses, omitting this state from the sample resulted in a similar pattern (although a lower number of calls) as that shown in Figure 1. Figure 2 shows a more detailed analysis of call volumes around the April 2009 tax increase; the daily call volumes from March through April 2009 compared to daily call volumes from March through April 2008. Daily call volume was higher in 2009 than 2008, particularly from

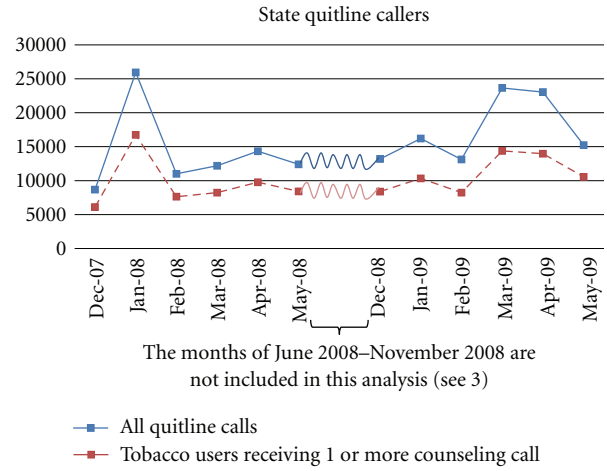

Figure 1: **Monthly number of calls and number who received counseling from 16 state quitlines, December 2007 through May 2009** ((1) See Table 1 for a description of services within the participating states. (2) All quitline calls (top line) include proxy callers, providers, general public, "hang ups," tobacco users wanting materials only, seeking treatment, or those enrolled who call back to speak with coach. Tobacco users (bottom line) represent those enrolled in the quitline who completed at least one counseling call. (3) The spike in January 2008 is primarily due to a cigarette tax increase in one large state and associated promotional activities. Call volumes tapered after May 2008 and May 2009, thus data from May 2008–November 2008 and after May 2009 are not included in the graph).

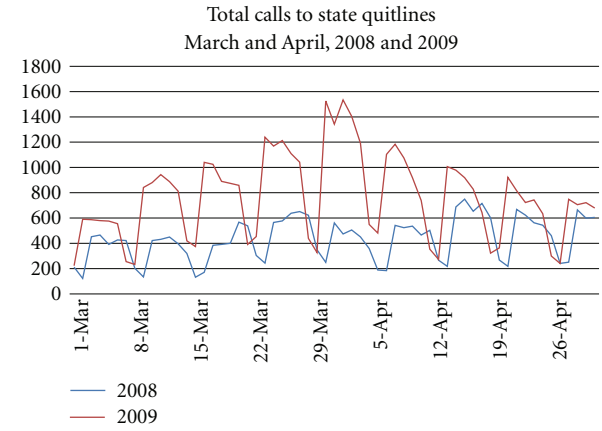

Figure 2: Daily number of calls to 16 state quitlines. All listed dates are Mondays.

March 8 through April 26. The dips in the figure represent weekends when call volumes are traditionally low.

Table 2 shows results of the comparisons of demographic and other characteristics between tobacco users who enrolled with the quitline before and after the announcement and implementation of the April 2009 federal tax increase. The time periods for this analysis were March 1, 2008 through May 31, 2008 versus March 1, 2009 through May 31, 2009 (the window of time showing the peak activity in call volumes). Results reveal differences in callers between the two time periods. In the after tax period, although the mean

Table 2: Characteristics of tobacco users who enrolled with the 16 quitlines around the time of the April 1, 2009 federal tax increase (March 2009–May 2009) and in the same months the previous year (March 2008–May 2008) (n = 79,928).

	March–May 2008 N = 29,674	March–May 2009 N = 50,254	P value
Age			<0.0001
Mean (SD)	41.2 (13.7)	41.9 (13.6)	
Age	%	%	0.0005
18–24	13.6	11.5	
25–44	43.3	43.6	
45–64	38.4	39.9	
65+	4.8	5.0	
Gender	%	%	0.2822
Female	59.1	59.8	
Race/ethnicity	%	%	0.0005
White/non-Hispanic	77.5	80.1	
African American/non-Hispanic	12.1	10.4	
American Indian/non-Hispanic	5.2	4.6	
Asian/non-Hispanic	0.8	0.7	
Hispanic	4.4	4.1	
Education	%	%	0.007
≤High school	58.6	61.0	
Insurance status[1]	%	%	0.323
Uninsured	41.7	43.0	
Insured	40.5	38.3	
Medicaid	17.8	18.7	
Live/work with smoker	%	%	<0.0001
smokers at home	34.0	37.2	
smokers at work	15.4	13.1	
smokers at both	16.3	15.3	
neither	34.4	34.4	
Years of tobacco use[1]	%	%	<0.0001
0–5	3.6	5.4	
6–19	25.0	30.9	
Use Tobacco 20+ yrs	71.4	63.7	
Use after waking	%	%	0.3981
First use w/in 5 min	52.0	52.7	
Mean (s.d.) cigarettes/day			0.006
Mean (s.d.)	20.0 (12.6) N = 29674	20.7 (12.4) N = 50254	
% Mailed NRT[1]	%	%	0.176
Yes	76.3	80.9	
Tobacco use[2]	%	%	
Cigar	2.4	3.0	<0.0001
Pipe	0.3	0.5	<0.0001
Smokeless	3.9	3.6	0.017
Chronic conditions:	%	%	
Asthma	17.9	17.0	0.140
Diabetes	9.3	9.3	0.832
COPD	13.4	11.9	0.015
CAD	7.2	6.7	0.025
NONE	66.0	67.4	0.133

Table 2: Continued.

	March–May 2008 $N = 29,674$	March–May 2009 $N = 50,254$	P value
How heard of QL	%	%	0.0013
HCP[3]	11.4	13.1	
Family/friend	20.3	31.2	
Media	34.8	27.0	
Other	33.6	28.8	
Service Received	%	%	
% in multicall program[4]	74.7	65.7	<0.0001

[1] Some variables had missing data either because the question was not routinely asked or participants did not answer the question. Items with >10% missing data include education, insurance status, duration smoked, household smoker, and percent mailed NRT.
[2] 97.3 and 97.9% (before, after) smoked cigarettes.
[3] HCP: health care provider.
[4] $N = 55,180$ enrolled in the multicall program.

age of callers was slightly younger (41.9 versus 41.2), fewer callers were aged 18–24 years (11.5% after tax versus 13.6% before tax). More callers in 2009 (compared with the prior year) were white, had less than a high school education, were more likely to live with a smoker, had shorter durations of cigarettes smoking, and were more likely to report hearing about the quitline from family or friends or their health care provider, rather than from the media. Although fewer callers enrolled in the multicall program (4-5 counseling calls) after tax, they completed slightly more counseling sessions compared with those who enrolled for the multiple calls before tax (1.9 versus 2.2, respectively, $P < 0.0001$). Although there were differences in the prevalence of chronic disease (COPD and CAD) and use of other tobacco products when comparing callers after the tax increase to those before the tax increase, these differences between the callers in these two time periods were small.

Table 3 shows results of analyses of seven-month outcomes data and suggests that participant quit rates did not differ significantly before versus after the tax. These results held for unadjusted and adjusted analyses of seven-day and 30-day respondent and intent-to-treat analyses. For example, seven-day respondent quit rates were 30.7% before and 28.7% after the tax (O.R. = 0.95, 95% C.I. = 0.63, 1.45). Analyses of the subgroup that participated in the multicall program showed a similar lack of change in smoking status after tax compared with a similar period before the tax.

6. Discussion

This study's results are consistent with prior research showing that implementing an increase in excise taxes on tobacco will drive calls to the state tobacco control programs' free quitline services [3, 17]. Harwell et al. reported an increase in call volumes to the Montana quitline following an increase in the state's cigarette taxes. They also reported that the tax attracted younger smokers to call the quitline, as well as more female and white smokers and heavier smokers [3]. In the current study, although smokers who called the quitline around the time of the federal tax increase were more likely to be white, no significant differences were found for gender or amount smoked. However, fewer young tobacco users (age 18–24) and fewer smokers with smoking durations of ≥20 years called around the time of the tax increase. Because tax increases tend to decrease the prevalence of smoking among younger persons and persons with lower incomes more than older persons and those with higher incomes [2], it was expected that differences would emerge in these demographic characteristics in callers during the time of the tax increase compared to those who called the year before. Although persons with lower education levels were more likely to call after the tax increase, young adults were slightly less likely to call. However, for all characteristics, the magnitude of the differences before and after the tax increase was small.

Observed changes in who called the quitline around the time of the tax increase versus the year before could be due to multiple factors such as state quitline promotional efforts that were timed to correspond to the tax increase as well as the local increases in actual cigarette prices themselves. This study is descriptive in nature and did not address the myriad of changes in tobacco control policies and interventions that may have occurred at the state and local levels during this time period and how those changes would have influenced both the number of calls to the quitline and demographic and other characteristics of quitline callers. For example, in addition to the federal excise tax increase in April 2009, 13 states in this study increased their cigarette excise taxes between November 2008 and November 2009. More research would be needed to estimate the effect of the federal tax increase apart from these and other changes that were occurring at the state and local levels.

Interestingly, in terms of caller characteristics, the variable that changed the most among callers around the time of the federal tax increase compared to the year before was how the caller heard about the quitline. Callers after the tax increase were more likely to report that friends and family told them about the quitline than those who called before the tax increase. Future research could explore how cigarette tax increases influence friends' and families' interest in encouraging and assisting smokers with cessation. Additional

Table 3: Treatment outcomes at 7 months among those sampled for follow-up surveys in four states and who enrolled around the time of the federal tax increase and in the previous year.

		Registered March–May 2008	Registered March–May 2009	Unadjusted *P* values	Adjusted[1] odds ratios (95% confidence interval)[2]
Full sample[3]: $N = 645/1651$ (39.1%)		$N = 287/802$ 35.8%	$N = 338/849$ 39.8%		$N = 564/1506$
% abstinent (7-day point prevalence)	Responders	30.7	28.7	0.59	0.95 (0.63, 1.45)
	ITT[4]	11.0	11.4	0.77	1.09 (0.77, 1.56)
% abstinent (30-day point prevalence)	Responders	26.8	24.9	0.57	0.96 (0.63, 1.46)
	ITT[4]	9.6	9.9	0.84	1.09 (0.76, 1.57)
In multicall program[5]: 430/1150		189/521	241/629		$N = 417/1126$
% abstinent (7-day point prevalence)	Responders	34.9	32.8	0.64	0.93 (0.58, 1.49)[5]
	ITT[4]	12.7	12.6	0.96	1.16 (0.78, 1.72)[5]
% abstinent (30-day point prevalence)	Responders	31.8	28.6	0.48	0.91 (0.56, 1.48)[5]
	ITT[4]	11.5	11.0	0.77	1.14 (0.76, 1.71)[5]

[1] Controlling for age, gender, race, education, chronic condition, amount smoked, how heard about quitline, and state.
[2] Before tax period is the reference group.
[3] Number of respondents/number sampled. Note that the response rate was 4% higher after tax.
[4] ITT = Intent to Treat analyses (missing outcomes = smoking).
[5] Also controlling for call program (multiple versus single), number of counseling calls completed and use of NRT.

research is also needed to determine the synergistic effects on call volumes and treatment outcomes of state promotional events that may have coincided with implementation of the tax increase.

The lack of higher quit rates after the tax is not surprising since the quitlines did not provide additional counseling or other services for tobacco users after the tax and in fact may have reduced the availability of more intensive cessation treatments (see Table 1) [18]. Although the quit rates were similar before and after the federal tax increase, the number of tobacco users who enrolled in the quitlines was larger after the tax increase. Therefore, in terms of absolute numbers, more persons successfully quit after the tax increase. In these 16 states, of the 19,911 additional tobacco users who called during the time of the tax an additional 5,714 would quit smoking (19,911 more callers after tax $*$ 28.7% quit rate). However, it is important to remember that only 1%–5% of smokers in the United States call quitlines each year and tobacco users often quit without the use of cessation services or medications [19]. Increasing the price of cigarettes is associated with increase quitting (1) and future research could examine the effects of the increase in the federal excise tax on more general population-based measures of cessation.

7. Limitations

Results of this study must take into consideration a number of potential limitations. One limitation is that the number and types of callers to quitlines vary within and between states over time and are a function of promotional events (e.g., offering free NRT) and eligibility criteria (e.g., NRT for uninsured only) that were not examined in this analysis. Note that the services provided did not change before/after in the four states with 7-month data. Furthermore, since the primary intention of this paper is to describe the populations using the quitlines around the tax increase, it is likely that the data accurately portrays the types of callers who were calling around that time. Although analyses of individual states' promotional activities or other tobacco control initiatives were not conducted, "state" was included in the statistical models to control for such variability. Note that the pattern of calls was similar in graphs with and without one outlier state that had paired the normal January increase in calls with a state tax increase and promotional activities around the quitline. Future studies should consider including a more detailed analysis of promotional efforts as well as state-specific tax increases. Unfortunately, there is no data source currently available that tracks the amount, content, and timing of state antitobacco promotional efforts [20, 21]. Another consideration is that data were missing for both time periods for over 10% of enrolled callers at intake for four variables (education, presence of other household smokers, years of tobacco use, and whether they were mailed NRT by the quitline). This is a reasonable amount of missing responses for these specific measures obtained during quitline enrollment. However, results for those variables may have been influenced by this nonresponse although it is difficult to predict the magnitude and direction of how the nonresponse would affect the relationship to the tax increase. In addition, only four states had seven-month quit rate data that spanned the study period; therefore, these quit rate results might not generalize to other quitlines. Analyses compared cessation rates among those who enrolled around the time of the tax increase compared to persons who enrolled during the same months during the prior year but there were no questions to determine if success was due to the individual's interaction with the quitline. Also, seven-month survey response rates tend to be fairly low. Low response rates are a common finding in phone-based follow-up surveys with individuals seeking treatments. Response rates in the 30–40% range are reasonable and consistent with other studies (NAQC 2009). Although analyses controlled for response rates by reporting the intent to treat quit rates,

the assumption that nonrespondents are continued smokers has been challenged as being too conservative [22]. Cessation rates may have differed significantly between time periods if higher response rates had been obtained. The true quit rates will lie somewhere between the responder and intent-to-treat results. Because of the above limitations, conclusions about changes in quit rates among quitline callers after the federal tax increase should be interpreted with caution.

8. Conclusions

This study provides important data relevant to public health policy on tobacco control. Evidence-based cessation services combined with tax and price increases, smoke-free laws, antitobacco advertising, and bans on tobacco advertising and promotion increase cessation and decrease tobacco use prevalence [2]. Frieden and colleagues found that intensive tobacco control measures decreased the prevalence of smoking by 11% among New York City adults from 2002 to 2003 and estimated that 59% of that reduction in smoking was due to price increases [23]. Further, the interactive effects of multiple policies are more effective and have a greater public health impact when combined with other evidence-based components of tobacco control programs [24]. States must ensure that consumers have access to effective services (including quitlines) [25]. However, in a recent survey of quitline service providers, 89% reported that reduced funding had a direct effect on provision of services (e.g., limiting eligibility for services, reducing the number of counseling sessions, or eliminating provision of NRT) [18]. This is unfortunate since offering free NRT through the Quitline can increase calls and increase cessation [5, 7, 9]. In the current study, variability in the type and intensity of cessation services (e.g., number of counseling sessions, amount of NRT offered) provided by each state over the two time periods may have been due to budgetary constraints [6]. Through *Best Practices for Comprehensive Tobacco Control Programs,* CDC recommends funding levels for comprehensive tobacco control programs, including effective interventions such as quitlines [26]. If all states met CDC's recommended annual levels of funding for tobacco control programs ($9–$18 per capita), in five years, an estimated five million fewer persons would smoke and hundreds of thousands of premature tobacco-related deaths could be prevented [27].

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Research Article

Cigarette Design Features in Low-, Middle-, and High-Income Countries

Rosalie V. Caruso and Richard J. O'Connor

Department Of Health Behavior, Roswell Park Cancer Institute, Elm and Carlton Streets, Buffalo, NY 14263, USA

Correspondence should be addressed to Richard J. O'Connor, richard.oconnor@roswellpark.org

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Previous studies have shown that country income grouping is correlated with cigarette engineering. Cigarettes ($N = 111$ brands) were purchased during 2008–2010 from 11 low-, middle-, and high-income countries to assess physical dimensions and an array of cigarette design features. Mean ventilation varied significantly across low- (7.5%), middle- (15.3%), and high-income (26.2%) countries ($P \leq 0.001$). Differences across income groups were also seen in cigarette length ($P = 0.001$), length of the tipping paper ($P = 0.01$), filter weight ($P = 0.017$), number of vent rows ($P = 0.003$), per-cigarette tobacco weight ($P = 0.04$), and paper porosity ($P = 0.008$). Stepwise linear regression showed ventilation and tobacco length as major predictors of ISO tar yields in low-income countries ($P = 0.909, 0.047$), while tipping paper ($P < 0.001$), filter length ($P < 0.001$), number of vent rows ($P = 0.014$), and per-cigarette weight ($P = 0.015$) were predictors of tar yields in middle-income countries. Ventilation ($P < 0.001$), number of vent rows ($P = 0.009$), per-cigarette weight ($P < 0.001$), and filter diameter ($P = 0.004$) predicted tar yields in high-income countries. Health officials must be cognizant of cigarette design issues to provide effective regulation of tobacco products.

1. Introduction

Tobacco production and consumption have risen dramatically in the developing world [1]. While smoking rates have declined in high-income countries, the public health burden of tobacco is shifting towards the developing world, where by 2030 more than 80% of the world's tobacco-related deaths will occur [2]. Coinciding with this shift to developing countries, health knowledge in these countries is increasing, albeit slowly in some places. While overall awareness of the health hazards of tobacco has improved in the last 15 years in China, it is still relatively poor. A household survey in China found that 81.8% of the population knew that smoking causes serious diseases, but fewer people realized the diseases that second hand smoke could present (64.3%) [3]. Surveys in Ghana, however, show comparatively low smoking prevalence, high awareness of health risks, limited exposure to tobacco advertising, and frequent efforts by smokers to quit [4].

There is evidence that the multinational tobacco industry appears to be targeting Asia and Africa as growth regions [5]. The Framework Convention on Tobacco Control (FCTC), to which 174 countries are currently parties, contains a number of key demand-reducing strategies, such as tobacco taxation, education about health effects (including health warnings on packages), removal of misleading product descriptors, and support for cessation. FCTC also addresses the product itself, and the World Health Organization has received advice from its Study Group on Tobacco Product Regulation on tobacco product testing, reporting requirements, and possible emissions regulation [6, 7]. The problems presented in developing countries will be multifold: to deal with the increasing public health burden, while implementing provisions of the FTC, including educating consumers about the harmful effects of cigarettes and regulating tobacco products.

Over the last five decades, as consumers have grown increasingly aware of the health hazards of smoking, tobacco companies have responded by designing and marketing seemingly lower tar and nicotine products that were positioned as less dangerous to health [8, 9]. However, the testing methodology (e.g., International Organization for Standardization (ISO) and Federal Trade Commission (FTC)) that

depicted lower tar and nicotine levels was unrepresentative of human smoking behavior, therefore, labels such as "low tar" often presented on packs or in advertising were meaningless to consumers as health indicators [10]. To market lower tar and nicotine cigarettes, tobacco manufacturers designed their cigarettes with characteristics such as cigarette filters on the ends of rods, which are able to reduce the machine yields of tar and nicotine by 40–50% [11]. Additionally, ventilation holes, which appear as a ring of holes in the cigarette paper surrounding the filter, dilute tobacco smoke coming from the mouth end when smoked by a machine and further reduce tar and nicotine emissions [11]. However, when smoked by consumers, vents can be blocked by fingers and lips, or their effect is reduced by greater puffing effort, such that smokers inhale more tar and nicotine than would be predicted by machine testing [12].

Broadly speaking, cigarette emissions are predictable to a large degree from design features [13–15]. In light of the shifting public health burden of tobacco use toward the developing world, Calafat et al. [16] showed that cigarette emissions and design varied widely across WHO regions, with cigarettes sold in the Eastern Mediterranean, South East Asia, and Western Pacific Regions having higher tar and lower ventilation than those sold in the African, American, or European regions. O'Connor et al. [17] examined the differences in cigarette design characteristics in high-, middle-, and low-income countries, with the general trend being that as country income group increased, cigarettes sold became more highly engineered and the nominal emission levels decreased [17]. All cigarettes from high-income countries had filters, compared with 95% of brands in middle-income and 86% of brands in low-income countries, and among these, the proportion having ventilated filters was 95% in high-income countries, 87.5% in middle income countries, and 44.4% in low-income countries. This current study seeks to replicate earlier findings relating cigarette design (and by extension, emissions) to country development grouping. More evidence from studies such as this one is needed in order for countries to implement meaningful regulation of tobacco, given the important links between cigarette design and smoke emissions [18].

2. Methods

Methods for this project mirror a previous study by O'Connor et al. [17], comparing cigarette design features of samples obtained from multiple low-, middle-, and high-income countries. Country income classification was based on the World Bank's Gross National Income per capita data [19]. The current study analyzed cigarettes from 11 countries ($N = 111$ brands) purchased between 2008–2010 (see Table 1). Collaborators in each country purchased popular brands of cigarettes based on sales and prevalence data within each country. Nepal was the only country used in the current study that was also included in the previous study, but these were two separate purchases in two separate years. Packs were then shipped to Roswell Park Cancer Institute where the cigarettes were catalogued and stored at -20°C until analysis. Before testing, cigarettes were conditioned for a minimum of 48 hours at $22 \pm 2.0^{\circ}$C and $60 \pm 2.0\%$ relative humidity in an environmental chamber.

Product testing procedures followed those previously published by the same laboratory [14, 17]. After conditioning, five cigarettes were selected from each pack for physical analysis. Digital calipers were used to measure the length of the entire cigarette, the length and diameter of the tobacco rod, and the length and diameter of the filter. Filter and tobacco weight measurements were also taken using an analytical balance. The length of the tipping paper was then recorded and observed using a light box for the presence of vent holes. Tobacco moisture and dry weight were assessed using an HR83 Moisture Analyzer (Mettler-Toledo, Columbus, OH, USA). Filter ventilation and pressure drop were assessed using a KC-3 apparatus (Borgwaldt-KC, Richmond, VA). The level of porosity of the cigarette paper was measured using the vacuum method on a PPM1000M paper porosity device (Cerulean, Milton Keynes, UK). Tar and nicotine values were obtained from product packages where these were listed (Table 1).

Data analysis was completed using Statistical Package for the Social Sciences Version 16.0 (SPSS Inc., Chicago, IL, USA). Basic descriptive statistics and analysis of variance (ANOVA) were used to compare product design features by country income grouping. Discriminant function analysis was used to examine how combinations of design features distinguished low-, middle-, and high-income countries. Stepwise linear regression was used to assess the influence of design features on labeled tar and nicotine values. In these regression models, ventilation was forced into the model given extant literature on its major influence on ISO yields [13, 14, 17], while other design features were entered using stepwise procedures (P-entry = 0.10, P-removal = 0.15). Since tar and nicotine yields were provided on packs for only seven countries (see Table 1), the remaining countries were excluded from the regression analyses.

3. Results

Nearly all the cigarettes tested were filtered cigarettes; 100% of cigarettes from both high- and middle-income countries had filters while 89% of cigarettes from low-income countries had filters. Among filtered cigarettes, only 16.0% in low-income countries had vent holes, compared to 65.5% in middle-income countries and 82.1% in high-income countries.

ANOVA analyses (Table 2) revealed basic differences in physical cigarette parameters by income groups in terms of: cigarette length ($P = 0.001$), length of the tipping paper ($P = 0.010$), filter weight ($P = 0.017$), number of vent rows ($P = 0.003$), per-cigarette tobacco weight ($P = 0.040$), ventilation ($P < 0.001$), and paper porosities ($P = 0.008$). The average percentage of cigarette ventilation differed significantly across income groups, with means of 7.49%, 15.34%, and 26.21% for low-, middle-, and high-income groups, respectively, ($P < 0.001$). Rod diameter, filter diameter, tobacco length, and filter length were not shown to have significant differences by income groups.

Table 1: Summary of countries, income groupings and brands studied.

	Income group	Number of brands	Year pack was collected	Primary manufacturer	T & N label on pack
Bangladesh	Low	5	2009	British American Tobacco	No
Ghana	Low	7	2008	British American Tobacco	Yes
Nepal	Low	16	2009	Other	No
Argentina	Middle	10	2008	Philip Morris	Some packs
Malaysia	Middle	13	2008	British American Tobacco	Yes
Nigeria	Middle	14	2008	British American Tobacco	Yes
Thailand	Middle	10	2008	Thailand tobacco Monopoly	No
Uruguay	Middle	8	2010	Other	No
Canada	High	7	2009	British American Tobacco	Yes
Taiwan	High	11	2008	Taiwan Tobacco and Liquor Corporation	Some packs
UK	High	10	2010	Imperial Tobacco	Yes

Table 2: ANOVA, basic differences in physical parameters by income group.

	Income group	Mean	Standard error	Minimum	Maximum	ANOVA	P
Cigarette length	Low	79.45	1.24	66.57	84.16	$F(2, 108) = 7.010$	0.001
	Middle	82.77	0.34	78.61	93.87		
	High	83.80	1.04	71.79	99.08		
Rod diameter	Low	7.59	0.02	7.34	7.91	$F(2, 108) = 0.079$	0.924
	Middle	7.56	0.02	6.84	8.02		
	High	7.54	0.17	2.88	8.02		
Filter diameter	Low	7.58	0.02	7.20	7.77	$F(2, 108) = 0.326$	0.723
	Middle	7.60	0.02	6.81	7.85		
	High	7.50	0.18	2.55	7.82		
Tobacco length	Low	61.51	0.56	56.96	68.58	$F(2, 108) = 0.845$	0.432
	Middle	60.46	0.49	54.15	70.27		
	High	60.40	0.88	50.21	72.46		
Length of tipping paper	Low	25.70	0.76	18.39	32.65	$F(2, 105) = 4.805$	0.010
	Middle	27.98	0.48	15.32	36.40		
	High	28.93	0.87	18.94	38.30		
Filter length	Low	19.92	0.90	8.94	27.23	$F(2, 97) = 2.552$	0.083
	Middle	22.89	0.88	11.04	63.26		
	High	21.44	0.71	14.94	26.95		
Filter weight	Low	0.1029	0.0055	0.0458	0.1547	$F(2, 97) = 4.263$	0.017
	Middle	0.1178	0.0028	0.0600	0.1556		
	High	0.1172	0.0037	0.0895	0.1585		
Number of vent rows	Low	0.33	0.19	0.00	4.00	$F(2, 93) = 6.226$	0.003
	Middle	1.00	0.15	0.00	4.00		
	High	1.46	0.30	0.00	6.00		
Per-cigarette tobacco weight	Low	0.6928	0.0075	0.62	0.77	$F(2, 108) = 3.324$	0.040
	Middle	0.6581	0.0116	0.52	1.16		
	High	0.6486	0.0099	0.55	0.75		
Ventilation (%)	Low	7.49	2.3595	0.00	42.22	$F(2, 105) = 2.299$	<0.001
	Middle	15.34	1.6746	0.00	39.54		
	High	26.21	3.3641	0.76	68.20		
Paper porosity	Low	35.01	3.16	15.74	80.05	$F(2, 106) = 5.18$	0.008
	Middle	44.09	2.40	15.88	81.57		
	High	48.47	2.21	31.42	72.41		

A discriminant function analysis was used to examine how linear combinations of the panel of design features distinguished among low-, middle-, and high-income countries. Two functions were derived, accounting for 71.4% and 28.6% of variance, respectively. The first function [X^2 (22) = 45.6, $P < 0.002$] maximally separated the high-income group from low and middle, while the second function [X^2 (11) = 14.1, $P = 0.167$] separated low- and middle-income groups but did not achieve statistical significance. Examination of the structure matrix suggested that ventilation, paper porosity, cigarette length, and rod diameter distinguished high from the remaining income group brands. Analysis of classification statistics showed that the discriminant functions correctly classified 56.3% of cases, ranging from 72.2% of the high-income brands to 43.5% of the middle-income brands and 69.9% of the low-income brands.

Stepwise linear regressions were done for all cigarettes with tar and nicotine values recorded on the pack. Per-cigarette weight, tipping paper, filter diameter, tobacco length, and paper porosity were all associated independently with tar yields, after ventilation was forced into the model (Adjusted R square = 0.852, see Table 3). For nicotine, ventilation, tipping paper, filter weight, and filter length were the variables predicting nicotine yields (Adjusted R square = 0.774; see Table 4). When stratified by income group, regression analyses found that a number of design features contributed independently to tar yields in high-income group countries, including ventilation ($P < 0.001$), tipping paper ($P = 0.015$), number of vent rows ($P = 0.009$), per-cigarette weight ($P < 0.001$), cigarette length ($P = 0.055$), and filter diameter ($P = 0.004$) (Table 3). Middle-income countries had five variables accounting for differences in tar: ventilation, tipping paper length, filter length, number of vent rows in the tipping paper, per-cigarette weight, and cigarette length. In low-income countries ventilation and tobacco length primarily accounted for differences in tar. Ventilation was not statistically significant in both low- and middle-income countries (see Table 3).

When examining correlates of nicotine yield stratified by income group, we found a broadly similar pattern of results (Table 4). In all cases, ventilation and per-cigarette weight had the strongest independent associations with nicotine yield. Other contributors did differ across income groups: filter weight for the low-income ($P = 0.078$), tipping paper length ($P < 0.001$) and filter length ($P < 0.001$) for middle-income countries, and tobacco length for the high-income group countries ($P = 0.046$; see Table 4).

4. Discussion

This study largely replicates an earlier study [17] on the differences in cigarette characteristics between high-, middle-, and low-income countries. As expected, brands in higher income countries were engineered with filters and ventilation more commonly and at higher levels than in lower income countries. Ventilation is the main factor in the differences in tar and nicotine levels among cigarettes [13–15], and a majority of cigarettes in higher income countries employed ventilation to affect tar and nicotine. The main features that distinguished the high-income group brands from the lower income group brands were ventilation, paper porosity, cigarette length, and rod diameter, features which dilute the smoke and/or alter the amount of tobacco available for burning.

Patterns in variability in tar across products, by income group, were slightly different than for nicotine. While middle- and low-income countries shared ventilation and tobacco length accounting for most of the variability in tar across their cigarette products, in high-income countries a wider array of design features appeared to have independent influences on tar yields. The added length of the tipping paper is particularly interesting, as it sequesters otherwise smokeable tobacco from burning in a machine test, hence lowering yields [20]. In some countries, maximum tar levels, as measured by standardized smoking machines, have been set, such at the "10-1-10" upper limits for tar, nicotine, and carbon monoxide in the EU [21]. Consumers typically believe products with lower levels to be "healthier", even though the primary way those numbers are achieved is primarily through increased ventilation. The problem arises in that consumers can directly manipulate how much tar and nicotine they obtain from their cigarettes by blocking the vent holes in the filter or indirectly by taking larger puffs, which ventilation facilitates [11]. In either case, consumers receive more tar and nicotine than stated on the product while believing they have reduced their risks. Given the past history of light and mild cigarettes in developed countries, health officials in developing countries need to be cognizant of these design alterations that can contribute to seemingly "healthier" (i.e., reduced machine-measured tar and nicotine) products introduced into their markets in the coming years.

Parties to the World Health Organization Framework Convention on Tobacco Control (WHO FCTC) should see this study as further reason to consider cigarette design feature reporting when proposing measures in their countries that regulate the contents and emission of tobacco products (Article 9) and tobacco product disclosures by manufacturers (Article 10) [18]. As noted at COP-4, "Collecting data on product characteristics, such as cigarette design features, would help Parties improve their understanding of the impact these characteristics have on smoke emission levels, properly interpret measurements obtained and, more importantly, keep abreast of any changes to cigarette design features" [18]. In order to have effective product regulation, it is essential that governmental authorities have accurate information about the composition of those products to understand how manufacturers are complying with regulations [18].

A strength of the current study is its consistency with prior findings of statistically significant differences in cigarette design between high-, middle-, and low-income countries, even though completely different sets of cigarettes were tested from different high-, middle-, and low-income countries. The replication of the study further validates the differences in cigarette design between country income groups. At the same time, this study also shared the limitations of the first study [13], that is, the selected brands

Table 3: Design features associated with ISO tar yields across all brands (a) and stratified by country income group (b).

(a) Overall

Final adjusted *R*-square value	Model	Standardized coefficients	Sig.
0.852	Vent	−0.722	<0.001
	Per-cig weight	0.475	<0.001
	Tipping	−0.344	<0.001
	Filter diameter	0.233	0.004
	Tobacco length	−0.244	0.017
	Paper porosity	−0.150	0.070

(b) Stratified by income group

	Final adjusted *R*-square value	Model	Standardized coefficients	Sig.
Low	0.561	Vent	−0.037	0.909
		Tobacco length	−0.857	0.047
Middle	0.894	Vent	0.055	0.795
		Tipping	−2.139	<0.001
		Filter length	2.212	<0.001
		Number of rows	−0.547	0.014
		Per-cigarette weight	0.620	0.015
		Cigarette length	−0.391	0.072
High	0.956	Vent	−0.897	<0.001
		Tipping	−0.308	0.015
		Number of rows	0.266	0.009
		Per-cigarette weight	0.522	<0.001
		Cigarette length	−0.204	0.055
		Filter diameter	0.282	0.004

Table 4: Design features associated with ISO nicotine yields across all brands (a) and stratified by country income group (b).

(a) Overall

Final adjusted *R*-square value	Model	Standardized coefficients	Sig.
0.774	Vent	−0.568	<0.001
	Tipping	−0.752	<0.001
	Filter weight	0.937	<0.001
	Filter length	−0.447	0.059

(b) Stratified by income group

	Final adjusted *R*-square value	Model	Standardized coefficients	Sig.
Low	0.860	Vent	−0.191	0.385
		Per-cigarette weight	1.372	0.013
		Filter weight	−0.627	0.078
Middle	0.915	Vent	−0.430	<0.001
		Per-cigarette weight	0.200	0.033
		Tipping	−2.310	<0.001
		Filter length	2.063	<0.001
High	0.710	Vent	−0.637	<0.001
		Per-cigarette weight	0.537	0.003
		Tobacco length	−0.333	0.046

may not be fully representative of the market within each country. In addition to this, only brands from three low-income countries were tested in this study. Future research on this topic should incorporate more design data from lower income countries. Also, the lower income countries chosen may not be completely representative of all cigarette design from lower income markets around the world.

As expected with our hypothesis, the current study shows how different cigarette design characteristics are among high-, middle-, and low-income countries. Smokers in higher income countries have been misled with cigarettes that appear to be less hazardous and have highly engineered cigarette design; lower income countries could avert these same mistakes by immediately establishing ways to regulate product ingredients and design. Public health officials need scientific evidence to better understand cigarette design and function.

Conflict of Interests

R. J. O'Connor has served as a consultant to the World Health Organization and the US Food and Drug Administration with respect to tobacco product regulation.

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Research Article

Reshuffling and Relocating: The Gendered and Income-Related Differential Effects of Restricting Smoking Locations

Natalie Hemsing,[1] Lorraine Greaves,[1] Nancy Poole,[1] and Joan Bottorff[2]

[1] *British Columbia Centre of Excellence for Women's Health, E311-4500 Oak Street (Box 48), Vancouver, BC, Canada V6H 3N1*
[2] *School of Nursing, University of British Columbia, 3333 University Way, Kelowna, BC, Canada V6T 1Z3*

Correspondence should be addressed to Natalie Hemsing, nhemsing@cw.bc.ca

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This study investigates secondhand smoke (SHS) exposure and management in the context of smoking location restrictions, for nonsmokers, former, and current smokers. A purposive sample of 47 low income and non-low-income men and women of varied smoking statuses was recruited to participate in a telephone interview or a focus group. Amidst general approval of increased restrictions there were gendered patterns of SHS exposure and management, and effects of SHS policies that reflect power, control, and social roles that need to be considered as policies are developed, implemented and monitored. The experience of smoking restrictions and the management of SHS is influenced by the social context (relationship with a partner, family member, or stranger), the space of exposure (public or private, worksite), the social location of individuals involved (gender, income), and differential tolerance to SHS. This confluence of factors creates differing unintended and unexpected consequences to the social and physical situations of male and female smokers, nonsmokers, and former smokers. These factors deserve further study, in the interests of informing the development of future interventions and policies restricting SHS.

1. Introduction

Smoking restrictions in public places, or secondhand smoke (SHS) policies, are increasingly common in many parts of the world. In some countries, smoking restrictions have extended to private spaces (such as cars) and outdoor spaces (such as doorways, patios, parks, and beaches). In the province of British Columbia, Canada, smoking restrictions exist in workplaces including restaurants and bars (since 2001 in some municipalities), within 3 metres from doorways of public buildings (since 2008), and in cars where a person under the age of 16 is present (since April 2009). Several municipalities have even stronger bylaws. In Vancouver, for example, smoking is prohibited on restaurant/bar patios, within 6 metres of doorways, at bus shelters, and on beaches and parks [1].

The potential health effects of SHS have been widely documented as support for these policies in Canada [2], including the effect of SHS exposure in increasing the risk for cancer, heart disease, and lung diseases [3, 4]. Some research has concluded that smoking restrictions are associated with a decrease in SHS exposure (Callinan, Clarke et al. [5]), [6, 7] and may also be associated with increased smoking reduction or cessation [8–10]. SHS policies have the potential to improve health and decrease risk for disease [11].

However, the gendered implications of SHS initiatives and policies for women and men may result in specific unintended consequences as gendered dynamics shape women's and men's smoking behaviours, place of exposure, and management of SHS. For example, women may confront challenges in managing SHS exposure in the home due to gender inequalities within the domestic sphere [12]. Women and men may also face specific vulnerabilities due to the gendered and classed nature of work and the type of jobs women and men living on a low income are more likely to occupy. For example, one focus group study found that low-income women working primarily in office and retail environments reported a prosmoking environment (including more opportunities for smoke breaks and the presence of other coworkers who smoke) [13]. Low-income men, particularly older men working in outdoor environments, also noted a prosmoking context and lack

of smoking restrictions [13]. Another study found that smoking restrictions in bars and restaurants in California have resulted in more smokers congregating in bars where restrictions are not enforced, where low-income women are typically employed, thereby increasing their vulnerability to SHS exposure [14].

Research also suggests that women and men of different income levels may encounter specific vulnerabilities due to social and physical disadvantage. Residing in a low-income area [15, 16] or an area of physical disorder or deprivation [17] has been linked to greater tobacco use. In a qualitative study exploring the social context of smoking, participants in low-income groups reported that they had not perceived a decline in smoking, and often described smoking as being more socially acceptable in low-income neighbourhoods [13]. A review of the unintended consequences of SHS policies for disadvantaged women revealed that women living on a low income may experience more barriers to quitting smoking and more vulnerabilities to SHS exposure [18].

In short, social, economic, and environmental issues shape the conditions of women and men's smoking and exposure to SHS and their responses to smoking restrictions. This study explored the effects of SHS policies on diverse groups of women and men who smoke and/or are exposed to SHS, and gauges the relationship between their social and built environments and their capacity to manage SHS exposure. In particular, what are the consequences of location restrictions for women and men, and how do the social (i.e., social roles, social positions) and built environments (i.e., housing conditions, work facilities, and daily settings) that women and men experience and inhabit influence their capacity to manage smoke exposure? To explore these questions, we asked women and men to describe the context of their SHS exposure (source and setting, and challenges in managing exposure) and discuss their experiences of smoking restrictions in Vancouver.

2. Background

The majority of studies investigating SHS policies focus on the impact of various policies on health outcomes and public opinion following implementation. Many studies have examined the impact of SHS policies on smoking cessation in the workplace [19–28] and the home [29–33]. In addition, researchers have investigated attitudes and public support following implementation of SHS policies [34–37].

A body of literature also exists on the connection between smoking restrictions and the denormalization of smoking—the process wherein smoking has gradually been redefined as socially unacceptable [38, 39]. Several authors have discussed the potential for discrimination and stigma among smokers as an adverse outcome of location restrictions, particularly among already vulnerable populations [39–42]. There have been debates among researchers over whether denormalization and stigma are effective tobacco control strategies [43, 44] or unethical and discriminatory against smokers [45, 46]. More recently, debates have centred around smoking restrictions in outdoor spaces, with some researchers claiming these policies may be particularly stigmatizing and are backed by relatively weak scientific evidence of health harms [45, 47, 48]. Denormalization may actually impede cessation efforts, particularly for socially disadvantaged smokers. For example, Thompson and colleagues examined the effect of the denormalization of smoking and associated smoking-related stigma on creating "smoking islands" where smoking becomes normalized and smoking reduction and cessation efforts are inhibited [49].

Several studies have examined individual responses to SHS policies and SHS management. Bell and colleagues explored responses to location restrictions among smokers in Vancouver and found that smokers experienced stigma, and changes in their access to and use of space [50]. Ritchie and colleagues' qualitative study of stigma following SHS legislation in Scotland revealed that smokers utilized different strategies to cope with stigma, such as managing spaces where they smoke, limiting social activities, stigmatizing other smokers and/or discussing the benefits of location restrictions [51]. Their study of the social context of smoking in Scotland following legislation, also revealed changes in participants' use of public space and smoking behaviours following implementation [52]. Poland and colleagues identified heterogeneity in smokers and nonsmokers attitudes to SHS management, distinguishing between the various tolerance levels, interactions, and response styles of smokers and nonsmokers to smoke exposure [53]. Robinson and colleagues discovered a range of implementation styles among participants with home smoking policies in Scotland, including those based on informal discussions, to "negotiated" or "enforced" smoking restrictions [54]. A population based study by Germain and co-authors examined the responses of nonsmokers to smokers and SHS in Australia and found that many nonsmokers were unwilling to confront smokers, despite being bothered by SHS exposure [55]. Together, these studies suggest that responses to SHS policies and SHS management are mixed due to differences in social location and context, smoking status, and individual and personal characteristics and dynamics.

This project built upon this work by examining differential effects on women and men of varied income levels and smoking statuses, in experiences of SHS exposure and management (in both private and public spaces) and responses to smoking restrictions in Vancouver.

3. Methods

To explore the everyday experiences of women and men in relation to smoking, SHS, and SHS policies, we employed a variety of qualitative methods. Participants were recruited via advertisements in universities, coffee shops, hospitals, local media, and Craigslist (a free online classified advertisement). Participants who responded to advertisements completed a telephone screening to determine their eligibility for the study (exposed to SHS daily or almost daily and who were 19 years and older). After telephone interviews were completed with 40 individuals, additional participants were put on a waiting list to participate in focus groups.

Forty telephone interviews were held between March 2010 and February 2011, with 21 women and 19 men in Greater Vancouver. Women and men were also screened according to their income levels and classified as low income or not low income according to their self-reported combined family income before deductions, using the Low-Income Cut-Offs (LICOs) from Statistics Canada for 2004, and based on Vancouver population size (500,000+) (see Table 1). Interviews were held with 9 low-income women and 9 low-income men, and 12 non-low-income women and 10 non-low-income men. Although participants' smoking status was recorded, sampling was not performed based on smoking status. Please see Table 2 for demographic characteristics.

Following individual interviews, we held focus groups with women and men to explore emerging themes in more depth. Focus groups were held with one group of 3 low-income women, one group of 3 non-low-income men, and one non-low-income woman (additional participants were recruited but did not participate in the focus group). We were unable to recruit men living on a low income to attend a focus group. After providing consent, participants in phone interviews and focus groups completed a questionnaire (including demographics, smoking status and measures of exposure). Interviews and focus groups were semistructured and included questions about experiences of increasing SHS restrictions, how they deal with SHS, how SHS restrictions impact their own smoking, if and how they negotiate child-caring duties within the context of SHS and SHS restrictions, how they deal with partners, friends, and family within these contexts, how they experience the built environment, including public and private spaces, and their experience of the general public and their reaction to both smoking, smoke exposure and women and men's attempts to control SHS. The interviews were conducted by a trained female interviewer over the phone, and the focus groups by a trained, female facilitator in a meeting room at BC Women's Hospital (transportation vouchers and child care reimbursement were offered). Participants received gift cards to local retailers as honorarium for their participation, in the amount of $20 for the phone interviews and $40 for the focus groups.

All interviews and groups were recorded and transcribed, and qualitative analysis (NVivo 8) software was utilized to analyze interview and focus group transcripts. Recurring themes were identified, paying particular attention to gendered factors and differences between women and men, and income levels. Data associated with each specific theme were organized under each code. Preliminary themes were discussed and reviewed in a team meeting, and themes further refined, the key themes identified form the basis of this paper.

Table 1: Income classification scheme[1].

Before-Tax Low-Income Cut-Offs (LICOs), 2004	
Family size	Population of community of residence
	500,000 +
1	$20,337
2	$25,319
3	$31,126
4	$37,791
5	$42,862
6	$48,341
7 +	$53,821

[1] Notes: this table uses the 1992 base. Income refers to total pretax household income.
Source: prepared by the Canadian Council on Social Development using Statistics Canada's Low Income Cut-Offs, from Low income cut-offs for 2004 and low income measures for 2002 Catalogue #75F0002MIE2005003.

Table 2: Demographic characteristics of telephone interview participants.

	Smokers	Nonsmokers	Total
Group 1= male, low-income	4	5	9
Group 2= male, not low-income	3	7	10
Group 3= female, low-income	4	5	9
Group 4= female, not low-income	4	8	12
Total	15	25	

4. Results

Depending upon their particular experience, women and men described SHS exposure and challenges in managing smoke exposure in both public (in workplaces, bars and restaurants, outside of public buildings, and in beaches and parks) and private spaces (particularly the home, but also in cars). Examining SHS exposure more broadly, in addition to specific experiences of SHS policies in Vancouver (situated primarily in public spaces) allows for an exploration of the specific vulnerabilities that women and men of varied incomes and smoking statuses encounter, and the potential unintended consequences of SHS policies. Results are organized according to three key themes: (1) the reshuffling and relocation of where people are smoking; (2) SHS management and the impact on social relations and interactions; (3) disparities in the effect of policies and management of SHS.

4.1. Reshuffling and Relocating Where People Smoke. When asked about their experience of SHS policies, many participants reported being satisfied with smoking restrictions and felt their exposure had decreased as a result. However, other participants thought that policies have not decreased smoking or smoke exposure, but rather simply reshuffled where people are smoking.

> They're (smokers) just finding other places to do it, that's all, and then people's exposure increases in different scenarios, like the bus stop or places where maybe they weren't or like a lot less so years ago when people could smoke under a building or whatever (female, non smoker, not low income).

With people no longer permitted to smoke in the workplace, restaurants, bars, hotels, some apartments/housing, and most recently beaches and parks, the spaces where

smoking is allowed are shifting and narrowing. Participants clearly articulated a shift in social norms regarding smoking, connected to increasing restrictions on smoking locations. As it has become less socially acceptable to light up, smokers who abide by smoking restrictions must navigate their use of public space in new ways.

> A smoker is going to smoke pretty much everywhere. But there'll be some of those smokers that are really aware that their smoking is, people do not like it, and you'll see them go into like a corner or something, like kind of out of the way, like they'll get up out of a restaurant and they won't like smoke right in front of the restaurant, because they know the windows are open, the doors are open, it's going to come inside. And so you'll see them either go across the street or you know around the corner, and they'll be somewhere where you know, that it's not going to affect somebody else. (male, non-smoker, not low income).

Some participants described how smokers are being moved to increasingly marginal spaces, such as street-corners or alleyways, spaces physically and visibly divided from the majority of nonsmokers. Further implications of the physical and social marginality were made by participants who compared a smoker to a "back alley drug user."

Participants also commented on the increased concentration of smokers in certain public spaces such as at bus stops, sidewalks, outside of workplaces, restaurants, and bars. While smoking policies do exist for bus stops and business fronts in Vancouver, these restrictions are frequently broken or SHS travels to the area where others are positioned or waiting. As smokers reshuffle where they are smoking, or cluster in particular smoking areas, those people trying to manage SHS must also manoeuvre their environment in new ways. Expanding smoking restrictions therefore impact the use of space, and the social interactions between smokers and nonsmokers over SHS exposure.

Although SHS policies are focused primarily on public spaces, another effect of this reshuffling is the displacement of smoking into private spaces, particularly homes and cars where restrictions are less likely to exist. For example, one participant explained:

> At my place, we have a condo that used to allow smoking on the balcony, and about six months ago they actually came out with a bylaw that said "No smoking on balconies." So my girlfriend now smokes inside (male, non smoker, not low income).

Similarly, some female participants spoke about their male partner's preference to remain in the home (where he could continue to smoke) rather than visit restaurants or bars with smoking restrictions.

> My husband won't go out for a nice dinner, because he thinks "I cannot have a cigarette, so I ain't going to no—you know, unless we can go somewhere fast food or whatever," so a lot of times we just do not go out with him, you know. I'll go out on my own or go out with a friend or my daughter or whatever. (female, low income, former smoker)

With increasing prohibitions around public smoking and the movement of smoking into private spaces, individuals are increasingly required to negotiate smoking in this domain. In cases where smokers and nonsmokers are sharing a space, or where there are disagreements related to home smoking policies, the power differences between individuals (and partners in particular) may come to the fore. SHS policies are transforming the use of public and private space and the social interactions within these spaces.

4.2. SHS Management and the Impact on Social Relations and Interactions. Participants were asked to describe their experience of managing SHS and the impact on social relations and interactions. These experiences were influenced by tolerance to SHS and perceived priority of SHS management; place of exposure (private or public space) and interactions with smokers in that domain.

4.2.1. Tolerance to SHS & Priority of SHS Management. Some women and men reported being intolerant to smoking and smokers in their lives, choosing to limit their time with friends and family who smoke.

> Well there's a couple of friends I used to go and just visit and have coffee and tea and that, but more and more it turned me off because every time I'd go I'd just reek of tobacco, and I couldn't handle it no more. Finally I told them too, right, and I said "Well it's not you, it's the tobacco" it just, you know . . . it was too much. So you avoid some people that it's, you know, and it's too much. (male, former smoker, not low income).

> I tend to spend little time with people who smoke. I just have less and less tolerance for it. So people who were my friends and smoke, I just, I do not spend time with them anymore or if I have family members out of town who smoke, I won't stay at their home. (female, non-smoker, not low income).

Women and men from both income groups discussed choosing partners and friends who are nonsmokers and avoiding those who smoke, but this was more salient for non-low-income women and men. For these individuals, avoiding SHS is such a priority that they made changes to their social groups in an effort to limit exposure.

In contrast, some participants reported that they are not bothered by smoke and therefore have not made any changes to limit their smoke exposure. In some cases, participants implied that the value of their relationships (with friends, family, partners) outweighed their concerns over SHS exposure:

> I do not [have a smoke-free home] If I had a smoke-free [home] nobody would come visit me! (female, non-smoker, low income).

> Socially . . . honestly I cannot say I've done anything to decrease—like the friends, I'm not—the friends that I have I'm not going to drop, right. (male, smoker, low income).

Women and men from both low and non-low-income groups reported tolerance for SHS or no actions to manage SHS, but this feedback more often came from low-income women and men. These quotes (particularly the first quote) also indicate how the composition of the social group influences reactions to smoking restrictions and SHS management. If most or all individuals in a social group are smokers, reducing exposure may mean reducing or eliminating time spent with friends and family who smoke. Many participants did not want to reduce or give up social activities and relationships they share with people who smoke.

4.2.2. Variations in Interactions over SHS Exposure in the Private Sphere. Often, the greatest and most sustained source of exposure to SHS came from friends and family members within private spaces (their home, car or during social gatherings with friends/family) rather than strangers in public spaces. For those people who have a partner or family member who smokes or are sharing a living space with someone who smokes, the effect of public smoking restrictions on decreasing overall SHS exposure may be negligible. Participants who experienced SHS exposure in the home and were trying to limit or reduce their exposure, discussed how they negotiated smoking restrictions in the home, or experienced challenges or conflict with friends or family over smoking in the home.

For example, the following nonsmoking participants explained how they have negotiated smokefree spaces in their homes and social environment to avoid exposure while still maintaining relationships.

> [One] of my friends, he's kind of an addict to it. We're friends up to a point, but you know he does not smoke in front of me, he goes outside . . . he came to my place; I make it abundantly clear, if you want to smoke you go outside. And that's it, he knows the rules . . . in my case I won't bend on that. (male, non-smoker, not low income).

> Over my environment I [have control]. If someone comes over to my house and wants to smoke, you know, it's kind of my house, my rules, but I do not have that control over other people's environments so it's a lot harder (female, non-smoker, not low income).

All respondents suggested that they negotiate smoke-free spaces with friends, family, and partners, yet non-low-income participants more often described the process of negotiating a smoke-free space. These participants implied that they have the means to negotiate rules around smoking, particularly in their homes or cars. In addition, some smokers revealed ways in which they cooperate in either reducing their smoking around others or their partner.

> I think—rules or not, if you're respectful of the people that you have relationships with, then you take their feelings into consideration when it comes to something like smoking. I do not apologize to anybody for the fact that I do smoke cigarettes, but I'm very respectful of their wishes. (female, smoker, not low income).

In some cases, agreements are made between smokers and nonsmokers, and smokers may also willingly accommodate the requests or "rules" of nonsmokers. For these participants, there is a sense of cooperative exchange between smokers and nonsmokers.

Yet for other participants, managing SHS exposure in the home was marked by conflict with partners, friends, or family members.

> The only thing I find is that with my husband, a lot of people won't come and visit because of his smoking. And you know, he's really stubborn when it comes to trying to tell him that he cannot smoke inside a house, right. (female, non smoker low income).

> P: [I'm] fighting with my mom and my dad all the time.

> I: What's the gist of the fight? Like are you trying to tell them to stop, or you're trying to tell them to smoke someplace else, or?P: Smoke someplace else, do not waste our money, I work hard, you smell, I do not want to kiss you, I do not want to touch you, you stink, it goes on. (female, smoking status unknown, low income).

Women and men from low-income and non-low-income groups reported arguing with partners or family members over their smoking and some participants indicated that smoking had resulted in a previous break-up with a partner. However, women, and particularly women living on a low income, were more likely to cite challenges in negotiating a smoking restriction in the home. Differences in smoking status, tolerance to SHS, and decision-making power contribute to the interpersonal challenges and conflict associated with the management of SHS.

4.2.3. Interactions over SHS Exposure in the Public Sphere. For some individuals, the main source of SHS exposure is from strangers, mostly in public outdoor spaces. Participants who reported having strict no-smoking policies within their homes and cars often discussed challenges in managing their SHS exposure in outdoor public spaces. In attempting to limit their smoke exposure in these environments, participants described avoidance strategies, or confrontation and in some cases conflict with smokers.

For example, women and men from both income groups discussed how they reposition themselves in public spaces, avoid particular activities (smoky clubs or bars), or change their commuting route to avoid smokers.

> Sometimes what I do is I try to like I put my hands up and kind of air out the air in front of my face, or sometimes I'll just walk fast and try to avoid it, or I'll move myself away, try to move myself away as much from the area (female, non smoker, low income).

> I mean aside from standing upwind I'm always, you know, juggling myself around so I'm out of it. (male, former smoker, not low income).

Conscious repositioning allowed participants to create and maintain distance from SHS and avoid contact with smoke and smokers.

Similarly, some participants described how they alter their smoking behaviour to avoid affecting nonsmokers. However, other participants reported difficulties in managing their smoke exposure in public spaces, sometimes escalating into conflict when confronting strangers who were not respecting SHS policies.

> I went to the Salvation Army for a meal, you know, so a guy comes and sits beside me, picks up a cigarette and starts blowing smoke at me, you know. And then I asked him, you know "That's kind of rude" and he says "Oh well, this is the way people smoke", you know, right. "I'm allowed to smoke at this table here!" you know "Okay". But you know, I just got up and left. (male, non smoker, low income).

> I've had one where the guy came back and I was sitting there waiting in a line-up to buy tickets and I asked him politely. He looked at me and said "Get lost" and "moron" and this and that and started mouthing off to me. (male, former smoker, not low income).

These statements display the tension that exists between some smokers and nonsmokers. Several participants described smokers as being "rude" or "inconsiderate" in subjecting them to SHS and were hostile when confronted about their smoking. However, variations clearly exist in how nonsmokers cope with and control their exposure, and the interaction that occurs between smokers and nonsmokers.

4.3. Disparities in the Effect of Policies and Management of SHS. Participants suggested that not all women and men are experiencing the potential benefits of SHS policies (i.e., reduced SHS exposure, improved health). Gender roles and responsibilities, and social and economic differences impact women and men's vulnerabilities to smoking and SHS exposure. An unintended and undesirable consequence of smoking restrictions is the potential to reinforce or enhance these vulnerabilities, contributing to disparities in health between women and men, and subpopulations of women and men. We have identified the potential for the following disparities related to SHS exposure and management: stigma during pregnancy and parenting, gender differences in vulnerabilities to exposure in the home and workplace, gender differences in the management of SHS and socioeconomic disadvantage.

4.3.1. Stigma during Pregnancy and Parenting. Both men and women spoke about their experiences of stigma or discrimination as smokers. However, one of the key vulnerabilities that emerged for women in regards to SHS is the effects of the denormalization of smoking particularly during pregnancy and mothering, and the heightened potential for stigma and shaming within this context. The following quotes demonstrate the strong pressures that exist in regards to smoking during pregnancy:

> P: . . . I have not been friends with anyone that smokes when they're pregnant, and in this day and age I do not know if I could be friends with them.

> I: It's a really, it's a contentious issue, right. Like so what happens if you live with that woman who's pregnant, right?

> P: If I was a man, I would probably say "I'm going to divorce you if you do not, and I'm going to fight for the child." Yeah, I would divorce someone for that. (female, smoking status unknown, low income).

> [My partner] knows she cannot, she's pretty, she's aware that she cannot, you know, endanger another person or a child or a life, so I know for a fact that if she was to get pregnant she wouldn't be smoking, I know that. She would never put a child at risk like that. (male, non smoker, not low income).

During interviews and focus groups, smoking during pregnancy was framed as an irresponsible behaviour. Media and health advocacy around SHS have often focused on exposure during pregnancy and among children. For women who are not able to spontaneously quit, the moral implications associated with smoking during pregnancy and parenthood exacerbates the feeling of stigma and shame for women, hindering their capacity to reduce or quit smoking. An unintended consequence is that women may avoid seeking cessation help from practitioners or their partners or families for fear of conflict, judgement, or incrimination.

4.3.2. Gendered Aspects of Vulnerability to Exposure in the Home and Workplace. Women more often talked about their challenges in managing their smoke exposure in the home. Higher rates of smoking among men were understood to result in greater rates of exposure for women in the home if they have a male partner who smokes. Furthermore,

participants articulated experiences of conflict related to SHS as stemming from gender differences in power or control over financial resources. For example, the following female participants suggested that they lack decision-making power in the home.

> I: Okay. Now can you describe any challenges you have in managing your smoke exposure?
>
> P: Yeah, I like having air in my house (female, non smoker, low income).
>
> Well the way it is right now, I mean my husband's the one that smokes, so he does not, like "Oh no, eh, whoever wants to come and smoke, eh, why not?" Excuse me. That's all, I mean this—it's almost gotten us for, you know, a divorce over this issue. (female, smoking status unknown, low income).

In particular, the ownership of private space (homes, cars) was understood to warrant the decision-making authority around smoking or smoking restrictions. Due to sex segregation of both paid and domestic work, women may have more responsibilities within the domestic sphere but a limited ability to participate in decision making on SHS policies. With increasing public smoking restrictions, a potential unintended consequence is that women may endure more SHS exposure and challenges related to SHS management in the home.

While women face particular vulnerabilities in the home, participants thought that men were more likely to be exposed to SHS in the workplace. In particular, men involved in trades-based occupations, which tend to be male dominated, were perceived to be more vulnerable to smoking and smoke exposure. These types of occupations may in certain cases be exempt from workplace SHS laws. For example, although smoking in work vehicles is prohibited in British Columbia, participants still reported observing or experiencing male workers smoking during their commute to work sites. Similarly, if work is done outdoors, employees may be permitted to smoke on the job site. Gender divisions in the home and workplace shape women and men's vulnerabilities to smoking and smoke exposure.

4.3.3. Gendered Aspects of the Management of SHS. Gender differences were noted in responses to, and management of, SHS. Findings suggest that men confront a particular set of challenges in managing SHS. According to feedback from participants, men face more pressure to smoke and less social support to assist with reduction or cessation.

> There might be more peer pressure to smoke with men, because it's, I do not know, like from the crowd that I come from, it's not really like okay for the women to smoke, but the men typically smoke all the time and because my boyfriend does not smoke, so when he comes over my father is like "Oh, here a smoke, have a smoke," and my boyfriend's like "Oh no, that's fine." And then it's like "No, no, no, no, here have one." So it's, it's just a little awkward, so I guess a man thing I guess. (female, smoker, not low income).

In some situations, men may be encouraged by other men to smoke, possibly due to expectations regarding "masculinity" or the use of smoking as a socialization tool. While women may be more likely to be exposed to their partner's smoking, men may face unique vulnerabilities to SHS due to their gender identities and social expectations regarding smoking and tolerance to SHS.

> [Secondhand smoke is] not as that much of an issue for us [men], like it is on women. Like men it's not that big of a deal … [Have] a smoke around [a woman], she'll cover her nose, she'll pull her shirt over her nose, and she goes "Can you stop doing that? Can you smoke over, go down the street," like she'll actually freak out, she hates it. And like some of the guys, like they just do not do anything. They just stand there, whatever. The girls always are just like running around and like, trying to like get away from it. (male, smoker, low income).
>
> Yeah. I think that men generally, when they're exposed, they—my impression is that they just put up with it, they do not really, or it does not seem to bother them as much … Just because, well, I do not know, to me it's perceived like a macho thing and you know, like they seem to be just more compliant or more acceptable of it. (female, non-smoker, low income).

It may be more socially acceptable for men to smoke compared to women and more acceptable for women to ask others not to smoke. While women may have less power or capacity to make decisions regarding smoke exposure in partnerships (particularly in the home), in certain contexts women may be more likely to ask others not to smoke or demonstrate less tolerance for smoke exposure.

> Well, I would have to say that the men that I know are less likely to complain to friends who happen to be smokers, and are more likely to put up with it. Women possibly who are in relationships may not be as likely to complain to the partner that they happen to be with, but that's just an assumption. (female, non-smoker, low income).

In some social circumstances, it is not perceived as "manly" to voice concern or "complain" about SHS, particularly within groups of men. Women, on the other hand, were regarded as being more health conscious and more likely to limit their exposure to SHS. However, under different conditions, participants thought that women would be less assertive and less likely to confront a stranger about their SHS.

> I guess if it were a group of men smoking and a woman being exposed to it, she may feel sort of, either a little bit more daunted if she were going to approach them about it or ask them to move away, or something like that, opposed to a guy asking a group of women. (female, non-smoker, not low income).

It may not be that either women or men are more at risk for SHS exposure, but rather that they encounter unique vulnerabilities based on gender roles and expectations, and power differences in relationships or social situations.

4.3.4. Socioeconomic Disadvantage. The majority of participants thought that people living on a low income would be more vulnerable to SHS, face more smoking-related challenges and be less likely to benefit from SHS policies.

> [People living on a low income] would have more challenges in life, so it could be a coping mechanism, or someone in their family is the one smoking so there would be even greater chances of being exposed to second-hand smoke . . . They may not be able to afford other options that someone more well off could if they wanted to choose a healthier lifestyle (female, non smoker, not low income).

Participants noted that smokers tend to be poor and have fewer resources to afford healthier options, experience more stress and anxiety and are more likely to use smoking as a coping mechanism. Some people living on a low income use smoking to cope with mental illness, and therefore face more barriers to reducing or quitting smoking.

Participants thought that people living on a low income tend to be surrounded by more smokers, and also that smoking restrictions are less likely to be regulated. Low-income neighbourhoods or housing areas often lack access to private outdoor space, creating challenges for those individuals trying to reduce their smoking or SHS exposure.

> Um, I would feel that if you're in a lower income area for example, living-wise, you are kind of grouped together in a smaller area and more pushed together, I guess, and it's just a smaller space with more people smoking, so it would be harder to get away from (female, smoker, low income).

Women and men living on a low income are more likely to live in more crowded areas, with more smokers and less safe, open spaces. These physical constraints limit opportunities to avoid SHS exposure in spite of increasing restrictions. The physical, social, and economic barriers low-income women and men encounter to reducing smoking and smoke exposure may reinforce or intensify health-related disparities.

5. Discussion

Smoking restrictions have resulted in a reshaping of both the social and physical environment. Participants described a reshuffling and relocating of where people are smoking, bringing new challenges both for smokers and for those managing smoke exposure. These findings align with previous qualitative work done by Bell and colleagues that found that smokers in Vancouver are experiencing a narrowing of space due to location restrictions [50]. A study by Kaufman and colleagues [56] in Toronto also revealed how nonsmokers are navigating their environment in new ways to avoid smoking in outdoor urban spaces, particularly around doorways of businesses where smoking continues to cluster.

Likewise, participants in our study discussed difficulties in avoiding outdoor SHS, particularly in bus stops and near businesses. While smoking is prohibited in these spaces in Vancouver, the lack of other available spaces for smoking in public, coupled with the difficulty of enforcement in all places at all times, impedes the effect of policies in these spaces. Without the effective enforcement of smoking restrictions in public outdoor spaces, the narrowing of available space for smokers, along with the increasing denormalization of smoking, may increase the presence and frequency of social tensions between smokers and nonsmokers. Smoking restrictions need to be coupled with strong and tailored tobacco reduction and cessation support, particularly for vulnerable populations who experience more barriers to quitting.

There was variation in participants' management of SHS and the impact of restrictions on social relations and interactions. The differences identified by participants in the effects of SHS policies and SHS management on social interactions include the attitudes towards and tolerance of smoking and SHS, relationship dynamics, place of exposure, and capacity or power to control exposure. Smoking restrictions appear to be contributing to the increasing division of smokers and nonsmokers and are impacting social exchanges related to SHS. But differences in tolerance to SHS and/or power differences structure some participants' ability to modify their SHS, sometimes leading to conflict in the private domain [57].

The differences between participants' experiences of policies and SHS management are backed up by other qualitative studies that have identified different levels of tolerance, interaction styles, and power dynamics related to smoke exposure [53, 54], the implementation of home smoking policies [54], and reducing or quitting smoking during pregnancy [58]. Poland and colleagues identified heterogeneity in smokers and nonsmokers attitudes and responses to SHS. They distinguish between "reluctant" smokers who demonstrate concern over smoking around others, "easygoing" smokers who support restrictions and limit their smoking around others, and "adamant smokers" who are less inclined to limit their smoking around nonsmokers [53]. Similarly, they identified nonsmokers as either "adamant" or highly intolerant to smoking, "unempowered" smokers who oppose but do not or cannot manage their exposure, or "laissez-faire" nonsmokers who are less opposed and therefore less likely to manage their exposure. Different relationship dynamics related to the implementation of a home SHS policy, ranging from voluntary to negotiated or enforced restrictions have also been described [54]. Finally, Bottorff and colleagues

have discussed the social context and relationship dynamics associated with smoking reduction and cessation, within the context of pregnancy. They found complex tobacco-related interaction patterns between couples when quitting during pregnancy [58], including disengaged (individualized decision-making), conflictual (shaming, monitoring, hostility), and accommodating (work together/open communication) interaction patterns. For example, for couples with a conflictual interaction pattern, smoking cessation during pregnancy may result in the "policing" of the other partner's smoking behaviour [58] or even abusive and controlling behaviour [57]. Together with our findings, these suggest that SHS management is a complex process, influenced by individual tolerance of SHS and responses to smoking restrictions, along with social and situational differences and interpersonal dynamics and relationships. Tobacco control policies and programs are needed that respond to these complexities and support varied approaches to reduction, cessation, and SHS management.

While the process of denormalization may in fact encourage some people to quit smoking, for smokers who are unable or lack the resources to quit, smoking-related stigma negatively impacts their health and quality of life and may undermine their ability to quit. Individuals who experience social stigma may be more likely to conceal their smoking, inhibiting access to cessation support from health care providers and friends and family [59]. In particular, our study revealed high levels of denormalization and potential for smoking-related stigma in the context of pregnancy and motherhood. Policies aimed at reducing SHS have also been found to contribute to smoking stigmatization among mothers by others, and that these effects are particularly harmful for socially disadvantaged mothers [60]. Given that women who smoke during pregnancy are more likely to be socially disadvantaged and experience more barriers to quitting, these findings support the need for women-centred approaches to smoking cessation and reduction during pregnancy that reduce stigma and focus on the health of women in and of itself [61]. Emerging qualitative research reveals that new fathers who smoke experience negative judgement, and perceive smoking to conflict with dominant ideals of masculinity and their role as provider and protector of the family [62]. While this theme did not emerge during interviews and focus groups in our study, this remains an important area for further research.

Participants described unique vulnerabilities related to power differentials, access to economic resources and gendered roles and relations. Our findings suggest that women have more challenges in reducing smoke exposure in the home and men in the workplace. In support of this, a study by Paul and colleagues found that low-income men working outdoors were vulnerable to smoking and smoke exposure [13]. While participants in our study thought men are more exposed to SHS at work, other research suggests that women may also face special challenges in managing SHS in the workplace. For example, research reveals that women more often occupy restaurant and bar jobs and face challenges in enforcing smoke-free establishments in these settings [63] and also encounter a prosmoking context when working in office and retail positions [13]. Together, these findings suggest that both men and women are at risk of SHS exposure at work, in part due to a gendered and classed division of labour.

The finding that women tend to cite more difficulties in negotiating a smoke-free home may in part be due to higher smoking rates among men, making it more likely that a woman would be exposed to a male partner's smoking. Furthermore, research reveals that as smoking restrictions intensify, smoking may shift into the home, valued by some smokers as one of the last "comfortable" places to smoke [13]. Yet these differences are also indicative of power differences that exist between women and men, particularly related to the control of financial resources and home ownership. Men more often control the financial resources in the home, and women may be less able to speak up about SHS exposure. Given that women and children living with smokers are at an increased risk of disease and death, these reports have serious health implications [64]. Smoking cessation interventions are needed for women that explicitly address these factors and differences in power and incorporate negotiation skills and empowerment principles.

On the other hand, our findings indicate that men encounter specific vulnerabilities to SHS due to perceptions of masculinity. Smoking among men appears to be more socially acceptable, and asking others not to smoke conflicts with social understandings of "manliness". For example, a study by Germain and colleagues found that males were less likely than females to move away from SHS [55]. Smoking may also be used as a tool for socializing, in the absence of other opportunities for meaningful connections between men. Morrow and colleagues discuss how the practice of risk behaviours, such as smoking, by men are used as an expression of masculinity [65]. Other research found that men hesitate to use cessation resources due to dominant ideals of masculinity such as "independence" and "strength" [66]. Findings from our study support similar dominant ideals of masculinity that prevent men from limiting their exposure to SHS. Gender-specific and gender-sensitive policies and smoking cessation interventions are needed that account for and address these differences in a men-centred manner.

Furthermore, women and men living on a low income experience numerous barriers to smoking reduction and cessation and SHS management. Smoking in low-income areas may be normalized, smoking restrictions less enforced, and individuals experiencing the many stresses associated with living on a low income may find it difficult to quit [13, 49]. These findings support previous research revealing that people living on a low income are more likely to inhabit a "prosmoking context," receive less education on the health risks of smoking and SHS exposure and are less likely to have smoke-free homes [13]. While there may be less stigma associated with smoking in low-income areas, the relative normalization of smoking within low-income areas makes reducing or quitting smoking or managing smoke exposure a greater challenge. Christakis and Fowler found that the presence of smokers in one's social network discourages smoking cessation, as smokers tend to group

together and in effect normalize smoking within the social group [67]. In a similar vein, the combined stigmatization of smokers with the spatial segregation of low-income groups has been described as producing "smoking islands" that encourage continued smoking and impede cessation efforts [49]. It has been suggested that the perception of smoking as socially unacceptable and the stigmatization of smokers is facilitated by the shift in tobacco consumption to low-income groups [42]. Tobacco control initiatives are required that acknowledge and respond to these inequities and prevent further stigmatization, by addressing the social determinants of health in tailored smoking reduction and cessation interventions.

5.1. Limitations. There are a number of methodological limitations to report. First, due to the qualitative nature of this study, we cannot draw conclusions about the observed differences between women and men of varied income levels in British Columbia or Canada, in general. Second, we were unable to recruit men living on a low income to attend a focus group, and only met with one non-low-income women for a focus group (more women were recruited, but did not show up to the focus group). Because of this, we were only able to collect rich focus group data from low-income women and non-low-income men. Third, although participants' smoking statuses were recorded, sampling was not performed based on smoking status. We recruited more nonsmokers (25) than smokers (15) for the telephone interviews. Therefore, the data collected and presented here does not capture the experiences and viewpoints of smokers and nonsmokers equally. Finally, focus group participants were not identified in connection with questionnaire data during the audio recording or on transcripts. Because focus groups were not organized according to the smoking status of participants, we are therefore unable to include smoking statuses for the quotes of some focus group participants. Despite these limitations, this qualitative study surfaced important themes related to the experience of smoking restrictions and SHS management for women and men of varied income levels and smoking statuses, that warrant further research and consideration during policy development.

6. Conclusions

The experience of smoking restrictions and the management of SHS is influenced by the social context (relationship with a partner, family member or stranger, and control of resources), the space of exposure (outdoor/public or private space, worksite), the social location of individuals involved (gender, income), and tolerance to SHS. As smoking restrictions increase, both smokers and nonsmokers are required to develop new skills to navigate the built and social environment in new ways. Tobacco control policies and interventions are required that acknowledge and respond to the specific vulnerabilities of women and men, and low-income subpopulations. Approaches are needed that prevent further marginalization of the groups most vulnerable to smoking and SHS smoke exposure, such as low-income women, while maximizing the effect and impact of policies. For example, these may include health education messaging that is gender and diversity sensitive, gender-specific workplace interventions, the training of health care providers to address and respond to stigma, and the integration of tobacco control policies with economic and social policies (including housing, child care, and antiviolence). Policies need to be gender sensitive and tailored with women and men in mind, to target (and measure) the unique issues that women and men, and subpopulations of women and men, encounter when managing SHS.

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Research Article

Results of a Feasibility and Acceptability Trial of an Online Smoking Cessation Program Targeting Young Adult Nondaily Smokers

Carla J. Berg and Gillian L. Schauer

Department of Behavioral Sciences and Health Education, Emory University School of Public Health, 1518 Clifton Road NE, Atlanta, GA 30322, USA

Correspondence should be addressed to Carla J. Berg, cjberg@emory.edu

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Despite increases in nondaily smoking among young adults, no prior research has aimed to develop and test an intervention targeting this group. Thus, we aimed to develop and test the feasibility, acceptability, and potential effectiveness of an online intervention targeting college student nondaily smokers. We conducted a one-arm feasibility and acceptability trial of a four-week online intervention with weekly contacts among 31 college student nondaily smokers. We conducted assessments at baseline (B), end of treatment (EOT), and six-week followup (FU). We maintained a 100% retention rate over the 10-week period. Google Analytics data indicated positive utilization results, and 71.0% were satisfied with the program. There were increases ($P < .001$) in the number of people refraining from smoking for the past 30 days and reducing their smoking from B to EOT and to FU, with additional individuals reporting being quit despite recent smoking. Participants also increased in their perceptions of how bothersome secondhand smoke is to others ($P < .05$); however, no other attitudinal variables were altered. Thus, this intervention demonstrated feasibility, acceptability, and potential effectiveness among college-aged nondaily smokers. Additional research is needed to understand how nondaily smokers define cessation, improve measures for cessation, and examine theoretical constructs related to smoking among this population.

1. Introduction

Tobacco use is the number one preventable cause of death in the United States. Despite preventive efforts, approximately 46 million people or 19.9% of the US population smokes cigarettes [1]. Among American smokers, up to 33% smoke nondaily [2] or smoke between 1 and 29 days out of every 30 [3]. Nondaily smoking represents a common smoking pattern among young adults, with 19.9% reporting smoking less than 30 days per month [4].

Nondaily smokers suffer from significant smoking-related morbidity and mortality compared to individuals who have never smoked [5, 6]. According to the 2004 US Surgeon General's Report on the health consequences of smoking, individuals that are exposed to low levels of tobacco are still at risk for cardiovascular disease, lung and gastrointestinal cancers, lower respiratory tract infections, cataracts, compromised reproductive health, and osteoporosis [7]. In addition, smoking 5 or more days per month is associated with shortness of breath and fatigue and smoking at least 21 days per month is associated with symptoms of cough and sore throat [8]. Due to the health consequences of nondaily smoking, it is important to promote cessation, especially among young adult smokers since individuals that quit before the age of 30 will reduce their chances of dying prematurely from smoking-related diseases by more than 90 percent [7].

While a great deal of research has focused on developing cessation interventions for daily smokers, nondaily smokers are typically excluded from intervention studies because their level of smoking often does not meet the inclusion criteria for trials [9]. Unfortunately, nondaily smokers are less likely than heavier smokers to seek or receive treatment [10–12]. Nondaily smokers are significantly different in terms

of their reasons for smoking and motivation to quit and thus require specific intervention strategies and messages. Nondaily smokers have also been shown to be more likely to be ready to quit in the next month, are more confident that they can quit, and are less likely to consider themselves to be addicted when compared to daily smokers [13]. While some report motivation to quit, they have difficulty quitting [14, 15].

From our prior research [16], we have identified several themes related to motivation to quit smoking, including wanting to avoid the stigma of being a smoker, particularly given that the majority of nondaily smokers do not consider themselves to be smokers [17]. Moreover, nondaily smokers reported concern about the opinions of friends, family, and significant others regarding smoking and concern about the impact of secondhand smoke exposure to others around them [16]. A number of nondaily smokers also reported only "smoking when they are drinking" and difficulty refraining from smoking while drinking [16]. Moreover, our research suggests that nondaily smokers more frequently use alcohol than daily smokers [18, 19]. Finally, nondaily smokers report a desire to quit smoking in order to avoid becoming addicted to cigarettes [16]. However, prior research indicated, that over 4 years, 50% of nondaily or occasional smokers in college continued to smoke, with one-third of these smokers progressing onto regular smoking [20].

Given these findings, we developed a four-module online intervention targeting nondaily smokers in the young adult population. The theoretical underpinnings for the intervention were drawn from (1) the Theory of Reasoned Action [21], which posits that behavior is the direct result of intention, which is, in turn, a function of the individual's attitude toward the behavior and his or her subjective norms about the behavior; (2) the Transtheoretical Model and Stages of Change [22], which states that change is a process of progressing through "stages of change" that related to measures of readiness. Based on our formative research and these theoretical frameworks, we developed an intervention targeting nondaily smoking in the college student population and subsequently tested the intervention for feasibility and acceptability as well as potential effectiveness.

2. Materials and Methods

2.1. Procedure. In October 2010, students at six colleges in the Southeast were recruited to complete an online survey assessing general health behaviors [23]. A random sample of 5,000 students at each school (with the exclusion of two schools who had enrollment less than 5,000) were invited to complete the survey (total invited $N = 24{,}055$). Of students who received the invitation to participate, 4,840 (20.1%) returned a completed survey. Eligibility requirements for this study included being between the ages of 18 and 30 years and being a nondaily smoker (i.e., smoking between 1 and 29 days of the past 30 days). We recruited 65 participants who met the eligibility criteria at the time of survey assessment. We enrolled 31 participants who met eligibility requirements, with the majority of participants that were not enrolled being excluded because they either increased their cigarette consumption to daily smoking or did not smoke in the past 30 days. The Emory University Institutional Review Board approved this study, IRB no. 00030631.

The intervention had a duration of four weeks and involved four weekly web-based sessions. Participants were asked to complete an online baseline assessment prior to the beginning of the intervention. During the intervention, participants were contacted via e-mail each week to request that they log into the intervention site. Upon logging in, participants were asked to complete a 7-day timeline followback reporting the number of drinks consumed on each day and the number of cigarettes they had on each day of the past 7 days. Upon clicking the "submit" button, participants were routed to the main intervention landing page. The website provided a graphical depiction of their daily alcohol consumption and daily cigarette consumption over the course of the intervention to date. In addition to this, they were presented with four modules over the four-week period, each of which included a video of 60 to 90 seconds in duration and a targeted message of approximately two brief paragraphs. The modules piloted in this feasibility and acceptability trial included (1) considering oneself a smoker versus the social stigma of being perceived as a smoker; (2) secondhand smoke exposure as a burden to others around you; (3) concurrent alcohol consumption and cigarette smoking; (4) likelihood of continued smoking or progression to regular smoking by graduation. These modules were selected given our prior research indicating the relevance of these four topics to nondaily smokers.

2.2. Measures. Participants completed assessments at baseline (Week 0), end of treatment (EOT; Week 4), and six-week followup (FU; Week 10). Participants received a $20 gift card for completing each of the assessments. We outline the data collected at each time point.

2.2.1. Demographic Characteristics. We assessed included participants' age, gender, and ethnicity. Ethnicity was categorized as non-Hispanic White, Black, or Other due to the small numbers of participants who reported other race/ethnicities.

2.2.2. Process Evaluation Assessments. We assessed participant retention over the course of the intervention. To assess the intervention components, we asked the questions listed in Table 1 at end of treatment. Response options were "yes" or "no" for questions with dichotomous answers or on a scale of 1 to 5 for questions using Likert scales, with a 5 indicating more favorable attitudes.

Data from Google Analytics [24] were also used to examine participant interaction with the website. We assessed average time spent on the site, number of participant visits, bounce rate, and number of page visits. The bounce rate indicates percentage of single-page visits or visits in which an individual left the site from the landing page, with a bounce rate of less than 35% being deemed as reasonable [25]. A high pages per visit average—of at least 3 pages—means visitors are interacting with site content, whereas

Table 1: Process evaluation outcomes at Week 4.

Variable	Mean (SD) or *N* (%)
Participant assessments	
How helpful was it to track your own smoking and alcohol use over time?	3.74 (0.77)
How helpful was it to see a graph of your smoking/drinking level during the program?	3.81 (1.01)
*Would you recommend keeping this in the program?	30 (96.8)
How much of the reading material did you read?	3.58 (1.20)
How relevant was the material to you?	3.42 (1.20)
How interesting or engaging were the messages?	3.55 (1.12)
*Did the messages increase your motivation to quit smoking?	19 (61.3)
*Did the messages increase your confidence in being able to quit smoking?	21 (67.7)
*Would you recommend keeping these messages in the quit smoking program?	30 (96.8)
How much of the videos did you watch?	3.52 (1.26)
How relevant was the video content to you?	3.65 (1.36)
How interesting or engaging were the videos?	3.62 (1.20)
*Did the videos increase your motivation to quit smoking?	20 (64.5)
*Did the videos increase your confidence in being able to quit smoking?	18 (58.1)
*Would you recommend keeping the videos in the quit smoking program?	31 (100.0)
Overall, how satisfied were you with the program?	4.16 (0.93)
How much influence did the program have on your motivation to quit?	3.39 (1.25)
How much influence did the program have on your confidence to quit smoking?	3.32 (1.24)
*Would you recommend participating in this program to your friends who are smoking?	28 (90.3)
Web utilization	
Average time on the site	4: 02
Total visits	379
Bounce rate	28.5%
Number of pages per visit	4.80

Note. Scale items are on a scale of 1 to 5 with higher ratings indicating more favorable attitudes.
*% reporting "yes."

a low average means visitors are viewing one page and quickly moving on to other sites [26].

2.2.3. Alcohol Consumption. To assess alcohol consumption, participants were asked, "In the past 30 days, on how many days did you drink alcohol?" and "In the past 30 days, on how many of those days did you drink 5 or more drinks on one occasion?" These questions have been used to assess alcohol consumption and binge drinking, respectively, in the American College Health Association (ACHA) surveys, National College Health Risk Behavior Survey (NCHRBS), and Youth Risk Behavior Survey (YRBS), and their reliability and validity have been documented by previous research [3].

2.2.4. Smoking Behaviors. To assess smoking status, participants were asked, "In the past 30 days, on how many days did you smoke a cigarette (even a puff)?" and "On the days that you smoke cigarettes, how many cigarettes do you smoke on average?" These questions have been used to assess tobacco use in the American College Health Association (ACHA) surveys, National College Health Risk Behavior Survey (NCHRBS), and Youth Risk Behavior Survey (YRBS), and their reliability and validity have been documented by previous research [3]. At baseline, participants were also asked to report the age at which they smoked their first whole cigarette and the age at which they started smoking regularly.

2.2.5. Social Smoking. To assess social smoking, participants were asked, "In the past 30 days, did you smoke: mainly when you were with other people; mainly when you were alone, as often by yourself as with others, or not at all" [27]. This variable was dichotomized as "social smoking" (i.e., smoking mainly when with others) versus other responses.

2.2.6. Identification of a Smoker. Participants were asked, "Do you consider yourself a smoker?" [17].

2.2.7. Quit Attempts. At baseline, participants were asked, "During the past 12 months, how many times have you stopped smoking for one day or longer because you were trying to quit smoking?" [28]. This variable was dichotomized as having made at least one quit attempt in the past year versus not having made an attempt to quit. At baseline, they were also asked, "What is the longest time you were able to go without cigarettes in the past year? <24 hours; 1 to 7 days;

1 to 4 week; 1 to 3 months; 3 to 6 months; or 6 months to 1 year." At end of treatment, they were asked, "What is the longest time you were able to go without cigarettes in the past four weeks? <24 hours; 1 to 7 days; 1 to 2 weeks; or 2 to 4 weeks." At 6-week followup, participants were asked, "What is the longest time you were able to go without cigarettes in the past 10 weeks? <24 hours; 1 to 7 days; 1 to 2 weeks; 2 to 4 weeks; 4 to 6 weeks; 6 to 8 weeks; or 8 to 10 weeks."

2.2.8. Readiness to Quit Smoking. Readiness to quit was assessed by asking, "What best describes your intentions regarding quitting smoking: never expect to quit; may quit in the future, but not in the next 6 months; will quit in the next 6 months; will quit in the next month; and already quit" [29]. For the present study, this variable was categorized as already quit, intending to quit in the next 30 days, and all other responses.

2.2.9. Concurrent Alcohol Use and Smoking. Participants were asked, "On a scale of 0 to 10, with 0 being 'not at all difficult' and 10 being 'extremely difficult,' how difficult is it for you to consume alcohol without smoking a cigarette?".

2.2.10. Perceived Harm of Smoking. Participants were asked, "On a scale of 0 to 10 with 0 being 'not at all harmful' and 10 being 'extremely harmful,' how harmful to your health is smoking cigarettes?".

2.2.11. Beliefs about Secondhand Smoke (SHS). Participants were asked, "On a scale of 0 to 10 with 0 being 'not at all harmful' and 10 being 'extremely harmful,' how harmful to one's health do you think it is for people to be exposed to secondhand smoke?" and "On a scale of 0 to 10 with 0 being 'no bother at all' and 10 being 'extremely bothersome,' how much do you think secondhand smoke bothers those around you?".

2.3. Data Analysis. Participant characteristics at baseline (Week 0), end of treatment (EOT; Week 4), and six-week followup (FU; Week 10) were summarized using descriptive statistics. Process evaluation assessments were summarized as well. Pairwise (within subjects) t-tests were conducted to examine differences in drinking, smoking-related variables, and psychosocial variables from baseline to EOT and from baseline to FU. Chi-squared tests examined categorical variables across time, comparing baseline to EOT and baseline to FU. SPSS 18.0 was used for all data analysis. Statistical significance was set at $\alpha = .05$ for all tests.

3. Results and Discussion

3.1. Results. Participants were 23.16 years of age on average (SD = 4.60), 80.6% ($n = 25$) female, 64.5% ($n = 20$) White, and 32.3% ($n = 10$) Black. Average age of having their first whole cigarettes was 17.35 years (SD = 3.62), and average age of starting smoking regularly was 19.03 years (SD = 4.08). At baseline, 15 (48.4%) reported having made a quit attempt in the past year, 22 (71.0%) were categorized as social smokers, and 15 (48.4%) considered themselves to be a smoker.

3.1.1. Process Evaluation. The intervention demonstrated 100% retention from baseline to EOT and to FU. Table 1 presents detailed data regarding the process evaluation of the study. Importantly, 54.9% of individuals gave scores of 4 or 5 regarding how helpful it was to track their smoking and alcohol over time, with 67.7% indicating that it was helpful to see a tailored graph of this information. Moreover, 71.0% reported being satisfied with the program (i.e., giving a score of 4 or 5), with 90.3% indicating that they would recommend the program to their friends who smoke.

In addition, the utilization of the website per Google Analytics demonstrated positive results. Average time on the website per visit was 4 minutes and 2 seconds. We had a total of 379 visits over the course of the four weeks, averaging 3.05 visits per week per participant. There was a 28.5% bounce rate, and participants also were active on the website, with 4.80 pages per visit.

3.1.2. Change in Smoking Behaviors and Attitudes. In terms of changes in average number of days of cigarette and alcohol consumption between baseline and the end of treatment (Week 4), no significant differences existed (see Table 2). However, significant decreases existed between baseline and followup (week 10) with regard to the number of days of alcohol consumption ($P = .004$), binge drinking ($P = .02$), and cigarette smoking ($P < .001$) as well as average CPD on smoking days ($P = .003$). In addition, there were increases in the number of people refraining from smoking for the past 30 days from baseline to EOT ($P < .001$) and to FU ($P < .001$), with 2 reporting no smoking in the past 30 days at EOT and 5 reporting no smoking in the past 30 days at FU. In terms of psychosocial factors, being quit for the past 30 days at EOT and FU was associated with confidence in quitting (EOT: 10.0 ± 0.00 versus 8.48 ± 1.50, $P < .001$; FU: 10.00 ± 0.00 versus 8.31 ± 1.49, $P < .001$). In addition, participants increased in their perceptions of how bothersome SHS is to others from baseline to EOT ($P = .04$) and to FU ($P = .02$); however, no other attitudinal variables were altered, and no attitudinal factors, either from baseline or as change scores, were related to smoking cessation outcomes at either EOT or FU.

At EOT, in addition to the two individuals that had not smoked in the past 30 days, 9 (29.0%) reported having reduced their smoking, with the average reduction of cigarette consumption on smoking days being 3.33 cigarettes (SD = 2.55) among those who reduced their smoking. At FU, in addition to the five individuals that had not smoked in the past 30 days, 17 (65.4%) reported having reduced their smoking, with the average reduction of cigarettes on smoking days being 1.73 cigarettes (SD = 1.35) among those who reduced their smoking.

Participants reported increases in readiness to quit from baseline to EOT ($P = .001$) and to FU ($P = .003$), with some individuals transitioning to quit status and some becoming ready to quit in the next 30 days, although this may be

Table 2: Bivariate analyses comparing Week 0 to Week 4 and Week 10 factors.

Variable	Week 0 (baseline)	Week 4 (End of Tx)	*P* value	Week 10 (6-week FU)	*P* value
	Mean (SD) or *N* (%)	Mean (SD) or *N* (%)		Mean (SD) or *N* (%)	
Number of days of drinking, past 30 days (SD)	9.97 (7.38)	11.00 (8.01)	.38	7.55 (6.92)	.004
Number of days of binge drinking, past 30 days (SD)	3.54 (4.79)	3.29 (3.60)	.74	2.32 (2.81)	.02
Number of days of smoking, past 30 days (SD)	14.83 (10.43)	14.45 (10.21)	.54	10.87 (10.92)	<.001
Smoked in the past 30 days (%)	31 (100.0)	29 (93.5)	<.001	26 (83.9)	<.001
Ave. CPD on smoking days (SD)	3.00 (2.24)	2.80 (1.87)	.37	2.29 (1.87)	.003
Longest abstinence in the past year (%)					
<24 hours	—	—	—		—
1 to 7 days	8 (25.8)				
1 to 4 week	3 (9.7)				
1 to 3 months	8 (25.8)				
3 to 6 months	9 (29.0)				
6 months to 1 year	3 (9.7)				
Longest abstinence in the past four weeks (%)					
<24 hours	—	—	—		—
1 to 7 days		22 (71.0)			
1 to 2 weeks		2 (6.5)			
2 to 4 weeks		7 (22.6)			
Longest abstinence in the past 10 weeks (%)					
<24 hours	—	—	—	1 (3.2)	—
1 to 7 days				10 (32.3)	
1 to 2 weeks				4 (12.9)	
2 to 4 weeks				8 (25.8)	
4 to 6 weeks				3 (9.7)	
6 to 8 weeks				0 (0.0)	
8 to 10 weeks				5 (16.1)	
Readiness to quit in next 30 days (%)			.001		.003
No	26 (83.9)	20 (64.5)		21 (67.7)	
Yes	5 (16.1)	5 (16.1)		6 (19.4)	
Already quit	—	6 (19.4)		4 (12.9)	
Confidence in quitting (SD)	8.58 (1.50)	8.16 (2.30)	.28	8.48 (1.69)	.75
Motivation to quit (SD)	6.52 (3.38)	6.23 (3.12)	.42	7.06 (3.24)	.39
Difficulty drinking without smoking (SD)	4.74 (3.83)	4.80 (3.63)	.91	4.81 (3.62)	.92
Perceived harm of smoking (SD)	8.77 (2.09)	8.75 (1.98)	.93	9.00 (1.43)	.57
Perceived harm of secondhand smoke (SD)	8.67 (1.83)	8.52 (2.11)	.55	8.48 (2.04)	.47
Perceived bother of secondhand smoke (SD)	6.35 (3.31)	7.48 (2.11)	.04	7.52 (2.59)	.02

confounded by participants' definitions of the meaning "already quit smoking" (i.e., one of the response options for the readiness to quit smoking question) as compared to their reported number and frequency of cigarettes smoked. At the end of treatment (EOT), 6 (19.4%) reported having quit smoking per the assessment of readiness to quit, with two of these individuals not having smoked during the duration of the study and two individuals having smoked a total of 2 cigarettes over the course of the study (one had been abstinent over a week prior to the final assessment, and one had been abstinent over two weeks). Interestingly, one individual who reported being quit had smoked a total of 35 cigarettes over the course of the study on a total of 11 days, but had been abstinent for 3 days prior to the EOT assessment. This participant smoked 10 days of the past 30 days at baseline. Also, one individual who reported being quit at EOT reported smoking a total of 37 cigarettes over the course of the study on a total of 28 days without any abstinent days prior to the EOT assessment. Even more interestingly, 6 people had been abstinent for the entire fourth week, 5 had been abstinent during both the third and fourth weeks, 4 had been abstinent from the second to the fourth week,

and 3 had reported no smoking in the first to fourth week. However, only four of these individuals selected the "already quit smoking" option.

3.2. Discussion. This is the first study to focus exclusively on developing and pilot testing an intervention targeting nondaily smoking among young adults. The current study is important for several reasons. First, it documents the feasibility and acceptability of an online smoking cessation intervention targeting nondaily smoking in the young adult population, as well as the acceptability and relevance of nondaily smoking cessation messages targeting this population. Second, it suggests the potential effectiveness of this intervention in effecting smoking reduction and cessation among young adult nondaily smokers. Finally, it highlights methodological issues related to evaluating a cessation intervention targeting nondaily smokers.

In terms of feasibility, we were able to recruit the individuals who met eligibility for the current study; moreover, we were able to achieve 100% retention of our 31 participants over the four-week intervention period as well as over the six-week followup period. Our process evaluation assessments indicated that, on average, participants deemed the tracking and graphing of alcohol and cigarette consumption to be helpful and the messages and videos to be relevant and engaging. The majority also reported the messages and videos to have increased their motivation to and confidence in quitting smoking. Participants reported a high degree of satisfaction, and 90.3% reported that they would recommend the program to friends or family who smoke. Moreover, utilization of the website, per Google Analytics data, was appropriate, with a substantial amount of time spent on the website on average, repeated visits per participant per week over the course of the intervention, a reasonable bounce rate, and an appropriate pages per visit record [25, 26]. Thus, these data suggests the feasibility and acceptability of the intervention.

Regarding changes in smoking behavior and attitudes over the course of the intervention and assessment period, our intervention demonstrated potential effectiveness, with a significant number of people reporting no smoking in the past 30 days at followup, six weeks after the intervention. However, we are unable to ascertain the proportion of nondaily smokers that would have been abstinent for the past 30 days without the intervention since, by definition, nondaily smokers do not smoke every day, or even every week. No research to date has assessed the rapid changes in nondaily smoking or the patterns of cigarette consumption that exist.

From baseline to six-week followup, we also documented a significant decrease in number of days of cigarette consumption, alcohol consumption, and binge drinking. A significant proportion of individuals also decreased the average cigarettes smoked per day during smoking days from the baseline to the six-week followup period. Prior research has documented that monitoring behavior in and of itself can lead to improvements in health behaviors [30]. However, the current study did not document significant changes over the four-week monitoring period. It is possible that participants continued to monitor their behavior either intentionally or unintentionally after the completion of the study. Alternatively, perhaps the natural course of the academic year had an impact on cigarette and alcohol consumption. A randomized controlled trial of this intervention would be able to address this issue.

Finally, our intervention yielded promising results in terms of increasing participants' awareness regarding how bothersome nonsmokers around them may perceive SHS exposure to be. However, theoretical measures like motivation and confidence to quit smoking or attitudes about smoking were not significantly altered, nor were participants' appraisals of difficulty of drinking alcohol without smoking. Furthermore, participants did not demonstrate significant changes in perceived harm of smoking or SHS exposure. However, participants perceive a high level of harm of smoking and SHS at baseline; thus, this might reflect a ceiling effect for perceived harm. Moreover, it may also be that individuals who perceived a high level of harm were more likely to enroll in this study, which should be examined in subsequent research. Two factors may have influenced the effect of the intervention on perceived bother of SHS to others. First, baseline ratings on this assessment of perceived bother of SHS were lower than perceived harm and thus were less likely to have a ceiling effect. Second, one of the modules explicitly focused on the bother of SHS exposure to nonsmokers, whereas the other variables (addressing specific skills related to refraining from smoking while drinking or perceived harm of smoking or SHS exposure) were less central to other intervention messages. The fact that smoking behavior changed despite the fact that attitudinal, motivational, and perceived harm measures were not altered indicates that theoretical and psychosocial constructs that typically predict behavior may operate differently in nondaily smokers. Among regular or daily smokers, motivation and confidence to quit [31–33] as well as perceived harm of smoking [34, 35] predict smoking cessation. However, among our sample of nondaily smokers, confidence in quitting was the only baseline factor that was associated with EOT and FU cessation. It is possible that other factors are less central to behavior change in nondaily smokers given the less established pattern of the behavior and/or the cognitive dissonance that might exist around the behavior (e.g., nondaily smokers often do not consider themselves to be smokers [17]). Our findings suggest the need to examine the relative contribution of these varied factors to the process of smoking cessation and reduction among nondaily smokers.

Despite relatively few changes in attitudinal variables in general, participants demonstrated trends in increased readiness to quit smoking. However, a critical finding from this research relates to the varied definitions and perceptions that nondaily smokers have of being "quit." In light of the inconsistencies in reported "quits" as compared to reported smoking, further examination of nondaily smokers' conceptualization of smoking status and smoking cessation is warranted. Furthermore, our study highlights the need for additional qualitative research to better understand how

nondaily smokers define their own cessation and quantitative research to further define measurements for smoking cessation among nondaily smokers. It is critical to strive for consistency of research in this area and for clear articulation when gathering cessation status from nondaily smokers.

3.3. Limitations. A number of limitations should be considered when interpreting these results. First, this was a small sample, limiting the overall power of the study. However, despite the sample size, a number of significant and important findings were detected related to cessation in nondaily smokers, a population that has not been extensively studied. In addition, the sample was drawn exclusively from southeast colleges, which limits generalizability to other parts of the country or to other groups of young adults. On a related note, our sample was largely female despite the fact that young adult males have a higher rate of smoking [36]. Greater efforts are needed to recruit and enroll young adult male nondaily smokers into interventions targeting nondaily smoking. Furthermore, no control condition was included to determine whether or not changes were due to the intervention or simply to the changing smoking patterns of nondaily smokers. Future research should include a control arm and be tested for efficacy among a larger sample of nondaily smokers in the young adult population.

4. Conclusions

This study suggests that an online intervention targeting factors specific to nondaily smoking is acceptable to a college-aged nondaily smoker population and that individuals will participate and engage in such an intervention. Additional research is needed to better understand how nondaily smokers define cessation and to establish and improve measurement standards for cessation among this population.

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Research Article

Concurrent Use of Cigarettes and Smokeless Tobacco in Minnesota

Raymond G. Boyle,[1] Ann W. St. Claire,[1] Ann M. Kinney,[2] Joanne D'Silva,[1] and Charles Carusi[3]

[1] *Research Program, ClearWay Minnesota, 8011 34th Avenue South, Suite 400, Minneapolis, MN 55425, USA*
[2] *Minnesota Center for Health Statistics, Minnesota Department of Health, P.O. Box 64882, St. Paul, MN 55164-0882, USA*
[3] *Behavioral Health Group, Westat, 1600 Research Boulevard, Rockville, MD 20850, USA*

Correspondence should be addressed to Raymond G. Boyle, rboyle@clearwaymn.org

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Cigarette smokers are being encouraged to use smokeless tobacco (SLT) in locations where smoking is banned. We examined statewide data from Minnesota to measure changes over time in the use of SLT and concurrent use of cigarettes and SLT. The Minnesota Adult Tobacco Survey was conducted four times between 1999 and 2010 and has provided state-wide estimates of cigarette smoking, SLT use and concurrent use of SLT by smokers. The prevalence of SLT was essentially unchanged through 2007, then increased significantly between 2007 and 2010 (3.1% versus 4.3%, $P < 0.05$). Similarly, the prevalence of cigarette smokers who reported using SLT was stable then increased between 2007 and 2010 (4.4% versus 9.6%, $P < 0.05$). The finding of higher SLT use by smokers could indicate that smokers in Minnesota are in an experimental phase of testing alternative products as they adjust to recent public policies restricting smoking in public places. The findings are suggestive that some Minnesota smokers are switching to concurrent use of cigarettes and SLT. Future surveillance reports will be necessary to confirm the results.

1. Introduction

The use of snuff and chewing tobacco, commonly referred to as smokeless tobacco (SLT), has a long history of use in the United States that preceded the use of manufactured cigarettes [1]. However, use of SLT never gained the popularity of cigarettes instead it has been more common within specific subgroups such as outdoor workers and in certain geographic regions of the country. The most recent report from the Centers for Disease Control and Prevention (CDC) [2] identified key demographic characteristics associated with current use of SLT. Use was highest among males, young adults, and persons with fewer completed years of education. The CDC report provided for the first time state-specific estimates of current cigarette smokers using SLT, with the highest prevalence rates in Wyoming (13.7%) and Montana (12.1), with Minnesota also in the top tier (10.5%). The use of both cigarettes and SLT presents a unique public health challenge as concurrent users may have less desire to stop tobacco use [3] and may be less likely to quit tobacco compared to cigarette smokers [4]. This may be related to higher dependence as users of both cigarettes and SLT experience higher levels of serum cotinine [5].

In contrast to the declining sales of cigarettes [6], sales of SLT have increased in recent years [7]. However, up to this point there has been little evidence that cigarette smokers in USA switch to SLT as an alternative to cigarettes [8, 9]. We had an opportunity to examine the use of SLT among cigarette smokers as part of a tobacco surveillance system in Minnesota. The research goals for this paper are to measure changes in the prevalence rates of SLT and concurrent use of SLT by adult cigarette smokers. In addition the characteristics of smokers using SLT are described.

2. Methods

2.1. Data Source. This paper includes data from the Minnesota Adult tobacco Survey (MATS), a statewide, cross-sectional, and random digit dial (RDD) telephone survey. MATS measured tobacco use, behaviors, attitudes, and beliefs among adults aged 18 and older across 4 time

points: in 1999 ($N = 5,968$), 2003 ($n = 8,782$), 2007 ($n = 12,580$), and 2010 ($n = 7,057$). After the first survey the Minnesota Department of Health Institutional Review Board reviewed and approved the 2003, 2007, and 2010 MATS questionnaire, data collection, and data security procedures.

The RDD-sampling method for all rounds of the MATS involved a two-step process; a household screening questionnaire was developed to identify households and then identify and sample people within the households. The main questionnaire contained all of the questions for the MATS adult tobacco survey interview. All rounds of the MATS used computer-assisted telephone interviewing. The survey contained the same core questions for each round and lasted between 12 and 24 minutes depending on the smoking status of the respondent.

Several communication methods were used before and during data collection for each round of the survey to improve response rates and provide information about the survey. These included letters, an informational website, and contact numbers that potential respondents could call for information. Consistent with other large-scale, telephone-based surveys, MATS telephone interviewers made a second attempt to secure cooperation by recontacting persons who initially declined to participate in the survey.

It is notable that the sample sizes for the 2003 and 2007 surveys were larger than for the other surveys. Samples of Blue Cross and Blue Shield of Minnesota members were added for these two survey years by using stratified random samples of the membership lists, then combining this sample with the RDD sample into a single file with sample weights that reflected each case's probability of selection, including the combined probability of a Blue Cross member also being sampled in the RDD sample. There was also a change in the RDD sampling frame for the 2010 survey. In order to address growing concerns about coverage in telephone surveys, the 2010 MATS used two sampling frames: (1) all possible Minnesota cellular telephone numbers, and (2) all possible Minnesota landline telephone numbers. The two samples were combined into a single file with sample weights that reflected each case's probability of selection, including the combined probability of a household with both cell and landline phones being sampled in either frame.

The response rate for MATS 2010, calculated using the American Association for Public Opinion Research methodology, was 44.5 percent for the cell phone sample and 45.0 percent for the landline sample. These response rates are comparable to prior rounds of the MATS survey. More information on the MATS methodology can be found at http://www.mnadulttobaccosurvey.org/.

3. Measures

The MATS survey includes questions on demographics, tobacco use, harm perceptions, work place policies on smoking, and home policies on smoking. This paper examined variables that were asked of all users of cigarettes and SLT. Demographic questions included age, gender, marital status, and highest educational level completed. Current smokers were defined as those who reported having smoked 100 cigarettes in their lifetime and who currently smoked "every day" or "some days" at the time of the interview. Smoking intensity was categorized by the average number of cigarettes smoked per day as less than 10 cigarettes, 10 to 19 cigarettes, and a pack or more cigarettes per day.

Respondents were asked if they had used any kind of SLT, such as chewing tobacco, snuff, or snus. This categorization is consistent with the CDC's Behavioral Risk Factor Surveillance System (BRFSS). Also, respondents were asked if they thought SLT was more harmful, less harmful, or just as harmful as smoking cigarettes.

Respondents were asked in a separate question about ever use of snus, with "Camel snus or Tourney snus" as examples. This question was included because of the tobacco industry marketing that was attempting to position snus as distinct from other SLT products. For example, marketing has suggested that snus is spit-free compared to other SLTs. We defined a current snus user as using at least one day in the past 30 days.

In addition, respondents were asked how many adults who live in their household smoke. For analysis a variable was created that identified respondents (yes/no) who lived with an adult smoker. Respondents were also asked about the smoking rule in their home (not including decks, garages, or porches) "smoking is not allowed anywhere inside your home, smoking is allowed in some places or at some times, or smoking is allowed anywhere inside the home." Those who responded that "smoking is not allowed anywhere inside" were considered to have a smoke-free home. This is comparable to how smoke-free homes are assessed in the Current Population Survey Tobacco Use Supplement (CPS-TUS).

Respondents were asked about their perception of harm from smoking an occasional cigarette (yes/no), and from breathing the smoke from other people's cigarettes. Either very harmful or somewhat harmful were combined to denote a positive response. Finally, respondents were asked if they had used any alcohol in the past 30 days (yes/no; beer, wine, wine coolers, or liquor).

4. Data Analysis

Statistical analyses were conducted using SPSS version 19.0 with the *Complex Samples* module. The use of this module enables the data analysis to account for the complex sample designs (e.g., multiple frames and stratification) and the sample weighting. The SPSS complex samples module uses Taylor series linearization method for estimating population characteristics [10]. The MATS surveys were weighted to represent the entire noninstitutionalized adult population in Minnesota, using raking techniques and adjustment factors to account for the dual probability of selection of cases that could have been sampled from the dual frames used in the 2003, 2007, and 2010 surveys. The resulting weights were used in the SPSS complex samples module for all analyses.

We examined potential differences between different survey years using an analysis of nonoverlapping 95 percent confidence intervals to define significant differences. In addition statistical differences in the proportions between selected subgroups were assessed at a. 05 level based on

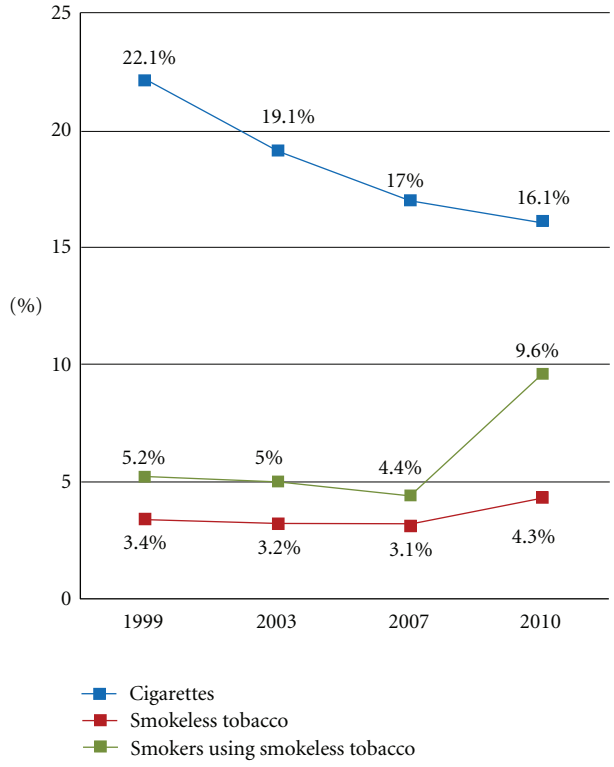

Figure 1: Use of cigarettes and smokeless tobacco in Minnesota, 1999–2010. The prevalence of smokeless tobacco was significantly greater ($P < 0.05$) in 2010 versus 2007. The prevalence of smokers using smokeless tobacco was significantly greater ($P < 0.05$) in 2010 versus 2007.

a z-distribution. For the purpose of analysis, we created three categories of tobacco use: a current smoker (every day or some days), a current SLT user, and a concurrent user (a smoker who reported past 30 day use of SLT). For some analyses of SLT use, we also looked at former smokers who had smoked 100 cigarettes but were not currently smoking and never smokers who had not smoked 100 cigarettes.

5. Results

Figure 1 presents the prevalence of cigarette smoking, SLT use, and concurrent use of cigarettes and SLT across the four MATS surveys. Between 1999 and 2010, adult cigarette smoking prevalence in Minnesota declined from 22.1% to 16.1%, a 27.1% decrease. The rate of decrease was greatest from 1999 to 2003, and the smallest change occurred between 2007 and 2010. The state-wide prevalence of SLT was essentially unchanged through 2007, then increased significantly between 2007 and 2010 (3.1% versus 4.3%, $P < 0.05$). Similarly, the prevalence of cigarette smokers who reported using SLT was stable then increased between 2007 and 2010 (4.4% versus 9.6%, $P < 0.05$). In addition, between 2007 and 2010, there was no significant increase in the use of SLT by former smokers (3.8% versus 4.5%) or never smokers (2.4% versus 2.9%).

The use of SLT by current smokers was examined by stratifying daily and some-day smoking, and by cigarettes per day. Compared to daily smoking, some-day smokers in 2010 were significantly more likely to report use of SLT (7.3% versus 17.3%, $P < 0.05$). Light smokers (1–9 cigarettes per day) were significantly more likely to report use of SLT than smokers using half a pack or more (10-19 cigarettes) (13.7% versus 5.5%, $P < 0.05$). Smokers using a pack of cigarettes or more per day reported similar SLT use (11.1%) as light smokers.

In 2010, rates of SLT use were higher among male smokers compared to female smokers (17.8% versus 1.2%, $P < 0.05$), and among young adults ages 18 to 24 compared to adults ages 45 to 64 (24.9% versus 2.1%, $P < 0.05$). Among all Minnesota adults, the prevalence of snus use in 2010 was 1.3%; however, among smokers the rate was 3.8%. Compared to female smokers, male smokers were more likely to report use of snus (0.7% versus 6.4%, $P < 0.05$), and the highest snus use was reported by male smokers ages 18 to 24 (15.2%).

The characteristics of current smokers, SLT users, and smokers using SLT in 2010 are presented in Table 1. SLT was used almost exclusively by men (98.2%), and most concurrent users were male (93.8%). A significantly greater percentage of concurrent users (32.5%) than cigarette-only smokers (15.6%) were young adults aged 18 to 24. SLT users (91.5%) were more likely to have a home smoking ban than cigarette-only smokers (54.4%) or concurrent users (70.5%). Very few cigarette-only smokers (5%) considered SLT less harmful than smoking cigarettes; tellingly, the cigarette smokers who also used smokeless deemed smokeless as less harmful at nearly five times the rate (24.7%) of the cigarette-only group. The perception of harm from an occasional cigarette did not vary between the groups, and the perception of harm from other's cigarette smoke was high across all groups. SLT users were significantly less likely to report living with a smoker compared to smokers and concurrent users.

6. Discussion

This paper details recent changes in reported use of SLT products in Minnesota. A significant increase in prevalence of SLT use and smokers using SLT was observed between 2007 and 2010. Of note is the doubling in use of SLT by smokers from 2007 to 2010 whereas no similar increase was observed among former smokers or never smokers. The estimate of past 30 day use of SLT by current smokers (9.6%) is supported by current research from the CDC that found 10.5% of Minnesota smokers reported using SLT in 2009 [2].

The increase in concurrent use observed in 2010 was not predicted from earlier research. For example, Zhu and colleagues examined data from a panel of respondents in the 2002/2003 CPS-TUS and found very few men (2.2%) who smoked in 2002 but also used SLT in 2003 [8]. Others have reported low rates of concurrent use. In an analysis of earlier years of the CPS-TUS, Backinger and colleagues [11] found concurrent use of cigarettes and SLT fluctuated nationally from 3.7% in 1995 to 7.9% in 1998. Examining the period

Table 1: Characteristics of Minnesota smokers, smokeless tobacco users, and users of both.

	Cigarette smokers ($n = 746$)		SLT users ($n = 133$)		Concurrent users ($n = 54$)	
	%	95% CI	%	95% CI	%	95% CI
Gender						
Male	46.4%	41.8–51.0	98.2%	94.1–99.5	93.8%	76.1–98.6
Female	53.6%	49.0–58.2	1.8%	0.5–5.9	6.2%	1.4–23.9
Age						
18–24	15.6%	12.3–19.6	23.8%	16.2–33.6	32.5%	20.9–46.7
25–44	41.0%	36.5–45.7	48.6%	39.1–58.1	60.5%	46.1–73.3
45–64	37.4%	33.2–41.7	23.0%	16.0–31.8	7.0%	2.8–16.3
65+	6.0%	4.8–7.6	4.6%	2.4–8.5	0%	—
Education						
Less HS	9.5%	7.0–12.8	13.9%	7.9–23.3	6.1%	1.5–21.0
HS graduate	38.3%	33.8–43.0	20.1%	13.1–29.7	52.4%	37.9–66.5
Some college	43.3%	38.9–47.9	35.9%	27.4–45.3	33.9%	22.0–48.4
College +	8.9%	7.1–11.1	30.0%	22.3–39.2	7.6%	3.3–16.4
Smoking rule at home						
Allowed	45.6%	41.0–50.2	8.5%	4.6–15.2	29.5%	17.8–44.7
Not allowed	54.4%	49.8–59.0	91.5%	84.8–95.4	70.5%	55.3–82.2
Compared to cigarettes, smokeless tobacco is…						
Less harmful	5.0%	3.4–7.4	32.2%	24.0–41.7	24.7%	13.9–40.1
More harmful	17.4%	14.1–21.2	5.1%	2.2–11.6	15.5%	6.8–31.5
Just as harmful	77.6%	73.5–81.3	62.7%	53.0–71.4	59.7%	44.2–73.5
Used alcohol past 30 days						
Yes	64.5%	59.9–68.8	76.2%	66.4–83.8	71.9%	56.3–83.6
No	35.5%	31.2–40.1	23.8%	16.2–33.6	28.1%	16.4–43.7
Harm of occasional cigarette						
Yes	54.2%	49.6–58.8	54.7%	44.7–64.3	55.2%	40.3–69.1
No	45.8%	41.2–50.4	45.3%	35.7–55.3	44.8%	30.9–59.7
Lives with a smoker						
Yes	46.0%	41.4–50.7	18.2%	12.0–26.5	48.1%	33.8–62.7
No	54.0%	49.3–58.6	81.8%	73.5–88.0	51.9%	37.3–66.2
Harm from another person's smoke						
Yes	83.4%	79.9–86.4	91.7%	83.5–96.0	84.4%	70.2–92.5
No	16.6%	13.6–20.1	8.3%	4.0–16.5	15.6%	7.5–29.8

from 1992 to 2002, Mumford and colleagues reported a decline in concurrent use from the CPS-TUS [9].

There are some possible reasons that may explain the doubling of concurrent use of SLT among smokers observed in 2010. In October 2007 Minnesota implemented a comprehensive workplace indoor smoking ban that included bars and restaurants [6]. The banning of smoking indoors may have provided an opportunity for some smokers to consider smokeless alternatives to smoking.

Another reason for the increase could be industry marketing. In a recent review of SLT advertising, researchers compared advertising messages in 1998/1999 with 2005/2006. The advertising in the later period had broadened in placement and content, with more "alternative to cigarette" messages found in the later time period [12]. The increased marketing of SLT is consistent with the results from a recent review of internal tobacco industry documents that determined that cigarette manufacturers have been developing plans to provide alternatives to smokers that would offset the restrictions from smoking bans [13].

The 2009 merger of SLT and cigarette manufacturers coincided with the introduction of new SLT products in regional markets [14, 15] and nationally [16, 17]. Camel Snus, for example, was launched nationally in early 2009 and Marlboro Snus in early 2010. The introduction of these products included direct marketing to smokers. In addition, the SLT industry had previously introduced a spit-less snuff, Revel, aimed at adult smokers [18] and had been actively

promoting smokeless products as alternatives, for example, promoting SLT as a substitute for cigarettes when travelling by plane (http://www.trinketsandtrash.org/).

Others have noted the advertising by the tobacco industry to encourage cigarette smokers to use SLT products as "situational substitutes" when smoking is prohibited by smoke-free air laws [14, 19]. Thus, the presence of a new indoor smoking ban, the increased advertising for SLT products, the introduction of new SLT products, and the marketing of those products to smokers may have collectively reached a receptive audience among Minnesota smokers between 2007 and 2010.

The finding of increased use of SLT products, however, represents one point in time and may not be a harbinger of future trends. Similarly, the 2010 survey was the first MATS to include a separate question about use of snus. The highest snus rate (15.2%) was among male current smokers ages 18 to 24. In another recent survey an estimated 29% of young adult male smokers reported trying snus sometime in the previous year [20]. Together these estimates suggest some receptivity by young men to the alternative product message that was promoted by the tobacco industry before and during the introduction of snus to the US market. Future surveillance will be required to determine the patterns of use and the situations in which smokers use SLT.

Our finding of higher concurrent use of SLT among younger smokers is consistent with other national surveys [3, 5]. McClave-Regan and Berkowitz [3] used a large consumer survey to examine characteristics and beliefs of adults using cigarettes, SLT, and both products. They found that a majority of concurrent users (63.6%) considered SLT as harmful as cigarettes, and far fewer (7.5%) who believed that SLT was less harmful than cigarettes. We found a similar proportion of concurrent users who considered SLT just as harmful as cigarettes (59.7%), but about 25% who considered SLT less harmful. This perception of reduced harm has received considerable debate in the scientific community [21, 22]. But our findings present one of the challenges of harm reduction, namely, that smokers may begin using SLT as a supplement to their use of cigarettes.

There are some implications that can be drawn from the information presented here. First, there is a need to consider product regulation. The tobacco industry is continuing to evolve, and this includes the introduction of new variations of current products such as snus, and the creation of novel products such as dissolvable tobacco (orbs, strips, and sticks). The introduction of new tobacco products presents an opportunity for local and state governments to consider additional regulations. The goal of reforming tobacco product regulation is to level the playing field across all tobacco products and to apply equal taxation classifications and youth access regulations to all these products. For example, in 2010 Minnesota passed the Tobacco Modernization and Compliance Act (2010 Minn. Laws ch. 305 or Senate File 3055). This law more broadly defines a tobacco product as one that can be ingested by any means. Additional information on the new law is available from the Public Health Law Center (http://www.publichealthlawcenter.org/).

A second implication is the effect on treatment. Users of both cigarettes and SLT may have a more difficult time quitting all tobacco as their dependence/cotinine levels may be higher [5]. State tobacco control programs, help lines, and health care providers should ask about concurrent use of SLT. If a new profile of tobacco use emerges to incorporate the concept of concurrent use then cessation programs may have to adapt to this new profile by including concurrent use as a part of program content. In addition, public campaigns to promote smoke-free places should be expanded to encourage tobacco-free places.

The findings in this paper should be interpreted in light of the reliance on self-reported information, which is subject to incomplete recall and social desirability bias. In general MATS has benefited from the use of the same set of core questions, and good response rates (>40%) using RDD methods. In addition to the 2010 data representing one point in time, the observed prevalence of concurrent use does not provide sufficient detail to determine if smokers were trying SLT or had substituted SLT for some cigarettes, for example. Future surveillance will help to determine if smokers are switching to SLT as a quitting strategy or cousing in response to environmental restrictions on smoking and the direct marketing from the tobacco industry.

7. Conclusion

The finding of higher SLT use by smokers in 2010 compared to 2007 could indicate that smokers in Minnesota are in an experimental phase of testing alternative products as they adjust to recent public policies restricting smoking in public places. In conjunction with smoking restrictions, the tobacco industry has shifted marketing focus to SLT as an alternative to smoking. Although the findings suggest some Minnesota smokers report using SLT, future surveillance reports will be necessary to confirm these results.

Conflict of Interests

All authors declare no competing interests.

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