

Cigarette butts near building entrances: what is the impact of smoke-free college campus policies?

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ABSTRACT

Background Indoor and outdoor tobacco-free campus policies for schools, hospitals and universities are increasingly being adopted. Yet, little direct evidence exists on the impact of tobacco-free campuses on tobacco outcomes.

Objectives To identify differences in cigarettes smoked at main campus building entrances by campus policy strength.

Methods Researchers collected cigarette butts (n=3427) at main building entrances (n=67) at baseline and follow-up on 19 community college campuses stratified by strength of campus outdoor tobacco policy (none, perimeter/designated area, 100% tobacco free). Outcome measures included the number of butts per day at building entrances averaged to create a campus score. Analysis of variance techniques examined differences in scores by the strength of campuses' outdoor tobacco policy.

Results One hundred per cent tobacco-free community college campuses had significantly fewer cigarette butts at doors than campuses with no outdoor restrictions. Butts on community college campuses with partial policies were not statistically different from campuses with no policy or campuses with a 100% tobacco-free policy but indicated that a dose-response relationship may exist.

Conclusions This study provides some of the first evidence on the impact of 100% tobacco-free outdoor policies on college campuses using an objective and reproducible measure. Such policies likely provide a more healthful environment for students, staff, faculty and visitors.

INTRODUCTION

Approximately 16%–26% of college students smoke,^{1 2} with even higher rates among community college students.^{3–5} The college campus remains a contested space where tobacco industry marketing heavily targets students^{6–10} to initiate tobacco use at the same time that campus officials work to aid students in their development into healthy productive adults.^{11–14} The tobacco industry recognises college as a time of transition and thus as a uniquely vulnerable^{8 15} time for experimenting with tobacco products or deepening addiction to existing low-level smoking.^{16 17} Conversely, the college environment is uniquely suited to interventions against tobacco use with a well-defined spatial and social environment.^{8 18 19} On college campuses, outdoor policy protections against secondhand smoke are increasingly common,²⁰ and the American College Health

Association recommends 100% tobacco-free campuses, indoors and outdoors.²¹ Such recommendations stem from ecological approaches²² to college student well-being that seek to change normative behaviours in smoking through changing the environment at multiple levels. Such efforts have been successful with smoke-free worksite and school policies.²³

This ecological approach to promote health was applied after researchers identified increases in smoking among college students in the 1990s.²⁴ The North Carolina (NC) Tobacco-Free Colleges Initiative, developed at the University of North Carolina at Chapel Hill, has worked to address this through policy change.²⁵ As of June 2011, 40% of NC's 110 colleges and universities had adopted 100% smoke- or tobacco-free campus policies, protecting students, faculty and staff from secondhand smoke in *all* indoor and outdoor areas.²⁶ Among the 58 members of the NC Community College System, policy adoption was even higher with over 50% having 100% smoke- or tobacco-free campus policies.

While research shows that workplace smoke- or tobacco-free policies reduce prevalence and consumption of cigarettes in workplaces,²⁷ little research has examined outcomes of college campus tobacco-free policies. Little research has directly addressed the impact of 100% smoke- or tobacco-free college campus policies (ie, including outdoor areas) on smoking behaviour.²⁸ Prior work that has addressed smoking on college campus through health education and information approaches has shown limited to no success.^{18 29} Other research has examined the impact of indoor policies on college campuses, rather than campus-wide policies.^{30 31}

Cigarette butts are a unique source of data for identifying the presence of smoking in prohibited areas, secondhand smoke exposure for non-smokers, cigarette brand preferences and information such as environmental problems with litter.^{32–34} As is clear to visitors on most college and university campuses, cigarette butts are a ubiquitous by-product of the tobacco epidemic.³⁴ Given the increasing evidence of the harms of secondhand smoke, including asthma and heart attacks,^{35–37} and recent evidence on outdoor smoking's impact on indoor air quality,³⁸ we sought to identify if 100% smoke-free college campus policies result in lower rates of cigarette butts than less protective smoking policies on college campuses. We hypothesised that campuses with <100% smoke-free policy may send a mixed message to students about the harms of smoking and be interpreted as more lenient, prompting smokers to ignore the policy as has been suggested in other research.^{39–41} This

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study sought to test if there is more smoking by main entrance doors to key buildings on campuses with no restriction or partial restrictions than on campuses with 100% smoke-free policies. Such information is important to college campus administrators interested in adopting policies with the greatest benefits for student, faculty and staff wellness.

METHODS

Sampling frame

We chose to conduct the study on NC's community colleges. Community colleges, as part of a state-funded 2-year vocation and technical system (<http://www.ncccs.cc.nc.us/>) across NC, are more homogeneous in terms of degree programmes and services than the state's 4-year public and private colleges and universities. The choice of community colleges also reduces confounding by religious affiliation and public versus private campuses. In the 2009–2010 academic year, the NC Community College system reported serving over 334 300 students in curriculum programmes and over an additional 847 100 students in continuing education classes.⁴² Community college students in NC are an average of 34 years old⁴³ and are more likely to be men (54%) than women (46%).⁴⁴ A quarter of students are African–American, 8% are Hispanic and 62% are non-Hispanic Caucasian.⁴⁴ Community college students represent one of every eight North Carolinians aged 18 or older.⁴⁵

To create a sampling frame, we systematically searched each NC community college (n=58) website for a copy of smoking or tobacco use policies using standard key words 'smoking' and 'tobacco'. If this failed to produce results, we identified the online version of the student handbook and searched within it for tobacco-related policies. When websites did not have search functions, we used Google and limited to the domain of the college's website. Online searching of campus policies was selected to avoid delays from requesting documents from colleges. Our past experience with the NC Tobacco-Free Colleges Initiative has found that knowledge about campus policies may depend on the organisational position of the respondent. This web-based procedure identified policies for all campuses. Once identified, two researchers independently coded the policies for policy type. A third researcher decided in cases of disagreement. We based our coding off the American College Health Association's (ACHA) recommended tobacco-free campus policy statement²¹ and coded for the presence or absence of 100% smoke- or tobacco-free indoors and outdoors (ie, no smoking anywhere on campus), perimeter policies prohibiting smoking (eg, smoking prohibited to 15 foot or more from buildings or entrances), designated area policies (ie, policies which prohibit smoking except in designated areas) and policies which only covered indoor areas (ie, no mention is made of smoking in outdoor areas). For our purposes, policies without a specific limit on the number of linear feet from doors (eg, 'no smoking near doorways') were coded as only covering indoor areas. This policy census, conducted in March 2011, revealed that 32 campuses had 100% tobacco-free policies or 100% smoke-free policies (55%), 14 campuses restricted smoking to designated areas only (24%), seven campuses had perimeter policies (12%) and five campuses had no outdoor policies (8%).

Measures and definitions

After identifying the campuses' policies, the team agreed on three groups of campuses to represent low, medium and high policy strength. The low policy group included campuses with protections only for indoor air. The medium policy group included campuses with a perimeter policy of 15 foot or more or

a policy that restricted all smoking on the campus to designated areas. The high policy group included campuses with 100% smoke- or tobacco-free policies covering the entire campus, indoors and outdoors. All campuses in the high policy strength group had 100% tobacco-free policies.

We calculated an entrance cigarette butt rate (number of butts/number of days between first cleanup and cleanup/count at second visit) for each building. We defined butts as any filter or butt of a smoked tobacco product (eg, we include cigars, cigarillos) within 15 foot of the main entrance. The team collected cigarette butts from smoking urns/sand receptacles if they were in the 15-foot radius so as to ensure a more accurate measure of exposure. The team agreed that a 15-foot radius provided a conservative estimate of exposure to anyone entering the door and to indoor air quality.³⁸ Moreover, the team hoped to avoid capturing cigarette butts disposed while walking *by* a building instead of *into* a building. Our survey team also documented the presence of open (eg, sand pit) and closed (eg, 'smokers' pole) ash/butt receptacles within 15' of the door and of visible 'smoking policy' signage. The team operationalised these two measures on the protocol as: 'Is there an (open/closed) container to dispose of cigarette butts present in the 15' area?' and 'Standing 15' from the entrance and facing the entrance, do you see any signs, door stickers, or other information about a smoking policy?' Further questions requested a description of signage, if present.

Selection of campuses

Because only five campuses had no outdoor policies, we chose to conduct a census of these campuses instead of sampling. Because we could not adequately match campuses between the three groups due to the small number of campuses in the low policy strength group, we eliminated the campuses with the highest student enrolments serving NC's larger cities to achieve parity in enrolment size in each of the sampling frames. In the middle policy strength group, we assigned each campus a number and then randomly selected numbers until we reached the desired number of campuses. This process was then repeated with the high policy strength group. We used independent t tests to identify if there were differences in enrolment size between included and not included campuses in the middle and high policy strength groups. Selected campuses did not differ from the rest of their respective sampling frames (data not shown).

Power analysis

To estimate the number of schools needed in the middle and highest policy strength groups, we used Power and Precision 11 (Biostat, Englewood, New Jersey, USA) for a one-way analysis of variance (ANOVA) power analysis with unequal group sizes. We estimated the number of cigarette butts per day (seven, five and two on average at building entrances) based on previous research¹ and informed by a limited pilot of our methodology on four local college campuses with different policy types. The power analysis suggested that approximately 80% power could be achieved with a sample of 24 campuses with nine in the top policy strength group.

¹Fallin A, Murrey M, Johnson A, Riker C, Hahn E. Protocol for measuring adherence to a tobacco-free university policy, unpublished conference poster presented at the American Public Health Association, November 8, 2010, and Fallin A, Johnson AO, Kostygina G, Cohen E, Rayens MK, Hahn EJ. An intervention to promote compliance with a tobacco-free campus policy, unpublished conference poster presented at Southern Nursing Research Society, February 2011.

Recruitment

We approached existing campus contacts (n=12) developed by grantees in the NC Tobacco-Free Colleges Initiative or campus facilities management directors (n=12) on each campus to request assistance in preventing cleanup of cigarette butts during implementation and allow for opt-out.

Survey protocol

We developed and pilot tested a protocol for conducting cigarette butt pickups at up to five buildings per campus: (1) the library, (2) the building housing the English department or equivalent, (3) the building housing the Mathematics department or equivalent, (4) the building housing the main student lounge/cafeteria and (5) the main administrative building. We chose to use five buildings to better capture differences on smoking patterns that might exist by different building types (eg, smoking policies could be better enforced at the administration building but not at the library). The protocol contained a number of important restrictions. When a college had more than one campus, we surveyed only at the flagship campus. When buildings were combined (eg, English and math were in the same building), we did not add in additional buildings as many smaller campuses had a limited number of buildings.

We trained four undergraduate students and two staff members on the data collection protocol. We provided student and staff researchers with a campus map with the above buildings marked, a 15-foot string to measure distance, gloves and trash bags. Researchers were encouraged to seal collected butts in multiple layers of bags, store bags in separate areas of the vehicle (ie, the trunk) and to use gloves. Student and staff researchers recorded visits and data using a standardised tracking sheet that included sketching the area under study to aid in returning to the same building. They also photographed the entrance. We visited each campus twice. At the first visit, the team cleaned up the cigarette butts around the five buildings within a 15-foot radius of the main door. If more than once entrance could be the main entrance, the team chose the entrance nearest the largest road visible from the building.

Pilot testing

Our pilot testing indicated that some campuses have architectural details that complicated the protocol, such as bridges to the main door, porticos, long stairways and walled pathways. We expanded the 15-foot radius to include any means of egress that a visitor would have to pass through. For example, our pilot testing indicated that smokers may stand at the bottom of the stairs leading directly to a door or at the edge of a portico. As this would lead to the same exposure for people passing through the area in order to enter the door, we included these areas in the cleanup area. The cleanup area was only extended when visitors had to pass through the area.

Protocol implementation

The protocol had the same team member return 7 days later with their diagram and directions to cleanup a second time and count cigarette butts. For each campus, the same team member returned and picked up cigarette butts in the same area. As previous research shows high inter-rater reliability among students counting cigarette butts (Fallin A, Murrey M, Johnson A, Riker C, Hahn E. Protocol for measuring adherence to a tobacco-free university policy, unpublished conference poster presented at the American Public Health Association, 8 November 2010), we did not re-count cigarette butts. However, the survey team did return with the cigarette butts.

Importantly, members of the survey teams did not know the policy status or category of campuses, unless visibly posted on campus. Upon completion of the study, each campus contact received a letter with findings from their campus and a comparison to averages across all campuses.

Analysis

We calculated a rate of cigarettes smoked at doors per day for each building. We then averaged up to five building rate scores from each campus to create a single score for the campus (average cigarettes per day at building entrances). We a priori planned to use ANOVA to test for the presence of differences between the three policy strength tiers. When the ANOVA returned significant results, we used Fisher protected Least Significant Difference (LSD) test to determine the differences between the measures for the three types of campuses (the LSD test is particularly powerful for three groups; it is not advised for four or more groups due to inflation of type I error).⁴⁵ We used SPSS V.17 (IBM) for all statistical testing.

The University of North Carolina Biomedical Institutional Review Board reviewed the research protocol and found it to be exempt from further review (#11-0635).

RESULTS

Of the 24 community colleges selected, four campuses chose not to participate (17% of those approached), and one campus's data collection was delayed due to scheduling, eliminating them from the study. The four campuses declining to participate were spread across the three policy strength groups, and we identified no policy or size differences between them and participating campuses. The remaining 19 campuses did not differ in enrolment among the three policy strength tiers (ANOVA, $F^2=0.30$, $p=0.74$) (table 1).

Research staff collected 3427 cigarette butts at the 19 campuses included in analyses, visiting a total of 67 buildings ($M=3.5$ buildings per campus). Many campuses located the targeted departments and offices in a single building (eg, English and Mathematics departments located in the same building), thus reducing the average number of buildings visited per campus. Table 2 shows the number of butts cleaned up at baseline, at follow-up, the rate of butts by entrances, the percentage of campuses with visible signage and the percentage of campuses with cigarette butt receptacles in places where smoking was restricted. A full 26% of campuses had cigarette butt receptacles present in non-smoking areas, all of which were on low- or medium-strength policy campuses.

The average rate of cigarette butts per day at key building entrances was significant ($F^2=3.85$, $p=0.04$), indicating one or more differences between policy types. Fisher LSD post-hoc analysis indicated statistically significant differences between the low and high policy strength groups (table 3). While not

Table 1 Campus characteristics by policy strength

	Low	Medium	High	ANOVA p value
Campuses approached (refused)	5 (1)	11 (1)	8 (2)	—
Included campuses	4	9*	6	—
Mean enrolment	2800	3598	3194	0.74
Mean number of buildings	3.5	4.0	2.8	0.06
Mean days elapsed between visits	16.3	11.9	10.5	0.44

*Note: delays in data collection until after classes ended caused us to remove one additional campus from analysis.
ANOVA, analysis of variance.

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Table 2 Survey findings by policy strength

	Low (n=4)	Medium (n=9)	High (n=6)	ANOVA p value
Mean butts cleaned up at first visit	142	159	19	0.15
Mean butts cleaned up at second visit	121	79	20	0.08
Mean rate of butts by building entrances per day	2.6	1.7	0.6	0.04
Number of campuses with signage at all entrances (%)	1 (25)	5 (56)	2 (33)	—
Number of campuses with signage at some but not all entrances (%)	2 (50)	2 (22)	4 (67)	—
Number of campuses with receptacles in 15' of one or more entrances (%)	4 (100)	5 (56)	0 (0)	—
Number of campuses with one or more receptacles in non-smoking entrance areas (%)	1 (25)	4 (44)	0 (0)	—

Note: we did not conduct statistical testing of categorical variables due to small cell sizes. ANOVA, analysis of variance.

statistically significant, the medium policy strength group trended towards low policy strength schools.

Figure 1 shows box plots of the outcome measure by policy group. The average rate showed a dose-response to the strength of the policy. No campuses had values >1.5 times the interquartile range, indicating no outliers. Further analysis indicated that statistical significance is maintained when aggregating the low and medium tiers and comparing to the highest policy strength tier ($t(15.7)=3.4$, $p=0.004$, two tailed).

DISCUSSION

Given the extensive debate on the appropriateness of outdoor policies^{46–49} and keen interest in tobacco-free campus policies,²⁰ evidence on the relationship between smoking at building entrances and the strength of campus smoking policies is timely. This paper presents the first study showing the impact of 100% smoke-free policies in college outdoor areas on smoking near doorways using an economical objective measurement. This research shows that 100% smoke-free (and tobacco-free) policies are associated with reduced cigarette butts near building entrances compared with campuses with limited to no restrictions. Such reductions may reflect fewer cigarettes smoked near

Table 3 Comparison of policy strength on average cigarette butts per day at building entrances

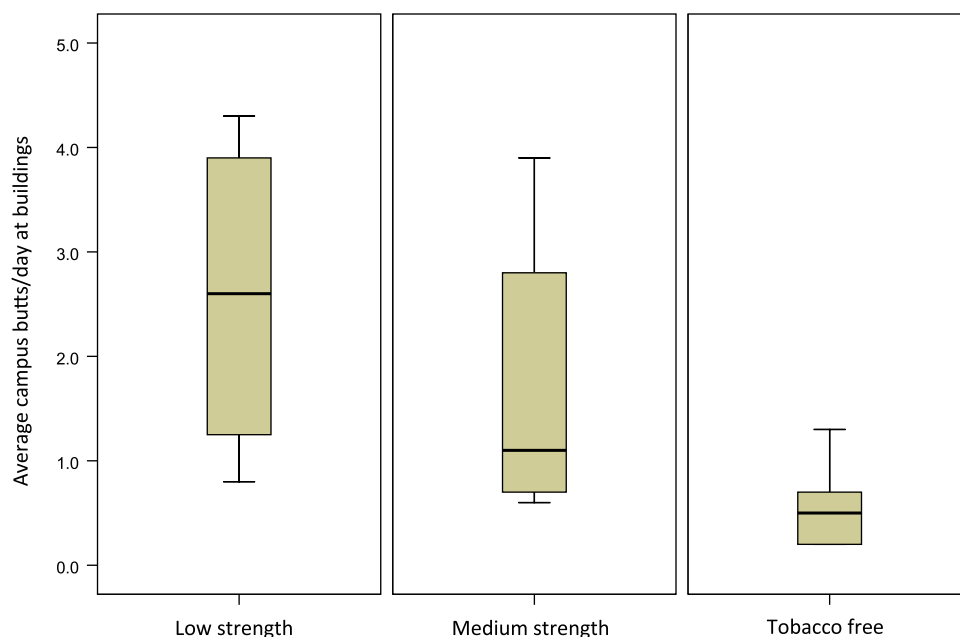
College tobacco policy strength	Comparison groups	p Value	CI	
			Lower	Upper
Low	Medium	0.22	-0.59	2.34
	High	0.02	0.43	3.58
Medium	Low	0.22	-2.34	0.59
	High	0.08	-0.15	2.42
High	Low	0.02	-3.58	-0.43
	Medium	0.08	-2.42	0.15

these entrances and reduced exposure to secondhand smoke for staff, students, faculty and visitors to these campuses. These changes may also help change campus norms around smoking. This paper is among the first to show the prevalence of tobacco-related signage near building main entrances and placement of cigarette butt receptacles in non-smoking areas on community college campuses. The lack of signage and the placement of butt receptacles in non-smoking areas are implicated in decreased compliance with policies, likely due to lack of awareness and/or conflicting messaging.⁵⁰

This pilot work also further reinforces the potential for policy-based interventions to address tobacco on college campuses, such as the NC Tobacco-Free Colleges Initiative,²⁵ which go beyond standard health knowledge and attitude interventions. Colleges and universities should consider protecting all students from exposure to secondhand smoke across campus, as is recommended by the American College Health Association.²¹ While many college administrators may view tobacco use to be a less immediate problem,⁵¹ the long-term impact of smoking initiation or continuance among college students yields substantial long-term morbidity and mortality in addition to short-term health consequences for vulnerable students, faculty and staff.⁵² Duke University, for example, considered changing its policy after a secondhand smoke-induced asthma attack.⁵³

Resources are available in many states to aid in tobacco-free policy development and implementation as well as through American Lung Association affiliates, state/local departments of health and the Center for Tobacco Policy (<http://www>.

Figure 1 Box plots of average cigarette butts per day at building entrances, by policy strength. Note that the centre bold line represents the median rate, the box represents the 25th through 75th percentiles and the 'whiskers' show the range of rates.



tobaccofreenow.org/). The implementation of policies remains important to their effectiveness.^{39–41} The cost of implementation yields equivalent cost savings⁵⁴ and can help reduce expensive litter cleanup.⁵⁵

Limitations

This study is subject to a number of important limitations. Cigarette butts do not capture all smoking behaviour, and the relationship between cigarette butts and exposure to second-hand smoke is not quantified. We were unable to control or measure cleanup of the door areas by facilities or grounds staff. The impact of cleanup by campus staff is unknown as it could bias results towards the null if cleanup is more frequent at campuses with weaker policies. Thus, our results may have been attenuated. While the protocol succeeded in sending the same team members to both visits, not all campuses had the data collection finished in the same time frame. We instructed surveyors to measure 15 foot from the end of the access point to the door. There is undoubtedly some variability in this by surveyor due to interpretation of different architectural details; however, for each building, the same surveyor conducted the baseline and follow-up. This consistency in surveyor in addition to the diagrams and photographs used to document the area studied should have helped reduce variability from butts missed in the initial cleanup.

Due to the relatively small size of the study, its geographic limitation to a single state and the use of community colleges, further research is needed to replicate this study and extend it to other campus settings. Future efforts should consider that within-campus comparisons may be impacted by weather in ways that our simultaneously implemented across-campus comparisons were not. Campus entrances with cigarette butt receptacles may draw in smokers who have smoked cigarettes elsewhere but want to properly dispose of the butts. Stratification or exclusion of entrances with receptacles could improve the precision of estimates.

While it appears that 100% smoke-free campus policies may have greater impact than medium-strength policies allowing for designated areas or a smoke-free perimeter, assessing this relationship may require a higher power study design. Only five of NC's 58 community colleges have no or virtually no restrictions on smoking in outdoor areas. As there has been rapid and widespread adoption of stronger clean air policies on NC college campuses due to the NC Tobacco-Free Colleges Initiative and secular trends,²⁵ these campuses may not represent campuses without outdoor policies in other states.

Even if these results are replicated, fewer cigarette butts, less secondhand smoke and fewer normative cues for smoking on campus may not indicate lower smoking prevalence as smokers could be moving to off campus areas or areas not measured in

our study. Further investigation of these possibilities is necessary in future studies of prevalence and policy compliance at the periphery of campuses.

CONCLUSIONS

The American College Health Association calls for 100% tobacco-free campuses indoors and outdoors.²¹ Our pilot data in this study indicate that such policies reduce litter near entrances to key campus buildings and thus may have impact on smoking behaviour. Such approaches can help monitor and evaluate the implementation and impacts of policies. As the tobacco industry invests heavily in targeting college students and adults during transitional moments, college administrators may find the tobacco-free campus policy to be an important component of promoting well-being to students.

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Contributors All authors planned the study and approved the final version. JGLL managed the survey, conducted all analyses and drafted the manuscript. LMR and AOG edited the manuscripts and provided critical feedback.

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What this paper adds

- ▶ This paper provides some of the first evidence on the impact of outdoor smoke-free policies on college campuses.
- ▶ Such policies decrease cigarette butts near building entrances on 100% smoke-free campuses compared with campuses with no outdoor policy.
- ▶ One-hundred per cent smoke- or tobacco-free policies may be an important strategy for promoting well-being among faculty, staff, students and visitors.

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Cigarette butts near building entrances: what is the impact of smoke-free college campus policies?

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