Published in final edited form as:

Am J Obstet Gynecol. 2011 March ; 204(3): 213.e1–213.e6. doi:10.1016/j.ajog.2010.10.909.

Passive smoke exposure and abnormal cervical cytology in a predominantly Hispanic population

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Abstract

OBJECTIVES—To evaluate the association between passive cigarette smoke exposure and cervical cytological abnormalities in a predominantly Hispanic sample.

METHODS—Data were collected as part of a larger, ongoing randomized clinical trial. Inclusion criteria were met by 4403 Hispanic (73%) and non-Hispanic (27%) women between 18 and 55 years of age (mean=30.14±8.7). ANOVA and multivariate logistic regression determined the association between passive smoke exposure and Pap abnormality.

RESULTS—Passive smoke exposure was positively associated with having an abnormal Pap smear (OR 1.70, 95% CI 1.14–2.52) as was current active smoking (OR 1.45, 95% CI 1.03–2.04). Neither effect was modified by ethnicity. Increasing hours per week of passive smoke exposure was associated with LSIL ($P < 0.05$).

CONCLUSION—Passive smoke exposure is an important independent risk factor for cytological abnormalities in Hispanic and non-Hispanic women. This study adds to the growing body of evidence of the dangers of passive smoke exposure.

Keywords

Hispanic; cervical cytology; Pap test; secondhand smoke; passive cigarette smoke

INTRODUCTION

A causal association between cigarette smoking and squamous cell carcinoma of the cervix is well-established.^{1–4} Cigarette smoking is also associated with cervical dysplasia, and many studies have identified an increased risk of high-grade lesions of the cervix among smokers.^{5–9} However, the relation between passive exposure to cigarette smoke and cervical neoplasia is less clear.¹

Studies evaluating passive smoke exposure and cervical neoplasia have not been consistent in their findings. Investigations by Slattery et al. and Trimble et al. have demonstrated an

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The abstract has been presented at the Society of Gynecologic Oncologists 2010 annual meeting as a poster presentation.

increased cervical cancer risk among women exposed to passive smoke.^{10; 11} Among women exposed to cigarette smoke in the home, Scholes et al. found an association with exposure and low-grade cervical abnormalities.¹² Similarly, studies by Tay and Tay and Coker et al. reported an increased risk of high grade squamous intraepithelial lesions (HSIL) among women exposed to passive smoke.^{13; 14} Earlier work by Coker, however, failed to show a consistent association between CIN II/III and passive smoke exposure.¹⁵ Furthermore, survey results of husbands of women with cervical dysplasia did not support an association between the husbands' smoking habits and their wives' cervical cytology.¹⁶

The lack of a clear understanding of the relationship between passive exposure to cigarette smoke and changes in cervical cytology is especially noticeable when considering Hispanic women. This is an important gap in the literature as Hispanic women have a disproportionately higher rate of cervical cancer than non-Hispanic women.¹⁷ Hispanic women were not included in five of the seven studies addressing passive smoke exposure and cervical cancer noted above,^{10; 11; 13–15} and the remaining two did not specify ethnicity.^{12; 16} Two studies that included the same sample of Hispanic women examined active smoking but not passive exposure to cigarette smoke; neither study found an association between active smoking and cervical dysplasia among Hispanics.^{18; 19}

In the present study, we examine the relationship between passive exposure to cigarette smoke and Pap test results in a large, predominately Hispanic sample of women undergoing routine screening. We hypothesize that passive smoke exposure will be an independent risk factor for abnormal cervical cytology among Hispanic and non-Hispanic women.

METHODS

Data for the present study were collected between June 1, 2006 and May 29, 2009 as part of a larger, ongoing randomized clinical trial addressing cervical cancer prevention (NCT00575510). Hispanic, non-Hispanic black and non-Hispanic white women between 18 and 55 years of age who were patients in one of five University of Texas Medical Branch (UTMB) clinics in southeast Texas were screened for eligibility for the main study. Pregnant women, women diagnosed with cervical cancer, women who were under the age of 18 or over the age of 55, or women who were unable to understand English or Spanish were excluded from participation from the main study. During the recruitment period captured in the present study, approximately 80% of those meeting eligibility criteria agreed to participate and provided written informed consent. Available refusal data suggest that women who refused to participate did not significantly differ from women who agreed to participate with regard to age ($P=.35$) or ethnicity ($P=.80$). Women were reimbursed \$5 for their time. The research was approved by the UTMB Institutional Review Board.

Patients attending one of the study clinics for a routine appointment in which it was anticipated that a Pap test would be performed were asked to complete a comprehensive survey as part of study participation. The survey contained demographic questions including age, ethnicity, marital status, education level, number of pregnancies, and number of children. Sexual history questions included age at first sexual intercourse, number of sexual partners in the past year and in her lifetime, and history of sexually transmitted infections (STI) including genital warts, gonorrhea, trichomonas, chlamydia, syphilis, and herpes.

The survey also included questions on history of cigarette smoking and passive exposure to smoke (second-hand smoke exposure). Subjects answered if they were never, past, or current smokers. For a qualitative measure of passive smoke exposure, subjects were asked if they were exposed to none, a little, some, or a lot of second-hand smoke in the past 5 years. They were also asked to quantify the amount of time they were exposed as number of

hours per day, week, or month in the past 5 years. The median hours of passive smoke exposure for each qualitative category were as follows: “none”- 0 hours/week, “a little”- 1.25 hours/week, “some”- 5.0 hours per week, and “a lot”- 35.0 hours/week.

A total of 4582 subjects completed the survey; of those, 4500 (98%) underwent Pap screening. The most common reasons for not performing a Pap test were proximity of the visit to the previous Pap test and current heavy vaginal bleeding. For this investigation, 7 women were excluded secondary to a history of HIV infection and 89 were excluded secondary to a history of cervical cancer. One additional subject was excluded due to inconsistent responses on the survey which suggested that she was selecting answers without considering the question. The final sample for analysis included 4403 subjects.

All subjects underwent liquid-based Pap screening (SurePath™) and pelvic examination by a practitioner at one of the study clinics. Cytology was reviewed per routine by the UTMB pathology department, with the exception of one clinic, which used LabCorp (San Antonio, TX). Patients were clinically managed per UTMB guidelines. Pap test results are analyzed as a dichotomous outcome (normal vs. abnormal) as well as by specific type of result (normal, atypical squamous cells of undetermined significance (ASC-US)/atypical glandular cells of undetermined significance (AGC-US), low-grade squamous intraepithelial lesion (LSIL), or HSIL).

Hours of passive exposure to smoke per week were calculated for women who answered the question regarding hours per day/week/month of exposure. All responses were converted to reflect hours per week (h/wk) as a common metric. If the participant indicated “0” or “no” or “none,” this was coded as “0” hours per week.

Statistical analyses were performed using SPSS 15.0 for Windows (Chicago, IL). Descriptive data are reported as frequencies, percentages and means (M) $\pm$ standard deviations (SD). In general, missing data were between 1–5% with the exception of household income, where 15% of the data were missing. When asked if exposed to passive smoke, 96% of participants gave a valid answer. However, the follow-up question asking subjects to quantify their smoke exposure into hours was only answered fully by 39% of respondents. Associations between categorical variables were analyzed using the Fisher Exact or χ^2 test. Independent sample t-tests were performed to evaluate the relationship between Pap test results (normal vs. abnormal) and passive exposure to smoke (hours/wk). Univariate ANOVAs were performed to evaluate the relationship between more specific Pap test results (normal, ASC-US/AGC-US, LSIL, HSIL) and hours per week exposed to passive smoke. Multivariate analysis was performed using logistic regression in which Pap test result (normal vs. abnormal) was regressed onto active smoking and passive exposure to smoke, with ethnicity, age, number of sexual partners in the past year, and history of an abnormal Pap included in the model. A final logistic model was estimated to predict an abnormal (vs. normal) Pap test result. Odds ratios (OR), Bonferroni-adjusted 95% confidence intervals (CI), and levels of significance are reported. A two-sided significance level of .05 was used to indicate statistical significance.

RESULTS

The majority of the sample was Hispanic (72.6%), which reflects the patient population of the UTMB clinics. The mean age of the sample was 30.14 ($\pm$ 8.7) years with a range of 18 to 55 years. Overall, 15.7% of the sample currently smoked and 64.4% reported exposure to passive smoke. With regard to the sexual risk factors for an abnormal Pap test, on average, women were 17.5 years old at first sexual intercourse, reported 1.2 sex partners in the past

year and 4.2 lifetime sex partners. Furthermore, 20.1% had a positive STI history and 22.6% reported having an abnormal Pap test in the past.

The demographic characteristics of the study population, stratified by Pap test results, are shown in Table 1. In general, women with an abnormal Pap result were unmarried, reported an annual household income less than \$10,000, were younger, and had an increased gravidity and parity. A greater proportion of non-Hispanic women had an abnormal Pap test compared to Hispanic women (8.6% vs. 6.8%, respectively, $P < 0.05$). The overall incidence of abnormal Pap result was 7.3% with 4.9% ASC-US/AGC-US, 1.9% LSIL, and 0.5% HSIL.

Given that Hispanic women had a disproportionately lower rate of abnormal Pap tests in our sample, differences in the known risk factors for an abnormal Pap test were examined by ethnicity. Relative to non-Hispanic women, Hispanic women engaged less frequently in risk behaviors associated with an abnormal Pap result (Table 2). Specifically, non-Hispanic women were younger at age of first intercourse, had more partners in the past year and in their lifetime, were more likely to have had an STI or a previous abnormal Pap test, and were more likely to smoke and to experience passive exposure to smoke (all $P < .001$). At the univariate level, a relationship was found between Pap test result and passive exposure to smoke when quantified as hours per week exposed to smoke. Specifically, women who had an abnormal Pap test reported greater exposure to passive smoke ($M = 30.6 \pm 44.3$ h/wk), on average, relative to women who had a normal Pap test ($M = 22.1 \pm 36.3$ h/wk), $P < 0.01$.

These relationships were also evaluated in the context of more specific Pap test outcomes, i.e., normal, ASC-US/AGC-US, LSIL, and HSIL. The pattern of results was the same as those observed with Pap test as a dichotomous outcome ($P < 0.05$). Specifically, using Bonferroni-adjusted pairwise comparisons, passive exposure to smoke was greater among women with LSIL ($M = 32.1 \pm 49.5$ h/wk) than women with a normal Pap result ($M = 22.1 \pm 36.3$ h/wk). No other pairwise differences were statistically significant.

To examine the relationship between passive exposure to smoke and Pap test results in a multivariate context, a logistic regression model was estimated using backwards stepwise elimination. The initial model included the qualitative measure of passive smoke exposure, smoking status, history of an abnormal Pap test, number of sexual partners in the past year, number of lifetime sexual partners, age, ethnicity, gravidity, parity, age at first sexual intercourse, and STI history. In this initial model, STI history, ethnicity, number of lifetime sexual partners, gravidity, parity, and age at first sex were non-significant. The final model included age, history of an abnormal Pap, number of sex partners in the past year, current smoking and the qualitative measure of passive smoke exposure; ethnicity was included as a covariate because of its relationship with each of the risk factors. Selected model statistics are shown in Table 3. Table 4 presents the correlations among the predictors. In support of our hypothesis, exposure to “some” passive smoke (vs. “none”) was an independent risk factor for an abnormal Pap test (OR 1.70, 95% CI 1.14–2.52) when examined in the context of sexual risk factors (number of sex partners in the past year and history of an abnormal Pap), active smoking, age, and ethnicity. In contrast, active smoking was generally unassociated with Pap results in the multivariate model ($P = .07$), although current smokers appeared to be at a slightly increased risk of an abnormal Pap relative to women who never smoked (OR 1.45, 95% CI 1.03–2.04). In a separate exploratory analysis, Pap result (normal vs. abnormal) was regressed onto active smoking, ethnicity, and the interaction term (smoking $\times$ ethnicity) to examine the hypothesis that the effect of smoking on Pap results may differ for Hispanic and non-Hispanic women. The interaction term was non-significant, suggesting that any effect of smoking on Pap test results in this sample does not differ, i.e., was not modified by, ethnicity.

DISCUSSION

Passive exposure to cigarette smoke was associated with an abnormal Pap test among a large, predominantly Hispanic sample. This relationship remained significant while controlling for important sexual risk factors and active smoking. In addition, as hours of passive exposure to smoke increased, the incidence of LSIL increased. This finding is consistent with other studies.^{12; 14} While we did not find an association between hours of smoke exposure and HSIL as previous studies have,^{13; 14} we had limited power to do so, as only 0.5% of our sample had a high-grade result. Current active smoking was also found to be associated with an abnormal Pap test; this association did not differ among Hispanic and non-Hispanic women. This finding departs from previous studies which found that smoking was associated with dysplasia only among non-Hispanic women.^{18; 19}

When number of sexual partners in the past year was included in the regression model predicting an abnormal Pap test, history of STI, number of lifetime sexual partners, age at first sex, gravidity, and parity became non-significant. This indicates that in this sample, number of sexual partners in the past year is a stronger predictor of abnormal Pap results than any of the above-mentioned risk factors. As all of these factors are indicators of sexual activity, they predict exposure to human papillomavirus (HPV), the most important risk factor for cervical neoplasia.^{20; 21} Most young women will contract one or more types of the virus and will usually clear the infection within 8 months to 3 years, even when manifested as a low-grade cervical abnormality.²²⁻²⁴ This sample is relatively young and most abnormalities are low-grade, indicating that if they are infected with HPV, it is likely a recent infection. Therefore, it is reasonable that sexual partners in the past year would be a stronger predictor for Pap abnormalities.

While ethnicity itself was not related to Pap test results, Hispanic women were less likely to be exposed to known risk factors than non-Hispanic women. Few studies have examined risk factors for cervical dysplasia in Hispanic women; two studies that did reported findings consistent with ours, i.e., Hispanic women are less likely to smoke, have fewer sexual partners, and are less likely to report a history of an STI.^{18;19} It is important to recognize that the Hispanic population living in the United States is diverse. In part due to geographic location, the majority of our population is Mexican American. Care should be taken in generalizing our findings to Hispanic women from other countries of origin.

This study was a secondary analysis of data from an ongoing clinical trial. We therefore were limited by the design of the original study. While most risk factors for cervical dysplasia were included in the study, there are some variables that were not collected and may have provided more information for the current analysis and greater explanatory power for the overall outcome of an abnormal Pap result (i.e. menstrual history, birth control usage, history of immunosuppression, DES exposure, more extensive Pap history). All subjects were treated according to UTMB practice guidelines and therefore HPV samples were not collected on all patients. While sexual history is a strong predictor of HPV infection, it does not correlate absolutely with infection rates. Another potential concern is the measure of passive smoke exposure. While the qualitative passive smoke exposure measure has been validated,²⁵ it is unfortunate that the measure of hours of exposure was unable to be interpreted for most respondents. However, we were able to obtain useable data from the respondents that did complete the measure. As it appears the format of this question was confusing to this sample, future studies should revise the format of this quantitative measure in order to obtain a better response rate.

The strengths of this study include a large sample size overall and a large proportion of Hispanic subjects. The multi-site conduct of the trial enabled us to sample from a large,

diverse population across southeast Texas while still receiving equivocal care according to the standardized UTMB treatment guidelines established for all of the university-based clinics. As the majority of patients had normal or low-grade Pap test results, this would be an appropriate population to target for education at the time of routine screening about exposure to passive smoke and other risk factors prior to the potential development of invasive lesions.

There are few studies that evaluate passive exposure to smoke in relation to Pap test results; none of these included women of Hispanic ethnicity. This study adds important information to this limited topic. While the vast majority of women with abnormal Pap results will not require treatment, they will require more intense follow-up than women with normal Pap results.²⁶ Additional Pap testing, HPV testing, and colposcopy require more healthcare dollars. As colposcopy must be performed by providers with specialized training, this may mean increasing travel time and costs for the patients, and may increase non-compliance with follow-up recommendations. For instance, data from this same patient population showed that although 88% of women voiced intention to return for follow-up if their Pap results were abnormal, only 60% of those with abnormal results returned.²⁷

Efforts to increase awareness about the dangers of active smoking have succeeded in decreasing the incidence of active smoking. As there are fewer people smoking, exposure to passive smoke has also decreased. However, a majority of subjects in this study reported some daily exposure to cigarette smoke. We did not ask where the exposure to passive smoke occurred (i.e. at home, at work, while performing daily errands). Further, while the standard measure of passive smoke exposure is five years, future research should investigate different temporal exposure periods and locations of exposure.

Within the past few years, many areas have recognized the dangers of secondhand smoke exposure and have placed restrictions on smoking in public venues. A recent meta-analysis has received widespread attention as there is a significant decrease in acute myocardial infarction risk per year in communities that have banned smoking in public areas.²⁸ Our study adds to the growing body of evidence of the dangers of passive smoke exposure and gives further support to increasing bans on smoking in public places. Education and intervention by healthcare providers is still needed to decrease both active smoking and passive exposure to smoke overall in order to decrease the risk of all smoking-related illnesses, including cervical dysplasia and cancer.

Acknowledgments

Dr. Ward is a Kirschstein-NRSA postdoctoral fellow supported by an institutional training grant (T32HD055163) from the Eunice Kennedy Shriver National Institute of Child Health & Human Development. Dr. Berenson is the principal investigator of the above-mentioned grant. This research is part of a larger study supported by the National Cancer Institute, R01CA107015, awarded to Dr. Radecki Breitkopf. The content is solely the responsibility of the authors and does not necessarily represent the official views of the Eunice Kennedy Shriver National Institute of Child Health & Human Development or the National Institutes of Health.

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Table 1

Sample demographics by Pap result (N=4403)

Demographic Characteristic	Normal Pap	Abnormal Pap	P
	4083 (92.7%)	320 (7.3%)	
Ethnicity			.037
Hispanic	2979 (67.7%)	216 (4.9%)	
Non-Hispanic	1104 (25.1%)	104 (2.4%)	
Marital Status			<.001
Single, Never Married	1416 (32.9%)	177 (4.1%)	
Married	1766 (41.0%)	68 (1.6%)	
Divorced	379 (8.8%)	28 (0.7%)	
Separated	394 (9.1%)	37 (0.9%)	
Widowed	37 (0.9%)	5 (0.1%)	
Education Level			.341
≤ High School	2832 (65.0%)	214 (4.9%)	
> High School	1210 (27.8%)	103 (2.4%)	
Annual household income			.002
< \$10,000	1210 (32.5%)	122 (3.3%)	
≥ \$10,000	2237 (60.1%)	152 (4.1%)	
Age (y)			<.001
Mean (±SD)	30.35 (8.7)	27.49 (7.8)	
Gravidity			<.001
0	489 (11.1%)	61 (1.4%)	
1–5	3274 (74.4%)	243 (5.5%)	
>5	320 (7.3%)	16 (0.4%)	
Parity			<.001
0	571 (13.0%)	77 (1.7%)	
1–5	3392 (77.0%)	236 (5.4%)	
>5	120 (2.7%)	7 (0.2%)	

Frequencies that do not total 4403 reflect missing data.

Table 2

Risk factors for abnormal Pap result by ethnicity (N=4403)

	Hispanic	Non-Hispanic	P
Age at first intercourse (y)			
Mean ($\pm$ SD)	18.10 ($\pm$ 3.7)	15.98 ($\pm$ 2.3)	<.001
Number of sexual partners			
Past year ($\pm$ SD)	1.13 ($\pm$ 0.7)	1.42 ($\pm$ 1.0)	<.001
Lifetime ($\pm$ SD)	2.97 ($\pm$ 3.9)	7.47 ($\pm$ 7.1)	<.001
STI history			<.001
No	2687 (61.5%)	802 (18.3%)	
Yes	483 (11.0%)	400 (9.1%)	
History of abnormal Pap			<.001
No	2560 (59.0%)	782 (18.0%)	
Yes	583 (13.4%)	414 (9.5%)	
Active smoking			<.001
Never	2438 (56.8%)	549 (12.8%)	
Past	398 (9.3%)	217 (5.1%)	
Current	274 (6.4%)	417 (9.7%)	
Passive smoke exposure			<.001
None	1236 (29.3%)	152 (3.6%)	
A little	652 (15.4%)	250 (5.9%)	
Some	865 (20.5%)	354 (8.4%)	
A lot	282 (6.7%)	432 (10.2%)	

Frequencies that do not total 4403 reflect missing data.

Table 3

Logistic regression model for abnormal Pap result (N=3996)

Predictor	β	SE β	P value	Exp (β)	95% CI for Exp (β)
Constant	-1.52	.26	<.001	.22	
Age	-.04	.01	<.001	.96	.95-.98
Ethnicity (Hispanic)	-.02	.15	.91	.98	.74-1.31
History of abnormal Pap	.40	.14	.003	1.49	1.14-1.95
Sex partners in past year	.22	.06	<.001	1.25	1.12-1.40
Ever smoked ^a			.07		
Past smoker	.26	.17	.13	1.30	.93-1.82
Current smoker	.37	.17	.03	1.45	1.03-2.04
Passive smoke exposure ^b			.04		
A little	.19	.22	.38	1.21	.79-1.86
Some	.53	.20	.01	1.70	1.14-2.52
A lot	.34	.19	.08	1.41	.96-2.06

^aReference group = never.^bReference group = a lot.

Table 4

Correlations among Predictor Variables (N=4403)

	1	2	3	4	5	6	7
1. Reports history of abnormal Pap test	—						
2. Ethnicity (Hispanic or non-Hispanic)	.17	—					
3. History of STI	.29	.20	—				
4. Number of sexual partners in the past year	.08	.19	.15	—			
5. Number of sexual partners in lifetime	.29	.46	.36	.35	—		
6. Age at first sexual intercourse	-.17	-.29	-.24	-.17	-.34	—	
7. Pap test result (normal or abnormal)	.06	.03	.04	.09	.10	-.06	—

All $P < .001$

Spearman's rho presented unless indicated by italics. Numbers in italics represent Pearson correlations.