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Influence of Measurement Setting and Home Smoking Policy on Smoking Topography

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Abstract

While cigarette puffing style, measured by smoking topography, is highly variable between individuals, smoking behavior or style tends to vary relatively little within individuals. Recent research has demonstrated that certain situational factors may produce variation in smoking topography, including location of smoking. Smoking topography directly observed by researchers in a laboratory may differ from that indirectly observed via portable measurement devices at participants' homes. The introduction of clean indoor air laws may also influence smokers' puffing styles, as smokers modify their smoking topography to ensure a quicker, more efficient smoking style. The goal of this analysis was to examine whether directly observed laboratory measures are representative of indirectly observed smoking behavior and to examine the influence of smokers' preference for indoor or outdoor home smoking on puffing style. Overall, participants smoked more intensively in the directly observed setting than when indirectly observed setting in terms of total volume intake, inter-puff interval, and total time spent smoking. This difference was most pronounced among individuals who reported smoking indoors when at home. The data suggest that adherence to an indoor home smoking policy may further influence an individual's smoking behavior.

Keywords

Smoking topography; puffing style; behavior; observational study

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CONTRIBUTORS

Vaughan W. Rees and Richard J. O'Connor together designed the study and contributed to the manuscript write-up. Kaila J. Norton collected data and contributed to the manuscript write up. Kristie M. June completed all data analyses and contributed to the manuscript write up, particularly the original draft.

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1 INTRODUCTION

Diseases associated with cigarette smoking and second hand smoke are the leading causes of preventable death in the United States (US Surgeon General, 2004). The act of smoking comprises many complex behaviors that have the potential to influence nicotine and toxicant delivery and exposure (Marian et al., 2009). Smoking (or puffing) topography, defined as the physical characteristics of the smoking response (Frederiksen et al., 1977), includes features such as number of puffs per cigarette, puff volume, total volume drawn per cigarette, puff flow rate (sometimes called velocity), puff duration, and inter-puff interval. Topography measures have helped reveal the manner in which smokers compensate for lower tar and nicotine levels in cigarettes by puffing more intensively (Russell, 1974), and control smoking behavior in an effort to reduce perceived risk of smoke intake (Frederiksen & Peterson, 1976). While substantial differences exist between individuals on measures of smoking topography (Morgan et al., 1985), intra-individual smoking styles show relatively less variability (Hammond et al., 2005). Nevertheless, intra-individual smoking topography varies throughout the course of the day, likely due to situational circumstances (Grainge et al., 2009; Chapman et al., 1997).

The introduction of clean indoor air laws over the past decade may influence smokers' puffing styles. As the smoking location is moved from indoors to outdoors, smokers may modify their smoking topography to ensure a quicker, more efficient smoking style. Following smoking bans in the workplace, Chapman et al. (1997) observed the behaviors of smokers in the work place and in social settings. Using puff frequency and time taken to smoke a cigarette as measures of smoking topography, Chapman concluded that smokers puff more intensively when on outdoor work breaks where there may be confounding pressures such as time restraints than when smoking in more relaxed indoor and outdoor social settings. More recently, Rüge and colleagues (2009) reported that while daily cigarette consumption was lower among workers with worksite smoking restrictions in Germany, there was no difference in puffs per cigarette or filter tar color. Other evidence suggests that smokers puff no more intensively when smoking outside public venues in which smoking is banned, compared to smoking indoors. Examination of nicotine levels in cigarette filters provided by 322 smokers after an indoor smoking ban in Scotland revealed that estimated tar and nicotine delivered to smokers decreased after the ban, suggesting no increase in smoking intensity (Ashley et al, in press). While a link between outdoor location and smoking intensity is plausible and has received limited empirical support, studies to date have examined outdoor smoking behavior only under a limited range of time-limited contexts.

Typically, most free time (approximately 69%) is spent in or around the home (United States Department of Labor, 2010). However, individuals may differ in the extent to which they choose to, or are permitted to, smoke inside the home. In the United States, for example, there is a growing trend towards implementing complete home-smoking bans (Malarcher et al., 2009). This trend is positively correlated with the proliferation of workplace smoking bans and may be attributable to adult smokers electing to protect children and non-smoking adults in the household from the health effects of second-hand smoke (Borland et al., 2006; Shopland et al., 2006). Implementation of home bans is associated with lower nicotine dependence (as measured by H.S.I.) (Borland et al., 2006), which may be an important factor underlying an observed association between smoke free homes, increased likelihood of quit attempts, and reduced relapse rates (Gilpin et al., 1999; Messer et al., 2008; Hyland et al., 2009).

Measurement of smoking topography in private settings such as the home has been made technologically feasible with the development of unobtrusive, portable topography devices (e.g. see Hammond et al., 2005; Rees et al, 2008; Blank et al., 2009). Portable topography devices, such as the CReSSmicro device, have been shown not only to generate reliable results in a supervised setting (such as a lab), but also under naturalistic conditions (free from direct observation) (cf. Blank et al., 2009). However, it is unknown how closely indirectly observed smoking behavior compares with smoking behavior under directly supervised laboratory conditions. Puffing behavior at home is presumed to be more ‘naturalistic’ (and thus less intensive) than that produced in a research laboratory. Puffing behavior may also be influenced by adherence to bans on indoor smoking, such that puffing styles of those who smoke indoors may differ from those who smoke outdoors. Hence, smokers’ puffing styles may be under the influence of setting (home or lab) as well as home smoking preference or policy.

The present study sought to establish whether laboratory (i.e. directly observed) measures are representative of naturalistic (i.e. indirectly observed) smoking behaviors by comparing smokers’ puffing topography measured under each condition. Further, the study aimed to investigate whether indirectly observed smoking behavior varies according to whether it occurs inside or outside the home. Smokers who typically smoke outdoors were hypothesized to smoke more intensively, even when not directly observed, compared with those whose smoking at home occurs indoors.

2 METHODS

2.1 Participants

Data from this study were derived from a parent study of the short-term effects of switching to reduced ignition propensity cigarettes (O’Connor et al., 2010). Detailed descriptions of study methodology and participant characteristics are available in that publication. In brief, 160 participants were recruited at sites in Buffalo, NY (n=83) and Boston, MA (n=77). Participants were daily smokers of at least 5 cigarettes per day, aged 18–55 years, having smoked over 100 cigarettes in their lifetime with no intention to quit in the next six months. These individuals had to report smoking Marlboro, Newport, or Camel brand cigarettes for eligibility. Participants were excluded if they reported serious health conditions, reported being pregnant, or planning to become pregnant. The current study included all participants from the parent study who reported smoking behavior in the home (n=156). Demographic and smoking related information is presented in Table 1.

2.2 Design and Procedures

The parent study conferred a study design in which smoking behavior of all participants was measured under both directly observed and indirectly observed conditions, each while smoking either indoors or outdoors. Directly observed smoking in Buffalo was conducted outdoors, whereas Boston participants were observed smoking indoors. Indirectly observed (home) smoking was conducted indoors or outdoors, according to the participant’s home smoking policy.

Data were collected over an 18 day period involving four research sessions and two separate field collection periods as part of a parent study on reduced ignition propensity cigarettes (O’Connor et al., 2010). Participants attended a research session on Day 1 and completed a 20 minute paper and pencil baseline survey, followed by instruction on the proper use of the CReSSmicro device. On Day 1, subjects were observed smoking one cigarette using the CReSSmicro outdoors (Buffalo sample) or indoors (Boston sample). On Days 2 and 3, participants smoked their preferred cigarette brand on an indirectly observed, *ad libitum* basis while using the CReSSmicro and were required to consume at least five cigarettes on each of those days. Participants were then observed smoking on Day 4, when topography

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measures were again obtained directly. After a period of habituation with a reduced ignition version of participant's preferred brand, directly observed sessions were repeated on Days 15 and 18, with indirectly observed smoking measured on Days 16 and 17. Thus, directly observed smoking topography data was obtained from a total of four sessions, while indirectly observed topography was obtained from two, two-day field sessions. The study protocol was reviewed and approved by the institutional review boards of Roswell Park Cancer Institute and Harvard School of Public Health.

2.2.1 Measures—The CReSSmicro (Plowshare/Borgwaldt-KC, Richmond VA) was used to record smoking topography and is a small portable device that provides valid, objective measures of smoking topography in naturalistic settings. Topography measures include puff number, puff volume (ml/puff), puff duration (msec), average flow (ml/sec), inter-puff interval (msec), time, and date of smoking. For reporting purposes, duration and inter-puff interval were converted from milliseconds to seconds.

Measures of puff topography comprised total puff volume per cigarette, inter-puff interval (IPI), and total time smoked. Total volume provides a useful measure of puffing as a proxy for smoke exposure. IPI and total time smoked were examined as a means to measure the manner in which an individual puffed more or less intensely.

The baseline survey provided information on demographics, including an indicator item on home smoking restrictions -- "How often do you smoke inside your home"? Response categories included "Never," "Rarely," "Sometimes," "Often," "All the Time," "Don't Know," and "Refused." Home smoking status was dichotomized as "Smokes in the Home" (comprising categories Rarely, Sometimes, Often, and All the Time) or "Never".

3 CALCULATIONS

Total volume inhaled per cigarette was calculated by the product of puff number and average puff volume, per cigarette. Total puff duration per cigarette was derived from the product of average duration and puff number, per cigarette. Finally, total smoking time per cigarette was calculated by the sum of total IPI and total puff duration, per cigarette. Chi-squares and Spearman rank correlations were used to initially characterize the data. Generalized estimating equations (linear, identity link, with unstructured working correlation matrix) were used to examine influence of person-level (age, sex, race/ethnicity, nicotine dependence) and contextual (site, smoking behavior in the home) factors on topography measures, with setting (directly observed or indirectly observed) treated as a within-subjects factor. Statistical significance was accepted at $p<0.05$, two tailed. All analyses were performed using SPSS 16.0 (SPSS, Chicago, IL).

We also analyzed the effect of season in Buffalo and Boston on smoking topography. The eight month study period was organized in four, two-month blocks, as per the general change of climate in the northeast region of the United States. January–February comprised winter, March–April were late winter/early spring, May–June made up late spring/early summer, and July–August defined late summer. We used a univariate ANOVA first to detect differences in smoking topography with change of season during the directly observed condition in Buffalo (smoked outdoors) and then in Boston (smoked indoors). Then, we implemented the same approach to detect seasonal differences in topography measures among participants who reported never smoking in their home while not directly observed. Statistical significance was again accepted at $p<0.05$.

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4 RESULTS

4.1 Demographics and Home Smoking Bans

As shown in Table 1, younger people were in general significantly more likely to implement home smoking bans than older people ($p<0.001$); white individuals showed a nonsignificant trend toward implementing the smoking bans ($p=0.051$). Although there was a significant difference between the brand of cigarette used and smoking behavior in the home, this effect was predominantly due to non-white individuals primarily smoking Newport cigarettes and younger smokers using Camel cigarettes.

4.2 Influence of Smoking Setting on Puffing Behavior

Means of major topography variables total puff volume, IPI, and total smoking time per cigarette did not differ between the Buffalo and Boston samples in both the directly observed laboratory condition and the indirectly observed field condition using univariate ANOVAs (p’s>0.2). Because prior analysis revealed no significant changes in any of the smoking topography measures across visits for either site (O’Connor et al., 2010), all directly observed topography values were averaged across study days 1, 4, 15, & 18 and indirectly observed topography values were averaged across days 2, 3, 16, & 17 to generate respective summary measures for each participant. Figure 1 depicts the average values for each topography measure organized for setting by smoking behavior in the home.

4.2.1 Total Puff Volume (mL)—Using generalized estimating equations models controlling for age, gender, race, brand, and H.S.I.; total puff volume was found to be greater when directly observed compared with indirectly observed. We found a 7.0% difference in those who never smoked in the home and a 20.3% difference in those who did smoke in the home. This difference was most pronounced among participants who reported smoking in the home (20.3% difference) and driven by their topography in the indirectly observed condition (B = −97.4 (1), $p<0.001$). Analysis on total volume revealed a significant difference in brand only ($\chi^2 = 15.2$ (1), $p<0.001$) such that Camel and Marlboro cigarettes were smoked more intensely than Newport cigarettes ($B_{Camel} = 180.4$ (1), $p<0.001$ & $B_{Marlboro} = 105.5$ (1), p<0.05). There were no further effects of demographics on the total volume intake.

4.2.2 Inter-Puff Interval (seconds)—Overall, participants had shorter IPIs when they were directly observed than indirectly observed. Here, we saw a 12.5% difference in those who never smoked in the home and 67.6% difference in those who did smoke in the home. Again, these differences were greatly dissimilar when participants reported smoking in the home (67.6% difference) and in the indirectly observed condition (B = 9356.7(1), $p<0.001$). There were no demographic effects of any kind on IPI (*p’s*>0.1).

4.2.3 Total Time Smoking (min/cig)—Here again, participants smoked more quickly when directly observed than when indirectly observed. Following a similar trend as total volume and IPI, there was 10.6% difference in people who did not smoke in the home and 32.6% difference in people who did smoke in the home. The difference between conditions was greatest for participants who smoked in the home (32.6%), not under observation (B = 57869.1 (1), $p<0.05$).

4.2.4 General Results—Overall, participants smoked more intensively when directly observed compared with when indirectly observed. A significant interaction was revealed between setting and smoking behavior in the home ($p<0.001$). Although participants who claimed to never smoke in the home did puff more intensely when observed than not as indicated by greater total volume intake coupled with shorter IPIs and shorter total smoking time, the difference between the two conditions was minimal (7.0%, 12.7%, and 10.6% differences respectively). Thus, the interaction was driven predominantly by individuals who did smoke in their homes. Participants who reported smoking indoors at home exhibited a much greater difference between directly observed and indirectly observed conditions than did participants who smoked outdoors at home ($p<0.001$). When participants who smoked indoors were indirectly observed, they puffed much less intensely than when they were directly observed in that they took in a smaller volume of smoke (20.3% smaller) driven by much larger IPIs (67.6% larger) and subsequent longer smoking time (32.6% longer). All other topography variables followed a similar trend. Other demographic variables had little or no influence on smoking style.

4.3 Seasonal Effects

Because this study was carried out over the course of approximately one year and we were specifically interested in effects of smoking location and conditions, we used a univariate analysis of variance (ANOVA) model to test for possible effects of season. First, we tested for seasonal differences between the Buffalo directly observed condition (where participants smoked outdoors) and Boston directly observed condition (where participants smoked indoors). In general, we found no statistical difference in either site between season on the variables total volume, IPI, and total time spent smoking (*p's*>0.07). However, we did notice a small trend such that Buffalo participants smoked slightly more intensively during the coldest months (January-February) characterized by greater total volume intake (M=850.4mL Jan–Feb, M=659.0mL Mar–Apr) due to shorter IPIs (M=16.9sec Jan–Feb, M=17.2sec Mar–Apr) and shorter total time spent smoking (M=3.5min Jan–Feb, M=4.1min Mar–Apr). Although these trends appeared, none were statistically significant (*p's*>0.07). This slight trend was not seen amongst the Boston participants.

We used the univariate ANOVA model again to check for seasonal differences in indirectly observed topography measures for all participants who reported not smoking in the home. Here again, although there were no significant differences in season for total volume, IPI, and total time spent smoking (*p's*>0.110), participants smoked slightly more intensively under colder weather conditions ($M_{\text{Total Volume}}$= 697.8mL Jan–Feb; $M_{\text{Total Volume}}$= 665.5mL Mar–Apr).

5 DISCUSSION

Overall, participants smoked more intensively when directly observed during research lab visits than when indirectly observed smoking in a private setting. This supports findings by Hammond et al. (2005) and Rees et al. (2008), further confirming that direct observation of a smoker can produce an alteration in puffing style that may be associated with greater exposure to nicotine and other tobacco smoke toxicants.

These findings may also provide further insight into variations in directly observed and indirectly observed puffing style based upon a smoker's home smoking policy. The most marked changes in smoking topography were seen among people who smoked inside the home. These individuals puffed more intensively when smoking under directly observed conditions than when they were indirectly observed. In contrast, participants who smoked outside their home also demonstrated more intensive puffing when observed, although this effect was less pronounced. That is, individuals accustomed to smoking outside the home smoked with a similar intensity whether they were directly or indirectly observed. Since most smoking behavior presumably occurs in a natural home environment, it is important to consider the impact of smoking behavior around the home as a potential moderator of puffing style.

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The data suggest that, for smokers who are accustomed to smoking in the home, direct observation may have an important influence on measured puffing behavior. Smokers who are accustomed to smoking in the home would presumably not have spectators, time constraints, or climactic considerations. For these individuals, smoking under direct observation may have contributed to more intensive puffing behaviors. Conversely, those participants who were accustomed to smoking outside the home appeared to adapt more easily to the directly observed condition; perhaps because they were already comfortable with direct observation in a public place and within potential time constraints (such as wanting to return indoors).

These present data suggest that the trend towards adoption of smoke-free home policies may impact the generalizablity of smoking topography measurements. As more people implement home smoking bans, the typically observed differences between directly observed and indirectly observed smoking may become less marked. This has implications for the development of so-called 'human mimic' machine smoking protocols, where smoking characteristics are reproduced by machines based on data from smokers (Stellman & Djordjevic, 2009). Clearly such profiles should take location of smoking into account in modeling as our results indicate that location and circumstance may play a role in the manner in which an individual puffs a cigarette.

It is important to note that although recent research indicates that most homes in the United States are smoke free (and many include those where at least one person is a smoker), our study sample did not follow the same trend. Our combined sample from both Buffalo, NY and Boston, MA showed that only 18.6% of our participants never smoked in the home while 81.4% did smoke in the home. A 2006 survey in NY and a similar 2007 survey in MA (O'Connor, unpublished data) revealed that, respectively, 29.4% and 32.4% of smoker homes were smoke-free. With lower proportions of smokers in our sample reporting a smoke-free home policy than suggested in representative surveys, it is possible that smokers recruited for the current study have other individual characteristics that make these findings more difficult to generalize. For example, social anxiety, especially when in the directly observed condition, may have contributed to our results. Future studies should apply better testing taking into account individual differences such as social anxiety, comfort level in different situations, compliance, etc to give a broader perspective on smoking behavior per person.

Additional restraints imposed by the parent study produced important limitations for this secondary analysis. In the directly observed condition, the study site was perfectly confounded with outdoor and indoor smoking. That is, all Buffalo participants smoked outdoors and all Boston participants smoked indoors. Nevertheless, there were no topography differences in the directly observed condition between sites. While it is possible that there could be an interaction between preference for smoking location based on home smoking policy (indoors vs outdoors) and place of observation (indoors vs outdoors), the indirectly observed condition is not perfectly confounded by site. We found individuals in both Buffalo and Boston who preferred to smoke either indoors or outdoors. Additionally, setting (directly observed vs indirectly observed) is a within subjects measure, while both site (Buffalo vs Boston) and smoking policy (smokes in the home vs never smokes in the home) are between subjects measures. Thus, we were neither able to split the data into indoor and outdoor subgroups nor complete a clean factorial design because these subgroups are not perfectly crossed. A future study design should perfectly cross all subject conditions to test all possible interactions.

This exploratory study has shown that smoking in the home may significantly influence the manner and intensity of smoking in different settings; in this case directly observed in the lab or indirectly observed in the field. Our findings suggest that home smoking policy does have an impact on how a person smokes when directly and indirectly observed. Future research could examine prospective smoking topography changes in individuals who implement a smoking ban in the home (compared to those who do not) to more directly assess the impact of the policy on typical smoking patterns. These studies should better represent the broader smoking population, perfectly crossing all participants; while taking a closer look into better examining individual differences such as social anxiety, situational comfort level, and compliance, as with respect to home smoking policy.

6 CONCLUSIONS

Participants smoke differently and more intensively under directly observed observatory research conditions than under indirectly observed naturalistic conditions. These results were further influenced by the participant's home smoking policy. Those who enforced a smoking ban, and thus smoked outdoors, exhibited puffing behaviors akin to what was shown in the observed laboratory condition. However, participants who were accustomed to smoking in the relative privacy of their home puffed significantly less intensely at home than when observed in the lab. In fact, these individuals puffed harder than those who were accustomed to smoking outdoors on the measures of inter-puff interval and total time spent smoking. Although season did not seem to play a large role in contributing to these differences, a slight trend was shown such that participants smoked slightly more intensely in colder weather months (January–February). As it currently stands, location and circumstance, particularly direct or indirect observation and the implementation of home-smoking bans, may alter the manner in which an individual puffs a cigarette and possibly the amount of nicotine and toxicant exposure. However, as more people adopt a non-smoking policy in the home, the currently observed differences between natural and experimental smoking may disappear.

RESEARCH HIGHLIGHTS

- Participants tend to smoke more intensively in directly observed laboratory settings than in indirectly observed settings such as the home.
- The difference in intensity of smoking behaviors between the two settings is most pronounced when participants reported smoking inside the home.
- Laboratory results may or may not be indicative of natural behaviors based on home smoking conditions.

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Abbreviations

H.S.I.	Heaviness of Smoking Index
mL	milliliters
mL/puff	milliliters per puff

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msec	millisecond
mL/sec	milliliters per second
IPI	inter puff interval
ANOVA	analysis of variance
min/cig	minutes per cigarette

REFERENCES

Ashley M, Saunders P, Mullard G, Prasad K, Mariner D, Williamson J, Richter A. Smoking intensity before and after introduction of the public place smoking ban in Scotland. Regul Toxicol Pharmacol. 2010 Mar 25. [Epub ahead of print].

Blank MD, Disharoon S, Eissenberg T. Comparison of methods for measurement of smoking behavior: Mouthpiece-based computer devices versus direct observation. Nicotine Tob. Res., Advance Access. 2009:1–8.

Borland R, Yong H-H, Cummings KM, Hyland A, Anderson S, Fong GT. Determinants and consequences of smoke-free homes: findings from the International Tobacco Control (ITC) Four Country Survey. Tob Control. 2006; 15(suppl III):iii42–iii50. [PubMed: 16754946]

Chapman S, Haddad S, Sindhusake D. Do work-place smoking bans cause smokers to smoke "harder"? Results from a naturalistic observation study. Addiction. 1997; 92(5):607–610. [PubMed: 9219383]

Frederiksen LW, Miller PM, Peterson GL. Topographical Components of Smoking Behavior. Addict Behav. 1977; 2:55–61. [PubMed: 848375]

Frederiksen, LW.; Peterson, GL. Controlled smoking: An Alternative to abstinence. Behavioral research on addictive behaviors: Alcoholism, drug abuse, obesity, and smoking: Symposium presented at the meeting of the Southeastern Psychological Association; 1976.

Gilpin EA, White MM, Farkas AJ, Pierce JP. Home smoking behavior restriction: which smokers have them and how they are associated with smoking behavior. Nicotine Tob. Res. 1999; 1:153–162. [PubMed: 11072396]

Grainge MJ, Shahab L, Hammond D, O'Connor RJ, McNeill A. First cigarette on waking and time of day as predictors of puffing behaviour in UK adult smokers. Drug Alcohol Depend. 2009; 101(3): 191–195. [PubMed: 19231111]

Hammond D, Fong GT, Cummings KM, Hyland A. Smoking Topography, Brand Switching, and Nicotine Delivery: Results from an In vivo Study. Cancer Epidemiol., Biomarkers, and Prev. 2005; 14(6):1370–1375.

Hyland A, Higbee C, Travers MJ, Deusen AV, Bansal-Travers M, King B, Cummings KM. Smoke-free homes and smoking cessation and relapse in a longitudinal population of adults. Nicotine Tob. Res. 2009; 11(6):614–618. [PubMed: 19346505]

Malarcher A, Shah N, Tynan M, Maurice E, Rock V. State-specific secondhand smoke exposure and current cigarette smoking among adults – United States, 2008. MMWR Morb. Mortal. Wkly. Rep. 2009; 58(44) 1232(4).

Marian C, O'Connor RJ, Djordjevic MV, Rees VW, Hatsukami DK, Shields PG. Reconciling human smoking behavior and machine smoking patterns: implications for understanding smoking behavior and the impact on laboratory studies. Cancer Epidemiol. Biomarkers Prev. 2009; 18(12): 3305–3320. [PubMed: 19959678]

Messer K, Mills AJ, White MM, Pierce JP. The effect of smoke-free homes on smoking behavior in the U.S. Am J Prev Med. 2008; 35(3):210–216. [PubMed: 18620837]

Morgan SF, Gust SW, Pickens RW, Champagne SE, Hughes JR. Temporal Patterns of Smoking Topography in the Natural Environment. Int J Addict. 1985; 20(4):613–621. [PubMed: 4030176]

O'Connor RJ, Rees VW, Norton KJ, Cummings KM, Connolly GN, Alpert HR, Sjodin A, Romanoff L, Li Z, June KM, Giovino GA. Does Switching to Reduced Ignition Propensity Cigarettes Alter

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Smoking Behavior or Exposure to Tobacco Smoke Constituents? Nicotine Tob. Res. 2010; 12(10): 1011–1018. [PubMed: 20805292]

Rees VW, Wayne GF, Connolly GN. Puffing style and human exposure minimally altered by switching to a carbon-filtered cigarette. Cancer Epidemiol. Biomarkers Prev. 2008; 17(11):2995–3003. [PubMed: 18990741]

Russell MAH. Realistic goals for smoking and health: A case for safer smoking. Lancet. 1974; 1:254–258. [PubMed: 4130257]

Rüge J, Broda A, Ulbricht S, Klein G, Rumpf HJ, John U, Meyer C. Workplace smoking restrictions: smoking behavior and the intention to change among continuing smokers. Int J Public Health. 2009 [Epub ahead of print].

Shopland DR, Anderson CM, Burns DM. Association between home smoking restrictions and changes in smoking behaviour among employed women. J Epidemiol Community Health. 2006; 60(Suppl II):ii44–ii50.

Stellman SD, Djordjevic MV. Monitoring the tobacco use epidemic II. The Agent: Current and Emerging Tobacco Products. Prev Med. 2009; 48(1 Suppl):S11–S15. [PubMed: 18848577]

United States Department of Labor – Bureau of Labor Statistics. American Time Use Survey Summary 2009. Economic News Release; 2010.

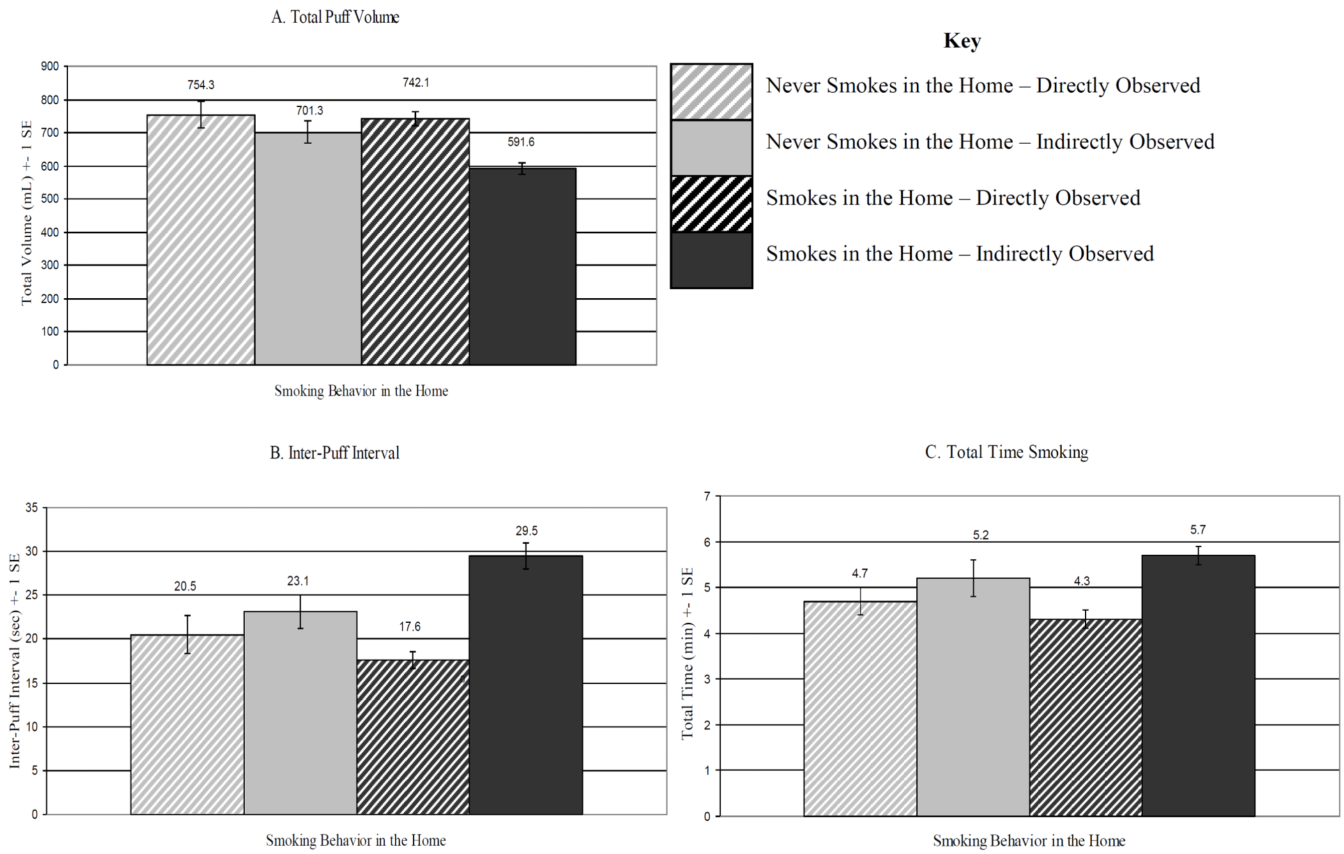

Figure 1.

Topography Means for Setting by Smoking Behavior in the Home The figure represents the average value topography measures for total puff volume, inter-puff interval, and total time smoking. All graphs in the figure are organized by means of reported home smoking behavior (Never Smokes in the Home and Smokes in the Home) and research condition (Observed and Unobserved). Total Volume is measured in mL, inter-puff interval is depicted in seconds, and total smoking time is represented in minutes. All models are adjusted for age, gender, race, brand, and H.S.I.

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Table 1

Home smoking status by demographic sub-group

Demographic	Level	Never Smokes in the Home		Smokes in the Home		Chi Squared	
		N	% w/in SBiH	n	% w/in SBiH	value (df)	P
Age	10yrs–30yrs	19	76	38	33	16.1 (2)	0
	31yrs–45yrs	5	20	44	38.6		
	46+	1	4	32	28.1		
Gender	Male	17	58.6	64	50.8	0.6 (1)	0.4
	Female	12	41.4	62	49.2		
Race	White	22	75.9	69	56.1	3.8 (1)	0.051
	Other	7	24.1	54	43.9		
Brand	Newport	8	27.6	67	52.8	10.0(2)	0.007
	Marlboro	11	37.9	44	34.6		
	Camel	10	34.5	16	12.6		