The Complex Relationship between Cigarette Smoking and Obesity

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Abstract

Cigarette smoking and obesity are the first and second largest causes, respectively, of premature mortality in the United States. Among individuals, there is a negative relationship between cigarette smoking and body weight; smokers tend to weigh less than non-smokers. At the aggregate level, the relationship is more complex. We use data from the Behavioral Risk Factor Surveillance System (BRFSS) to examine the inconsistency between the individual-level relationship and the state-level relationship between these two behavioral risk factors. We show a positive relationship across states: states with a high prevalence of smoking also experience a high prevalence of obesity. We also note that this geographic pattern does not violate the individual-level relationship: individual smokers within states weigh less than non-smokers. We suggest that state differences in approaches to health-related behavior interventions and policies may contribute to the acceptability of both behaviors over time.

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Introduction

Health behaviors represent an important topic of inquiry for sociologists and demographers since they are both situated in social context and have implications for population health (Pampel et al. 2010). Cigarette smoking and obesity represent the two largest causes of premature mortality in the United States, respectively (Fenelon & Preston 2012; Preston & Stokes 2011). These two behaviors, however, exhibit an interesting relationship. Among individuals, smokers tend to weigh less than non-smokers, preserving a negative relationship between the two behaviors. At the aggregate level, however, the opposite is true; US states with high smoking prevalence also exhibit high prevalence of obesity. We seek to explain this unexpected dichotomy in the relationship between cigarette smoking and obesity using two nationally-representative datasets providing information on cigarette smoking and obesity across US states. We identify a large concentration of both smoking and obesity in the Southern and Great Lakes states. We also suggest that the concentration of these behaviors may reflect a potential role for state investments in health.

Background

Recent research indicates cigarette smoking and obesity-related diseases may be responsible for as many as one-third to two-fifths of all adult deaths in the United States, having a substantial impact on US life expectancy (Mokdad et al. 2004; Allison et al. 1999; Preston et al. 2010). Both cigarette smoking and obesity are associated with significant excess risk of disability and mortality resulting from a number of chronic conditions, including cardiovascular diseases, many cancers, diabetes, and respiratory diseases (Thun et al. 1997; Al Snih et al. 2007). Over time, the combination of the cigarette smoking and obesity epidemics have presented an

important challenge for health policy in the United States, and remain a significant contributor to the health disadvantage of the US compared to countries with similar levels of economic development (Preston et al. 2010).

At the individual level, there is a well-known inverse relationship between cigarette smoking and body weight (as measured by Body Mass Index). Smokers tend to weigh less than non-smokers, all else being equal, and individuals often report weight gain following smoking cessation (Albanes et al. 1987; Wehby et al. 2012; Chiolero et al. 2007). This relationship may reflect a variety of factors including physiological mechanisms, social context responses, and behavioral tradeoffs. One possibility is that nicotine intake tends to diminish appetite among smokers, and thus may reduce overall calorie intake and lead to decreased body weight and a lower likelihood of obesity. Alternatively, cigarette consumption may also raise basal metabolism, leading to quicker burning of calories and reduction of overall body mass (Wack & Rodin 1982; Audrain-McGovern et al. 2009). The inverse relationship may also reflect behavioral substitutions—between cigarette consumption and high-calorie diets or a lack of exercise. To some extent, both smoking and the behaviors leading to obesity may represent substitutes in individual consumption. Economic theories of smoking and obesity treat eating, smoking, and body weight as economic decisions, in the utility of deleterious behaviors must be balanced against potential negative health outcomes that result (Ruhm 2012). As such, there is some evidence that many health-related behaviors represent approximate substitutes with respect to individual choices (Chou et al. 2004). This explanation has substantial implications both for policies aimed at reducing health risk behaviors as well as for geographic inequalities in health and mortality in the United States during the obesity epidemic. The inverse relationship between these two behaviors has been known to lead to bias in studies of the relationship between obesity

and a variety of health outcomes (Yang et al. 2013). The strong relationship between cigarette smoking and both obesity and mortality tends to lead to underestimates of the independent negative impacts of obesity (Preston et al. 2013).

At the aggregate level, however, the relationship between smoking and body weight is more complex. Across US states, there is a strong positive correlation between smoking prevalence and obesity prevalence among adults (see Figure 1). Indeed, states with a large number of smokers also tend to be those with a greater prevalence of obesity, and vice versa. Kentucky, West Virginia, Mississippi, and Ohio all fall in the top 10 on both smoking and obesity. Likewise, Arizona, California, Connecticut, and Vermont are among the 10 states with the lowest prevalence of both smoking and obesity. The geographic similarity of the impacts of the smoking and obesity epidemics is striking, especially given the inverse relationship between the behaviors at the individual level.

Furthermore, the strong spatial concentration of cigarette smoking and obesity negatively impacts health and well-being in the southern United States compared to other regions (Fenelon 2013). Thus the specific dynamics in the relationship between these two behavioral factors lead to increased geographic inequalities in health and longevity in the United States, despite a tradeoff at the individual level. Our goal is to explain the notable difference in the shape of the relationship at the individual level and the level of the state. We use data from two nationally-representative health and demographic surveys in the United States between 2000 and 2011. Our analysis can help to explain the reasons both for the inverse relationship at the individual level as well as implications for health policy aimed at promoting healthy behavior.

Conceptualizing the Relationship

What explains the positive aggregate relationship between cigarette smoking and obesity? We consider two possibilities to explain the unexpected aggregate relationship:

1) Compositional Factors – States vary considerably in the socioeconomic, race/ethnic, and nativity compositions of their populations. These characteristics are also strongly correlated with health behaviors. States with large proportions of very unhealthy populations may be more likely to have individuals who are both smokers and obese. Thus, the inverse relationship between smoking and excess body weight may be weaker in states that are more disadvantaged with respect to health behaviors. If population composition is important, we expect a negative relationship between the prevalence of smoking/obesity and the obesity ratio of non-smokers to smokers.

2) State Regulatory Environments – States vary in their approaches to health policy, both in terms of providing health-based services as well as promoting healthier behaviors (Adda & Cornaglia 2006). There are large geographic differences in the degree of emphasis placed on behavioral regulation, the public value placed on individual health, and the acceptability of unhealthy behaviors (Gruber & Frakes 2006). To the extent that state strategies of regulating of health and health behaviors impacts the acceptability of unhealthy behaviors, smoking and obesity prevalence will display a positive correlation across states. In other words, the least healthy states will tend to have more individuals who are either smokers or obese, although not necessarily both.

The first explanation implies that the inverse individual-level relationship between

smoking and obesity represents an average, but does not hold in the least healthy states. In states with particularly disadvantaged high-risk populations, the relationship between smoking and obesity may be somewhat positive. The second explanation suggests that state differences reflect structural factors, while still maintaining the negative correlation among individuals. We consider the state-by-state pattern in the relationship between cigarette smoking and obesity in order to distinguish between these explanations.

Data

We use smoking and obesity data from the Behavioral Risk Factor Surveillance System (BRFSS) operated by the Centers for Disease Control and Prevention (CDC). BRFSS involves a large-sample state-based telephone survey conducted in annual cross sections since the mid 1980s. Since 1993, data have been available for all U.S. states. Our data span the period 1995 through 2010. The BRFSS sample combines state-by-state surveys collecting information on a large number of demographic, geographic, health, and behavioral variables in each year. The primary benefit of the BRFSS is the large and geographically diverse sample. Total US sample sizes range from 113,000 to 451,000, large enough to capture less populated states. We focus on individuals age 25 and above.

We focus on state-level prevalence of cigarette smoking and obesity. Smoking status is ascertained using a series of questions about current and past behavior. Individuals are asked whether they have smoked at least 100 cigarettes in their entire life. Those who answer “no” are considered never smokers. Those who answer “yes” are considered ever smokers. Among ever smokers, those who report that they currently smoke cigarettes are considered current smokers. Individuals are also asked to report the number of cigarettes they currently smoke per day.

Obesity is measured using Body Mass Index (BMI). Individuals report their current height and weight, which is converted into a BMI value (kg/m^2). Individuals with BMI>30 are considered obese.

Approach

In order to examine state variation in the obesity risk differential between smoking statuses, we calculate the ratio of obesity prevalence among non-smokers to that of smokers (θ_i)

$$ratio = \frac{P_i^*(obesity)}{P_i(obesity)}$$

where $P_i(obesity)$ is the prevalence of obesity among smokers in state *i* and $P_i^*(obesity)$ is the identical measure among non-smokers. This measure denotes the increased obesity risk among non-smokers. A value greater than 1 indicates greater risk among non-smokers (theoretical expectation), and less than 1 indicates greater risk among smokers. A value of 1 indicates equal obesity prevalence regardless of smoking status.

We also model an individual's likelihood of obesity as a function of demographic characteristics, current smoking status, and state characteristics

$$\ln\left[\frac{p(BMI\ 30+)}{1-p(BMI\ 30+)}\right] = \beta_0 + \beta_X \boldsymbol{X} + \beta_Z \boldsymbol{Z} + \beta_s s + \beta_s (s \cdot O) + \varepsilon$$

$p(BMI\ 30+)$ indicates whether an individual is obese or not according to the CDC definition. $\boldsymbol{X}$ is a vector of individual demographic covariates and $\boldsymbol{Z}$ is a vector of state-level covariates. *s* refers to whether the individual is a current cigarette smoker, and *O* is the obesity prevalence in

the state. We include an interaction between smoking status (*s*) and the state-level prevalence of obesity (*O*) in order to determine how smoking status differences in obesity vary across states.

Preliminary Results

First, we confirm the inverse relationship between smoking and obesity at the individual level. Mean BMI among smokers is 27.4 among men and 27.0 among women and among non smokers is 28.4 among men and 27.6 among women. Likewise, the prevalence of obesity is substantially lower among smokers, 25.2% among men and 26.1% among women. Among non-smokers, the corresponding prevalence is 30.3% and 28.8%. We also demonstrate that the relationship between smoking and obesity at the aggregate level is positive. Figure 1 shows obesity prevalence by state in 2010 for men and women. Obesity prevalence ranges from 20% in Colorado to 35% in Mississippi and Kentucky. Figure 2 shows the prevalence of smoking.

The geographic patterns in Figures 1 and 2 are quite similar, with many states in the South and Great Lakes exhibiting high prevalence of both smoking and obesity. Figure 3 confirms the strong association between these patterns. The correlation between smoking and obesity prevalence at the state level is high, 0.62 among men and 0.56 among women. Many states in the South and Midwest exhibit high prevalence of both smoking and obesity, appearing in the upper-right corner of the scatterplots. Alternatively, many states in the West and New England tend to have low prevalence of both behaviors.

One consideration is whether the joint high prevalence of smoking and obesity in many southern states occurs because these states have a large number of individuals who are both obese *AND* smokers, or whether these states separately have a high number of smokers as well as

a high number of obese individuals. This depends on the ratio of obesity prevalence of non-smokers to that among smokers. In the US as a whole, this ratio is 1.2 for men and 1.1 for women. But this value varies considerably across states. The scatterplots in Figure 4 show the relationship between this ratio and the prevalence of either smoking OR obesity. The correlation is quite strong, and indicates that states with the greatest prevalence of smoking and obesity do not show greater overlap in these behaviors. On the contrary these states exhibit even greater difference in obesity risk between smokers and non-smokers. The consequence of this is that states that have been particularly hard hit by the smoking and obesity epidemics have a greater percentage of the population that is either a smoker or obese than would be expected if all states shared the same ratio. It is unclear what is responsible for the greater distinction between smokers and non-smokers in these states.

Discussion and next steps

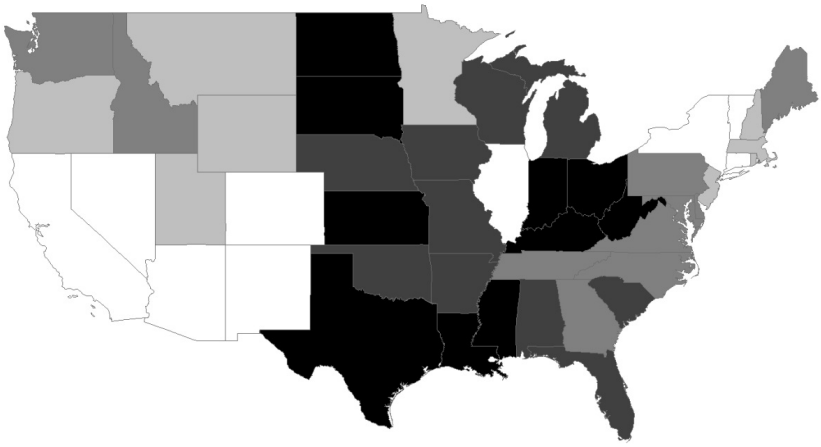
Research indicates that the relationship between cigarette smoking and obesity is quite complex; the two most important behavioral risk factors exhibit distinct associations at the individual level and the population level. Although individuals who smoke are less likely to become obese, states with a high prevalence of smoking also tend to have a relatively high prevalence of overweight and obesity.

Our results suggest that the geographic similarity of the impact of the smoking and obesity epidemics does not reflect population composition. Structural factors, such as state investments in health-related behavior education and promotion may impact the prevalence of both smoking and obesity. The most important finding is that the geographic correspondence between high smoking and high obesity does not appear to violate the individual-level negative

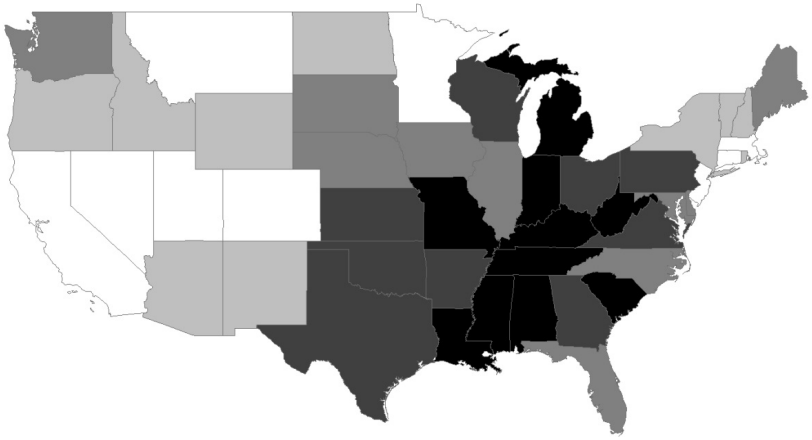
relationship. Additional analyses will consider possible state-level factors that may explain this pattern.

Figure 1. Prevalence of obesity across US states (quintiles): 2010

(a) Men



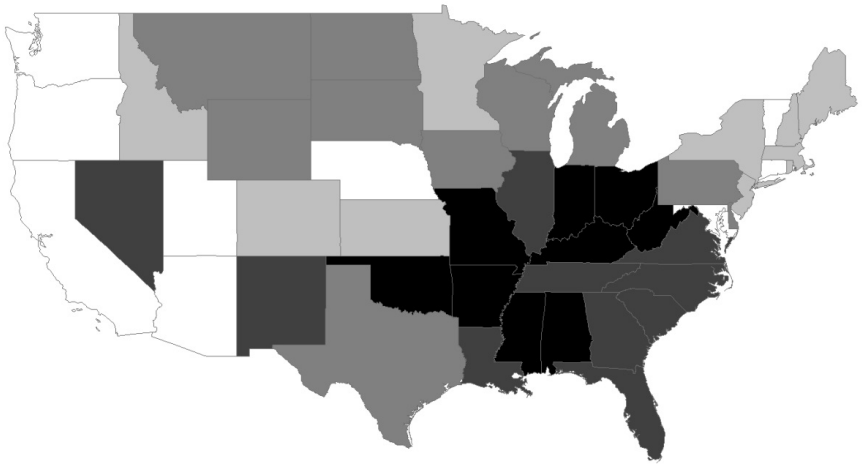
(b) Women



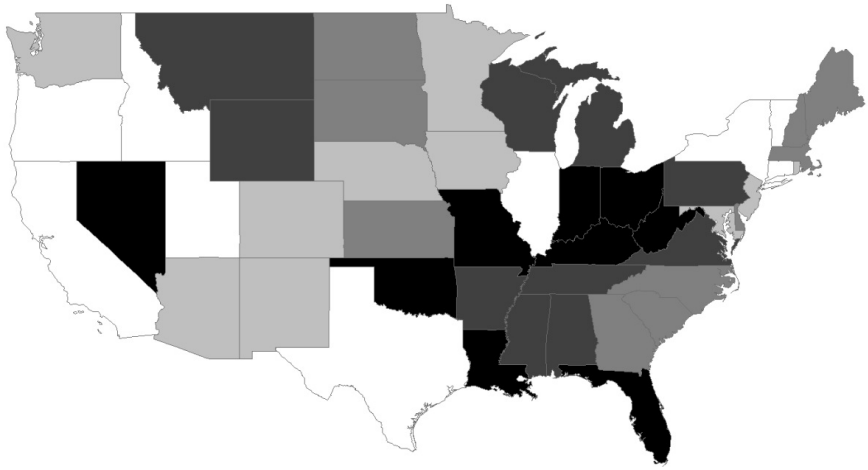
Notes: Data refer to the prevalence of obesity (BMI 30+) for individuals aged 25 and above by state. Data are classified into quintiles. Darker shades represent higher obesity prevalence

Source: Authors calculations from Behavioral Risk Factor Surveillance System (BRFSS) data 2010

Figure 2: Prevalence of Cigarette Smoking across US States: 2010
(b) Men



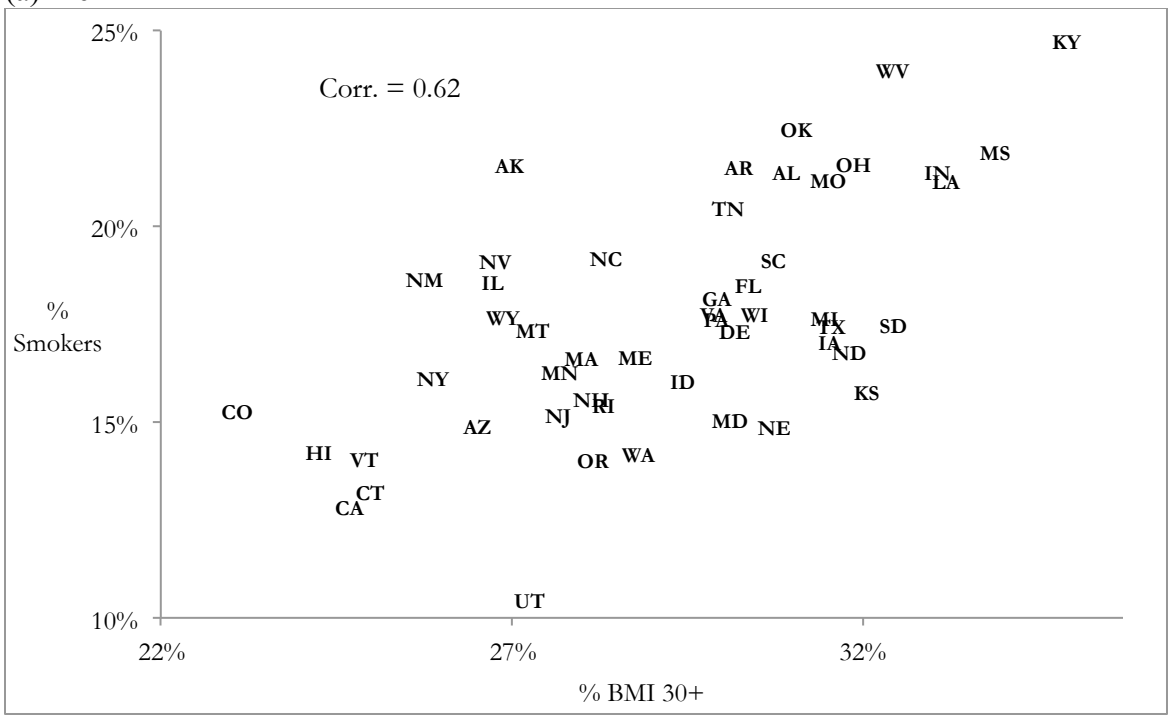
(b) Women



Notes: Data refer to the prevalence of current smoking among individuals aged 25 and above by state. Data are classified into quintiles. Darker shades represent higher smoking prevalence
Source: Authors calculations from Behavioral Risk Factor Surveillance System (BRFSS) data 2010

Figure 3: Correlation between smoking and obesity across states

(a) Men



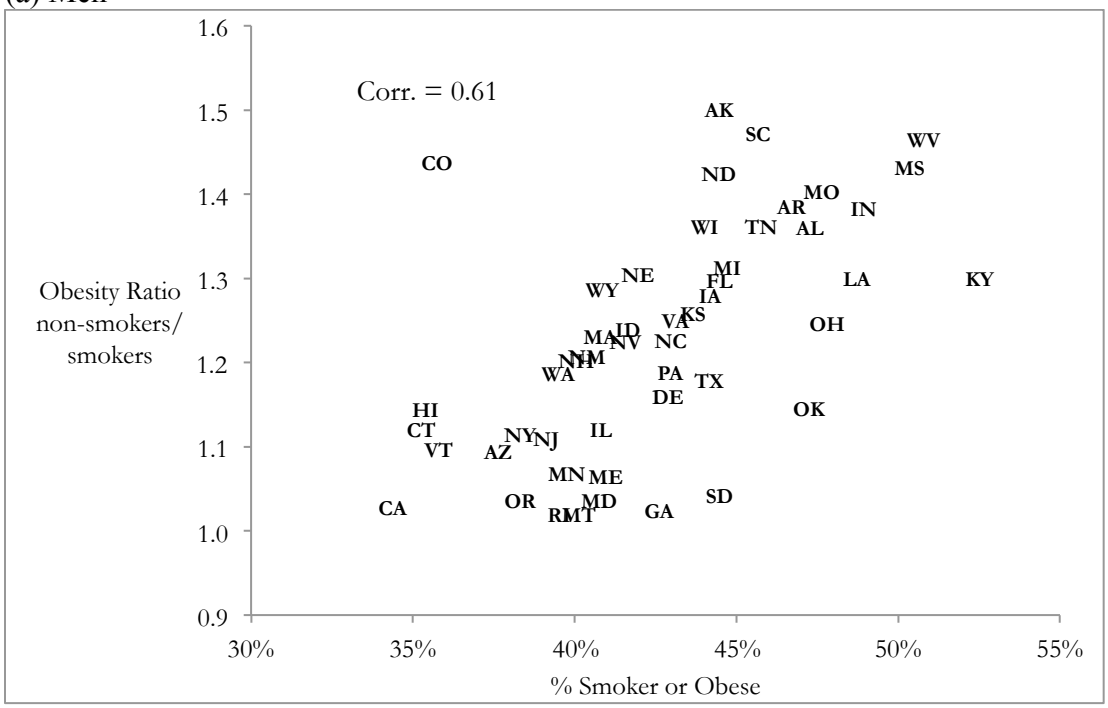
(b) Women

Notes: Refers to the correlation between the prevalence of obesity (BMI 30+) and the prevalence of current cigarette smoking across states in 2010.

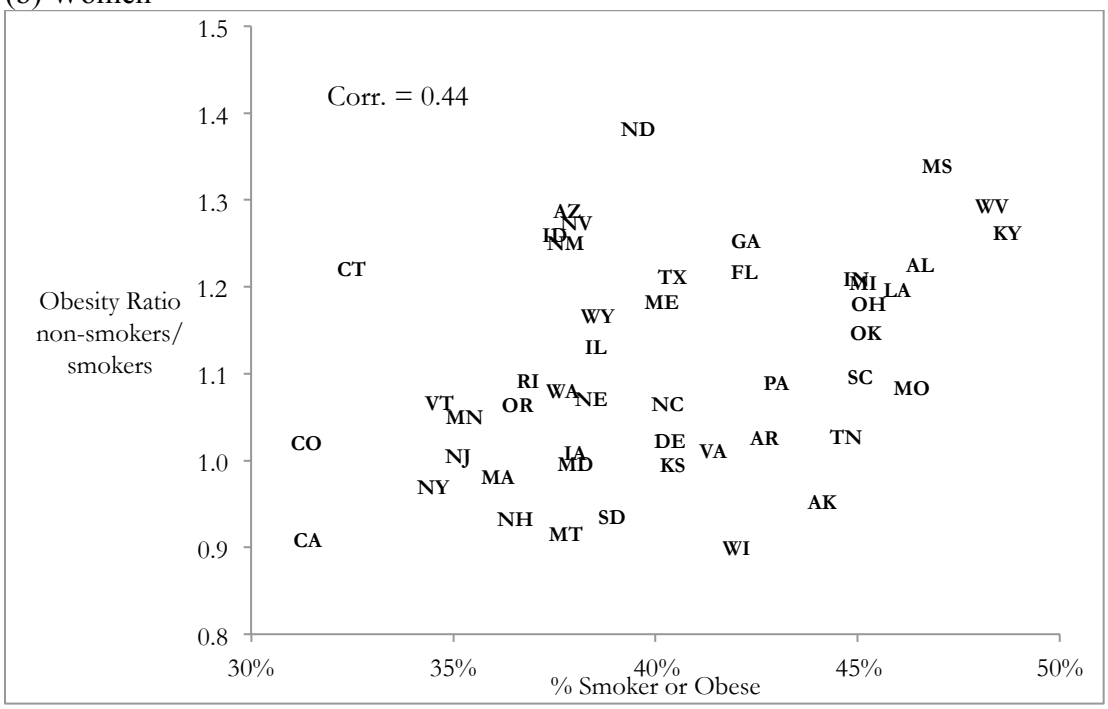
Source: Author's calculations from Behavioral Risk Factor Surveillance System (BRFSS) in 2010

Figure 4: Correlation of obesity/smoking prevalence and the non-smoker/smoker obesity ratio by state 2010

(a) Men



(b) Women



Notes: Refers to the correlation between the prevalence of smoking OR obesity (either current smoker or BMI 30+) and the ratio of obesity prevalence among non-smokers to that among smokers in each state. Ratio >1 indicates that non-smokers are more likely to be obese, <1 indicates that smokers are more likely to be obese, and 1 indicates equal obesity risk regardless of smoking status.

Source: Author's calculations from Behavioral Risk Factor Surveillance System (BRFSS) in 2010

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