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Reduced smoking and rising obesity: Does smoking ban in the workplace matter?

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ABSTRACT

Using worksite smoking ban as an instrumental variable for smoking, we examine the relationship between smoking and body weight in a two-stage least square estimation. We find evidence that reduced smoking may lead to the rising of obesity.

1. Introduction

During the past three decades, obesity rate raised from 15% in 1970 to 34% in 2004, while smoking rate reduced from 37% to 20% (Ogden et al., 2006). Although medical studies suggest that these two trends were related (Gordon et al., 1975; Flegal et al., 1995), a causal link is yet to be found. Smoking is an endogenous decision since overweight people may initiate smoking to lose weight (Cawley et al., 2004), or reversely, smokers do not quit smoking for fear of weight gains (Caan et al., 1996). Hence, researchers use state-wide policies as a proxy of smoking. Chou et al. (2004) found a positive relationship between tobacco prices and obesity rate, suggesting that a decrease in smoking increases obesity rates. In contrast, Gruber and Frakes (2006), detected a negative relationship between cigarette taxes and body mass index (BMI),[1] implying that lowering smoking has no effects on obesity rates. Baum (2009), after carefully controlling for state-specific time trends, found that both cigarette taxes and prices had positive effects on BMI and obesity prevalence. Finally, Courtemanche (2009) showed that when lags of cigarette price/tax were included, a rise in cigarette prices was actually associated with a long-run reduction in BMI and obesity.

Econometric theory predicts that in time periods with little within-state variations, cigarette prices (or taxes) are highly collinear with state dummy variables, which results in high standard errors of estimated coefficients. This paper avoids this problem by employing individual-level reported smoking bans at worksites as an instrumental variable for smoking. Using the data from the Behavioral Risk Factor Surveillance System (BRFSS) for the years 1998–2006, we find that current smokers were 1.8 and 3.6 indexes lower in BMI, and 9.4 and 18.5 percentage points lower in likelihood of obesity, than never and former smokers, respectively. These results provide evidence that reduced smoking may lead to rising obesity. The central implication of this study is, while tobacco control policies such as worksite smoking bans are effective at achieving the goals of reducing smoking, they may have an unintended consequence of increasing the problem of obesity.

2. Data and method

Our data come from the BRFSS between 1998 and 2006, a nationally representative survey on American adults over 18 years old. The data contain information on respondents' body weight, height, smoking bans at workplace for the employed,[2] smoking behaviors, and various demographic characteristics. The baseline

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[1] BMI = weight/height^2, in the unit of kg/m^2.

[2] Self-employed respondents are not included.

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specification investigates the correlation between cigarette smoking and weight outcomes

$$Y_{ijt} = \beta_0 + \beta_1 \times Smoke_{ijt} + \beta_2 X_{ijt} + \beta_3 S_j + \beta_4 T_t + \varepsilon_{ijt} \quad (1)$$

The subscript i, j, and t refer to individuals, states, and years, respectively. Outcome variable is continuous in BMI estimation and dichotomous in obesity (BMI≥30) estimation. Smoke is an indicator showing whether the respondent was a current smoker at the time of survey. X is a vector of individual characteristics, including gender, age, race, education, household income, marital status, and the number of children. S and T control for state and time (year and month) fixed effects.

Two potential problems arise. Some unobserved characteristics, such as risk aversion, environmental factors, or parental backgrounds, can simultaneously affect smoking and obesity (Viscusi and Hersch, 2001). Reverse causality is also plausible since overweight people choose smoking as a method of weight control (Cawley et al., 2004). To address these concerns, we employ smoking ban in working places as an instrumental variable for smoking in estimations. In particular, the smoking ban variable (i.e., "Ban") is 1 if smoking is prohibited at both indoor public areas and work areas. The two-stage least square (2SLS) model is,

$$Smoke_{ijt} = \delta_0 + \delta_1 \times Ban_{ijt} + \delta_2 X_{ijt} + \delta_3 S_j + \delta_4 T_t + \zeta_{ijt} \quad (2)$$

$$Y_{ijt} = \beta_0 + \beta_1 \times \widehat{Smoke}_{ijt} + \beta_1 X_{ijt} + \beta_2 S_j + \beta_3 T_t + \varepsilon_{ijt}$$

In the above estimation, however, the selection into workplaces, based on smoking policies and unobserved factors may correlate with smoking, obesity and other risky behaviors. To assess the robustness of the IV estimates, in an alternative specification, we control for other individual characteristics, such as physical activities, alcohol drinking, eating fruits and vegetables, health insurance coverage, and self-reported physical and mental health status.

Finally, we examine the effect of workplace smoking ban on weight outcomes in a reduced-form model following Baum (2009),

$$Y_{ijt} = \beta_0 + \beta_1 \times (Treatment)_{ijt} + \beta_2 \times Ban_{ijt} + \beta_3 \times (Treatment \times Ban)_{ijt} + \beta_4 X_{ijt} + \beta_5 S_j + \beta_6 T_t + \xi_{ijt} \quad (3)$$

In Eq. (3), the variable, Treatment, is defined as a group of respondents who were ever-smokers (either current smokers or former-smokers), and control group is never-smokers. Because most smoking initiations occur before age 18, if respondents have not yet been a smoker by 18, they are unlikely to become one in later years. Therefore, respondents in the control group would seem to be unlikely affected by workplace smoking ban. We hypothesize that workplace smoking bans have the strongest effect on ever-smokers because smoking ban can either encourage current smokers to quit smoking or to prevent former-smokers from relapse. However, it is possible that former smokers have quit smoking before being employed at a firm with a workplace ban, and are unlikely to relapse, so they would not be affected by workplace bans. We address this issue by only comparing current smokers to never-smokers and excluding former smokers.

3. Results

Table 1 summarizes the data. Overall, 24% of sample respondents were obese and around 76% reported to have smoking bans at both indoor public areas and working place. Estimation results are presented in Table 2. Specification 1 is the ordinary-least-square (OLS) baseline model, which independent variables include only gender, age, race, education, income, marital status and number of children in the household. The OLS estimations show that weight outcomes are negatively correlated with smoking. Current smokers were 1.2 less in BMI and 7.2 percentage points lower in obesity rate than non-smokers; and 1.4 less in BMI and 8.2 percentage points lower in obesity rate than former-smokers. Results from 2SLS estimates show that the BMI of current smokers was 1.8 lower, and probability of obesity was 9.4 percentage points lower, than non-smokers, and 3.6 less in BMI and 18.5 percentage points lower in likelihood of obesity than former-smokers. Several reasons can explain why IV estimates are larger than OLS estimates. Besides endogeneity, measurement errors of BMI and smoking status cause attenuation bias in OLS results. Moreover, the IV estimator is the local average treatment effect, which captures the marginal effect of smoking among the group affected by smoking bans. Hence, our results should be interpreted as the effect of smoking on body weight for the employed people that have been induced to quit smoking (or choose not to relapse) because of smoking bans at workplaces. The

Table 1
Sample statistics.
Source: BRFSS 1998–2006.

	Overall	Ever-smoker
BMI	27.040	26.944
Obese	0.243	0.235
Smoking now	0.236	0.527
Female	0.623	0.600
Age (omitted: 18–24)		
- Age 25–34	0.221	0.191
- Age 35–44	0.284	0.272
- Age 45–54	0.276	0.298
- Age 55–64	0.147	0.174
Race (omitted: white)		
- Black	0.098	0.074
- Hispanic	0.057	0.049
- Other race	0.040	0.040
Education (omitted: less than high school)		
- High school	0.272	0.328
- Some college	0.278	0.304
- College degree	0.402	0.302
Household Income (omitted: 0 to $24,999)		
- $25,000 to $34,999	0.144	0.157
- $35,000 to $49,999	0.200	0.206
- $50,000 to $74,999	0.214	0.203
- $75,000 or more	0.261	0.225
Marital status (omitted: never married)		
- Married	0.582	0.542
- Divorced, widowed, separated	0.216	0.266
Number of children	0.875	0.818
Any physical activities in past month	0.790	0.759
Health status—fair or poor	0.079	0.100
Number of days—physical health not good in past month	2.131	2.496
Number of days—mental health not good in past month	3.122	3.820
Health insurance coverage	0.893	0.868
Number of drinks in past month (omitted: 0)		
- 1–4	0.199	0.175
- 5–30	0.244	0.270
- 30+	0.077	0.114
- No answer	0.116	0.118
Eating fruits and vegetables per day (omitted: less than one or never)		
- 1–2 times	0.337	0.359
- 3–4 times	0.332	0.322
- 5+ times	0.186	0.167
- No answer	0.104	0.104
Smoking is prohibited in any indoor public areas and working areas	0.757	0.712
N	227,147	101,781

Table 2
Effect of smoking on BMI and obesity.

	OLS		2SLS	
	Specification 1	Specification 2	Specification 1	Specification 2
Overall sample				
BMI	−1.195[a]	−1.264[a]	−1.825[a]	−2.054[a]
	(0.058)	(0.070)	(0.369)	(0.412)
Obese	−0.072[a]	−0.078[a]	−0.094[a]	−0.128[a]
	(0.003)	(0.004)	(0.029)	(0.039)
F-statistic for instruments			806.76	426.97
Ever-smoker sample				
BMI	−1.366[a]	−1.406[a]	−3.629[a]	−4.242[a]
	(0.061)	(0.077)	(0.490)	(0.780)
Obese	−0.082[a]	−0.084[a]	−0.185[a]	−0.245[a]
	(0.003)	(0.004)	(0.037)	(0.065)
F-statistic for instruments			369.65	157.55

Listed are coefficients on smoking status. Standard errors (clustered at state-level) are in parentheses.
Other independent variables refer to the context.
We use linear probability model for obese equation, but probit model results are similar.
[a] Significant at 1% significance level.

F-statistic from the first-stage, as illustrated in Table 2, is sufficiently large, suggesting that our IV is very powerful. In specification 2, we control for other health behaviors, lifestyles, and health status. The estimated coefficients on BMI and obesity remain statistically significant at the 1%-level, although the magnitudes are slightly higher than those in baseline specifications. This fact shows that our estimation is robust across different model specifications.

Finally, Table 3 presents the estimates from Eq. (3), a reduced-form estimation. Having smoking bans at workplaces increases BMI by 0.58 index points and the prevalence of obesity by 3.1 percentage points, which is consistent with previous estimations. According to the results from specification 1 in 2SLS (see Table 2), smoking bans reduced smoking participation by 31%,[3] and the effect of smoking on BMI is 1.825, hence, the implied effect of smoking bans on BMI should be about 0.56 index points (31% X 1.825), which is similar to the findings in Table 3. More importantly, results are robust across specifications when different controls for state-time trends are used (see Table 3). We include year dummies in Model 1, a quadratic year trend in Model 2, state-specific linear year trends in Model 3, and separate dummies for a large range of state-year policies in Model 4, including anti-smoking sentiment, programs promoting healthy life-style and measures of medical services. The inclusion of these variables is a significant improvement compared to previous studies. Also, estimates in BMI models show statistically significant and negative effects of workplace smoking bans on control group (never-smoker). This probably reflects that workers with better health habits are more likely to work at firms with smoking bans (Evans et al., 1999). Lastly, in the alternative model, we only include current smokers in the treatment group. The results are similar to those in the overall sample, although the magnitude is slightly lower.

BRFSS data have the information on number of cigarettes smoked until 2000. We make use of this information and estimate the effects of quantity smoked on BMI/obesity. The results are reported in Appendix A. For non-smokers, the number of cigarettes smoked is coded as 0. The results are consistent with models using dichotomous smoking decision.

Table 3
Effect of workplace smoking ban on BMI and obesity.

	Model 1	Model 2	Model 3	Model 4
Overall sample				
BMI				
Smoking ban	−0.186[a]	−0.185[a]	−0.186[a]	−0.186[a]
	(0.038)	(0.038)	(0.038)	(0.038)
Smoking ban*treatment	0.577[a]	0.576[a]	0.576[a]	0.575[a]
	(0.041)	(0.041)	(0.041)	(0.041)
R-squared	0.083	0.083	0.083	0.083
Obesity				
Smoking ban	−0.011[a]	−0.011[a]	−0.011[a]	−0.011[a]
	(0.003)	(0.003)	(0.003)	(0.003)
Smoking ban*treatment	0.031[a]	0.031[a]	0.031[a]	0.031[a]
	(0.003)	(0.003)	(0.003)	(0.003)
R-squared	0.050	0.050	0.050	0.050
Current smokers and never-smokers				
BMI				
Smoking ban	−0.137[a]	−0.137[a]	−0.138[a]	−0.137[a]
	(0.038)	(0.038)	(0.038)	(0.038)
Smoking ban*treatment	0.516[a]	0.515[a]	0.515[a]	0.515[a]
	(0.045)	(0.045)	(0.045)	(0.045)
R-squared	0.083	0.083	0.083	0.083
Obesity				
Smoking ban	−0.008[b]	−0.008[b]	−0.008[b]	−0.008[b]
	(0.003)	(0.003)	(0.003)	(0.003)
Smoking ban*treatment	0.027[a]	0.027[a]	0.027[a]	0.027[a]
	(0.004)	(0.004)	(0.004)	(0.004)
R-squared	0.050	0.050	0.050	0.050
State and year controls	State dummies and year dummies	State dummies, linear and quadratic year	State dummies, year dummies, and state-year linear interactions	Separate dummies for each state-year interaction

Listed are coefficients. Standard errors (clustered at state-level) are in parentheses.
Other independent variables refer to the context.
[a] Significant at 1% significance level.
[b] Significant at 5% significance level.

4. Conclusions

This paper finds a causal impact of smoking on body weight. Along the way we also explore the consequences of workplace smoking bans on smoking and obesity.

The original goal of workplace smoking bans is to protect non-smokers from second-hand smoke. However, the findings from this study point out this policy may bring an unintended consequence — rising obesity. To better understand the impact of workplace smoking bans, we calculate how much workplace smoking bans have contributed to the rising obesity in the U.S. In 1998, 69% of workers worked in firms with workplace smoking bans. By 2006, the figure rose to 79%.[4] If workplace smoking bans increase obesity by 3.1 percentage points, then these numbers suggest that between 1998 and 2006, workplace smoking bans should have increased obesity rates by (0.79–0. 69)*3.1 = 0.31 percentage points. Given that obesity prevalence rose from 18.4% to 26.2% among ever-smoking workers during this period, smoking bans have contributed 4% to the rising obesity.

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[3] In the first-stage regression (available upon request), smoking bans reduce smoking participation by 7.3 percentage points and current smoking rate among overall sample is 23.6%. Therefore, the smoking participation reduced by 7.3/23.6 = 31%.

[4] Authors calculated from the BRFSS 1998–2006.

Appendix A

Table A
Effect of Number of Cigarettes Smoked per Day on BMI and Obesity.

	OLS		2SLS	
	Specification 1	Specification 2	Specification 1	Specification 2
Overall sample				
BMI	−0.050***	−0.063***	−0.028	−0.062*
	(0.004)	(0.006)	(0.027)	(0.033)
Obese	−0.003***	−0.004***	−0.003	−0.007**
	(0.0002)	(0.0003)	(0.002)	(0.003)
F-statistic for instruments			451.88	238.53
Ever-smoker sample				
BMI	−0.038***	−0.049***	−0.099***	−0.138***
	(0.004)	(0.006)	(0.034)	(0.039)
Obese	−0.002***	−0.003***	−0.008***	−0.012***
	(0.0003)	(0.0004)	(0.003)	(0.003)
F-statistic for instruments			340.36	257.92

Listed are coefficients. Standard errors (clustered at state-level) are in parentheses.
*** Significant at 1% significance level, ** Significant at 5% significance level, * Significant at 10% significance level.
Other independent variables refer to the context.

Table B
Effect of Workplace Smoking Ban on BMI and Obesity.

	Model 1	Model 2	Model 3	Model 4
Current smokers and never smokers				
BMI				
Smoking Ban	−0.116*	−0.116*	−0.113*	−0.096
	(0.060)	(0.060)	(0.060)	(0.062)
Smoking Ban * Treatment	0.016***	0.016***	0.015***	0.015***
	(0.005)	(0.005)	(0.005)	(0.005)
R-squared	0.073	0.073	0.073	0.073
Obesity				
Smoking Ban	−0.007	−0.007	−0.007	−0.007
	(0.005)	(0.005)	(0.005)	(0.005)
Smoking Ban * Treatment	0.001***	0.001***	0.001***	0.001***
	(0.0003)	(0.0003)	(0.0003)	(0.0003)
R-squared	0.037	0.037	0.037	0.037
State and Year controls	State dummies and year dummies	State dummies and quadratic year	State dummies, year dummies, and state-year linear interactions	Separate dummies for each state-year interaction

Listed are coefficients. Standard errors (clustered at state-level) are in parentheses.
*** Significant at 1% significance level, * Significant at 10% significance level.
Other independent variables refer to the context.
Treatment is the number of cigarettes smoked per day.

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