# Occupational Gradients in Smoking Behavior and Exposure to Workplace Environmental Tobacco Smoke

## *The Multi-Ethnic Study of Atherosclerosis*

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**Objective:** This study examines associations of occupation with smoking status, amount smoked among current and former smokers (number of cigarettes per day and lifetime cigarette consumption (pack-years)), and workplace exposure to environmental tobacco smoke (ETS) independent from income and education. **Methods:** This is a cross-sectional analysis of data from a community sample ($n = 6355$, age range: 45–84) using logistic and multinomial regression. All analyses were stratified by sex and adjusted for sociodemographic variables. **Results:** Male blue-collar and sales/office workers had higher odds of having consumed more than 20 pack-years of cigarettes than managers/professionals. For both male and female current or former smokers, exposure to workplace ETS was consistently and strongly associated with heavy smoking and greater pack-years. **Conclusions:** Blue-collar workplaces are associated with intense smoking and ETS exposure. Smoking must be addressed at both the individual and workplace levels especially in blue-collar workplaces.

The adult smoking rate in the United States gradually declined from more than 40% in the 1960s to about 20% in recent years.[1] Nevertheless, differences in the prevalence of tobacco use by socioeconomic position (SEP) persist. Among currently working adults in the United States, 28% of those who are below poverty level smoke while only 18% of those above poverty level do.[2] The discrepancy is reflected in a disproportional burden of tobacco-related health problems among the poor.[3] Understanding the mechanisms that create SEP gradients in tobacco use is a public health imperative.

Income, education, and occupation are the 3 most commonly used measures of SEP, all indicating a person's position relative to others in society. However, each SEP indicator's independent associations with tobacco use may also provide clues regarding the causes of the social patterning of tobacco use. For example, education may in part reflect the ability to obtain health enhancing information and to act on the knowledge.[4] Therefore, educational gradients in tobacco use[4–7] may imply that interventions should focus on delivery of health information and assistance to individuals. Income could in part reflect access to material resources,[8,9] including smoking-cessation treatments. Thus, income gradients in tobacco use[6] could suggest that making treatment for smoking affordable would reduce the disparities.

The role of occupation in tobacco disparities is complex. Occupational gradients in smoking[10–13] may simply reflect the education and income associated with the occupation. On the other hand, occupation may also reflect other unmeasured factors that facilitate smoking, such as work stress (with use of smoking as a coping mechanism), access to tobacco, and social norms that may facilitate or discourage tobacco use in the workplace. Studies that have investigated the association of smoking with occupation independent of income or education have reported inconsistent results. Using a Finnish sample, Laaksonen et al[14] showed that occupational differences in the current smoking rate disappeared after adjustments were made for economic factors. In contrast, a national sample of young Americans showed that blue-collar and service workers had significantly higher rates of current smokers and heavy smokers even after household income and education were taken into account.[15] Because most studies of occupational gradients in smoking only present descriptive statistics,[16] it is not well understood whether the differences across occupational groups are associated with some aspects of the job or simply reflect the education and income level correlated with the job.

Another issue that needs to be taken into account in examining tobacco disparities across occupations is exposure to environmental tobacco smoke (ETS) in the workplace. Health impacts of ETS exposure have been widely recognized,[17,18] and workplace smoking regulations have been implemented in many states.[19,20] Nevertheless, protection from workplace ETS varies by SEP. Workers with low income, low education, and in blue-collar and service jobs are less likely to be protected by the regulations.[21] Moreover, even if workplace smoking regulations are in place, violations have been reported, especially in blue-collar and service occupations.[22] While workplace smoking policies are associated with reduced tobacco consumption,[23,24] those who work in occupations at the lower end of SEP may not benefit from the policies as much as those in other occupations, thereby increasing disparities in tobacco exposure.

In sum, the impact of occupation on tobacco exposure, and especially whether occupation has an impact independent of income and education, remains an understudied question. Specifically, it is not clear if the high prevalence of smoking among blue-collar workers is merely the function of income and education, or if there are other factors specific to blue-collar occupations that increase tobacco exposure. Identifying and eliminating occupational gradients in tobacco use is important because workers toward the bottom of the occupational hierarchy are more likely to be exposed to other hazards that may have synergistic effects with tobacco exposure, such as asbestos.[25] Using data from a sample of community residents, this study examines occupational gradients in various tobacco-related exposures while taking education and income into account.

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## METHODS

### Study Setting and Participants

We used data from the Multi-Ethnic Study of Atherosclerosis (MESA), an ongoing multicenter prospective cohort study designed to investigate the prevalence and progression of subclinical cardiovascular disease.[26] Between 2000 and 2002, MESA established a cohort of 6814 men and women 45 to 84 years old who were free of clinical cardiovascular disease and lived in California, Illinois, Maryland, Minnesota, New York, and North Carolina. The cohort consists of white non-Hispanic, African American, Hispanic, and Asian (mostly of Chinese origin) participants, with racial/ethnic minority groups oversampled. The MESA protocol was approved by the institutional review boards of all collaborating institutions and the National Heart, Lung, and Blood Institute. This study uses baseline data for all MESA participants who ever worked outside home and provided occupation data for their current occupation or their main occupation before they stopped working ($n = 6360$, 93% of the entire cohort).

### Measures

#### Tobacco-Related Outcomes

All information was obtained via self- or interviewer-administered questionnaires in the participant's preferred language. *Current smoking* was defined as self-report of smoking a cigarette in the 30 days prior to the examination. *Former smoking* was defined as self-report of having smoked at least 100 cigarettes in the participant's lifetime but not having smoked in the previous 30 days. Both current and former smokers reported average number of cigarettes smoked per day. As a measure of lifetime cigarette consumption, pack-years was calculated as the duration of smoking (age of smoking cessation, or the current date if currently smoking, minus age of smoking initiation) times the average number of cigarettes smoked per day, divided by 20 cigarettes per pack.[27]

Self-report of retrospective ETS exposure at work was obtained during the second and third MESA clinical examinations (2002–2005) as part of a residential history questionnaire. First, the participants were asked to list every residential address they had lived from 1980 to the date of data collection. Then the participants were asked to recall while they lived in each address, whether or not their coworkers smoked at work. Because 40% reported no exposure while another 40% reported workplace ETS exposure for the entire time period, we dichotomized the variable as "never exposed to workplace ETS" and "have been exposed to workplace ETS." Environmental tobacco smoke was examined as an outcome in relation to occupation and also as a predictor of smoking and amount smoked. In addition, because smoking among coworkers may affect the likelihood that a given individual smokes, we also explored whether differences in workplace ETS exposure contributed to occupational differences in smoking.

#### Occupation

Current occupation was obtained during the first data collection via a self-administered questionnaire with four open-ended questions modeled on US Census questions (eg, What is your job title?, What are your most important duties?). For those who no longer work, the main occupation before they stopped working was asked. Trained coders at the National Institute for Occupational Safety and Health assigned a 3-digit 2000 Census Occupation Code to the responses. There were 413 occupations represented in the sample, ranging from chief executive officers to grocery baggers. These codes were then categorized into six main occupation groups according to the US Census system: management/professional; office/sales; service; farming, fishing, and forestry; construction, extraction, and maintenance; production, transportation, and material moving. The last three categories were combined into one category, blue-collar jobs, because of the small number of participants in the three categories.

#### Other Participant Characteristics

Age, sex, race/ethnicity, place of birth, level of education, and annual household income were self-reported. Participants identified themselves as white non-Hispanic, black/African American, Hispanic, or Chinese in response to the 2000 US Census questions. Place of birth was coded as US- (within the 50 US states) or foreign-born. The level of education was coded in six categories: grade 8 or less, grades 9–11, complete high school (reference), technical school, associate degree, some college, bachelor's degree, and graduate or professional school. Annual household income was coded in seven categories: <$12,000, $12,000–$24,999, $25,000–$34,999, $35,000–$49,999 (reference), $50,000–$74,999, $75,000–$99,999, and ≥$100,000.

### Data Analysis

Of the 6360 participants who ever worked outside the home and provided occupation data, five were excluded because of missing information on current smoking status ($n = 6355$). A small fraction of participants had missing information on household income ($n = 84$, 1.3%), average number of cigarettes per day ($n = 40$, 0.6%), and pack-years ($n = 67$, 1.1%). Those who did not provide household income were coded as "missing" and retained in the analysis. Those without data on amount smoked were excluded from corresponding analyses. As described earlier, workplace ETS exposure data were collected 2 to 3 years after all other data were collected. This resulted in a sizable proportion of missing ETS information because of attrition (15.9%). Workplace ETS analyses were thus conducted with a reduced sample size of 5347.

All analyses were stratified by sex because of the different patterns of tobacco use for men and women. We first examined lifetime smoking status (ever/never smoker) and workplace ETS exposure during the last 20 years (ever/never exposed). Next, focusing on ever smokers only, we examined current smoking status (current vs. former smoker), intensity of smoking (the average number of cigarettes smoked per day, ≤10, 11–20, >20) as well as lifetime cigarette consumption (pack-years ≤10, 11–20, >20). We also examined if workplace ETS exposure was associated with these smoking outcomes. Logistic regression was used to model dichotomized lifetime smoking status, workplace ETS exposure, and current smoking status as a function of occupation and covariates. We first examined the association, adjusting for demographic covariates only (model 1, with age, race/ethnicity, foreign- or US-born, current working status, and marital status). Then we added household income and education (model 2). Finally, we added workplace ETS exposure as a predictor (model 3). In examining smoking intensity and lifetime cigarette consumption, we made an additional adjustment for current smoking status (former/current). Multinomial logistic regression was used to model smoking intensity and lifetime cigarette consumption. All analyses were performed using SAS 9.2 (SAS Institute Inc, Cary, NC).

## RESULTS

Table 1 presents characteristics of the study participants by sex. The average age was about 62 years for both men and women. Management and professional occupations were the most common for both men and women, followed by blue-collar jobs for men and sales/office jobs for women. Among men, 14.4% were current smokers; among women, 12.0%. The proportion of heavy smokers is higher for men than for women. Workplace ETS exposure was reported by more than half of the participants.

Table 2 describes the distribution of tobacco exposure characteristics across occupational groups. Among men, those in management/professional occupations were more likely to be never

 

**TABLE 1** Participant Characteristics: Multi-Ethnic Study of Atherosclerosis (MESA), Examination 1 (2000–2002)

| | Men ($n = 3106$) | | Women ($n = 3249$) | |
|---|---|---|---|---|
| **Demographic and Smoking Characteristic** | **Frequency** | **%** | **Frequency** | **%** |
| Age, yrs | | | | |
| 45–54 | 880 | 28.3 | 979 | 30.1 |
| 55–64 | 855 | 27.5 | 925 | 28.5 |
| 65–74 | 935 | 30.1 | 924 | 28.4 |
| 75–84 | 436 | 14.1 | 421 | 13.0 |
| Race/ethnicity | | | | |
| Caucasian | 1238 | 39.9 | 1281 | 39.4 |
| African American | 807 | 26.0 | 996 | 30.7 |
| Hispanics | 696 | 22.4 | 644 | 19.8 |
| Chinese American | 365 | 11.8 | 328 | 10.1 |
| Foreign-born* | 948 | 30.5 | 945 | 29.1 |
| Household income | | | | |
| <$12,000 | 270 | 8.8 | 407 | 12.5 |
| $12,000–$24,999 | 501 | 16.1 | 706 | 21.7 |
| $25,000–$34,999 | 349 | 11.2 | 464 | 14.3 |
| $35,000–$49,999 | 492 | 15.8 | 523 | 16.1 |
| $50,000–$74,999 | 586 | 18.9 | 517 | 15.9 |
| $75,000–$99,999 | 326 | 10.5 | 265 | 8.2 |
| ≥$100,000 | 537 | 17.3 | 328 | 10.1 |
| Missing | 45 | 1.5 | 39 | 1.2 |
| Education | | | | |
| Grade 8 or less | 303 | 9.8 | 316 | 9.7 |
| Grades 9–11 | 190 | 6.1 | 230 | 7.1 |
| High school completed | 472 | 15.2 | 653 | 20.1 |
| Technical school, associate degree, some college | 850 | 27.4 | 1005 | 30.9 |
| Bachelors degree | 595 | 19.2 | 539 | 16.7 |
| Graduate or professional school | 696 | 22.4 | 506 | 15.6 |
| Marital status | | | | |
| Married/living as married | 2246 | 72.3 | 1615 | 49.7 |
| Widowed/divorced/separated | 608 | 19.6 | 1306 | 40.2 |
| Never married | 237 | 7.6 | 296 | 9.1 |
| Prefer not to answer | 15 | 0.5 | 32 | 1.0 |
| Current working status | | | | |
| Working for pay, not retired | 1638 | 52.7 | 1583 | 48.7 |
| Occupation | | | | |
| Management/professional | 1428 | 46.0 | 1334 | 41.1 |
| Sales/Office | 435 | 14.0 | 925 | 28.5 |
| Service occupation | 387 | 12.5 | 617 | 19.0 |
| Blue collar | 856 | 27.6 | 373 | 11.5 |
| Current smoking status at examination 1 | | | | |
| Never | 1262 | 40.6 | 1880 | 57.8 |
| Former | 1396 | 45.0 | 979 | 30.1 |
| Current | 448 | 14.4 | 390 | 12.0 |
| Exposure to workplace environmental tobacco smoke (ETS)† | 1776 | 66.8 | 1486 | 55.2 |
| Smoking intensity (average no. of cigarettes per day)‡ | | | | |
| ≥10 | 782 | 42.8 | 747 | 55.5 |
| 11–20 | 662 | 36.2 | 405 | 30.1 |
| >20 | 384 | 21.0 | 193 | 14.3 |
| Lifetime cigarette consumption (pack-years)‡ | | | | |
| ≥10 | 633 | 35.0 | 565 | 42.3 |
| 11–20 | 354 | 19.6 | 280 | 20.9 |
| >20 | 822 | 45.4 | 492 | 36.8 |

All variables are based on self-report; % calculated for race/ethnicity and gender categories.
*Self-reported as having been born outside of the 50 US states.
†$n = 2656$ for men, $n = 2691$ for women because of attrition in ETS data collection.
‡Calculated for current and former smokers only ($n = 1844$ for men; $n = 1369$ for women).

**TABLE 2** Distribution of Tobacco-Related Exposures Across Categories of Occupation: Multi-Ethnic Study of Atherosclerosis (MESA), Examination 1 (2000–2002)

| | Men | | | | | Women | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Tobacco Exposure** | **Management/ Professional (%)** | **Sales/Office (%)** | **Service (%)** | **Blue-Collar (%)** | ***P* Value** | **Management/ Professional (%)** | **Sales/Office (%)** | **Service (%)** | **Blue Collar (%)** | ***P* Value** |
| | $n = 1428$ | $n = 435$ | $n = 387$ | $n = 856$ | | $n = 1334$ | $n = 925$ | $n = 617$ | $n = 373$ | |
| Current smoking status | | | | | <0.001 | | | | | <0.001 |
| Never smoker | 46.5 | 35.9 | 39.0 | 34.0 | | 55.2 | 52.9 | 63.9 | 70.0 | |
| Former smoker | 42.8 | 48.3 | 42.4 | 48.0 | | 34.5 | 33.5 | 21.4 | 20.6 | |
| Current smoker | 10.7 | 15.9 | 18.6 | 18.0 | | 10.3 | 13.6 | 14.8 | 9.4 | |
| | $n = 1254$ | $n = 372$ | $n = 315$ | $n = 715$ | | $n = 1133$ | $n = 779$ | $n = 489$ | $n = 290$ | |
| Workplace ETS exposure | 59.9 | 66.7 | 72.1 | 76.6 | <0.001 | 53.9 | 56.2 | 52.8 | 61.7 | 0.065 |
| | $n = 758$ | $n = 278$ | $n = 233$ | $n = 559$ | | $n = 591$ | $n = 428$ | $n = 216$ | $n = 110$ | |
| Smoking intensity (average no. of cigarettes per day) | | | | | 0.127 | | | | | 0 .042 |
| ≤10 | 41.6 | 40.3 | 51.5 | 42.0 | | 53.5 | 53.5 | 62.5 | 60.9 | |
| 11–20 | 36.5 | 38.5 | 33.1 | 36.0 | | 31.1 | 29.9 | 26.4 | 32.7 | |
| >20 | 21.9 | 21.2 | 15.5 | 22.0 | | 15.4 | 16.6 | 11.1 | 6.4 | |
| | $n = 753$ | $n = 274$ | $n = 229$ | $n = 553$ | | $n = 588$ | $n = 426$ | $n = 213$ | $n = 110$ | |
| Lifetime tobacco consumption (pack-years) | | | | | 0.006 | | | | | 0 .024 |
| ≥10 | 39.7 | 30.7 | 35.4 | 30.6 | | 42.7 | 36.4 | 51.6 | 44.6 | |
| 11–20 | 19.4 | 22.3 | 19.7 | 18.4 | | 21.1 | 22.3 | 18.8 | 19.1 | |
| >20 | 40.9 | 47.1 | 45.0 | 51.0 | | 36.2 | 41.3 | 29.6 | 36.4 | |

ETS indicates environmental tobacco smoke.

smokers than other occupational groups. Among women, the distribution of never smokers appeared opposite of men: blue-collar workers had the highest proportion of never smokers and management/professional workers the lowest. Workplace ETS exposure among men had a clear occupational gradient with managers and professionals having the lowest proportion of ETS exposure and blue-collar workers the highest. In contrast, workplace ETS exposure did not show an occupational gradient among women as it did among men: the proportion of ETS exposure was the lowest for the female service workers.

Table 2 also shows smoking intensity and lifetime tobacco consumption among current and former smokers. While the number of cigarettes per day for men did not differ across occupational groups, pack-years was higher for blue-collar workers than those in the management/professional occupations. Among women, blue-collar workers daily smoked less compared to those in management/professional and sales/office jobs. Pack-years was the lowest for female service workers.

Table 3 shows odds ratios of never being a smoker by occupational groups. Occupation was significantly associated with being a never smoker among men before income and education were included in the model (model 1). Compared to managers and professionals, men in other occupations were less likely to have never smoked. However this association disappeared after further adjustment for income and education were made (model 2). For women, occupation was not associated with never being a smoker. For both men and women, having been exposed to workplace ETS was a strong predictor for not being a never smoker.

Occupation was also associated with ETS exposure in men (Table 4). Male blue-collar workers had higher odds of reporting the exposure than managers and professionals, even after adjustments were made for income and education. For women, there was no occupational gradient in workplace ETS exposure. Nevertheless, when the analyses were restricted to never smokers, stronger associations between occupation and ETS exposure were observed. After all covariates were adjusted for, male nonsmokers in service and blue-collar jobs as well as female nonsmokers in blue-collar jobs had significantly higher odds of reporting workplace ETS exposure.

Tables 5 and 6 (for men and women, respectively) show associations of occupation with being a former smoker (vs current smoker) and with smoking intensity and lifetime cigarette consumption among current and former smokers. Compared to managers and professionals, men in service jobs and women in nonmanagerial/nonprofessional jobs had lower odds of being a former smoker, but these associations were reduced and no longer statistically significant after income and education were included in the model. Those

**TABLE 3** Odds Ratios of Being a Never Smoker by Occupation and Workplace ETS Exposure: Multi-Ethnic Study of Atherosclerosis (MESA), Examination 1 (2000–2002)

| | Men | | | Women | | |
|---|---|---|---|---|---|---|
| Never Smoker | Model 1 OR (95% CI) | Model 2 OR (95% CI) | Model 3 OR (95% CI) | Model 1 OR (95% CI) | Model 2 OR (95% CI) | Model 3 OR (95% CI) |
| Management/ professional | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Sales/office | **0.64 (0.51, 0.80)** | 0.87 (0.69, 1.11) | 0.87 (0.67, 1.14) | 0.88 (0.74, 1.06) | 0.84 (0.68, 1.03) | 0.84 (0.67, 1.05) |
| Service | **0.69 (0.54, 0.88)** | 1.05 (0.80, 1.38) | 1.14 (0.84, 1.55) | 1.17 (0.90, 1.39) | 1.01 (0.78, 1.32) | 0.85 (0.63, 1.13) |
| Blue collar | **0.60 (0.49, 0.72)** | 0.92 (0.74, 1.16) | 1.02 (0.79, 1.32) | 1.19 (0.90, 1.58) | 1.06 (0.77, 1.46) | 1.08 (0.75, 1.55) |
| Never exposed to workplace ETS | — | — | 1.00 | — | — | 1.00 |
| Exposed to workplace ETS | — | — | **0.39 (0.32, 0.46)** | — | — | **0.45 (0.37, 0.53)** |

Model 1: Adjusted for age, race/ethnicity (white, Chinese, African American, Hispanic), place of birth (foreign- or US-born), current working status, and marital status.
Model 2: In addition to model 1 covariates, income and education were included.
Model 3: Workplace ETS exposure was added to the model.
The bold face indicates statistical significance at the 0.05 level.

**TABLE 4** Odds Ratios of Having Been Exposed to Workplace ETS by Occupation Among All Participants and Among Never Smokers: Multi-Ethnic Study of Atherosclerosis (MESA), Examination 1 (2000–2002)

| | All Participants | | Never Smokers Only | |
|---|---|---|---|---|
| Ever Exposed to Workplace ETS (vs Never) | Men OR (95% CI) | Women OR (95% CI) | Men OR (95% CI) | Women OR (95% CI) |
| Management/professional | 1.00 | 1.00 | 1.00 | |
| Sales/office | 1.05 (0.80, 1.37) | 0.95 (0.76, 1.17) | 1.16 (0.77, 1.76) | 0.85 (0.64, 1.14) |
| Service | 1.32 (0.95, 1.83) | 0.83 (0.63, 1.10) | **1.67 (1.01, 2.77)** | 0.95 (0.67, 1.36) |
| Blue collar | **1.59 (1.21, 2.08)** | 1.33 (0.96, 1.86) | **1.87 (1.24, 2.83)** | **1.53 (1.01, 2.30)** |

All models are adjusted for age, race/ethnicity (white, Chinese, African American, Hispanic), place of birth (foreign- or US-born), current working status, marital status, household income, and education.
The bold face indicates statistical significance at the 0.05 level.

**TABLE 5** Associations of Occupation With Smoking Cessation and With Amount Smoked Among Male Ever Smokers: Multi-Ethnic Study of Atherosclerosis (MESA), Examination 1 (2000–2002)

| Tobacco Exposure | Model 1* OR (95% CI) | Model 2* OR (95% CI) | Model 3* OR (95% CI) |
|---|---|---|---|
| Smoking cessation | | | |
| Management/professional | 1.00 | 1.00 | 1.00 |
| Sales/office | 0.80 (0.57, 1.13) | 0.95 (0.66, 1.37) | 1.10 (0.74, 1.63) |
| Service | **0.68 (0.48, 0.98)** | 0.94 (0.63, 1.40) | 1.01 (0.65, 1.58) |
| Blue collar | 0.79 (0.60, 1.05) | 1.10 (0.78, 1.53) | 0.99 (0.69, 1.42) |
| Never exposed to workplace ETS | — | — | 1.00 |
| Have been exposed to workplace ETS | — | — | **1.42 (1.03, 1.95)** |
| Smoking intensity† | | | |
| 11–20 cigarettes per day (vs ≤10) | | | |
| Management/professional | 1.00 | 1.00 | 1.00 |
| Sales/office | 1.25 (0.91, 1.72) | 1.22 (0.87, 1.72) | 1.14 (0.79, 1.65) |
| Service | 1.02 (0.72, 1.44) | 0.94 (0.64, 1.39) | 1.00 (0.65, 1.53) |
| Blue collar | 1.23 (0.74, 1.61) | 1.14 (0.83, 1.57) | 1.05 (0.74, 1.49) |
| Never exposed to workplace ETS | — | — | 1.00 |
| Have been exposed to workplace ETS | — | — | **1.50 (1.14, 1.97)** |
| >20 cigarettes per day (vs ≤10) | | | |
| Management/professional | 1.00 | 1.00 | 1.00 |
| Sales/office | 1.31 (0.89, 1.93) | 1.18 (0.78, 1.79) | 1.17 (0.74, 1.84) |
| Service | 1.18 (0.75, 1.85) | 1.11 (0.67, 1.84) | 1.12 (0.64, 1.96) |
| Blue collar | **1.63 (1.18, 2.25)** | **1.52 (1.03, 2.24)** | 1.52 (0.99, 2.31) |
| Never exposed to workplace ETS | — | — | 1.00 |
| Have been exposed to workplace ETS | — | — | **2.07 (1.46, 2.95)** |
| Lifetime cigarette consumption† | | | |
| Pack-years 11–20 (vs ≤10) | | | |
| Management/professional | 1.00 | 1.00 | 1.00 |
| Sales/office | **1.62 (1.10, 2.40)** | 1.44 (0.95, 2.20) | 1.52 (0.96. 2.38) |
| Service | 1.38 (0.89, 2.14) | 1.19 (0.73, 1.94) | 1.36 (0.80, 2.32) |
| Blue collar | **1.53 (1.09, 2.14)** | 1.28 (0.85, 1.91) | 1.38 (0.90, 2.13) |
| Never exposed to workplace ETS | — | — | 1.00 |
| Have been exposed to workplace ETS | — | — | **1.59 (1.14, 2.21)** |
| Pack-years ≥20 (vs ≤10) | | | |
| Management/professional | 1.00 | 1.00 | 1.00 |
| Sales/office | **1.65 (1.18, 2.31)** | **1.43 (1.00, 2.04)** | **1.50 (1.01, 2.21)** |
| Service | **1.19 (1.15, 2.37)** | 1.29 (0.86, 1.94) | 1.35 (0.86, 2.11) |
| Blue collar | **2.05 (1.56, 2.70)** | **1.59 (1.15, 2.21)** | **1.58 (1.11, 2.27)** |
| Never exposed to workplace ETS | — | — | 1.00 |
| Have been exposed to workplace ETS | — | — | **2.21 (1.66, 2.93)** |

*Model 1: Adjusted for age, race/ethnicity (white, Chinese, African American, Hispanic), place of birth (foreign- or US-born), current working status, and marital status; Model 2: In addition to Model 1 covariates, income and education were included; Model 3: Workplace ETS exposure was added to the model.

†For smoking intensity and lifetime cigarette consumption analyses, current smoking status (current or former) was included in the model.

The bold face indicates statistical significance at the 0.05 level.

**TABLE 6** Associations of Occupation With Smoking Cessation and With Amount Smoked Among Female Ever Smokers: Multi-Ethnic Study of Atherosclerosis (MESA), Examination 1 (2000–2002)

| Tobacco exposure | Model 1* OR (95% CI) | Model 2* OR (95% CI) | Model 3* OR (95% CI) |
|---|---|---|---|
| Smoking cessation | | | |
| Management/professional | 1.00 | 1.00 | 1.00 |
| Sales/office | **0.65 (0.48, 0.87)** | 0.92 (0.66, 1.39) | 1.17 (0.80, 1.71) |
| Service | **0.46 (0.32, 0.66)** | 0.81 (0.53, 1.25) | 1.57 (0.98, 2.52) |
| Blue collar | **0.53 (0.32, 0.86)** | 1.02 (0.59, 1.77) | 1.21 (0.66, 2.23) |
| Never exposed to workplace ETS | — | — | 1.00 |
| Have been exposed to workplace ETS | — | — | **1.70 (1.24, 2.33)** |
| Smoking intensity† | | | |
| 11–20 cigarettes per day (vs ≤10) | | | |
| Management/professional | 1.00 | 1.00 | 1.00 |
| Sales/office | 1.02 (0.76, 1.17) | 0.95 (0.68, 1.34) | 0.98 (0.67, 1.42) |
| Service | 1.08 (0.73, 1.59) | 1.02 (0.64, 1.61) | 1.15 (0.70, 1.91) |
| Blue collar | 1.59 (0.97, 2.60) | 1.44 (0.82, 2.52) | 1.71 (0.91, 3.20) |
| Never exposed to workplace ETS | — | — | 1.00 |
| Have been exposed to workplace ETS | — | — | **1.55 (1.14, 2.10)** |
| >20 cigarettes per day (vs ≤10) | | | |
| Management/professional | 1.00 | 1.00 | 1.00 |
| Sales/office | 1.20 (0.83, 1.74) | 0.94 (0.61, 1.44) | 0.88 (0.54, 1.42) |
| Service | 1.17 (0.69, 2.00) | 0.96 (0.52, 1.79) | 0.75 (0.36, 1.55) |
| Blue collar | 0.73 (0.31, 1.72) | 0.60 (0.24, 1.52) | 1.44 (0.15, 1.29) |
| Never exposed to workplace ETS | — | — | 1.00 |
| Have been exposed to workplace ETS | — | — | **2.63 (1.71, 4.05)** |
| Lifetime cigarette consumption† | | | |
| Pack-years 11–20 (vs ≤10) | | | |
| Management/professional | 1.00 | 1.00 | 1.00 |
| Sales/office | 1.28 (0.91, 1.81) | 1.34 (0.90. 1.99) | 1.25 (0.81. 1.94) |
| Service | 0.75 (0.48, 1.18) | 0.78 (0.46, 1.33) | 0.93 (0.52, 1.66) |
| Blue collar | 1.10 (0.60, 2.02) | 1.28 (0.64, 2.53) | 1.38 (0.65, 2.95) |
| Never exposed to workplace ETS | — | — | 1.00 |
| Have been exposed to workplace ETS | — | — | **1.43 (1.01, 2.02)** |
| Pack-years ≥20 (vs ≤10) | | | |
| Management/professional | 1.00 | 1.00 | 1.00 |
| Sales/office | 1.32 (0.97, 1.78) | 0.99 (0.70, 1.41) | 0.93 (0.63, 1.37) |
| Service | 0.85 (0.56, 1.28) | 0.62 (0.38, 1.00) | 0.62 (0.36, 1.06) |
| Blue collar | 1.52 (0.90, 2.53) | 1.10 (0.60, 2.01) | 1.03 (0.52, 2.02) |
| Never exposed to workplace ETS | — | — | 1.00 |
| Have been exposed to workplace ETS | — | — | **2.76 (2.00, 3.82)** |

*Model 1: Adjusted for age, race/ethnicity (white, Chinese, African American, Hispanic), place of birth (foreign- or US-born), current working status, and marital status; Model 2: In addition to Model 1 covariates, income and education were included; Model 3: Workplace ETS exposure was added to the model.

†For smoking intensity and lifetime cigarette consumption analyses, current smoking status (current or former) was included in the model.

The bold face indicates statistical significance at the 0.05 level.

who reported workplace ETS exposure had higher odds of being a former smoker among both men and women (Tables 5 and 6).

Male blue-collar workers had higher odds of smoking more than 20 cigarettes per day (vs 10 cigarettes or less per day), even after income and education were controlled for. The strength of the association remained unchanged when workplace ETS was included in the model. Men who reported workplace ETS exposure had twice the odds of smoking more than 20 cigarettes per day (OR = 2.07, 95% CI: 1.46, 2.95); for women the association was even stronger (OR = 2.63, 95% CI: 1.71, 4.05). As for lifetime cigarette consumption, male sales/office and blue-collar workers had significantly higher odds of having smoked 20 or greater pack-years even after all covariates were included in the model. Workplace ETS exposure was also significantly associated with greater lifetime cigarette consumption. For women, occupation was not associated with lifetime cigarette consumption but workplace ETS was.

## DISCUSSION

This study examined occupational gradients in various aspects of tobacco exposure among a community sample of men and women. Our analysis was specifically focused on the distinction between occupational groups and other SEP indicators (income and education). We also examined whether workplace ETS was patterned by occupational categories as well as whether workplace ETS exposure predicted other types of tobacco exposure and contributed to occupational differences in amount smoked.

The results indicate that most occupational gradients in current smoking status could be explained by education and income. Nevertheless, among male smokers, occupational gradients in smoking intensity and lifetime cigarette consumption were still present even after we accounted for education and income: male blue-collar workers had higher odds of being a heavy smoker than managers and professionals independent from education and income levels. Workplace ETS exposure tended to be more common in male blue-collar and service workers and in female blue-collar workers, compared to professional and managerial workers. In addition, workplace ETS exposure was consistently and strongly associated with heavy smoking and greater lifetime cigarette consumption.

### Heavy Smoking Among Male Blue-Collar Workers

This study demonstrated that smoking status (never vs ever smoker) and the amount of smoking (smoking intensity, lifetime cigarette consumption) had different associations with occupational groups. Smoking status had no occupational gradients after income and education were taken into account. For most smokers, smoking habits are established before they enter the workforce,[28] and thus influence from family, school, and neighborhood could have stronger impacts on smoking status than workplace factors. These other factors may be better captured by income, education, or other family- or neighborhood-level measures.

Among ever smokers, categories of occupation were not associated with being a former smoker (ie, successfully quit smoking). Workplace ETS exposure and being a former smoker was strongly associated: former smokers were more likely to have been exposed to workplace ETS. This seems contradictory to the findings from studies that documented workplace smoking policies being associated with smoking cessation.[23,24] It could be that former smokers are more likely to report ETS exposure because they are more aware of others' smoking than never smokers. Our data did not allow us to investigate this further: because workplace ETS exposure was assessed as dichotomous (ever/never), we were not able to link it to the timing of smoking cessation.

While smoking status did not show occupational gradients independent from income and education, the amount of tobacco exposure among the current or former smokers did show occupational differences, especially among men. Male blue-collar workers were more likely to be heavy smokers rather than light smokers compared to managers and professionals even after analyses were adjusted for education and income. Our finding is consistent with Lawrence et al,[15] who examined young adults aged 18 to 24 years. The similar results from two samples with different ages (our study sample consisted of 45–84-year-olds) indicate that the association of heavy smoking with blue-collar jobs may be established early in an individual's work life and continues after retirement.

This finding suggests that features of blue-collar jobs may facilitate heavy smoking in men. Based on the affective, somatic, and cognitive benefits of nicotine,[29] previous studies have developed the positive resource model of nicotine effects.[30,31] This model posits that smokers use tobacco products to alleviate psychological and physical discomfort (ie, self-medication). Several studies have reported that job stress is associated with increased amount of smoking,[32–34] which supports the positive resource model. It is plausible that blue-collar workers in our sample were experiencing higher job stress than managers/professionals.

While the positive resource model primarily focuses on psychobiological reactions to nicotine, Sorensen et al[35] highlight the social benefits of smoking. These include distraction from boredom, relief from isolation, and development of camaraderie with other workers as "functional meanings of tobacco use." Compared to management/professional jobs, blue-collar jobs may isolate workers, be more monotonous, or make it difficult for workers to form friendships with coworkers. In these working conditions, social incentives that smoking can provide are valuable and thus encourage heavy smoking. The relation between working conditions in blue-collar jobs and smoking intensity deserves further examination.

### Workplace ETS Exposure for Blue-Collar Workers

Previous studies have shown that ETS exposure is associated with occupational and socioeconomic status,[21] but prior work has not examined whether occupational gradients in ETS exposure are merely a reflection of SEP gradients. Our findings suggest that occupation-specific characteristics may be related to ETS exposure independent of income and education: blue-collar workers were significantly more likely to be exposed to ETS than other occupational groups. These associations were present and especially strong among never smokers and were not affected by education or income levels.

Environmental tobacco smoke is different from other tobacco exposures because it involves *others*' tobacco behaviors and workplace policies. Our analysis showed that blue-collar workers are not only more likely to be smokers but also heavy smokers. This would result in others' greater exposure to workplace ETS. Compared to those in other jobs, blue-collar workers perceive less pressure to quit smoking and more acceptance of smoking around coworkers.[36] This perceived social acceptance not only discourages smoking reduction or cessation[36] but also increases ETS exposure for others. Our analysis also revealed that workplace ETS exposure was strongly associated with heavy smoking and greater lifetime cigarette consumption. This is consistent with previous research on smoke-free workplace policies and smoking behavior.[23,24] Our findings therefore suggest a vicious cycle by which workplace characteristics associated with blue-collar jobs are related to more smoking, which in turn not only increases ETS exposure but also reinforces even greater smoking among coworkers.

Our finding on ETS supports the importance of addressing smoking among blue-collar workers not only at the individual-level but also at the workplace-level. As of December 2010, 33 of the 50 states have workplace smoke-free laws,[20] which leaves about a third of US workers not protected by the legislation. Workplace smoke-free policies not only reduce ETS exposure[37] but are also associated with reduced prevalence of smoking and reduced amount of cigarette consumption.[23,37–39] Our findings suggest that increasing

 

smoke-free blue-collar workplaces may reduce the tobacco-related disparities across occupations.

### Study Strengths and Limitations

This study has a number of strengths that make our findings robust. First, our sample represents more than 400 occupations as well as a wide range of income and education levels. We were also able to statistically control for other SEP measures as well as race/ethnic and place of birth measures. Clearly, occupation, income, and education are interrelated, and income may be part of the pathways through which occupation affects smoking. For this reason our approach of estimating occupation associations after adjusting for income and education may be conservative. While our study addressed various tobacco-related measures other than current smoking status, no biological data were available to validate the self-reported information. We captured workplace ETS exposure in the last 20 years dichotomously (never vs ever); therefore, the current occupation reported in 2000–2002 is not directly linked to ETS exposure. We believe our findings about ETS are still worth reporting for two reasons. First, we analyzed four broad categories of occupation, and few participants would have changed jobs from one category to another.[40] It they did, our results for blue-collar workers might have been biased toward null. Second, a vast majority of our sample reported either being exposed to ETS for the entire 20 years or never being exposed at all, and therefore we combined the small number of those who were intermittently exposed to ETS with those who were constantly exposure. Removing those intermittently exposed from the analyses did not change the conclusion. Our ETS variable, however, does not reflect recent smoke-free state legislation. More detailed ETS exposure measures would have made it possible for us to examine whether or not blue-collar workers were less protected by these state laws. Finally, MESA excluded those who already had clinical cardiovascular disease, which is associated with smoking. This may have reduced the prevalence of smoking in the sample, and could potentially have affected our estimates of associations of occupation with smoking if participants were simultaneously selected on the basis of both occupation and smoking outcomes.

## CONCLUSION

As Sorensen et al[35] urged, "to reduce social disparities in tobacco use, we must disentangle the meaning of socioeconomic position; we must translate occupation into the ways it shapes everyday experiences on and off the job" (p237). As an attempt to "disentangle the meaning of socioeconomic position," this study differentiated occupation from income and education in examining its associations with various tobacco exposures. Two main findings are that the amount of tobacco consumption and workplace ETS exposure not only is a function of education and income levels but also has significant associations with blue-collar jobs, and that workplace ETS exposure is consistently and strongly associated with the amount of tobacco consumption. High prevalence of subclinical cardiovascular disease among blue-collar workers[41] may be explained by both the greater presence of heavy smokers among them as well as a higher likelihood of being exposed to ETS. Intervening to reduce adverse impacts of workplace characteristics on smoking is a public health need.

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