Area-Level Characteristics and Smoking in Women

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Despite a decline in smoking since the 1960s,[1] smoking prevalence rates among US women remain substantial.[2] Factors recognized as influencing smoking behavior include socioeconomic position,[1–3] stress,[4–6] parental and peer influence,[7,8] and community norms.[9,10] Moreover, among 4 recently conducted studies in Europe on determinants of smoking,[11–14] 3 of the studies suggest that area-level socioeconomic characteristics influence smoking.[11–13]

We examined the association between area-level characteristics and individual smoking behavior in a sample of North Carolina women. We conducted separate analyses to distinguish between correlates of smoking initiation and of continuing to smoke. Given possible links between environment, stress, and smoking behavior,[15–17] we focused on area-level characteristics that may serve as stressors,[18–20] including socioeconomic disadvantage,[11–13,21] crowding,[22,23] and high crime rates.[15,18]

Objectives. This study examined whether area-level characteristics are associated with individual smoking behavior among women.

Methods. Analyses included 648 women enrolled as control patients in the Carolina Breast Cancer Study (1993–1996). Smoking and covariate information was obtained from interviews. Area-level characteristics included census block-group education level, poverty, unemployment, car–home ownership, crowding, and, for 431 women, city-level crime rates.

Results. In multivariate logistic regression models, no area characteristics were clearly associated with a history of smoking. Among those who had ever smoked, continued smoking was associated with living in low-education areas (odds ratio [OR] = 1.7, 95% confidence interval [CI] = 1.0, 2.9), high-unemployment areas (OR = 1.7, 95% CI = 1.0, 2.8), and high-crime areas (OR = 1.6, 95% CI = 0.8, 3.2).

Conclusions. The present findings are consistent with a growing literature suggesting that area-level social and economic disadvantage influences individual smoking behavior. (*Am J Public Health.* 2001; 91:1847–1850)

METHODS

Our study sample was derived from the control population of the Carolina Breast Cancer Study, a case–control study conducted in North Carolina from 1993 to 1996. Selection of control patients, identified from North Carolina Division of Motor Vehicles and US Health Care Financing Administration records, followed a modified randomized recruitment strategy[24] to achieve age and race frequency matching with case patients. Of 1245 control patients who were contacted and found to be eligible, 790 (63%) were interviewed[25]; 773 of those completing interviews were White or African American.

Interviews included questions on cigarette use, alcohol consumption during 3 age periods (<25, 25–49, ≥50 years), marital status, and education. We defined *ever smoking* as having smoked at least 100 cigarettes, *ever drinking* as having consumed any alcohol during any of the 3 age periods, and *recent drink-*

ing as having consumed any alcohol in the current age interval.[26] Each woman's residence at the time of the interview was "geocoded" and linked to 1990 census block-group data. Census variables of interest included education level, poverty, unemployment, home and vehicle ownership, and crowding. Of 773 controls, 654 were geocoded, representing 479 different block groups.

Among 433 women from 18 different locations, residential information was also successfully linked to 1996 crime data from the Uniform Crime Reporting (UCR) system,[27] available for cities and towns with populations of 10 000 or more. Crime rate was calculated as the number of UCR Crime Index–based offenses (murder and nonnegligent manslaughter, forcible rape, robbery, aggravated assault, burglary, larceny–theft, and motor vehicle theft) divided by the population of each city or town.

We compared ever and never smokers to examine predictors of smoking initiation, and we compared current and former smokers to examine predictors of continued smoking. Analyses included 648 women not missing any covariate data. We constructed separate logistic regression models for each area-level variable, while adjusting for age (years) and race (Black or White).

More fully adjusted models included individual-level education (less than high school, high school, some college, or college), marital status (single/widowed/divorced or married), and either a history of drinking or recent drinking to better match the time frame for either a history of smoking or continued smoking. Education (≤25% vs >25% of residents with less than a high school education) and poverty (≤20% vs >20% of residents with household income below the poverty level) measures were dichotomized via cutpoints recommended in the literature.[21] Unemployment rates (≤3.7% vs >3.7%) and crime rates (≤9.4% vs >9.4%) were dichotomized at the median.

Vehicle ownership (<75% vs ≥75% of occupied housing units with a vehicle), home ownership (<50% vs ≥50% of occupied housing units owned vs rented), crowding (0% vs >0% of occupied housing units with an average of more than 1 person per room), and urban–rural status (≤50% vs >50% of residents in an urban area) were dichotomized with cutpoints that could be applied to other samples while ensuring adequate numbers in each comparison group for these analyses. Finally, because of known differences in smoking patterns by race,[1] we examined joint effects of area-level characteristics and individual-level race.

TABLE 1—Distributions of Individual- and Area-Level Characteristics and Odds Ratios for Ever vs Never Smoking and for Continuing vs Quitting Smoking Among Ever Smokers: Carolina Breast Cancer Study, 1993–1996

| | Ever vs Never Smokers[a] | | | | Current vs Former Smokers[b] | | | |
| | | | OR (95% CI) | | | | OR (95% CI) | |
	Never, % (n = 353)	Ever, % (n = 295)	Minimally Adjusted[c]	Fully Adjusted[d]	Former, % (n = 173)	Current, % (n = 122)	Minimally adjusted[c]	Fully adjusted[d]
Individual-level characteristics								
Age, y	...	...	1.0	1.0	...	...	1.0	1.0 (0.9, 1.0)
Black	48	35	0.6 (0.4, 0.8)	0.6 (0.4, 0.8)	28	45	2.0 (1.2, 3.3)	1.3 (0.8, 2.4)
Highest education completed								
Less than high school	21	18	1.0	1.0	14	24	1.0	1.0
High school	27	24	0.9 (0.5, 1.4)	0.9 (0.5, 1.5)	21	28	0.7 (0.3, 1.5)	0.7 (0.3, 1.5)
Some college	26	31	1.1 (0.7, 1.8)	0.9 (0.5, 1.6)	29	32	0.6 (0.3, 1.2)	0.5 (0.2, 1.1)
College	27	27	0.9 (0.6, 1.5)	0.7 (0.4, 1.2)	35	16	0.3 (0.1, 0.6)	0.3 (0.1, 0.6)
Single	35	36	1.3 (0.9, 1.8)	1.2 (0.8, 1.7)	31	44	1.7 (1.0, 2.9)	1.6 (0.9, 2.7)
Alcohol drinker[e]	60	86	4.8 (3.2, 7.4)	5.1 (3.3, 7.8)	69	77	1.3 (0.8, 2.4)	2.0 (1.1, 3.6)
Block-group characteristics								
Low education	57	48	0.8 (0.6, 1.2)	1.0 (0.7, 1.4)	40	61	2.0 (1.2, 3.3)	1.7 (1.0, 2.9)
High poverty	20	19	1.2 (0.8, 1.8)	1.2 (0.7, 1.8)	15	25	1.5 (0.8, 2.9)	1.2 (0.6, 2.4)
High unemployment	46	43	1.1 (0.8, 1.5)	1.2 (0.8, 1.7)	36	54	1.9 (1.1, 3.1)	1.7 (1.0, 2.8)
Low vehicle ownership	11	9	1.1 (0.6, 1.9)	1.1 (0.6, 2.0)	8	11	0.8 (0.3, 2.0)	0.6 (0.2, 1.4)
Low home ownership	20	21	1.3 (0.9, 2.0)	1.2 (0.8, 1.9)	19	24	0.9 (0.5, 1.8)	0.8 (0.4, 1.6)
High crowding	77	71	0.8 (0.6, 1.2)	0.8 (0.6, 1.2)	72	69	0.7 (0.4, 1.2)	0.8 (0.4, 1.3)
Urban	59	65	1.4 (1.0, 1.9)	1.2 (0.9, 1.7)	64	68	1.1 (0.6, 1.8)	0.9 (0.5, 1.6)
High-crime city	50	48	1.1 (0.8, 1.6)	1.2 (0.8, 1.7)	48	57	1.8 (1.0, 3.4)	1.6 (0.8, 3.2)

Note. OR = odds ratio; CI = confidence interval.
[a]Based on 295 ever smokers of 648 women total, except for crime analyses, based on 196 ever smokers of 431 women.
[b]Based on 122 current smokers of 295 ever smokers, except for crime analyses, based on 77 current smokers of 196 ever smokers.
[c]Models included age and individual-level race.
[d]Neighborhood-level variables were adjusted for age, individual-level race, alcohol drinking (yes/no), education level, and marital status. Individual-level variables were also adjusted for low-education block groups.
[e]Analyses on ever vs never smokers adjusted for ever drinking, while analyses on current vs former smokers adjusted for recent drinking only, as defined in text.

RESULTS

The mean age in our sample (n = 648) was 52 years (range: 21–75 years), and 42% of the respondents were African American. In logistic regression analyses (Table 1), a history of smoking was associated with being White and having a history of drinking, whereas associations with other individual- and area-level characteristics were close to the null. Continued smoking was initially associated with being Black, being single, having less education, living in a low-education or high-unemployment block group, and living in a high-crime city. After adjustment for individual-level characteristics, estimates for area-level education, unemployment, and crime persisted but were marginally or nonsignificant. Notably, adjustment for block-group variables reduced the odds ratio for race from 2.0 (95% confidence interval [CI] = 1.2, 3.3) to 1.3 (95% CI = 0.8, 2.4) and increased the odds ratio for alcohol consumption from 1.3 (95% CI = 0.8, 2.4) to 2.0 (95% CI = 1.1, 3.6).

The association between area-level education and continued smoking appeared to differ by race (Table 2): living in an undereducated block group was associated with continued smoking among White women but not among Black women. We found similar interactions between race and living in a high-poverty block group or a high-crime city. However, the number of women in some categories was small, and interaction *P* values were not significant.

In comparisons of covariate distributions, nongeocoded women were more likely than geocoded women to be current smokers and were less well educated, suggesting that some area-level effects might be underestimates. Comparisons of women living in cities with and without crime statistics showed no meaningful differences in distributions of ever, former, or current smoking.

DISCUSSION

We found, as have others,[11–13] that some area-level characteristics may be associated with individual smoking behavior, particularly continued smoking among ever smokers. Our findings are also consistent with previous results indicating that Blacks are less likely than Whites to have ever smoked but that, if they have a history of smoking, they are more likely to continue smoking.[1] In less educated

TABLE 2—Odds Ratios[a] Showing Effect Modification, by Race,[b] for Current vs Former Smoking Status: Carolina Breast Cancer Study, 1993–1996

	Odds Ratio (95% Confidence Interval)	
	White	Black
Low-education block group		
No	1.0	2.1 (0.9, 4.8)
Yes	2.2 (1.1, 4.2)	2.2 (1.1, 4.4)
P for interaction	.20	
High-poverty block group		
No	1.0	1.7 (0.9, 3.1)
Yes	2.0 (0.7, 5.8)	1.5 (0.7, 3.3)
P for interaction	.25	
High-crime city		
No	1.0	1.9 (0.8, 4.5)
Yes	2.1 (0.8, 5.5)	2.7 (1.0, 6.9)
P for interaction	.55	

[a]Odds ratios adjusted for age, recent drinking, education level, and marital status.
[b]Analyses of block-group education and poverty levels included 191 White women and 104 Black women. Analyses of city crime level included 123 White women and 73 Black women.

areas, however, White women were as likely to continue smoking as Black women. Factors that promote smoking cessation among White women in more advantaged neighborhoods, or that encourage continued smoking among disadvantaged White women and Black women regardless of neighborhood, have yet to be elucidated but may involve differences in social support, sense of empowerment, or experiences with racism or classism.

Several limitations merit discussion. Our power to detect statistically significant associations was limited, especially in the analyses comparing current and former smokers. Also, our findings are based on respondents' residence at the time of the interview. Area-level effects could have been overestimated if former smokers were more likely to have moved to better educated areas or if areas in which continuing smokers resided were more likely to deteriorate over time.

Conversely, comparisons of women who were and were not geocoded indicate that smokers and less educated women were underrepresented. If these women were more likely to live in disadvantaged neighborhoods, our effect estimates are probably underestimates. Using other individual-level socioeconomic indicators rather than or in addition to education would be unlikely to change our results, in that education has been more strongly and consistently associated with cigarette smoking than has income, occupation, or a composite of all 3 measures.[3]

In our data, the association between continued smoking and living in a high-crime city was suggestive but not statistically significant after adjustment for individual-level characteristics. However, use of city-level crime data as a proxy for immediate residential exposure may have attenuated estimates. Crowding was not associated with either a history of smoking or continued smoking, but an individual-level rather than area-level measure of household crowding might have been more appropriate in relation to individual-level smoking.

We hypothesized that area-level characteristics could affect smoking by serving as a source of stressors to local residents.[16,28] The actual mechanisms by which area-level characteristics can influence individual smoking behaviors, however, are not easily specified and could also involve cultural norms,[9,10] advertising,[29–31] and enforcement of smoking regulations.[32,33] These factors, not measured in our study, may also have confounded effect estimates.

Future research will require integrating a wider variety of factors at multiple levels into a comprehensive theoretical framework and considering them simultaneously in statistical analyses. Such research may offer insight into why the once widespread practice of smoking is now concentrated in the lower socioeconomic subset of the population.[34] Individual-level characteristics such as education level are important, but the concentration of smoking into specific subpopulations may also result from a failure to uniformly create environments that promote smoking cessation. While differences in tobacco regulations, cigarette availability, and advertising contribute to this nonuniformity, so might different social and economic conditions not directly related to smoking behavior. ■

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References

1. Giovino G, Henningfield J, Tomar S, Escobedo L, Slade J. Epidemiology of tobacco use and dependence. *Epidemiol Rev.* 1995;17:48–65.

2. Cigarette smoking among adults—United States, 1995. *MMWR Morb Mortal Wkly Rep.* 1997;46:1217–1220.

3. Winkleby M, Jatulis D, Frank E, Fortmann S. Socioeconomic status and health: how education, income, and occupation contribute to risk factors for cardiovascular disease. *Am J Public Health.* 1992;82:816–820.

4. McCormick M, Brooks-Gunn J, Shorter T, Holmes J, Wallace C, Heagarty M. Factors associated with smoking in low-income pregnant women: relationship to birth weight, stressful life events, social support, health behaviors and mental distress. *J Clin Epidemiol.* 1990;43:441–448.

5. Romano P, Bloom J, Syme S. Smoking, social support, and hassles in an urban African-American community. *Am J Public Health.* 1991;81:1415–1422.

6. Green K, Johnson J. The effects of psychosocial work organization on patterns of cigarette smoking among male chemical plant employees. *Am J Public Health.* 1990;80:1368–1371.

7. Mittelmark M, Murray D, Luepker R, Pechacek T, Pirie P, Pallonen U. Predicting experimentation with cigarettes: the Childhood Antecedents of Smoking Study (CASS). *Am J Public Health.* 1987;77:206–208.

8. Greenlund K, Johnson C, Webber L, Berenson G. Cigarette smoking attitudes and first use among third-through sixth-grade students: the Bogalusa Heart Study. *Am J Public Health.* 1997;87:1345–1348.

9. Curry S, Wagner E, Cheadle A, et al. Assessment of community-level influences on individuals' attitudes about cigarette smoking, alcohol use, and consumption of dietary fat. *Am J Prev Med.* 1993;9:78–84.

10. Ross N, Taylor S. Geographical variation in attitudes towards smoking: findings from the COMMIT communities. *Soc Sci Med.* 1998;46:703–717.

11. Kleinschmidt I, Hills M, Elliott P. Smoking behaviour can be predicted by neighbourhood deprivation measures. *J Epidemiol Community Health.* 1995; 49(suppl 2):S72–S77.

12. Reijneveld S. The impact of individual and area characteristics on urban socioeconomic differences in health and smoking. *Int J Epidemiol.* 1998;27:33–40.

13. Duncan C, Jones K, Moon G. Smoking and deprivation: are there neighbourhood effects? *Soc Sci Med.* 1999;48:497–505.

14. Karvonen S, Rimpela A. Socio-regional context as a determinant of adolescents' health behaviour in Finland. *Soc Sci Med.* 1996;43:1467–1474.

15. Sooman A, Macintyre S. Health and perceptions of the local environment in socially contrasting neighbourhoods in Glasgow. *Health Place.* 1995;1:15–26.

16. Colby J Jr, Linsky A, Straus M. Social stress and state-to-state differences in smoking and smoking related mortality in the United States. *Soc Sci Med.* 1994; 38:373–381.

17. Ennett S, Flewelling R, Lindrooth R, Norton E. School and neighborhood characteristics associated with school rates of alcohol, cigarette, and marijuana use. *J Health Soc Behav.* 1997;38:55–71.

18. Cohen P, Struening E, Muhlin G, Genevie L, Kaplan S, Peck H. Community stressors, mediating conditions and wellbeing in urban neighborhoods. *J Community Psychol.* 1982;10:377–391.

19. Pacione M. Urban liveability: a review. *Urban Geography.* 1990;11:1–30.

20. Sundstrom E, Bell P, Busby P, Asmus C. Environmental psychology 1989–1994. *Annu Rev Psychol.* 1996;47:485–512.

21. Krieger N, Williams D, Moss N. Measuring social class in US public health research: concepts, methodologies, and guidelines. *Annu Rev Public Health.* 1997; 18:341–378.

22. Smith C, Smith C, Kearns R, Abbott M. Housing stressors, social support and psychological distress. *Soc Sci Med.* 1993;37:603–612.

23. Lepore S, Evans G, Schneider M. Dynamic role of social support in the link between chronic stress and psychological distress. *J Pers Soc Psychol.* 1991;61: 899–909.

24. Weinberg C, Sandler D. Randomized recruitment in case-control studies. *Am J Epidemiol.* 1991;134: 421–432.

25. Moorman P, Newman B, Millikan R, Tse C, Sandler D. Participation rates in a case-control study: the impact of age, race, and race of interviewer. *Ann Epidemiol.* 1999;9:188–195.

26. Kinney A, Millikan R, Lin Y, Moorman P, Newman B. Alcohol consumption and breast cancer among black and white women in North Carolina. *Cancer Causes Control.* 2000;11:345–357.

27. *Crime in the United States, 1996.* Washington, DC: Federal Bureau of Investigation; 1997.

28. Lacey L, Manfredi C, Balch G, Warnecke R, Allen K, Edwards C. Social support in smoking cessation among black women in Chicago public housing. *Public Health Rep.* 1993;108:387–394.

29. Schooler C, Feighery E, Flora J. Seventh graders' self-reported exposure to cigarette marketing and its relationship to their smoking behavior. *Am J Public Health.* 1996;86:1216–1221.

30. Moore D, Williams J, Qualls W. Target marketing of tobacco and alcohol-related products to ethnic minority groups in the United States. *Ethn Dis.* 1996;6: 83–98.

31. O'Keefe A, Pollay R. Deadly targeting of women in promoting cigarettes. *J Am Med Womens Assoc.* 1996;51:67–69.

32. Pentz M, Brannon B, Charlin V, Barrett E, MacKinnon D, Flay B. The power of policy: the relationship of smoking policy to adolescent smoking. *Am J Public Health.* 1989;79:857–862.

33. Scheg K. Public policy: effective treatment for tobacco disease. *J Am Med Womens Assoc.* 1996;51: 52–56, 69.

34. Nelson D, Emont S, Brackbill R, Cameron L, Peddicord J, Fiore M. Cigarette smoking prevalence by occupation in the United States. A comparison between 1978 to 1980 and 1987 to 1990. *J Occup Med.* 1994; 36:516–525.