Characteristics of Nonsmoking Women Exposed to Spouses Who Smoke: Epidemiologic Study on Environment and Health in Women from Four Italian Areas

Francesco Forastiere, Sandra Mallone, Elena Lo Presti, Sandra Baldacci, Francesco Pistelli, Marzia Simoni, Annarita Scalera, Marzia Pedreschi, Riccardo Pistelli, Giuseppe Corbo, Elisabetta Rapiti, Nera Agabiti, Sara Farchi, Salvatore Basso, Luigi Chiaffarelli, Gabriella Matteelli, Francesco Di Pede, Laura Carozzi, and Giovanni Viegi

1Agenzia di Sanità Pubblica, Regione Lazio, Rome, Italy; 2Istituto di Fisiologia Clinica CNR, Pisa, Italy; 3Dipartimento di Medicina Sperimentale e Diagnostica, Università di Ferrara, Ferrara, Italy; 4Fisiopatologia Respiratoria, Università Cattolica, Rome, Italy

The aim of this study was to evaluate whether risk factors associated with cardiovascular or respiratory diseases and lung cancer occur differently among nonsmoking women in Italy with and without exposure to environmental tobacco smoke (ETS) from husbands that smoke. We performed a cross-sectional study of 1,938 nonsmoking women in four areas of Italy. Data on respiratory and cardiovascular risk factors and on diet were collected using self-administered questionnaires. Medical examinations and blood tests were administered; urine cotinine levels were measured. Nonsmoking women ever exposed to husbands smoking were compared with unexposed women for several factors: education, husband's education, household crowding, number of children, current or past occupation, exposure to toxic substances at work, parental diseases, self-perceived health status, physician-diagnosed hypertension, hypercholesterolemia, diabetes, osteoporosis, chronic respiratory diseases, blood pressure, medications, lifestyle and preventive behaviors, dietary variables, systolic and diastolic blood pressure, body mass index, waist-to-hip ratio, triceps skin folds, plasma antioxidant (pro-) vitamins (α- and β-carotene, retinol, γ- and δ-tocopherol, lycopene), serum total and HDL cholesterol, and triglycerides. Women married to smokers were more likely to be less educated, to be married to a less educated husband, and to live in more crowded dwellings than women married to nonsmokers. Women married to smokers were significantly less likely to eat cooked (odds ratio (OR) = 0.72; 95% confidence interval (CI), 0.55–0.93) or fresh vegetables (OR = 0.63; CI, 0.49–0.82) more than once a day than women not exposed to ETS. Exposed women had significantly higher urinary cotinine than unexposed subjects (difference: 2.94 ng/mg creatinine). All the other variables were not more prevalent among exposed compared to unexposed subjects. The results regarding demographic factors are easily explained by the social class distribution of smoking in Italy. A lower intake of vegetables among exposed women in our study is consistent with the available literature. Overall, our results do not support previous claims of more frequent risk factors for cardiovascular and pulmonary diseases among ETS-exposed subjects. In Italy, as elsewhere in Europe and North America, women who have never smoked but are married to smokers are likely to be of lower social class than those married to never-smokers. However, once socioeconomic differences are considered, the possibility of confounding in studies on the health effects of ETS is minimal. Key words: confounding, environmental tobacco smoke, epidemiology, ischemic heart diseases, lung cancer, passive smoking, respiratory diseases. Environ Health Perspect 108:1171–1177 (2000). [Online 13 November 2000] http://ehpnet1.nih.gov/docs/2000/108p1171-1177forastiere/abstract.html

Several studies have indicated that exposure to environmental tobacco smoke (ETS) from spouses who smoke is associated with an increased risk of lung cancer (1–3) and ischemic heart disease (4,5) among nonsmoking women. In addition, living with a smoker is linked with respiratory symptoms and lung function decrements, although there are several uncertainties that make a judgment about causality difficult (6). The excess risks associated with ETS exposure are usually small (20–50% increase), and confounding from other known risk factors (including diet and exposure to occupational carcinogens) has been a reason for scientific (7) and public concerns.

The extent of confounding depends on the strength of the relationship between the confounder and the outcome under study, as well as on the asymmetry of the distribution of the confounder in the unexposed and exposed populations. The latter aspect is obviously population specific. It is not surprising that the studies comparing the characteristics of nonsmoking women exposed and unexposed to smoking by their spouses have yielded controversial results. Some investigators have found differences in sociodemographic and dietary characteristics; women married to a smoker were more frequently of lower socioeconomic status, more likely to be employed in manual occupations, and less prone to eat fruits and vegetables, especially those containing β-carotene (8,9). Kawachi and Colditz (7) detected a more hazardous pattern of risk factors for cardiovascular diseases (hypertension, diabetes, hypercholesterolemia, higher body mass index, saturated fat intake) among nonsmoking nurses enrolled in the Nurses Health Study and exposed to ETS at home. In contrast, a close examination of 13 risk factors for heart disease among nonsmoking adults from the Third National Health and Nutrition Examination Survey (NHANES III) in the United States did not reveal significant differences between exposed and unexposed women (after controlling for educational status) apart from dietary carotene intake, which was lower among exposed subjects (10). In a recent report from Switzerland, no differences between women exposed and unexposed at home were found regarding sociodemographic characteristics, dietary sources, food, and nutrients intake (11).

We conducted a study on the characteristics of nonsmoking women living in four areas of Italy to evaluate whether certain risk factors (sociodemographic factors, medical conditions, preventive behaviors, and dietary habits) potentially associated with cardiovascular or respiratory diseases and lung cancer are found differentially among women with...
and without exposure to ETS from their husbands. Laboratory data on urinary cotinine concentrations were used to validate the non-smoking status of the women, and blood samples were taken to compare plasma levels of (pro-) vitamins and lipids among exposed and unexposed subjects.

**Methods**

**Subjects.** The study was conducted in four areas characterized by different economic backgrounds and urbanization levels: the Po River Delta (a rural area in North Italy), Pisa (a historic, middle-sized town in Tuscany, Central Italy), Viterbo (a small town including the nearby rural area in Latium, Central Italy), and the metropolitan area of Rome (Central Italy). These areas were chosen because they had been examined in previous population studies which had already ascertained the smoking status of women. This made the selection of never-smoking women for the present study more efficient. A cross-sectional study through an interviewer-administered, standardized questionnaire was conducted in the Po River Delta and in Pisa from 1988 to 1993 (12,13) to evaluate the role of air pollution on respiratory conditions in the general population (8–97 years; response rates: 67% and 69%, respectively). Among the women participating in these studies (1,499 in the Po River Delta and 1,553 in Pisa), there were 1,811 women that had reported never being smokers at the time of initial interview (805 in Po River Delta and 1,006 in Pisa). A nationwide study on asthma prevalence among 6–7- and 13–14-year-old children, from randomly chosen primary and middle schools within defined geographical areas, was conducted in Italy in 1994–1995 (14–17) within the International Study of Asthma and Allergies in Childhood initiative (18). The areas of Viterbo and Rome were included in this study. Self-administered questionnaires were filled out by the parents of the child, and they included information on the lifetime smoking habits of the mother. A high response rate was obtained (94.1% in Viterbo and 91.7% in Rome). From the list of natural mothers whose smoking habits were known, a total of 4,880 women who had never smoked were ascertained at the local municipal registers, and due to moving or death, 3,330 women remained eligible for the study.

**Questionnaires.** The data collection was performed from September 1997 through the end of 1998. The study was approved by the Ethical Committee of the Catholic University in Rome. Eligible subjects were invited by mail, subsequent phone calls (mainly in Rome), and home visits by trained personnel to fill out two self-administered questionnaires (a core questionnaire and a food-frequency questionnaire). The study was presented as a survey on health status, environmental factors, and dietary habits, with no mention of the specific arms regarding ETS exposure. The questionnaires were sent by mail (Viterbo and Rome) or were hand delivered at home (Po River Delta and Pisa). The core questionnaire contained information on demographics, passive smoking exposure, exposure to toxic substances at work, family medical history, personal medical history, physical exercise, and other preventive behaviors. We used the Italian version of the EPIC food-frequency questionnaire (a self-administered questionnaire designed and used in the ongoing European Prospective Investigation into Cancer of Diet and Nutrition (19)) to assess dietary habits. During the phone conversation or personal contact at home, the women were invited to participate in the medical examination and blood testing. The questionnaires had to be returned (and checked for completeness by trained personnel) the day of the medical examination. In cases when the medical examination was refused, the completed questionnaires were returned to the study center by mail. The women were motivated to participate by free medical and laboratory tests; all participants in Rome and in Viterbo received a grocery coupon (equivalent to $10 U.S.).

**Medical examinations and biological samples.** Informed consent was obtained, and the medical examinations were performed by a physician at the hospital site.

| Variable | Unexposed | Exposed | ORa | ORb | 95% CI |
|----------|-----------|---------|-----|-----|-------|
| Center   |           |         |     |     |       |
| Po Delta | 184       | 220     | 1.00| 1.00| —     |
| Pisa     | 121       | 290     | 1.83| 1.86| (1.38–2.49) |
| Roma     | 290       | 467     | 1.72| 1.91| (1.42–2.57) |
| Viterbo  | 131       | 235     | 1.95| 2.04| (1.47–2.82) |
| Age (years) |       |         |     |     |       |
| 25–34    | 113       | 117     | 1.00| 1.00| —     |
| 35–44    | 313       | 474     | 1.37| 1.40| (1.03–1.90) |
| 45–54    | 161       | 308     | 1.82| 1.83| (1.30–2.58) |
| 55–64    | 89        | 172     | 2.13| 1.95| (1.26–3.00) |
| 65–74    | 50        | 141     | 3.03| 2.77| (1.70–4.51) |
| Women’s education (years) |       |         |     |     |       |
| >13      | 92        | 120     | 1.00| 1.00| —     |
| 9–13     | 252       | 362     | 1.24| 1.24| (0.89–1.71) |
| 6–8      | 187       | 314     | 1.44| 1.44| (1.02–2.04) |
| ≤6       | 193       | 413     | 1.54| 1.54| (1.04–2.28) |
| Husband’s education (years) |       |         |     |     |       |
| >13      | 109       | 132     | 1.00| 1.00| —     |
| 9–13     | 233       | 339     | 1.49| 1.24| (0.88–1.76) |
| 6–8      | 180       | 332     | 1.65| 1.50| (1.01–2.22) |
| ≤6       | 143       | 273     | 1.31| 1.33| (0.86–2.06) |
| Household crowding (persons/room) |       |         |     |     |       |
| Low (<0.8) | 287     | 434     | 1.00| 1.00| —     |
| Medium (0.8–1) | 205   | 351     | 1.28| 1.25| (0.97–2.38) |
| High (>1)  | 228     | 420     | 1.54| 1.45| (1.11–1.89) |
| Number of children |       |         |     |     |       |
| None      | 37        | 32      | 1.00| 1.00| —     |
| ≤2       | 557       | 951     | 1.38| 1.34| (0.75–2.38) |
| >3        | 127       | 226     | 1.44| 1.37| (0.74–2.54) |
| Women’s current or past occupation |       |         |     |     |       |
| Nonmanual | 349       | 569     | 1.00| 1.00| —     |
| Manual    | 90        | 167     | 1.08| 0.92| (0.66–1.30) |
| Self-employed, farmers, other occupation | 152   | 281     | 1.02| 0.91| (0.69–1.19) |
| Never employed, homemakers | 115   | 172     | 0.82| 0.72| (0.53–0.99) |
| Exposure to toxic substances at work | only among employed | | | | |
| No        | 466       | 810     | 1.00| 1.00| —     |
| Yes       | 125       | 207     | 0.92| 0.89| (0.68–1.15) |

*Totals may vary because of missing values.  
†Odds ratios adjusted for center, age, and center × age.  ‡Odds ratios adjusted for center, age, center × age, and woman’s education.
most convenient for each woman. Each subject undergoing physical examination was interviewed by the physician and had measurements taken of standing height, weight, circumferences of arm, waist, hips, and wrist and subscapular and triceps skin folds according to standardized procedures (20). Two measures of systolic and diastolic pressure, at an interval of 30 min, were performed using a mercury sphygmomanometer, and the mean of the two measurements was used. The subjects were asked to collect a sample of the first urine they passed on the day of the clinical examination. A blood sample of 30 cc was drawn in fasting conditions. Thirty minutes after being drawn, the blood sample to determine α- and β-carotene, retinol, l-ascorbic acid, α-tocopherol, lycopene, and lipidic pattern. A simultaneous measurement of fat-soluble compounds in serum was carried out using HPLC (21). The assay for determining l-ascorbic acid in serum was performed according to the NHANES III laboratory protocol (22). Total cholesterol, HDL cholesterol, and triglycerides were measured using standard enzymatic procedures performed by spectrophotometer on serum stored at 4°C. Urine cotinine levels were measured in duplicate with the radioimmunoassay (RIA) described by Van Vunakis et al. (23). We expressed urinary cotinine levels as ratio of cotinine to creatinine (nanograms per milligram).

Table 2. Odds ratios for parental diseases and personal medical conditions of women unexposed and exposed to husbands' smoking, 1997–1998.

| Variable                                | Unexposed (n = 741) | Exposed (n = 1,212) | ORa ORb 95% CI |
|------------------------------------------|---------------------|---------------------|----------------|
| Parental asthma                          |                     |                     |                |
| No                                       | 615                 | 996                 | 1.00 1.00 —    |
| Yes                                      | 111                 | 216                 | 1.12 1.08 (0.84-1.41) |
| Parental chronic respiratory disease     |                     |                     |                |
| No                                       | 573                 | 944                 | 1.00 1.00 —    |
| Yes                                      | 153                 | 268                 | 1.02 1.03 (0.81-1.29) |
| Parental heart disease                   |                     |                     |                |
| No                                       | 454                 | 772                 | 1.00 1.00 —    |
| Yes                                      | 272                 | 440                 | 0.88 0.89 (0.73-1.08) |
| Parental history of cancer               |                     |                     |                |
| No                                       | 512                 | 790                 | 1.00 1.00 —    |
| Yes                                      | 214                 | 422                 | 1.19 1.20 (0.98-1.47) |
| Self-perceived health status             |                     |                     |                |
| Very good                                | 125                 | 245                 | 1.00 1.00 —    |
| Good                                     | 467                 | 748                 | 0.97 0.98 (0.76-1.26) |
| Poor                                     | 127                 | 202                 | 1.04 1.09 (0.78-1.52) |
| Physician-diagnosed health conditions   |                     |                     |                |
| Hypertension                             |                     |                     |                |
| No                                       | 620                 | 1,003               | 1.00 1.00 —    |
| Yes                                      | 106                 | 209                 | 0.99 0.97 (0.73-1.28) |
| Hypercholesterol                         |                     |                     |                |
| No                                       | 614                 | 1,032               | 1.00 1.00 —    |
| Yes                                      | 112                 | 180                 | 0.76 0.75 (0.57-0.97) |
| Diabetes                                 |                     |                     |                |
| No                                       | 700                 | 1,172               | 1.00 1.00 —    |
| Yes                                      | 26                  | 40                  | 0.75 0.72 (0.43-1.22) |
| Osteoporosis                             |                     |                     |                |
| No                                       | 671                 | 1,091               | 1.00 1.00 —    |
| Yes                                      | 55                  | 121                 | 0.98 0.95 (0.66-1.37) |
| Chronic obstructive pulmonary disease    |                     |                     |                |
| No                                       | 715                 | 1,173               | 1.00 1.00 —    |
| Yes                                      | 11                  | 39                  | 1.78 1.75 (0.88-3.47) |
| Women taking blood pressure medications |                     |                     |                |
| No                                       | 654                 | 1,056               | 1.00 1.00 —    |
| Yes                                      | 72                  | 156                 | 1.09 1.12 (0.80-1.56) |

Totals may vary because of missing values.

aOdds ratio adjusted for center, age, and center x age. bOdds ratios adjusted for center, age, center x age, and woman's education.

Data analysis. Out of a total of 3,330 women eligible for the study, the two questionnaires were returned by 2,552 subjects (76.7%). The response rate varied slightly according to study center (highest in the Po River Delta, 84%; lowest in Viterbo, 73.4%). A comparison of the characteristics of participants versus nonparticipants revealed that participants were older, had a higher educational level, and were more likely to be employed than nonparticipants. A check of the smoking status of the participants revealed that 217 women were active smokers at the time of the study (most had started smoking in the period since the previous interview), and they were subsequently excluded from the analysis. Out of 2,335 confirmed never-smokers (negative answer to the question “have you ever smoked cigarettes?”), there were 2,072 in the 25–74 age range, among them, 1,633 (78.8%) participated in the medical examination and 1,817 (78%) gave blood to be tested. We finally excluded 112 women who had never been married and 22 women for whom smoking status of the husband was unknown. In total, we included in the present analysis 1,938 women, 25–74 years of age, ever married, and confirmed to have never been smokers.

Nonsmoking women ever exposed to their husbands' smoking were compared with the category of unexposed women for several factors: education, husband's education, household crowding, number of children, current or past occupation, exposure to toxic substances at work (dust, gas, fumes, and chemicals), parental diseases (asthma, chronic respiratory diseases, heart conditions, cancer), self-perceived health status, physician-diagnosed health conditions (hypertension, hypercholesterolemia, diabetes, osteoporosis, chronic respiratory diseases), blood pressure medications, lifestyle, and preventive behaviors (regular vigorous physical activity, supplemental minerals and vitamins, frequency of Pap test, mammography, and breast self-examination).

We examined the following dietary groups: pasta and rice, meat, cooked vegetables, fresh vegetables, tomatoes, fruit, citrus fruit (oranges, tangerines, kiwi), fruit rich in β-carotene (apricots, peaches), olive oil for dressing, butter for cooking, and wine. The categorization for all the variables to be examined was decided a priori on the basis of the frequency distribution in the overall sample.

The data analysis of the categorical variables followed the approach used by Matanoski et al. (9). We analyzed the association between exposure to spousal smoking and women's characteristics using odds ratios (OR; and 95% confidence intervals, CI) calculated from logistic regression models. The odds ratios express the relative odds of the occurrence of the variable in women with spouses who smoked compared with that in women with spouses who did not smoke. It should be considered that the OR overestimates the prevalence rate ratio when the outcome under study is not rare (24). The ORs were always adjusted for the study area (center), age (five classes), and women's education (four classes) as a measure of
socioeconomic status. Because the age distributions differed among centers, we also had a center-by-age interaction term in the model.

The following continuous variables were considered for the women who attended the medical examination and had a blood test: urinary cotinine/creatinine, systolic and diastolic blood pressure, body mass index (BMI; weight/height²), waist-hip ratio, tripces skin fold, α- and β-carotene, retinol, L-ascorbic acid, α-tocopherol, lycopene, serum total and HDL cholesterol, and triglycerides. We used linear multiple regression to evaluate differences between those exposed and unexposed to smoking habits after adjustment for study area (center), age, and women’s education.

Results

Among the 1,938 women never-smokers under study, 62.5% (1,212) had ever been married to a cigarette smoker, and 25.8% (711) were still living with a husband who currently smoked. Smoking cessation of the husband was the cause of the difference for 561 women, while 150 subjects were no longer exposed because of death of the husband or divorce. The demographic characteristics of the nonsmoking women with respect to the husband’s smoking history are reported in Table 1, which reports the number of unexposed and exposed cases. ORs adjusted for center, age, and center × age, and ORs (with 95% CI) after further adjustment for socioeconomic status. Because the age distributions differed among centers, we also had a center-by-age interaction term in the model for the women who attended the medical examination and had a blood test: urinary cotinine/creatinine, systolic and diastolic blood pressure, body mass index (BMI; weight/height²), waist-hip ratio, tripces skin fold, α- and β-carotene, retinol, L-ascorbic acid, α-tocopherol, lycopene, serum total and HDL cholesterol, and triglycerides. We used linear multiple regression to evaluate differences between those exposed and unexposed to smoking habits after adjustment for study area (center), age, and women’s education.

Table 3. Odds ratios for lifestyle and preventive behaviors of women unexposed and exposed to husbands’ smoking, 1997–1998.

| Variable | Unexposed (n = 741) | Exposed (n = 1,212) | ORa | ORb | 95% CI |
|----------|---------------------|---------------------|-----|-----|--------|
| Regular vigorous physical activity | | | | | |
| No | 556 | 977 | 1.00 | 1.00 | — |
| Yes | 165 | 228 | 0.88 | 0.88 | (0.69–1.11) |
| Supplementation with Vitamins | | | | | |
| No | 664 | 1,074 | 1.00 | 1.00 | — |
| Yes | 62 | 138 | 1.40 | 1.45 | (1.05–2.01) |
| Minerals | | | | | |
| No | 657 | 1,075 | 1.00 | 1.00 | — |
| Yes | 69 | 137 | 1.22 | 1.23 | (0.90–1.68) |
| Pap test | | | | | |
| Never | 92 | 141 | 1.00 | 1.00 | — |
| Rarely | 155 | 310 | 1.14 | 1.17 | (0.82–1.65) |
| Every 2–3 years | 175 | 261 | 0.96 | 0.99 | (0.73–1.36) |
| Every year | 276 | 463 | 1.12 | 1.16 | (0.83–1.62) |
| Mammography | | | | | |
| Never | 365 | 565 | 1.00 | 1.00 | — |
| Rarely | 141 | 253 | 1.04 | 1.04 | (0.80–1.35) |
| Every 2–3 years | 134 | 225 | 0.96 | 0.96 | (0.83–1.12) |
| Every year | 67 | 147 | 1.30 | 1.30 | (0.91–1.82) |
| Breast self-examination | | | | | |
| Never | 225 | 389 | 1.00 | 1.00 | — |
| Rarely | 239 | 412 | 1.04 | 1.07 | (0.84–1.36) |
| Every 2–3 months | 126 | 181 | 0.97 | 0.99 | (0.67–1.42) |
| Every month | 122 | 220 | 1.12 | 1.14 | (0.86–1.52) |

Discussion

We found that women married to a smoker had higher levels of urinary cotinine and were more likely to be of lower socioeconomic status. Because the age distributions differed among centers, we also had a center-by-age interaction term in the model. When considering lifestyle and preventive behaviors of Table 4, women taking vitamin supplements were more likely to be married to a smoker (OR = 1.45; CI, 1.05–2.01). No associations were found for vigorous physical activity, or for the frequency of Pap test, mammography, or breast self-examination. Table 4 presents the association between dietary variables and smoking habits of the husband. Women married to a smoker were significantly less likely to eat cooked vegetables (OR = 0.72; CI, 0.55–0.93) or fresh vegetables (including salads; OR = 0.63; CI, 0.49–0.82) more than once a day. No other statistically significant associations were found.

A total of 1,249 measurements of urinary cotinine were available. 462 among unexposed and 787 among exposed women. Only 8 subjects (0.6%) had a value > 100 ng/mg creatinine (all were < 300 ng/mg). No other statistically significant associations were found.

Exposure to spousal smoking was not statistically significant and a level > 100 ng/mg, the urinary cotinine/creatinine ratio was 6.46 ng/mg among nonexposed women, and it was significantly higher (2.94 ng/mg; p < 0.001) among exposed individuals (Table 5). No differences between women married to a smoker and those married to a non-smoker were found for all the other variables collected during the physical examination or for the laboratory data (Table 5), although the serum concentration of L-ascorbic acid was marginally lower in the exposed than in the unexposed women (p = 0.08). Although we were mainly interested in the differences between women ever exposed to a smoking husband and women never exposed, we reran all the analyses for the variables collected through the questionnaires considering women still living with a current smoker (501 subjects) in comparison with never exposed (741 subjects). All the results were similar to what had been found in the main analysis, and no additional differences were detected (data not shown). Women married to a current smoker were significantly less likely to eat cooked vegetables (OR = 0.64; CI, 0.46–0.89) or fresh vegetables (including salads; OR = 0.57; CI, 0.41–0.78) more than once a day.
tus, to be married to a less educated husband, and to live in more crowded dwellings than women married to a nonsmoker. After adjustment for women’s educational level, exposed subjects were more likely to supplement their diets with minerals and were less likely to eat vegetables (cooked or fresh) than unexposed women. However, all the other variables we investigated, including other dietary variables, results of the medical examination, and laboratory data, did not significantly differ between exposed and unexposed subjects.

The results of the present study regarding the socioeconomic factors associated with exposure to a husband who smokes are not surprising given the socioeconomic differences in the distribution of smoking habits in the adult Italian population. Smoking is more frequent in men of lower socioeconomic status, whereas the proportion of smokers is higher among women of higher social class (26). The differences that we found with regard to various indicators of social class (woman’s and husband’s education, crowding), with those in the lowest socioeconomic level being more exposed, clearly reflect gender and social class differences of smoking in Italy. Similar findings have been reported in studies conducted in the United States (7,9,10) and in the United Kingdom (27).

However, homemakers and unemployed women in our study were less likely to be exposed than ever-employed subjects, a finding that may be peculiar to the Italian situation. Our results suggest the importance of using more than one variable related to social class to control confounding in studies aimed at evaluating the health effects of ETS exposure. However, when we considered in the regression models husband’s education in addition to the women’s education, no substantial changes in the degree of association between exposure to ETS and several women’s characteristics were found. In some instances, social class may be considered as an effect modifier because the harmful health effects of passive smoking are detected in families of lower socioeconomic status where the proportion of exposed people and the intensity of exposure to ETS is high (28).

There are indications from the United States and from the United Kingdom that women whose spouses smoke have poorer diets than unexposed women. Sidney et al. (29) found that carbohydrate intake was significantly lower in those exposed in comparison to unexposed subjects among nonsmokers studied in the Kaiser Permanente system in California. Thornton et al. (27), in a study of British adults, reported that never-smokers reporting ETS exposure at home were more likely to eat less fruit and more fried foods than unexposed subjects.

Matanoski et al. (9) reported lower dietary intake of vitamins A and C among nonsmoking women married to a smoker compared to unexposed subjects in the N H A N E S I in the United States. Kawachi and Colditz (7) found that women in the Nurses’ Health Study reporting ETS exposure at home were more likely to be in the highest quintile of saturated fat intake. Steenland et al. (10) observed that ETS-exposed subjects in the N H A N E S III in the United States had a lower dietary carotene intake than unexposed individuals. No association between ETS exposure at home and diet, however, was found in a recent study from Switzerland (11). We found a lower intake of vegetables among exposed women in our study, a result that is in keeping with the evidence reviewed above. However, as in the Swiss study (11), it seems that the dietary pattern in this Italian population does not differ to a large extent between exposed and unexposed women. No significant association has been found for most of the items in the food-frequency questionnaire, nor for serum levels of vitamins.

Our results do not support previous reports of more frequent risk factors for cardiovascular diseases among exposed subjects—namely, hypertension (9) and elevated

### Table 4. Odds ratios for consumption of some foods by women unexposed and exposed to husbands’ smoking, 1997–1998.

| Variable                              | Husbands’ smoking |                  |                  |                  |
|---------------------------------------|-------------------|------------------|------------------|------------------|
|                                      | Unexposed | Exposed | OR^a | OR^b | 95% CI |
| Pasta and rice                        | n         | n       | OR   | OR   |        |
| Never                                 | 19        | 26      | 1.00 | 1.00 | —     |
| <1/day                                | 210       | 350     | 0.96 | 0.97 | (0.78–1.20) |
| 1/day                                 | 398       | 628     | 1.10 | 1.15 | (0.84–1.57) |
| Meat in general                       | n         | n       | OR   | OR   |        |
| Never                                 | 13        | 25      | 1.00 | 1.00 | —     |
| <1/day                                | 387       | 688     | 0.89 | 0.87 | (0.71–1.07) |
| 1/day                                 | 263       | 406     | 0.85 | 0.80 | (0.56–1.15) |
| Cooked vegetables                     | n         | n       | OR   | OR   |        |
| <1/day                                | 311       | 557     | 1.00 | 1.00 | —     |
| 1/day                                 | 248       | 450     | 1.01 | 1.03 | (0.83–1.28) |
| Fresh vegetables                      | n         | n       | OR   | OR   |        |
| <1/day                                | 163       | 346     | 0.72 | 0.72 | (0.55–0.93) |
| 1/day                                 | 306       | 543     | 0.64 | 0.63 | (0.49–0.82) |
| Tomatoes                              | n         | n       | OR   | OR   |        |
| <1/day                                | 89        | 196     | 1.00 | 1.00 | —     |
| 1/day                                 | 509       | 786     | 0.68 | 0.68 | (0.52–0.90) |
| Fruit in general                      | n         | n       | OR   | OR   |        |
| <1/day                                | 122       | 174     | 1.00 | 1.00 | —     |
| 1–2/day                               | 330       | 545     | 1.11 | 1.12 | (0.85–1.48) |
| ≥2/day                                | 270       | 490     | 1.08 | 1.09 | (0.82–1.45) |
| Citrus fruit (orange, tangerine, and kiwi) | n         | n       | OR   | OR   |        |
| <1/week                               | 50        | 83      | 1.00 | 1.00 | —     |
| 2–4/week                              | 233       | 390     | 1.08 | 1.11 | (0.74–1.66) |
| ≥4/week                               | 443       | 731     | 1.10 | 1.13 | (0.76–1.66) |
| Fruit rich in β-carotene (apricots, prunes, peaches) | n         | n       | OR   | OR   |        |
| <1/week                               | 235       | 379     | 1.00 | 1.00 | —     |
| 2–4/week                              | 162       | 298     | 1.10 | 1.12 | (0.86–1.46) |
| ≥4/week                               | 327       | 532     | 0.96 | 0.99 | (0.78–1.24) |
| Olive oil for dressing                | n         | n       | OR   | OR   |        |
| No                                    | 57        | 94      | 1.00 | 1.00 | —     |
| Yes                                   | 657       | 1,105   | 0.69 | 0.70 | (0.47–1.02) |
| Butter for cooking                    | n         | n       | OR   | OR   |        |
| No                                    | 680       | 1,139   | 1.00 | 1.00 | —     |
| Yes                                   | 43        | 62      | 1.04 | 1.06 | (0.69–1.61) |
| Wine                                  | n         | n       | OR   | OR   |        |
| Never                                 | 257       | 427     | 1.00 | 1.00 | —     |
| <1 Glass/week                         | 149       | 286     | 1.19 | 1.20 | (0.93–1.56) |
| ≥2 Glasses/day                        | 218       | 322     | 0.83 | 0.64 | (0.66–1.07) |

Totals may vary because of missing values. 
^aOdds ratio adjusted for center, age, and center × age. ^bOdds ratios adjusted for center, age, center × age, and woman’s education.
BM I (10). The profile of cardiovascular risk in our study was rather similar among women married to a smoker and those married to a nonsmoker. There were no differences when considering self-reports of physician-diagnosed diseases, familial history, medication for blood pressure, physical activity, nor the results of physical exams (blood pressure, BM I, triceps, waist–hip ratio), nor the laboratory data (total and HDL cholesterol, triglycerides). Considering that most of the variables related to a preventive behavior were also similar between the two groups, it seems that in the Italian situation, after having considered age and social class differences, women married to a smoker do not differ to a great extent from women married to a nonsmoker.

Paradoxically, exposed women were more likely to take vitamin supplements than unexposed ones, a result that is in contrast with the findings in NHANES I (9). Our results may simply reflect chance or may indicate that women married to a smoker follow the husband in taking vitamins and minerals under the false belief that this may prevent cancer occurrence (30).

Our study was initiated to elucidate the potential extent of confounding of the association between ETS exposure at home and several health effects among adult nonsmoking women. Like the current study, other work that examined the association between ETS exposure at home and risk of ischemic heart disease (31) and lung cancer (3,32) and which considered several confounders, including dietary patterns, has reported that confounding was minimal. For instance, Steenland et al. (31) showed that controlling for many cardiovascular risk factors in the follow-up of the American Cancer Society cohort had a small effect on the risk estimates of the association between ETS exposure and heart disease (from 1.31 to 1.19 for men and from 1.25 to 1.23 for women). In a recent report, Brennan et al. (32) found no confounding by dietary items in the association between ETS and lung cancer in the European case-control study. Our results also suggest that the extent of confounding from other factors, if any, is minimal.

In conclusion, we found few differences in socioeconomic and dietary characteristics among nonsmoking Italian women exposed and not exposed to spouses who smoke. Such differences would likely be controlled for when investigating health effects of passive smoking.

**References and Notes**

1. Fontham ET, Correa P, Reynolds P, Wu-Williams A, Buehler PA, Greenberg RS, Chen WV, Alterman T, Boyd P, Austin DF, et al. Environmental tobacco smoke and lung cancer in nonsmoking women: a multicenter study. JAMA 271:1752–1759 (1994).

2. Hackshaw AK, Law MR, Wald NJ. The accumulated evidence on lung cancer and environmental tobacco smoke. Br Med J 315:980–988 (1997).

3. Bojett P, Agudo A, Ahmed W, Benhamou E, Benhamou S, Darby SC, Ferro G, Forteza C, Gonzalez CA, Jockel KH, et al. Multicenter case-control study of exposure to environmental tobacco smoke and lung cancer in Europe. J Natl Cancer Inst 91:1440–1450 (1999).

4. Law MR, Morris JK, Wald NJ. Environmental tobacco smoke exposure and ischaemic heart disease: an evaluation of evidence. Br Med J 315:973–980 (1997).

5. Bailar J III. Passive smoking, coronary heart disease, and meta-analysis [Editorial]. N Engl J Med 340:958–959 (1999).

6. Coûttes DB. Health effects of passive smoking. Passive smoking and risk of adult asthma and COPD: an update. Thorax 53:381–387 (1998).

7. Kawachi I, Colditz GA. Invited commentary: confounding, measurement error, and publication bias in studies of passive smoking. Am J Epidemiol 144:909–915 (1996).

8. Cress Rd, Holey EA, Aston DA, Ahn DK, Krishnan J. Characteristics of women nonsmokers exposed to passive smoke. Prev Med 23:40–47 (1994).

9. Matanoski G, Canganarassisa S, Lantry D, Chang Y. Characteristics of nonsmoking women in NHANES I and NHANES I epidemiological follow-up study with exposure to spouses who smoke. Am J Epidemiol 142:139–157 (1996).

10. Steenland K, Sieber K, Etzel RA, Pechacek T, Mauer K. Exposure to environmental tobacco smoke and risk factors for heart disease among never smokers in the Third National Health and Nutrition Examination Survey. Am J Epidemiol 147:932–939 (1998).

11. Curtin F, Morabia A, Bernstein MS. Relation of environmental tobacco smoke to diet and health habits: variations according to site of exposure. J Clin Epidemiol 52:1055–1062 (1999).

12. Balducci S, Carrozzi L, Viegi G, Giuntini C. Assessment of respiratory effect of air pollution: study design on general population samples. J Environ Pathol Toxicol 16:777–83 (1997).

13. Viegi G, Pedroschi M, Balducci S, Chiatti L, Pistelli F, Modena P, Veutlini M, Di Pede F, Carrozzi L. Prevalence rates of respiratory symptoms and diseases in general population samples of North and Central Italy. Int J Tuberc Lung Dis 22:1034–1042 (1999).

14. SIDRIA Collaborative Group. Asthma and respiratory symptoms in 6-7 year old Italian children: gender, latitude, urbanization and socioeconomic factors. Eur Respir J 10:1760–1766 (1997).

15. Ciccone G, Forastiere F, Agabiti N, Biggieri A, Bisanti L, Chellini E, Corbo G, Dell’Orco V, Dalmasso P, Volante TF, et al. Road traffic and adverse respiratory effects in children. SIDRIA Collaborative Group. Occup Environ Med 55:771–778 (1999).

16. Agabiti N, Mallone S, Forastiere F, Corbo G, Renzoni E, Sestini P, Rusconi F, Ciccone G, Viegi G, Chellini E, et al. The impact of parental smoking on asthma and wheezing. Epidemiology 10:692–698 (1999).

17. Renzoni E, Forastiere F, Biggieri A, Viegi G, Bisanti L, Chellini E, Ciccone G, Corbo G, Galassi C, Rusconi F, et al. Difference in parental- and self-report of asthma, rhinitis and eczema among Italian adolescents. Eur Respir J 14:597–604 (1999).

18. The International Study of Asthma and Allergies in Childhood. Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and atopic eczema: ISAAC. Lancet 351:1225–1232 (1998).

19. Kaaks R, Simani N, Riboli E. Pilot phase studies on the accuracy of dietary intake measurements in the EPIC project: overall evaluation of results. European prospective investigation into cancer and nutrition. Int J Epidemiol 26(suppl 1):S26–36 (1997).

20. Lohman T, Roche AF, Martorelli A. Anthropometric Standardization Reference Manual. Champaign, IL:Human Kinetics Books, 1988.

21. Sowell AL, Huff DL, Yeager PR, Caudill SP, Gunter EW. Retinol, α-tocopherol, lutein/zeaxanthin, β-cryptoxanthin, lycopene, α-carotene, trans-β-carotene and four related esters in serum determined simultaneously by reversed-phase HPLC with multil wavelength detection. Clin Chem 40:411–416 (1994).

22. Gunter EW, Lewis BG, Konckowski SM. Laboratory Procedures Used for the Third National Health and Nutrition Examination Survey (NHANES III), 1988–1994. Atlanta, GA:Centers for Disease Control and Prevention, Center for Environmental Health; and Hyattsville, MD:National Center for Health Statistics, 1996.

23. Van Yurik KL, Gila HB, Lango I. Radiomimosaasay for nicotine and cotinine. JARC Sci Publ 109:293–299 (1993).
24. Thompson ML, Myers JE, Kriebel D. Prevalence odds ratio or prevalence ratio in the analysis of cross sectional data: what is to be done? Occup Environ Med 55(4):272–277 (1998).
25. Riboli E, Haley NJ, Tredaniel J, Saracci R, Preston-Martin S, Trichopoulou D. Misclassification of smoking status among women in relation to exposure to environmental tobacco smoke. Eur Respir J 8:285–290 (1995).
26. Pagano R, La Vecchia C, Decarli A. Smoking in Italy, 1995. Tumori 84:456–459 (1998).
27. Thornton A, Lee P, Fry J. Differences between smokers, ex-smokers, passive smokers, and nonsmokers. J Clin Epidemiol 47:1143–1162 (1994).
28. Forastiere F, Agabiti N, Corbo GM, Pistelli R, Dell’Orco V, Ciappi G, Perucci CA. Passive smoking as a determinant of bronchial responsiveness in children. Am J Respir Crit Care Med 149:365–370 (1994).
29. Sidney S, Caan BJ, Friedman GD. Dietary intake of carotene in nonsmokers with and without passive smoking at home. Am J Epidemiol 129:1305–1309 (1989).
30. The Alpha-Tocopherol, Beta Carotene Cancer Prevention Study Group. The effect of vitamin E and beta carotene on the incidence of lung cancer and other cancers in male smokers. N Engl J Med 330:1029–1035 (1994).
31. Steenland K, Thun M, Lally C, Health C Jr. Environmental tobacco smoke and coronary heart disease in American Cancer Society CPS-II cohort. Circulation 94:622–628 (1996).
32. Brennan P, Butler J, Agudo A, Benhamou S, Darby S, Fortes C, Jockel KH, Kreuzer M, Nyberg F, Pohlabeln H, et al. Joint effect of diet and environmental tobacco smoke on risk of lung cancer among nonsmokers. J Natl Cancer Inst 92:426–437 (2000).