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Smoking among construction workers: The nonlinear influence of the economy, cigarette prices, and antismoking sentiment

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Abstract

Little research has been conducted on the influence of macroeconomic environments on smoking among blue-collar workers, a group with high smoking prevalence and that is especially vulnerable to the effects of changing economic circumstances. Using data from 52,418 construction workers in the Tobacco Use Supplement to the United States Current Population Survey, we examined the association of labor market shock, cigarette prices, and state antismoking sentiments with smoking status and average number of cigarettes smoked daily. Data analysis included the use of multiple linear and logistic regressions, which employed the sampling and replicate weights to account for sampling design. Unemployed, American-Indian, lower-educated and lower-income workers had higher smoking rates. Labor market shock had a quadratic association, which was non-significant for smoking status and significant for number of cigarettes. The association of cigarette prices with smoking status became non-significant after adjusting for state-level antismoking sentiment. State-level antismoking sentiment had significant quadratic association with smoking status among employed workers and significant quadratic association with number of cigarettes for all smokers. The study highlights how both workplace-based smoking cessation interventions and antismoking sentiments could further contribute to disparities in smoking by employment status.

Keywords

construction; blue-collar; smoking; health disparities; tobacco control policies

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Introduction

Although the continuing decline of smoking rates is cited as one of the greatest public health advances in the past three decades (Schroeder, 2008), smoking remains a prominent problem among those employed in what has traditionally been called “blue-collar” jobs. U.S. national data from 1987 to 2004 show that only blue-collar occupations had smoking prevalence above 30% (D. Lee et al., 2007). Construction workers had the highest pooled prevalence of smoking at 38.8% (D. Lee et al., 2007). Compared to the general population, construction workers are more likely to smoke, to smoke a higher number of cigarettes, and to report failure after receiving smoking cessation interventions (D. Lee et al., 2007; Sorensen et al., 2007; Okechukwu et al., 2009; Nordenvall et al., 2011).

As is the case with many blue-collar occupations, the labor market for construction workers is particularly sensitive to economic cycles (Fallon & Lucas, 2002; Auer et al., 2008; Eichhorst et al., 2010). Construction workers and other blue-collar workers are among the first to feel the impact of macroeconomic changes (Sum et al., 2009; Eichhorst et al., 2010; McNay, 2010). Workers in the construction industry have suffered disproportionately in the current economic crises (Sum et al., 2009; Eichhorst et al., 2010; McNay, 2010; Borbely, March 2009). In Rhode Island, for example, blue-collar workers are experiencing three times their expected job loss from the financial downturn, with employment in the construction industry declining most rapidly, as measured by payroll employment declines (Sum et al., 2009).

What associations could be expected between the economy and smoking among construction workers? The answer to this question is unclear for many reasons beyond the fact that construction workers have smoking habits that differ from those of the general US population. Methodological and theoretical differences abound in studies that have examined the association between the economy and health or risk factors for illness (Catalano et al., 2011). One approach to understanding the influence of the economy on health is to compare the likelihood of risk taking among the unemployed (i.e., those who are not working but looking for work) versus other groups. Studies concerned with smoking, for example, have consistently found a higher proportion of smokers among those who are unemployed (A. Lee et al., 1991; Reine et al., 2004). The direction of causation in these studies cannot, of course, be inferred from cross-sectional data.

Another approach is to examine the cross-sectional association between individual job loss and smoking. The results from such studies have been inconsistent, with some studies finding associations between job loss and smoking (Montgomery et al., 1998; Falba et al., 2005) while others did not (Morris et al., 1992; Matoba et al., 2003). A third approach involves longitudinal observation of those who lose their jobs versus those who do not. We know of only two such studies. Both studies reported that participants who experienced job loss had significantly higher levels of smoking at the beginning of the study, but only one study found an association where job loss increased smoking (Morris et al., 1992; Montgomery et al., 1998). While these studies are useful for understanding the possible influence of individual job loss on smoking, they do not shed light on the influence of the economy on smoking.

Other attempts to study the association between the performance of the economy and smoking have used the unemployment rate at the national or state level to gauge the economic climate (Novo et al., 2000; Ruhm, 2000, 2005). These studies report that smoking increases and declines with the economy; however, the employment or unemployment rate at the state or national unemployment level might not capture the economic experiences of the studies population. As illustrated in the earlier discussion of the economy and

construction occupations, contractions and expansions in the economy do not usually occur uniformly across all occupations and industries. Therefore, the overall unemployment rate in the country or state might not describe the economy as experienced by workers in different occupations. This is especially important in an analysis of smoking because, even after controlling for age, gender, education, income and race/ethnicity, occupation has been consistently associated with smoking (Haenszel et al., 1956; A. Lee et al., 1991; Leigh, 1996; Giovino et al., 2000; Barbeau et al., 2004; D. Lee et al., 2007).

Apart from the economy, governmental antismoking measures could influence smoking. Twenty-five US states and the District of Columbia have passed Clean Indoor Air laws, which prohibit smoking in most indoor workplaces. Because they work outdoors, most construction workers are not covered by these laws. However, state taxes on cigarettes apply to everyone, determining cigarette prices, which may influence smoking. It is also possible that cigarette taxes could be a confounder of the association between the economy and smoking since states might be more or less willing to change cigarette taxes based on the economic climate.

Another potential influence on smoking, which is possibly related to both cigarette prices and the economy, is antismoking sentiments. Evaluations of tobacco control policies have led to contentious debates between public health researchers and economists. An important point of contention has been the contribution of antismoking sentiments to reported associations between tobacco control policies and smoking (Tauras, 2006; DeCicca et al., 2008). Most public health evaluations of tobacco control policies assume a random distribution of these policies among states even though a public health study showed that changes in social acceptability of smoking impact smoking behaviors (Alamar & Glantz, 2006). Many economists argue that tobacco control policies are enacted through a political process that makes states with such policies different and that these states most notably differ in antismoking sentiments (DeCicca et al., 2008). The buildup of antismoking sentiment could be what drives both the passage of tobacco-control policies and subsequent smoking-related behaviors. Some public health researchers have accounted for antismoking sentiments by controlling for the percent of state residents who supported state tobacco-related ballot initiatives, but not all states have had such ballot initiatives (Siegel et al., 2004). We examined the influence of state-level antismoking sentiment using a recently developed measure (Wasserman, 1991; DeCicca et al., 2008). The measure allowed us to control for the influence of state level characteristics that determine social norms around smoking and the possible nonrandom distribution of cigarette prices by state.

In our study, we evaluated the influence of state level occupation specific labor market shock, cigarette prices and antismoking sentiment on smoking outcomes among construction workers. Since previous studies have not investigated these predictors together, we first evaluated their influences separately before investigating the association of all predictors in the same model. We hypothesized that all three predictors will be associated with smoking separately but that controlling for antismoking sentiment would decrease the association between both labor market shock and cigarette prices on smoking outcomes.

METHODS

Data Sources

This study uses data from four sources: Tobacco Use supplement to the Current Population Survey (TUS-CPS), Bureau of Labor Statistics (BLS) construction specific employment by state, *Tax Burden on Tobacco* report, and TUS-CPS derived state antismoking sentiment. Detailed descriptions of the study and sampling procedures for the TUS-CPS, which is co-sponsored by the National Cancer Institute and the Centers for Disease Control and

Prevention, have been provided elsewhere (CPS, 2006; Soulakova et al., 2009). The survey, which is conducted as a supplement to the CPS three times over the course of nine months, uses a multistage probability design to capture data on smoking behaviors for a representative sample of non-institutionalized, US civilians 15 years of age and older. Since the main purpose of the CPS is to collect data on employment and changes in the labor force, it contains detailed information on occupation, industry, and employment status in addition to data on demographics (age, gender, education, income, state of residence). This study used data from seven waves of the survey from 1992/1993, 1995/1996, 1998/1999, 2001/2002, 2003, and 2006/2007.

We restricted our study population to working age adults (aged 18-65 years) whose primary jobs were in construction occupations and who work in one of the 50 states. There were 52,543 participants who met these criteria. Of the 52,543 who meet these criteria, we excluded those who were missing data on smoking status ($n = 125$) for a total sample of 52,418.

Study Measures

Dependent variables—Smoking status: Following CDC guidelines, smokers had to meet two criteria: lifetime smoking of at least 100 cigarettes and smoking every day or some days (CDC, 1994).

Number of cigarettes smoked per day: For those classified as smokers, we created a continuous measure of the average number of cigarettes smoked per day by using questions that asked respondents about the number of cigarettes they smoke per day.

Independent variables

Shock to the construction labor market (labor market shock): We constructed a measure of state-specific shock to the construction labor market through the following steps: First, we took the monthly percentage differences in the seasonally unadjusted number of persons employed in the Bureau of Labor Statistics “Construction Supersector” (i.e., Supersector 20) for each of the 50 states (<http://www.bls.gov/data/#employment>). Second, we built ARIMA time-series models of the monthly percentage differences for each state to arrive at the expected and residual (i.e., expected subtracted from observed) values (Box & Jenkins, 1994). The residual values are normally and independently (i.e., exhibit no seasonality or other autocorrelation) distributed around 0. Third, we calculated the 4-month average of the residuals for each state for the month of the survey and the 3 months prior to the survey. The 4-month average would be 0 or close to 0 if the months exhibited values expected from seasonality and other forms of autocorrelation. Values greater than 0 imply that the demand for construction workers increased to unexpectedly high levels (i.e., positive shock) during the 3 months prior to, and month of, the survey. Conversely, values less than 0 imply that the demand for construction workers declined from expected levels (i.e., negative shock) in the 3 months prior to, and month of, the survey. Fourth, we assigned each TUS-CUS response the appropriate 4-month state average calculated in step 3.

Cigarette prices: Using an annual compendium of cigarette tax and prices, the *Tax Burden on Tobacco* report, we obtained the average price per pack of cigarettes in each state for the year before the survey administration (Orzechowski & Walker, 2007). These prices were adjusted for inflation using the consumer price index.

Antismoking sentiments: Along with population-representative information on smoking behaviors, the TUS-CPS also contains respondents’ agreement with tobacco-related policies and practices such as smoking bans in public and private areas (e.g. restaurants, bars,

workplaces, sporting events, hospitals, and indoor shopping malls, homes) in addition to their agreement with cigarette advertisement practices. Using factor analysis of the 1992-2007 answers to these TUS-CPS questions, Decicca and colleagues (2008) created a measure of antismoking sentiments for each state, which could be used instead of state fixed effects to capture state-level influences on smoking behaviors.

Employment: All CPS respondents were asked questions about their job activities in the past week. Using this information, those who were in the labor force were classified as either employed or unemployed (i.e., not working but looking for work).

Sociodemographic variables: We collapsed annual family income into six categories and categorized educational attainment by credentials that are used for occupational qualifications. We used discrete continuous age from 18 to 65 years. Guided by the Office of Management and Budget directive 15, study participants were placed in five mutually exclusive race/ethnicity groups (Hispanic (from any racial group), White, Black, Asian/Pacific Islander and other races/ethnicity, which included non-Hispanic multiple race/ethnicity).

Statistical Analyses

The primary analysis of this paper examined the relationship between current smoking status among construction workers and (1) labor market shock, (2) cigarette prices, and (3) state antismoking sentiments. To conduct this analysis, we first obtained sociodemographic characteristics for the sample by smoking status. Independent samples t-tests were used to compare the continuous variables by smoking status, and Chi-square tests were used to compare the categorical variables by smoking status.

Simple logistic regression models were used to estimate the unadjusted effect of demographic variables, labor market shock, cigarette prices, and state antismoking sentiments on the smoking status of construction workers. Multiple logistic regression models were estimated to obtain the adjusted effects of our main predictors—labor market shock, cigarette prices, and state antismoking sentiments—on construction workers' current smoking status, controlling for gender, race/ethnicity, education, family income, employment status, data collection year, and age; there was theoretical and statistical evidence to support controlling for all of these variables. Separate models were first run for each predictor but the final model included all predictors.

Last, we used model-building techniques to find a model that best explained smoking status among construction workers. Since previous research suggested that the association between some predictors/covariates (namely age and cigarette prices) and smoking might be nonlinear (Dinno & Glantz, 2009), we used multiple logistic regression models to explore nonlinear relationships between current smoking status and age, cigarette prices, economic shock, and state antismoking status. We explored these nonlinear relationships by including squared and cubic terms to see if they were associated with our smoking status outcome after adjusting for all the other variables. We included the square and/or cubic term if it had a p-value <0.1. Finally, we examined interaction terms between employment status and labor market shock, cigarette prices, and state antismoking sentiments. We considered an interaction term to be significant if it had a p-value <0.1. The interaction between cigarette prices and employment status had a p-value <0.1, so we stratified our final analyses by employment status.

Secondary analyses examined the relationship between the number of cigarettes smoked per day among construction workers who were currently smoking and (1) labor market shock, (2) cigarette prices, and (3) state antismoking sentiments. Since the number of cigarettes

smoked per day is count data and bimodal at 20 and 40 (one and two packs of cigarettes), we log transformed this outcome variable for all analyses. Simple regression models were estimated to obtain the unadjusted effects of economic shock, cigarette prices, and state antismoking sentiments on the number of cigarettes smoked per day. Multiple regression models that controlled for gender, race/ethnicity, education, family income, employment status, data collection year, and age were estimated to obtain the adjusted effects of our predictors on the number of cigarettes smoked per day. These covariates were included in all subsequent regression models. Again, since previous research suggested that the relationship between some predictors and smoking might be nonlinear, we used multiple regression models to explore nonlinear relationships between the number of cigarettes smoked per day and age, cigarette prices, economic shock, and state antismoking sentiment. Nonlinear terms were kept in the model if they had a p-value <0.1. Since we found an interaction between cigarette prices and employment status in our primary analysis, we also explored potential interactions between employment status and our main predictors. None of these interactions was significant, so we did not stratify the final analysis.

SAS-Callable SUDAAN version 10 was used for all modeling as it allowed us to calculate standard errors and confidence intervals that are valid for the complex sampling design of TUS. All models used the TUS-supplied sampling and replicate weights to account for possible clustering within states, the TUS multi-stage sampling schema and nonresponse, as well as a balanced repeated replication Fay's adjustment factor of 4, which gives leads to more conservative estimates of standard errors for each parameter. A significance level of 0.10 was used for model building, and a significance level of 0.05 was used for the interpretation of results. Multi-collinearity was assessed in each of our final models using Pearson's correlation coefficient and variance inflation factors (VIF), and was determined to not influence the interpretation of our results.

RESULTS

Of the 52,418 construction workers in our sample, 36.0% were smokers. Table 1 presents the sample characteristics by smoking status. Men comprised 97.0% of both smokers and nonsmokers. Among smokers, 82.8% were white and 25.1% had less than a high school degree, compared to 75.8% white and 11.7% with less than high school degree among nonsmokers. Smokers were more likely to be unemployed (11.1%) than nonsmokers (6.4%).

Table 2 presents the results of the unadjusted logistic regression models for smoking status among the whole sample, the adjusted models for individual predictors, and the adjusted model with all predictors together. In the simple logistic regression models, only the main predictor of state antismoking sentiment was associated with smoking status (OR = 0.25, 95% CI = 0.11, 0.58). The demographic variables of employment status, race/ethnicity, education, and data collection year were also associated with smoking status. Those in the other and American Indian racial/ethnic categories were most likely to be smokers while Hispanics were least likely to be smokers. Higher education and income were consistently associated with decreased odds of smoking in the models.

In adjusted models for individual predictors, the association between state antismoking sentiment and smoking continued to be significant (OR = 0.45, 95% CI = 0.37, 0.55), while cigarette prices became significant (OR = 0.90, 95% CI = 0.85, 0.94) and labor market shock remained insignificant. When we included all three predictors in a model and controlled for age, gender, race/ethnicity, employment status, education, and data collection year, state antismoking sentiment was the only main predictor that was significantly associated with smoking status among construction workers (OR = 0.47, 95% CI = 0.39,

0.56). Unemployment was also significantly associated with smoking in this model (OR = 1.51, 95% CI = 1.38, 1.65).

Table 3 presents the results of the stratified multiple logistic regression models. These models estimated the probability of being a smoker among employed and unemployed construction workers separately while adjusting for age, gender, race/ethnicity, employment status, education, data collection year, and all nonlinear associations. Although it was not significant at the 0.05 significance level, labor market shock had a quadratic association with smoking status among the employed construction workers (OR = 0.98, 95% CI = 0.95, 1.00) but not among the unemployed construction workers. For the employed construction workers, the probability of smoking increased as the economy improved up until the economy began performing as expected (around value of -0.36). After this value, the probability of smoking decreased with further improvements in the economy. Cigarette prices were associated with smoking status among both unemployed and employed workers with larger magnitude for employed workers (OR_{employed} = 0.98, 95% CI = 0.93, 1.03, vs. OR_{unemployed} = 0.86, 95% CI = 0.72, 1.05). However, the association was not statistically significant.

Antismoking sentiment had a statistically significant quadratic relationship with the smoking status of the employed workers (OR = 0.17, 95% CI = 0.07, 0.45) but a non-significant linear relation with smoking status among the unemployed workers. For the employed workers, increases in state-level antismoking sentiment was associated with increase in the probability of smoking up until an antismoking sentiment of approximately -0.30 ; after this level, increases in antismoking sentiment was associated with a decrease in the probability of smoking. In contrast, there was no significant association between state antismoking sentiment and smoking among unemployed construction workers.

We conducted supplemental analysis to examine the probability of being an employed smoker, unemployed smoker, employed non-smoker, and unemployed non-smoking construction worker using a multinomial model with employed non-smokers as the comparison group. The results of this analysis are presented as a supplement to the paper.

We also examined the association between the number of cigarettes smoked per day and labor market shock, antismoking sentiment, and cigarette prices among those construction workers classified as smokers. Results from the simple and multiple regression models can be found in Table 4. Labor market shock and state antismoking sentiment were both associated with the average number of cigarettes smoked per day in unadjusted models, while cigarette prices were not.

The multiple regression model suggests that labor market shock had a significant quadratic association with the number of cigarettes smoked per day (IRR = 0.99; 95% CI = 0.98, 1.00). Similar to associations with the probability of smoking, the number of cigarettes increased as the economy improved up to the point at which the economy was performing as expected (-0.04). After this point, the number of cigarettes decreased with further improvements in the economy. Figure 1 depicts this non-linear association for a hypothetical worker in the state of Texas.

Cigarette prices had a significant cubic association with the average number of cigarettes smoked per day (IRR = 1.01, 95% CI = 1.01, 1.02) but this result should be interpreted with caution. The model is only valid for the values of cigarette prices found in the sample (i.e., \$1.80-\$6.30). The cubic association suggests that, controlling for the economy and antismoking sentiments, the number of cigarettes smoked per day increased as cigarette prices increased to approximately \$2.00. Between \$2.00 and \$6.00, increases in cigarette prices resulted in very little change in the number of cigarettes smoked per day. However,

after \$6.00, further increases in cigarette prices resulted in an increase in the number of cigarettes smoked per day (see figure 2).

As seen in figure 3, state-level antismoking sentiment had a quadratic association with the number of cigarettes smoked per day (IRR = 0.82, 95% CI = 0.70, 0.97). This quadratic association between antismoking sentiments and the number of cigarettes smoked per day suggests that the number of cigarettes smoked per day remained relatively constant as antismoking sentiments increased up to a certain level (approximately -0.66). After this level of antismoking sentiments, further increases in antismoking sentiment was associated with a rapid decline in the number of cigarettes smoked per day.

DISCUSSION

Our study examined the association of labor market shock, cigarette prices and antismoking sentiments with smoking among construction workers. We found the same high prevalence of smoking that other studies have found among construction workers (D. Lee et al., 2007; Okechukwu et al., 2009). The previously reported demographic trends in smoking in which increased risk of smoking was found for being American Indian or Other race/ethnicity, having lower income and having lower education was present among the construction workers (Barbeau et al., 2004).

Similar to findings from other studies, we found higher rates of smoking among those who were unemployed (A. Lee et al., 1991; Reine et al., 2004). Although it showed a quadratic pattern, labor market shock was not significantly associated with smoking status among the construction workers. Other studies have found an association between the economy and smoking (Novo et al., 2000; Ruhm, 2000, 2005). Novo and colleagues (2000) found that worse performance of the Swedish economy was generally associated with a decrease in cigarette consumption, but the only significant association found in their multivariable analysis was between long-term unemployment and smoking among women. This current study also found a multivariable association between unemployment and smoking. In a study that used average state employment within 3 months of the survey as a measure of the economy, Rhum (2005) found a procyclical association whereby smoking went up and down with the economy. This current study also used state average but we used a measure that is occupational specific and that captured labor market shock—the difference between expected versus observed employment. Consequently, we cannot directly compare the two results.

We found a nonlinear significant association between our measure of the economy and the average number of cigarettes smoked per day. There was a quadratic association between labor market shock and number of cigarettes, in which the positive association between the economy and smoking found by other studies is apparent while the economy is moving towards recovery (Novo et al., 2000; Ruhm, 2000, 2005). However, the association between the economy and smoking became inverse as the economy started to perform better than expected. The decrease in smoking when the economy is doing particularly well could be due to several factors. Several studies have reported a worsening of mental health and associated psychological distress during poor and unstable economy (Goldman-Mellor et al., 2010; Catalano et al., 2011). The decrease in smoking among construction workers when the economy is performing better than expected could be due to a reduction in the use of smoking for stress relief (Lundberg, 1999; Fidler & West, 2009). Also, contractions and expansions of the economy are associated with decreases and increases in investments in health expenditures including health promotion and mental health services (Gottret et al., 2009). Therefore, it is also possible that the decrease in smoking is as a result of greater access to both mental health services and health promotion.

There was a cubic association between cigarette prices and number of cigarettes, which showed that there was no effect of cigarette prices between the price ranges of \$2.00 to \$6.00. Because the results are only valid for values of cigarette prices found in the sample (i.e., \$1.80-\$6.30), we are interpreting the cubic association as showing no effect of cigarette prices. Most studies of the association between cigarette prices and smoking have concentrated on adolescents (Lewit et al., 1997; Liang & Chaloupka, 2002; Ross & Chaloupka, 2002). These studies have found that higher cigarette prices lead to reductions in youth smoking and cigarette consumption. However, many of the studies that have examined the association among a wide range of ages have found differences in response to cigarette prices between older and younger adults, with cigarette prices having a greater effect on younger people (Harris & Chan, 1999; Farrelly et al., 2008). Other studies have found that cigarette prices are associated with cigarette consumption among adults (Townsend et al., 1994; Franz, 2008). These later results mirror our results from the model in which we examined the influence of cigarette prices without controlling for the influence of labor market shock and state-level antismoking sentiment. However, we found that cigarette prices were no longer associated with smoking after controlling for the effects of state-level antismoking sentiments and labor market shock.

One limitation of our study is that we used state-level cigarette prices, which does not account for local taxes imposed in addition to state taxes. We could not get localities information for a significant portion of our sample (about 50%) due to privacy restrictions on the TUS-CPS data. We expect that the use of state-level cigarette prices diluted the strength of any associations seen, since local taxes increase (not decrease) the prices that consumers pay for cigarettes. Another limitation of our study is that we did not take into account potential price-subsidizing promotions employed by the tobacco industry to decrease the actual cost of cigarette to consumers (Pierce et al., 2005). We could not reliably get this information but, again, we expect that this limitation means that our results are conservative estimates of the association between cigarette prices and smoking behaviors in this population.

Another strength of our study is that we used construction- and state-specific estimates of employment rates for construction workers. This measure is more proximal to the actual macroeconomic climate for construction workers than those of previous studies because it is specific to the occupation in which the study population works. An important strength of our study is our use of a measure of antismoking sentiment that was derived from population-representative estimates about actual sentiments towards smoking by state residents.

This is the first study to examine the influence on smoking of labor market shock, cigarette prices and antismoking sentiments simultaneously and in a group of blue-collar workers. Studies often use nationally representative samples to generalize across populations of workers but rarely examine subgroup differences by occupation and employment status. Our study showed that, even within the same occupational group, state-level factors could have disparate influences on employed versus unemployed workers. Antismoking sentiment had a quadratic significant influence on the smoking status of employed construction workers but had no associations for the unemployed construction workers. Our unstratified model showed that unemployment was consistently associated with higher odds of smoking. We hypothesize that antismoking sentiment captures social norms surrounding smoking. It is possible that antismoking sentiments was not associated with smoking among those who are unemployed because being unemployed isolates unemployed workers from society and societal norms. In contrast, employed workers were influenced by public sentiments about smoking. Therefore, a rise in antismoking sentiment could be an opportunity to target smokers who are construction workers through workplace smoking cessation programs. However, the results also suggest the potential for workplace based programs and

antismoking sentiment to further increase the disparity in smoking between employed and unemployed construction workers.

The study results raised other concerns related to the consistently reported disparities in smoking by employment status (Reine et al., 2004). A recent qualitative study of discussions of smoking among supervisors and workers in construction found that both groups struggled with balancing the rights of nonsmokers and smokers in the workplace and that some contractors were choosing to employ only nonsmokers as a way to deal with the smoking issue (Bondy & Bercovitz, 2011). Such discriminatory practices against construction workers who smoke will likely contribute to an increasing isolation of smokers through unemployment. This is important to note given that current efforts to combat smoking among blue-collar worksites have concentrated on reaching them through workplace smoking cessation programs (Moher et al., 2005; Sorensen et al., 2007; Okechukwu et al., 2009).

The study results also yield information that will be important to understanding, and therefore combating, the high prevalence of smoking among construction workers. This study found that cigarette prices, the one state-level tobacco control policy that applies to most blue-collar workers, was not associated with smoking status or with number of cigarettes smoked by construction workers, the occupational group with the highest smoking prevalence. Coupled with the disparity in smoking prevalence by occupation is a failure of smoking cessation programs to produce prolonged smoking cessation among blue-collar workers. Community-based interventions to improve smoking cessation among blue-collar populations have produced mixed results, and many have been unsuccessful (Campbell et al., 2002; Moher et al., 2005; Okechukwu et al., 2009). Studies show that state-level clean indoor air (CIA) policies, which protect workers from second-hand smoking at workplace, have led to decrease in smoking among some working class populations (Farrelly et al., 1999; Brownson et al., 2002; Shopland et al., 2004). However, outdoor worksites, such as construction worksites, are exempt from these CIA laws. The qualitative study of discussions of smoking among construction workers and supervisors found that many of them preferred smoke-free worksites (Bondy & Bercovitz, 2011). Perhaps, future tobacco control efforts should consider extending clean air policies to workers who work outdoors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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1. Examined impact of macroeconomic factors on smoking among construction workers
2. Antismoking sentiments reduced associations of cigarette prices with smoking
3. Employed workers' smoking status was more susceptible to macroeconomic factors
4. Predictors had more influence on number of cigarettes than on smoking status

Figure 1. Influence of labor market shock on the number of cigarettes smoked per day among construction workers in 2006-2007

This figure displays the association between economic shock and the averaged number of cigarettes smoked daily among construction workers in 2006-2007 with the following characteristics: white, employed male with <high school degree, family income <\$20,000, age = average age in years (38.287), price of cigarettes = average cigarette price in Texas between years 2006-2007 (\$3.45), and a state antismoking sentiment = actual Texas antismoking sentiment = -0.063 . Other values of gender, race/ethnicity, education, family income, data collection year, age, cigarette prices, and a state's antismoking sentiment result in parallel vertical shifts in the above curves.

Figure 2. Influence of cigarette prices on the number of cigarettes smoked per day among construction workers in 2006-2007

This figure displays the association between cigarette prices and average number of cigarettes smoked daily among construction workers in 2006-2007 with the following characteristics: white, employed male with <high school degree, family income <\$20,000, age = average age in years (38.287 years), economic shock = average economic shock in Texas between the years 2006-2007 = -0.022 , and a state's antismoking sentiment = actual Texas antismoking sentiment = -0.063 . Other values of gender, race/ethnicity, education, family income, data collection year, age, cigarette prices, and a state's antismoking sentiment result in parallel vertical shifts in the above curves. The model is only valid for the values of cigarette prices found in the sample (i.e., \$1.80-\$6.30)

Figure 3. Influence of a state's antismoking sentiment on the number of cigarettes smoked per day among construction workers in 2006-2007

This figure displays the association between a state's antismoking sentiment and the average number of cigarettes smoked daily among construction workers in 2006-2007 with the following characteristics: white, employed male with <high school degree, family income < \$20,000, age = average age in years (38.287 years), cigarette price = average cigarette price in Texas between the years 2006-2007 (\$3.45), and economic shock = average economic shock in Texas between the years 2006-2007 = -0.022 . Other values of gender, race/ethnicity, education, family income, data collection year, age, cigarette price, and a state's antismoking sentiment result in parallel vertical shifts in the above curves.

Table 1Sample characteristics by smoking status^a

Characteristic	Current Smoker (N = 18,875)	Noncurrent Smoker (N = 33,543)
Gender		
Male	18,309 (97.0)	32,630 (97.3)
Female	566 (3.0)	913 (2.7)
Race ^b		
White	15,621 (82.8)	25,422 (75.8)
Black	951 (5.0)	1707 (5.1)
American Indian	342 (1.8)	388 (1.2)
Asian/Pacific Islander	249 (1.3)	490 (1.5)
Hispanic	1583 (8.4)	5338 (15.9)
Other	124 (0.7)	179 (0.5)
Education ^b		
< High School (HS)	4746 (25.1)	6265 (11.7)
HS/GED	9391 (49.8)	15,428 (46.0)
Some College/Associates deg.	4099 (21.7)	9423 (28.1)
College+	639 (3.4)	2427 (7.2)
Family Income ^b		
< \$20,000	5771 (33.6)	6876 (22.9)
\$20,000 – 34,999	3245 (18.9)	5090 (16.9)
\$35,000 – 49,999	3463 (20.2)	6453 (21.5)
\$50,000 – 74,999	3079 (17.9)	6885 (22.9)
\$75,000+	1612 (9.4)	4782 (15.9)
Employment Status ^b		
Employed	16,614 (89.0)	16,614 (89.0)
Unemployed	2063 (11.1)	2063 (11.1)
Data Collection Wave ^b		
1992-1993	3228 (17.1)	4989 (14.9)
1995-1996	2643 (14.0)	4018 (12.0)
1998-1999	2490 (13.2)	4180 (12.5)
2000	1860 (9.9)	3087 (9.2)
2001-2002	2770 (14.7)	4932 (14.7)
2003	2763 (14.6)	5521 (16.5)
2006-2007	3121 (16.5)	6816 (20.3)
	Mean (SD)	Mean (SD)
Age ^b	37.45 (10.69)	38.75 (11.58)

Characteristic	Current Smoker (N = 18,875)	Noncurrent Smoker (N = 33,543)
Labor Market Shock ^b	0.05 (0.74)	0.03 (0.73)
State Antismoking Sentiment ^b	−0.12 (0.13)	−0.10 (0.13)
Cigarette prices ^b	3.36 (0.88)	3.49 (0.89)

^aContinuous variables presented as mean (SD) and categorical variables presented as n (%)

^bDifferences between groups in the sample are statistically significant ($P < 0.05$)

Unadjusted and adjusted associations between economic shock, cigarette price, and state antismoking sentiment and smoking status among construction workers

Table 2

Predictors	Unadjusted Models	Adjusted Model 1	Adjusted Model 2	Adjusted Model 3	Adjusted Model 4
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Labor Market Shock	1.07 (0.99, 1.16)	1.00 (0.95, 1.04)			0.98 (0.94, 1.02)
Cigarette prices ^c	0.84 (0.65, 1.09)		0.90 (0.85, 0.94)		0.98 (0.93, 1.03)
State Antismoking Sentiment ^{a,b,d,e}	0.25 (0.11, 0.58)			0.45 (0.37, 0.55)	0.47 (0.39, 0.56)
Age ^{a,c,d}	0.99 (0.98, 1.01)	0.99 (0.99, 1.00)	0.99 (0.99, 1.00)	0.99 (0.99, 1.00)	0.99 (0.99, 1.00)
Sex					
Male	-----	-----	-----	-----	-----
Female	1.07 (0.68, 1.68)	1.08 (0.90, 1.29)	1.07 (0.90, 1.27)	1.08 (0.91, 1.28)	1.08 (0.90, 1.29)
Education ^{a,b,c,d,e}					
< High School (HS)	-----	-----	-----	-----	-----
HS/GED	0.87 (0.54, 1.41)	0.70 (0.66, 0.75)	0.72 (0.67, 0.77)	0.72 (0.67, 0.77)	0.71 (0.66, 0.75)
Some College/Associates degree	0.64 (0.43, 0.96)	0.54 (0.50, 0.58)	0.55 (0.51, 0.59)	0.55 (0.51, 0.60)	0.55 (0.51, 0.59)
College+	0.39 (0.18, 0.82)	0.34 (0.30, 0.38)	0.35 (0.31, 0.39)	0.35 (0.31, 0.39)	0.34 (0.30, 0.39)
Race/Ethnicity ^{a,b,c,d,e}					
Non-Hispanic White	-----	-----	-----	-----	-----
Non-Hispanic Black	0.85 (0.62, 1.15)	0.68 (0.62, 0.75)	0.68 (0.62, 0.75)	0.69 (0.62, 0.76)	0.68 (0.61, 0.75)
Asian/Pacific Islander	0.80 (0.32, 2.02)	0.86 (0.70, 1.06)	0.90 (0.73, 1.10)	0.94 (0.76, 1.16)	0.94 (0.76, 1.16)
American Indian	1.51 (0.62, 3.65)	1.12 (0.90, 1.39)	1.11 (0.90, 1.38)	1.13 (0.92, 1.40)	1.13 (0.91, 1.40)

Predictors	Unadjusted Models	Adjusted Model 1	Adjusted Model 2	Adjusted Model 3	Adjusted Model 4
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Other	1.12 (0.66, 1.90)	1.44 (1.04, 2.00)	1.41 (1.02, 1.94)	1.43 (1.03, 1.98)	1.48 (1.06, 2.06)
Hispanic	0.45 (0.39, 0.51)	0.30 (0.27, 0.34)	0.30 (0.27, 0.33)	0.32 (0.29, 0.36)	0.32 (0.29, 0.36)
Employment Status <i>a,b,c,d,e</i>					
Employed	-----	-----	-----	-----	-----
Unemployed	1.76 (1.32, 2.33)	1.49 (1.36, 1.63)	1.50 (1.38, 1.63)	1.49 (1.37, 1.63)	1.51 (1.38, 1.65)
Family Income <i>a,b,c,d,e</i>					
<20,000	-----	-----	-----	-----	-----
\$20,000 – 34,999	0.78 (0.58, 1.05)	0.81 (0.75, 0.87)	0.79 (0.74, 0.86)	0.80 (0.74, 0.86)	0.81 (0.75, 0.87)
\$35,000 – 49,999	0.69 (0.45, 1.05)	0.68 (0.63, 0.73)	0.68 (0.63, 0.73)	0.68 (0.62, 0.73)	0.68 (0.63, 0.74)
\$50,000 – 74,999	0.57 (0.28, 1.16)	0.57 (0.53, 0.62)	0.57 (0.53, 0.62)	0.57 (0.53, 0.62)	0.58 (0.54, 0.63)
\$75,000+	0.43 (0.24, 0.74)	0.44 (0.40, 0.49)	0.44 (0.40, 0.49)	0.44 (0.40, 0.49)	0.45 (0.41, 0.50)
Data Collection Year <i>a,b,c,d,e</i>					
1992-1993	-----	-----	-----	-----	-----
1995-1996	1.04 (0.97, 1.12)	1.29 (1.17, 1.42)	1.27 (1.16, 1.39)	1.28 (1.17, 1.40)	1.26 (1.15, 1.39)
1998-1999	0.96 (0.89, 1.03)	1.29 (1.16, 1.43)	1.36 (1.24, 1.51)	1.30 (1.18, 1.44)	1.28 (1.15, 1.42)
2000	0.97 (0.88, 1.06)	1.37 (1.22, 1.54)	1.54 (1.37, 1.73)	1.36 (1.22, 1.52)	1.39 (1.24, 1.56)
2001-2002	0.90 (0.84, 0.97)	1.33 (1.19, 1.48)	1.55 (1.37, 1.75)	1.32 (1.20, 1.46)	1.34 (1.18, 1.52)
2003	0.78 (0.72, 0.84)	1.15 (1.03, 1.29)	1.41 (1.25, 1.60)	1.17 (1.05, 1.30)	1.17 (1.03, 1.34)
2006-2007	0.71 (0.66, 0.76)	1.14 (1.03, 1.27)	1.37 (1.22, 1.54)	1.15 (1.04, 1.26)	1.16 (1.02, 1.31)

^a $P < 0.05$ in adjusted model 1

b $p < 0.05$ in the unadjusted model
 c $p < 0.05$ in adjusted model 2
 d $p < 0.05$ in adjusted model 3
 e $p < 0.05$ in adjusted model 4

Table 3

Multiple logistic regression results from our model building for the influence of various demographic and economic factors on smoking status among construction workers^a

Factor	Employed Workers (N = 47,789)		Unemployed Workers (N = 4,199)	
	OR (95% CI)	P-Value	OR (95% CI)	P-Value
Labor Market Shock ^b	0.99 (0.94, 1.03)	0.51	0.94 (0.83, 1.06)	0.30
Labor Market Shock ² ^b	0.98 (0.95, 1.00)	0.08	0.98 (0.87, 1.10)	0.70
Cigarette price	0.98 (0.93, 1.03)	0.40	0.86 (0.72, 1.05)	0.13
State's Antismoking Sentiment ^a	0.43 (0.35, 0.52)	<0.001	0.52 (0.24, 1.13)	0.09
State's Antismoking Sentiment ^{2a}	0.17 (0.07, 0.45)	<0.001	1.08 (0.05, 21.50)	0.96

^a Models adjusted for gender, race/ethnicity, education, family income, data collection year, and age. These models took into account the cubic relationship between age and smoking status.

^b Predictors have been grand mean-centered by subtracting the mean from the observed value.

Table 4

Influence of demographic and economic factors on the average number of cigarettes smoked among construction workers^a

Factor	Simple Regression Models		Multiple Regression Models	
	IRR (95% CI)	P-Value	IRR (95% CI)	P-Value
Labor Market Shock ^b	4.35 (1.45, 13.07)	0.01	1.00 (0.99, 1.01)	0.64
Labor Market Shock ^{2b}	-----	-----	0.99 (0.98, 1.00)	0.02
Cigarettes price	0.09 (0.01, 5.05)	0.24	0.96 (0.94, 0.98)	<0.01
Cigarettes price ² ^b	-----	-----	0.99 (0.98, 1.00)	0.24
Cigarettes price ³ ^b	-----	-----	1.01 (1.01, 1.02)	<0.001
State's Antismoking Sentiment	0.00 (0.00, 0.01)	0.001	0.80 (0.75, 0.86)	<0.001
State's Antismoking Sentiment ^{2b}	-----	-----	0.82 (0.70, 0.97)	0.02

^aModels adjusted for gender, race/ethnicity, education, family income, data collection year, and age.

^bPredictors have been grand mean-centered by subtracting the mean from the observed value.