



The effect of a smoke-free campus policy on college students' smoking behaviors and attitudes

Dong-Chul Seo*, Jonathan T. Macy, Mohammad R. Torabi, Susan E. Middlestadt

Department of Applied Health Science, Indiana University, Bloomington, IN 47405, USA

ARTICLE INFO

Available online 9 August 2011

Keywords:

Smoke-free campus policy
Tobacco use
College students

ABSTRACT

Objective. To evaluate the impact of a smoke-free campus policy on college students' smoking behaviors and attitudes.

Methods. The current study utilized repeated cross-sectional surveys with a nested 4-wave longitudinal cohort design. Data were collected from undergraduate students at two large matched public universities in Indiana before and after one of the campuses went smoke-free in January 2008. Baseline data were collected in fall 2007 ($n = 3266$) and follow-up data were collected in fall 2009 ($n = 3207$). In addition, volunteers provided longitudinal follow-up data at four different time points.

Results. In the cross-sectional analyses, students exposed to the smoke-free campus policy demonstrated significant favorable changes in smoking behavior (16.5% to 12.8%, $p < 0.001$), perceptions of peer tobacco use (73.6% to 66.8%, $p < 0.001$), and smoking norms (45.5% to 40.4%, $p < 0.001$) compared to students on the control campus. In the longitudinal analyses, students exposed to the smoke-free campus policy demonstrated these changes plus significant favorable changes in attitudes toward regulation of tobacco (83.2% to 89.9%, $p < 0.01$).

Conclusions. The implementation of a smoke-free campus policy may be an effective intervention for reducing tobacco use among college students.

© 2011 Elsevier Inc. All rights reserved.

Introduction

Cigarette smoking among young adults continues to be a major public health concern. In 2009, 22% of U.S. adults 18 to 24 years of age were current smokers (CDC, 2010). Among college students, the smoking rate peaked in 1999 and subsequently decreased throughout the 2000s. Despite this decline, 18% of college students were current smokers in 2008 (Johnston et al., 2009). Moreover, the tobacco industry targets college students with marketing and special promotions centered in bars and clubs close to college campuses (Katz and Lavack, 2002; Ling and Glantz, 2002; Rigotti et al., 2005).

Exposure to secondhand smoke among college students has received increased attention in recent years. The negative health effects of secondhand exposure among young adults (Celermajer et al., 1996; Moritsugu, 2007) and among the general adult population (Glantz and Parmley, 1995, 2001; He et al., 1999; Law et al., 1997; Seo and Torabi, 2007) are well documented. Because of college students' lifestyles, they are more likely to be regularly exposed to secondhand smoke in bars, clubs, and college housing. In a survey of North Carolina college students, 83% reported recent exposure to secondhand smoke (Wolfson et al., 2009).

In response to concerns about smoking and secondhand smoke exposure among college students, policies prohibiting smoking on college campuses have become more common in recent years (American Nonsmokers' Rights Foundation, 2011). Although there is evidence that workplace and public smoke-free air policies are effective in reducing smoking behavior (Bauer et al., 2005; Fichtenberg and Glantz, 2002; Hahn et al., 2008; Heloma and Jaakkola, 2003; Moskowitz et al., 2000; Siegel et al., 2008), there are no published studies evaluating the impact of smoke-free campus policies on college students' smoking.

The current study utilized a pre-post matched control group with a nested longitudinal cohort design to test the impact of a smoke-free campus policy on college students' behaviors and attitudes related to tobacco use. Specifically, changes in smoking behavior, perceptions of peer tobacco use, smoking norms, and attitudes toward regulation of tobacco were tested. Multiple waves of data were collected from students at two large public universities in Indiana before and after one of the campuses went smoke-free. On January 1, 2008, Indiana University-Bloomington (enrollment of 42,000) implemented a policy prohibiting smoking in all indoor and outdoor areas on campus. Smoking is prohibited in university-owned vehicles but permitted in privately owned vehicles. Purdue University in West Lafayette (enrollment of 40,000), which allowed smoking outdoors at a distance of at least 30 ft from university facilities during the study period, served as the control campus. The home cities of both universities had comprehensive community smoke-free air laws in

* Corresponding author at: Department of Applied Health Science, Indiana University, HPER Building 116, 1025 East 7th Street, Bloomington, IN 47405, USA. Fax: +1 812 855 3936.

E-mail address: seo@indiana.edu (D.-C. Seo).

effect at the time of data collection, similar population size, and similar racial/ethnic composition. The campuses showed similar proportions of in-state students (63% both), similar proportions of minority students (12% both), and similar proportions of underrepresented minority students (7% both).

Methods

Recruitment and data collection

In fall 2007, 84 Indiana University instructors and 67 Purdue University instructors were asked for permission to administer a survey in their classes. Among those contacted, 73 Indiana instructors and 55 Purdue instructors agreed. A total of 3492 students (2057 from Indiana and 1435 from Purdue) were invited to complete a group-administered paper-and-pencil survey, and 3266 students (1930 [93.8%] from Indiana and 1336 [93.1%] from Purdue) participated. In fall 2009, 77 out of 87 Indiana instructors and 54 out of 65 Purdue instructors agreed to have the survey administered in their classes. A total of 3455 students (2215 from Indiana and 1240 from Purdue) were invited to participate, and 3207 students (2042 [92.2%] from Indiana and 1165 [94.0%] from Purdue) completed the survey.

Volunteers for the longitudinal panel comparisons samples were identified from the 2007 cross-sectional survey. A total of 377 students at Indiana and 318 students at Purdue agreed to participate and provided their e-mail addresses. However, a substantial number of the e-mail addresses ($n = 76$ [20%] for Indiana and $n = 87$ [27%] for Purdue) were illegible, incomplete, or returned undeliverable. Those in the longitudinal panel sample ($n = 301$ for Indiana and $n = 231$ for Purdue) were invited to participate in online surveys at the start of the fall 2008, spring 2009, and fall 2009 semesters. Each participant was given a \$5 Starbucks gift card. Those who provided data at two or more waves were retained as the longitudinal panel sample for analyses ($n = 170$ for Indiana and $n = 128$ for Purdue).

Measures

Demographic characteristics

Participants reported their sex, race, ethnicity, age, year in school, and current housing.

Smoking behavior

To assess smoking status, participants reported whether they had smoked at least 100 cigarettes in their lifetime. Those who had smoked at least 100 cigarettes reported whether they currently smoked everyday, some days, or not at all. Everyday or some day smokers were categorized as current smokers. Current smokers also reported the number of cigarettes usually smoked per day.

Peer tobacco use

For perceived prevalence of smoking, participants responded to the question, "Out of every 100 students, how many of them do you think smoke cigarettes?" Response options were fewer than 10, 11 to 25, 26 to 40, 41 to 55, and 56 to 100. For analyses, this variable was dichotomized into 25 or less versus 26 or more. Participants also reported how many of their five closest friends smoked cigarettes. For analyses, this variable was dichotomized into 0 or 1 versus 2 or more.

Smoking norms

To assess smoking norms, students responded to three items, "Smoking among students is acceptable," "Most people on this campus believe students should be allowed to smoke," and "Most people on this campus believe students who smoke should quit," measured on five-point scales from strongly agree to strongly disagree. For analyses, three groups were created: agree or strongly agree, not sure, and disagree or strongly disagree.

Attitudes toward regulation of tobacco

Four items, "Regulation of smoking in public places is a good thing," "Smoking should be banned on all university-owned and -operated property," "Smoking should be banned in all university-owned and -operated vehicles," and "The sale of tobacco products should be banned on all university-owned property," assessed attitudes toward regulation of tobacco. All items were measured on a five-point scale from strongly agree to strongly disagree.

Data analysis

For the repeated cross-sectional comparisons, independent-samples *t*-tests were used for the continuous outcome changes within each university and between Indiana and Purdue. For percentage changes in categorical data, percentage difference *z*-tests for independent samples were used. For the longitudinal panel comparisons, paired-samples *t*-tests were used to test continuous outcome changes between wave 1 and wave 4 within each university. For percentage changes in categorical data between wave 1 and wave 4, percentage difference *z*-tests for correlated data were used. Independent-samples *t*-tests or percentage difference *z*-tests for independent samples were used to compare the wave 1 to wave 4 changes between Indiana and Purdue. These analyses were conducted using SAS 9.2. Linear growth models were fit using HLM 6.08 software to analyze the variation in change trajectories for the four waves of longitudinal data. A hierarchical model was fitted to the data for each outcome variable. Full maximum likelihood estimation was used in which estimates of the fixed effects and variance components maximize the probability of observing the specific pattern in the data (Singer and Willett, 2003). Deviance statistics were employed to test nested models.

Results

Repeated cross-sectional comparisons

Demographic characteristics of the cross-sectional samples, shown in Table 1, were similar for Indiana and Purdue in each survey administration. The mean age for both the Indiana and Purdue samples in 2007 and 2009 was 20. However, the prevalence of current cigarette smoking was different at baseline (16.5% for Indiana and 9.5% for Purdue). Data from two students who took both cross-sectional surveys were excluded to maintain independence between the two samples.

Table 2 displays comparisons of change scores between 2007 and 2009 for Indiana and Purdue. The proportion of current cigarette smokers significantly decreased for Indiana but not for Purdue. For peer tobacco use, there was a significant decrease in the percentage of Indiana students who perceived that 26% of students or more were smoking. In contrast, at Purdue there was a significant increase in the percentage of students who perceived that 26% of students or more were smoking. The percentage of students who reported that two or more of their five closest friends smoked cigarettes decreased significantly at Indiana, but there was no change at Purdue.

In terms of smoking norms, there was a significant decrease in the proportion of Indiana students who agreed that smoking among students was acceptable and who agreed that most people on campus believe students should be allowed to smoke. In contrast, at Purdue the only significant change was an increase in the proportion of students who agreed that most people on campus believe students should be allowed to smoke.

Longitudinal panel comparisons

Demographic characteristics of the longitudinal samples were similar to those of the cross-sectional samples except that the longitudinal cohort was 74% female at wave 1 for both campuses,

Table 1
Demographic characteristics of cross-sectional samples, USA, 2007 and 2009.

Variable	Indiana University, n (%)		Purdue University, n (%)	
	2007	2009	2007	2009
Total, n	1930	2042	1336	1165
Sex				
Male	817 (42.4)	767 (37.6)	540 (40.4)	414 (35.5)
Female	1111 (57.6)	1269 (62.2)	794 (59.4)	749 (64.3)
Transgender	1 (0.1)	4 (0.2)	2 (0.1)	2 (0.2)
Ethnicity				
Hispanic or Latino	38 (2.0)	59 (2.9)	42 (3.2)	38 (3.3)
Not Hispanic or Latino	1880 (98.0)	1968 (97.1)	1286 (96.8)	1122 (96.7)
Race				
White	1658 (87.0)	1719 (85.4)	1147 (87.6)	989 (85.8)
Black or African American	91 (4.8)	136 (6.8)	34 (2.6)	51 (4.4)
Asian	100 (5.2)	72 (3.6)	92 (7.0)	69 (6.0)
Pacific Islander	9 (0.5)	5 (0.2)	6 (0.5)	4 (0.3)
American Indian or Alaska Native	3 (0.2)	5 (0.2)	3 (0.2)	4 (0.3)
Multiracial	45 (2.4)	77 (3.8)	28 (2.1)	36 (3.1)
Year in School				
Freshman	375 (19.5)	549 (26.9)	364 (27.3)	204 (17.5)
Sophomore	635 (33.1)	599 (29.4)	445 (33.4)	440 (37.8)
Junior	460 (23.9)	410 (20.1)	343 (25.7)	335 (28.8)
Senior	445 (23.2)	448 (22.0)	123 (9.2)	162 (13.9)
Other	6 (0.3)	33 (1.6)	59 (4.4)	24 (2.1)
Housing				
Residence hall	513 (26.8)	689 (33.8)	494 (37.0)	361 (31.2)
Sorority/fraternity house	203 (10.6)	203 (10.0)	160 (12.0)	156 (13.5)
University-owned apartment or house	92 (4.8)	106 (5.2)	50 (3.7)	74 (6.4)
Privately-owned apartment or house	1109 (57.9)	1039 (51.0)	630 (47.2)	567 (49.0)

and there were fewer current smokers. Age, sex, ethnicity, race, year in school, and current housing distributions were similar for Indiana and Purdue.

Wave 1 to wave 4 changes are shown in Table 3. Among current smokers, the number of cigarettes usually smoked per day declined among Indiana students. For peer tobacco use, there were significant favorable changes in the percentages of Indiana students who perceived that 26 or more students out of 100 were smoking and who reported that two or more of their five closest friends smoked cigarettes. For smoking norms, there was a significant favorable change in the percentage of Indiana students who agreed that most people believe students should be allowed to smoke on campus.

There was a significant favorable change in the percentage of Indiana students, but not Purdue students, who agreed that regulation of smoking in public places is a good thing and that smoking should be

banned on all university property. Finally, there were significant changes in the percentages of students at both universities who agreed that smoking should be banned in all university vehicles.

Linear growth modeling

To further examine the longitudinal changes in attitudes toward tobacco regulation, which were not demonstrated in the repeated cross-sectional analyses, linear growth models were fitted to predict attitudes toward tobacco regulation as a function of time and campus. To conserve space, only significant findings are presented in Table 4. Indiana students demonstrated significant increases in agreement that regulation of smoking in public places is a good thing ($\gamma_{11} = 0.137, p < 0.05$) and agreement that smoking should be banned on all university owned property ($\gamma_{11} = 0.210, p < 0.05$) compared to Purdue students who

Table 2
Repeated cross-sectional comparisons of Indiana University and Purdue University, USA, 2007 and 2009.

Variable	Indiana University, %			Purdue University, %			Δ^b
	2007	2009	Δ^a	2007	2009	Δ^a	
Smoking behavior							
Currently smoke cigarettes	16.5	12.8	−3.7***	9.5	10.1	0.6	4.3***
Number of cigarettes usually smoked per day ^c	6.6	5.9	−0.7	5.2	6.8	1.6	2.3
Peer tobacco use							
Perceive that 26 or more students out of 100 smoke	73.6	66.8	−6.8***	59.2	67.1	7.9***	14.7***
Two or more of five closest friends smoked cigarettes	44.7	38.7	−6.0***	33.3	34.4	1.1	7.1
Smoking norms							
Agree that smoking among students is acceptable	39.8	34.3	−5.5***	32.3	30.6	−1.7	3.8*
Agree that most people believe students should be allowed to smoke	45.5	40.4	−5.1**	38.3	45.3	7.0***	12.1***
Agree that most people believe smoking students should quit	58.9	61.9	3.0*	67.5	63.9	−3.6	6.6***
Attitudes toward regulation of tobacco							
Agree that regulation of smoking in public places is a good thing	80.5	82.1	1.6	84.3	81.5	−2.8	4.4***
Agree that smoking should be banned on all university property	57.5	62.5	5.0	63.1	61.3	−1.8	6.8***
Agree that smoking should be banned in all university vehicles	68.4	69.0	0.6	72.0	71.7	−0.3	0.9
Agree that the sale of all tobacco products should be banned on all university owned property	44.6	42.8	−1.8	45.6	44.5	−1.1	0.7

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

^a Difference between 2007 and 2009.

^b Difference in the change between Indiana University and Purdue University.

^c Mean.

Table 3
Longitudinal panel comparisons of Indiana University and Purdue University, USA, 2007 to 2009.

Variable	Indiana University, %					Purdue University, %					Δ^b
	Fall 2007 (n = 228)	Fall 2008 (n = 183)	Spring 2009 (n = 153)	Fall 2009 (n = 132)	Δ^a	Fall 2007 (n = 172)	Fall 2008 (n = 85)	Spring 2009 (n = 133)	Fall 2009 (n = 124)	Δ^a	
Smoking behavior											
Currently smoke cigarettes	14.7	15.8	11.1	11.4	−3.3	4.7	4.7	5.3	4.8	0.1	3.4
Number of cigarettes usually smoked per day ^c	8.9	3.9	5.7	3.6	−5.3*	3.1	6.5	3.7	2.8	−0.3	5.0*
Peer tobacco use											
Perceive that 26 or more students out of 100 smoke	68.9	61.3	55.6	55.0	−13.9*	56.4	54.1	54.1	50.0	−6.4	7.5
Two or more of five closest friends smoked cigarettes	37.6	37.4	31.4	25.8	−11.8***	26.7	27.1	24.8	23.4	−3.3	8.5
Smoking norms											
Agree that smoking among students is acceptable	35.5	40.1	36.6	34.6	−0.9	20.9	27.1	28.6	22.8	1.9	2.8
Agree that most people believe students should be allowed to smoke	46.7	37.9	27.5	26.9	−19.8***	39.5	38.8	36.1	29.8	−9.7	10.1*
Agree that most people believe students should quit	67.0	68.0	69.1	71.5	4.5*	75.6	77.6	75.8	75.8	0.2	4.3
Attitudes toward regulation of tobacco											
Agree that regulation of smoking in public places is a good thing	83.2	90.0	91.5	89.9	6.7**	91.3	84.7	84.2	87.1	−4.2	10.9**
Agree that smoking should be banned on all university property	65.5	70.7	76.5	77.9	12.4***	75.0	77.6	73.3	73.4	−1.6	14.0**
Agree that smoking should be banned in all university vehicles	72.6	80.7	85.6	85.4	12.8***	75.0	86.9	82.0	91.1	16.1***	3.3
Agree that the sale of all tobacco products should be banned on all university owned property	55.8	65.4	66.7	74.0	18.2***	54.1	63.5	53.0	65.9	11.8*	6.4

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

^a Difference between Fall 2007 and Fall 2009.

^b Difference in the change between Indiana University and Purdue University.

^c Mean.

showed no significant change ($\gamma_{10} = -0.041$ and 0.010 , respectively). There was an increase in agreement that smoking should be banned in all university vehicles for both Indiana and Purdue students.

Discussion

This study used both cross-sectional and longitudinal data to test the effect of a campus-wide smoke-free air policy on college students' smoking behaviors and attitudes. The findings suggest that the Indiana University policy resulted in positive outcomes as compared to the control campus of Purdue University. Specifically, the cross-sectional analyses demonstrated a significant decrease in current smoking prevalence among Indiana students and no change among Purdue students. The longitudinal analyses did not show statistically significant differences but demonstrated the same pattern. Among students who continued to smoke, the Indiana students showed greater decreases in amount smoked after the policy went into effect. Our findings are consistent with one study that found that college students who lived in smoke-free residences were less likely to smoke than students in other campus residences (Wechsler et al., 2001) and with evaluations of smoke-free workplace policies and community-wide laws that have shown decreases in smoking behavior (Bauer et al., 2005; Fichtenberg and Glantz, 2002; Hahn et al., 2008; Heloma and Jaakkola, 2003; Moskowitz et al., 2000; Siegel et al., 2008).

The campus policy also seemed to positively influence students' perceptions of peer smoking. In both the cross-sectional and the longitudinal data, Indiana students demonstrated a larger decrease in perceived prevalence of smoking compared to Purdue students. Also, there was a significant decrease in the percentage of Indiana students who reported having two or more close friends who smoked cigarettes and no change among Purdue students. These findings are noteworthy since perceived prevalence and peer smoking have been shown to predict young adult smoking behavior (Chassin et al., 1991).

Moreover, Indiana students experienced a greater change in smoking norms as compared to Purdue students. It has been suggested that smoke-free air policies change the perceived norms related to smoking in a community, making smoking less socially acceptable (Levy and Friend, 2001). One study reported that strong smoke-free restaurant regulations were associated with smokers' perceptions that smoking was socially unacceptable (Albers et al., 2007). Theoretical models emphasize the importance of normative beliefs in predicting future behavior (Fishbein and Ajzen, 2010).

Finally, despite the lack of significant findings in the repeated cross-sectional samples, our longitudinal analyses indicated that Indiana students were more likely to increase their favorable attitudes toward regulation of tobacco. These findings were supported by the hierarchical linear growth models. It is important to note the high percentage of students in this sample who agreed with tobacco control regulations. This is consistent with a study that found strong support for campus tobacco control policies among a nationally representative sample of college students (Rigotti et al., 2003). Bloomington, where Indiana University is located, and West Lafayette, home of Purdue University, had comprehensive smoke-free air laws in place at the time of data collection. Thus, the students were already exposed to strong policies and may recognize their benefits. These results may benefit university administrators considering smoke-free campus policies.

The findings of the current study are subject to limitations. First, the samples were predominately White and Non-Hispanic and in the Midwest, so caution is warranted in generalization to college students in other regions. Second, the longitudinal sample consisted of volunteers rather than a random sample of initial participants. This might have introduced selection bias especially for Purdue whose longitudinal sample showed much smaller smoking rates than the cross-sectional sample. To minimize confounding due to the possible selection bias, longitudinal analyses were focused on changes in perception, attitudes, and the number of cigarettes smoked per day rather than a change in smoking status. Third, baseline smoking rates

Table 4
Results of Hierarchical Models Testing Attitudes toward Tobacco Regulation among Indiana University and Purdue University Students, USA, 2007 to 2009.

		Parameter	Unconditional Means Model	Unconditional Growth Model	Effect of the Policy
Agree that regulation of smoking in public places is a good thing					
Fixed Effects		Regression coefficient (standard error)			
Initial status, π_{0i}	Intercept	γ_{00}	4.45 (0.04)***	4.42 (0.05)***	4.46 (0.08)***
	CAMPUS	γ_{01}			-0.08 (0.11)
Rate of change, π_{1i}	Intercept	γ_{10}		0.03 (0.03)	-0.04 (0.04)
	CAMPUS	γ_{11}			0.14 (0.06)*
Random effects		Variance (standard error)			
Level 1	Within-person	σ_e^2	0.48 (0.02)***	0.40 (0.03)***	0.39 (0.03)***
Level 2	Initial status	σ_0^2	0.45 (0.05)***	0.70 (0.08)***	0.70 (0.08)***
	Rate of change	σ_1^2		0.10 (0.03)***	0.10 (0.03)***
	Covariance	σ_{01}^2		-0.16 (0.04)***	-0.16 (0.04)***
Intraclass correlation		ρ	0.49		
Goodness of fit					
Deviance			2988.70	2966.57	2960.04
Estimated parameters (<i>n</i>)			3	6	8
Hierarchical model testing ^a , χ^2 (<i>df</i>)				22.1 (3)***	6.5 (2)*
Agree that smoking should be banned on all university property					
Fixed Effects		Regression coefficient (standard error)			
Initial status, π_{0i}	Intercept	γ_{00}	4.06 (0.06)***	3.94 (0.07)***	4.08 (0.10)***
	CAMPUS	γ_{01}			-0.27 (0.13)*
Rate of change, π_{1i}	Intercept	γ_{10}		0.12 (0.03)***	0.01 (0.05)
	CAMPUS	γ_{11}			0.21 (0.07)*
Random Effects		Variance (standard error)			
Level 1	Within-person	σ_e^2	0.58 (0.03)***	0.47 (0.03)***	0.47 (0.03)***
Level 2	Initial status	σ_0^2	1.01 (0.09)***	1.28 (0.13)***	1.25 (0.13)***
	Rate of change	σ_1^2		0.01 (0.04)***	0.12 (0.03)***
	Covariance	σ_{01}^2		-0.19 (0.05)***	-0.17 (0.05)**
Intraclass correlation		ρ	0.63		
Goodness of fit					
Deviance			3418.87	3385.30	3375.32
Estimated parameters (<i>n</i>)			3	6	8
Hierarchical model testing ^a , χ^2 (<i>df</i>)				33.6 (3)***	10.0 (2)**
Agree that smoking should be banned in all university vehicles					
Fixed Effects		Regression coefficient (standard error)			
Initial status, π_{0i}	Intercept	γ_{00}	4.30 (0.04)***	4.120 (0.06)***	4.17 (0.09)***
	CAMPUS	γ_{01}			-0.083 (0.12)
Rate of change, π_{1i}	Intercept	γ_{10}		0.17 (0.03)***	0.15 (0.04)***
	CAMPUS	γ_{11}			0.06 (0.06)
Random Effects		Variance (standard error)			
Level 1	Within-person	σ_e^2	0.57 (0.03)***	0.46 (0.03)***	0.46 (0.03)***
Level 2	Initial status	σ_0^2	0.51 (0.05)***	0.90 (0.10)***	0.90 (0.10)***
	Rate of change	σ_1^2		0.14 (0.03)***	0.11 (0.03)***
	Covariance	σ_{01}^2		-0.24 (0.05)***	-0.24 (0.05)***
Intraclass correlation		ρ	0.47		
Goodness of fit					
Deviance			3182.12	3108.62	3107.86
Estimated parameters (<i>n</i>)			3	6	8
Hierarchical model testing ^a , χ^2 (<i>df</i>)				73.5 (3)***	0.8 (2)

Note. These models predict attitudes toward tobacco regulation as a function of time (baseline, 12 months, 18 months, and 24 months) (at level-1) and CAMPUS (at level-2). The CAMPUS represents presence (code 1) or absence (code 0) of a tobacco-free campus policy. The intraclass correlation of each model represents the proportion of total variation in the outcome variable that is attributable to differences among college students.

^a Each model was compared to the immediate previous model.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

for the two campus samples were different, with the rate at Purdue much lower. Thus, it is possible that the observed decrease in smoking at Indiana University reflected a continuing downward trend. Fourth, multiple comparisons in a single dataset might have increased Type I error. Finally, the combined effect of multiple tobacco control policies and pro-tobacco forces (e.g., the industry) operating simultaneously

was not considered. Purdue students, while not exposed to a smoke-free campus policy, are nonetheless exposed to other anti-smoking policies and messages (and pro-tobacco messages).

Despite these limitations, this study demonstrated changes in college students' smoking behaviors and attitudes after the implementation of smoke-free campus policy. It is important to note that

Indiana University officials did not actively enforce the policy after it went into effect. The positive changes may be attributable to increased awareness of the policy due to signage and media coverage. In addition, a campus bus completely wrapped with anti-tobacco messaging began regular campus routes in April 2009. Further research exploring the relative contributions of enforcement, signage, media coverage, and other promotional efforts that accompany policy interventions is needed. Future research that investigates changes in other forms of tobacco product use as a result of such a smoke-free policy would also be desirable. In short, these results are encouraging for university administrators considering stronger tobacco control policies.

Conflict of interest statement

The authors have no conflict of interest to disclose.

Human participant protection

The study protocol was approved by the institutional review board at Indiana University in Bloomington and Purdue University in West Lafayette.

Acknowledgments

Funding for this study was provided by Research Triangle Institute International and the Indiana Tobacco Prevention and Cessation Agency. The authors thank Julie Novak and Tristan Kirby for their help with data collection at Purdue University.

References

- Albers, A.B., et al., 2007. Effect of smoking regulations in local restaurants on smokers' anti-smoking attitudes and quitting behaviors. *Tob. Control*, 16, 101–106.
- American Nonsmokers' Rights Foundation, 2011. U.S. Colleges and Universities with Smokefree Air Policies Retrieved February 26, 2011 from <http://www.no-smoke.org/pdf/smokefreecollegesuniversities.pdf> 2011.
- Bauer, J.E., et al., 2005. A longitudinal assessment of the impact of smoke-free worksite policies on tobacco use. *Am. J. Public Health* 95, 1024–1029.
- Celermajer, D.S., et al., 1996. Passive smoking and impaired endothelium-dependent arterial dilation in healthy young adults. *N. Engl. J. Med.* 334, 150–154.
- Centers for Disease Control and Prevention, 2010. Vital signs: current cigarette smoking among adults aged ≥ 18 years — United States, 2009. *MMWR Morb. Mortal. Wkly. Rep.* 59, 1–6.
- Chassin, L., et al., 1991. Four pathways to young-adult smoking status: adolescent social-psychological antecedents in a midwestern community sample. *Health Psychol.* 10, 409–418.
- Fichtenberg, C.M., Glantz, S.A., 2002. Effect of smoke-free workplaces on smoking behaviour: systematic review. *Br. Med. J.* 325, 188–194.
- Fishbein, M., Ajzen, I., 2010. *Predicting and Changing Behavior: The Reasoned Action Approach*. Psychological Press, New York.
- Glantz, S.A., Parmley, W.W., 1995. Passive smoking and heart disease: mechanisms and risk. *J. Am. Med. Assoc.* 273, 1047–1053.
- Glantz, S.A., Parmley, W.W., 2001. Even a little secondhand smoke is dangerous. *J. Am. Med. Assoc.* 286, 462–463.
- Hahn, E.J., et al., 2008. Smoke-free air laws and adult smoking prevalence. *Prev. Med.* 47, 206–209.
- He, J., et al., 1999. Passive smoking and the risk of coronary heart disease: a meta-analysis of epidemiologic studies. *N. Engl. J. Med.* 340, 920–926.
- Heloma, A., Jaakkola, M.S., 2003. Four-year follow-up of smoke exposure, attitudes and smoking behavior following enactment of Finland's national smoke-free workplace law. *Addiction* 98, 1111–1117.
- Johnston, L.D., et al., 2009. *Monitoring the Future National Survey Results on Drug Use, 1975–2008: Volume II. College Students and Adults Ages 19–50* (NIH Publication No. 09–7403). National Institute on Drug Abuse, Bethesda, MD.
- Katz, S.K., Lavack, A.M., 2002. Tobacco related bar promotions: insights from tobacco industry documents. *Tob. Control*, 11 (Suppl. 1), I92–I101.
- Law, M.R., et al., 1997. Environmental tobacco smoke exposure and ischaemic heart disease: an evaluation of the evidence. *Br. Med. J.* 315, 973–980.
- Levy, D.T., Friend, K., 2001. A framework for evaluating and improving clean indoor air laws. *J. Public. Health. Manag. Pract.* 7, 87–96.
- Ling, P.M., Glantz, S.A., 2002. Why and how the tobacco industry sells cigarettes to young adults: evidence from industry documents. *Am. J. Public Health* 92, 908–916.
- Moritsugu, K.P., 2007. The 2006 Report of the Surgeon General: the health consequences of involuntary exposure to tobacco smoke. *Am. J. Prev. Med.* 32, 542–543.
- Moskowitz, J.M., et al., 2000. The impact of workplace smoking ordinances in California on smoking cessation. *Am. J. Public Health* 90, 757–761.
- Rigotti, N.A., Regan, S., et al., 2003. Students' opinion of tobacco control policies recommended for US colleges: a national survey. *Tob. Control*, 12, 251–256.
- Rigotti, N.A., Moran, S.E., et al., 2005. US college students' exposure to tobacco promotions: prevalence and association with tobacco use. *Am. J. Public Health* 95, 138–144.
- Seo, D.-C., Torabi, M.R., 2007. Reduced admissions for acute myocardial infarction associated with a public smoking ban: matched controlled study. *J. Drug. Educ.* 37, 217–226.
- Siegel, M., et al., 2008. Local restaurant smoking regulations and the adolescent smoking initiation process. *Arch. Pediatr. Adolesc. Med.* 162, 477–483.
- Singer, J.D., Willett, J.B., 2003. *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence*. Oxford University Press, New York.
- Wechsler, H., et al., 2001. Cigarette use by college students in smoke-free housing: results of a national study. *Am. J. Prev. Med.* 20, 202–207.
- Wolfson, M., et al., 2009. College students' exposure to secondhand smoke. *Nicotine Tob. Res.* 11, 977–984.