# Papers

## Cigarette tar yields in relation to mortality from lung cancer in the cancer prevention study II prospective cohort, 1982-8

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### Abstract

**Objective** To assess the risk of lung cancer in smokers of medium tar filter cigarettes compared with smokers of low tar and very low tar cigarettes.

**Design** Analysis of the association between the tar rating of the brand of cigarette smoked in 1982 and mortality from lung cancer over the next six years. Multivariate proportional hazards analyses used to assess hazard ratios, with adjustment for age at enrolment, race, educational level, marital status, blue collar employment, occupational exposure to asbestos, intake of vegetables, citrus fruits, and vitamins, and, in analyses of current and former smokers, for age when they started to smoke and number of cigarettes smoked per day.

**Setting** Cancer prevention study II (CPS-II).

**Participants** 364 239 men and 576 535 women, aged ≥ 30 years, who had either never smoked, were former smokers, or were currently smoking a specific brand of cigarette when they were enrolled in the cancer prevention study.

**Main outcome measure** Death from primary cancer of the lung among participants who had never smoked, former smokers, smokers of very low tar (≤ 7 mg tar/cigarette) filter, low tar (8-14 mg) filter, high tar (≥ 22 mg) non-filter brands and medium tar conventional filter brands (15-21 mg).

**Results** Irrespective of the tar level of their current brand, all current smokers had a far greater risk of lung cancer than people who had stopped smoking or had never smoked. Compared with smokers of medium tar (15-21 mg) filter cigarettes, risk was higher among men and women who smoked high tar (≥ 22 mg) non-filter brands (hazard ratio 1.44, 95% confidence interval 1.20 to 1.73, and 1.64, 1.26 to 2.15, respectively). There was no difference in risk among men who smoked brands rated as very low tar (1.17, 0.95 to 1.45) or low tar (1.02, 0.90 to 1.16) compared with those who smoked medium tar brands. The same was seen for women (0.98, 0.80 to 1.21, and 0.95, 0.82 to 1.11, respectively).

**Conclusion** The increase in lung cancer risk is similar in people who smoke medium tar cigarettes (15-21 mg), low tar cigarettes (8-14 mg), or very low tar cigarettes (≤ 7 mg). Men and women who smoke non-filtered cigarettes with tar ratings ≥ 22 mg have an even higher risk of lung cancer.

### Introduction

During the past 50 years, changes in the design and manufacture of cigarettes have markedly reduced their machine measured "tar" yields.[1 2] The introduction of cellulose acetate filters in the 1950s, and subsequently more porous cigarette papers, reduced the average tar rating per cigarette in the United States from about 37 mg in 1950 to 22 mg in 1967.[1] The introduction of air ventilation holes in the filter tip in the late 1960s and expanded tobacco in the 1970s permitted manufacturers to market low tar (generally in the range of 8-14 mg per cigarette) and very low tar cigarettes (≤ 7 mg per cigarette). Concomitantly, the US average tar level per cigarette, as rated by the US Federal Trade Commission, declined to about 13 mg by 1990.[1] Similar trends in standardised tar yields have been reported in the United Kingdom[3 4] and other countries.

While many case-control and cohort studies have examined risk of lung cancer in relation to type of cigarette smoked, nearly all have compared the risks of smoking high tar non-filter brands with smoking medium tar filter brands, or with the corresponding ranges of tar yield (see bmj.com for a detailed list of references). The three case-control studies that have included participants who smoked low tar brands[5–7] yielded negative or equivocal results, but the observation periods for these studies ended in 1980-1, when the combined market share of low tar and very low tar cigarettes in the United States had exceeded 10% for only five or six years.[8] In most epidemiological studies, the observation period ended before 1986, when the market share in the United States had exceeded 10% for only a decade.[8] Thus no large, long term prospective study has specifically compared the risk of lung cancer in smokers of medium tar filter cigarettes with that in smokers of low tar and very low tar filter cigarettes.

We analysed the relation between the tar rating of the brand of cigarette smoked in 1982 and mortality from lung cancer over six years among men and women in the cancer prevention study II (CPS-II), a nationwide prospective cohort of over one million US adults aged 30 years or older.

ELPS *This is an abridged version; the full version is on bmj.com*

## Methods

Details of the cancer prevention study, initiated by the American Cancer Society in 1982, have been published elsewhere.[9–12] From the cohort of 508 318 men and 676 270 women, we excluded those who reported a history of cancer other than non-melanoma skin cancer; men who ever smoked pipes or cigars or chewed tobacco; and men and women whose current smoking status could not be ascertained. The resulting cohort comprised 364 239 men and 576 535 women. The outcome measure was death from cancer of the trachea, bronchus, or lung as the underlying cause, coded from the death certificate. During the six year follow up, 2622 men and 1406 women died from these cancers.

On the basis of brand name reported by each current smoker at enrolment, as well as the size (regular, king size, 100 mm, 120 mm), and presence or absence of menthol and of a filter, we assigned a tar rating.[9 13] We then grouped current brand tar ratings into very low tar (≤7 mg), low tar (8-14 mg), medium tar (15-21 mg), and high tar (≥22 mg). Unspecified current brands, as well as those current brands that could not otherwise be classified, were considered as a separate category. All brands in the very low and low tar ranges, as well as 99% of brands in the medium range, were filter cigarettes. Those in the high tar range were exclusively non-filter cigarettes.

We restricted our mortality follow up to six years (1982-8) to reduce possible misclassification of exposure due to quitting or brand switching during longer follow up.

We used Cox proportional hazards methods to estimate hazard ratios and 95% confidence intervals of mortality from lung cancer in people who had never smoked, former smokers, and current smokers of very low, low, and high tar brands, relative to smokers of brands with tar ratings of 15-21 mg (medium tar). We adjusted for multiple covariates that reflected possible differences in participants' characteristics, dietary practices, occupational exposures, or medical histories.

## Results

Descriptive characteristics of the cohorts of 100 868 men and 124 270 women who were current smokers at enrolment and for the cohorts of 263 371 men and 452 265 women who had never smoked or who had quit smoking at enrolment are given on bmj.com. Smokers of brands with medium or high tar ratings were more likely to be African American, more likely to have attained no more than a high school education, more likely to have a recent blue collar job or a history of potential occupational asbestos exposure, and less likely to report use of vitamins A, C, and E than participants who smoked lower tar brands, who never smoked, or who quit smoking before age 35 years. Current smokers of very low tar cigarettes (especially men) tended to smoke more cigarettes a day. Moreover, among the 13% of current smokers who were re-enrolled in the CPS-II nutrition cohort,[10] those men and women who had smoked very low tar and low tar cigarettes in 1982 were more likely to have quit smoking by 1992.

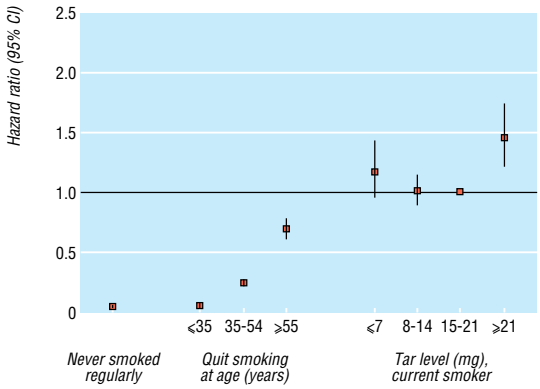


**Fig 1** Hazard ratios for lung cancer in men, 1982-8, by smoking status and tar yield of brand smoked, relative to current smokers of brands with tar ratings 15-21 mg

Men and women who smoked very low tar (≤7 mg) and low tar (8-14 mg) brands had risks of lung cancer indistinguishable from those who smoked medium tar (15-21 mg) brands (Wald test for homogeneity of strata[14] P=0.27 for men, P=0.80 for women). The risk was higher in those who smoked non-filter cigarettes and substantially lower in men (fig 1) and women (fig 2) who quit smoking. People who quit smoking before age 35 years had risks of lung cancer approaching those of people who had never smoked. Further adjustment for age when people started to smoke and number of cigarettes smoked a day showed nearly identical patterns in current and former smokers to those shown in figures 1 and 2 (see bmj.com).

Among men who never smoked, 93 died from lung cancer. Among men who quit smoking, 23 who quit aged ≤35 years, 344 who quit aged 35-54 years, and 540 who quit aged ≥55 years died from lung cancer. Among women who never smoked, 211 died from lung cancer. Among women who quit smoking, 16 who quit aged ≤35 years, 122 who quit aged 35-54 years, and 131 who quit aged ≥55 years died from lung cancer.

We used multivariate sensitivity analyses in current smokers to examine whether varying the exclusion criteria or the boundaries of the very low tar and low tar categories materially altered the results (tables 1 and 2).

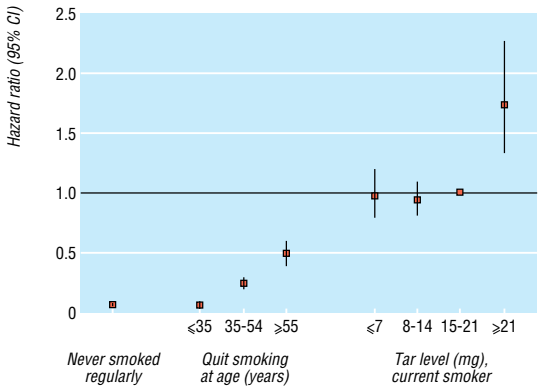


**Fig 2** Hazard ratios for lung cancer in women, 1982-8, by smoking status and tar yield of brand smoked, relative to current smokers of brands with tar ratings 15-21 mg

**Table 1** Multivariate analyses of mortality from lung cancer of men who were current smokers, according to tar level of cigarette smoked in 1982*

| | No of participants | No of deaths | Hazard ratio (95% CI) | |
|---|---|---|---|---|
| | | | Without cigarettes/day as covariate | With cigarettes/day as covariate |
| **Entire cohort** | | | | |
| 0-7 mg | 6 243 | 103 | 1.17 (0.95 to 1.45) | 1.11 (0.90 to 1.37) |
| 8-14 mg | 27 044 | 378 | 1.02 (0.90 to 1.16) | 1.00 (0.88 to 1.14) |
| 15-21 mg | 38 527 | 563 | 1.0 | 1.0 |
| ≥22 mg | 6 439 | 150 | 1.44 (1.20 to 1.73) | 1.43 (1.19 to 1.71) |
| Unclassifiable | 22 615 | 410 | 1.10 (0.97 to 1.25) | 1.12 (0.98 to 1.27) |
| **Excluding history of emphysema** | | | | |
| 0-7 mg | 5 896 | 84 | 1.11 (0.88 to 1.40) | 1.05 (0.83 to 1.32) |
| 8-14 mg | 25 835 | 322 | 0.99 (0.86 to 1.14) | 0.97 (0.85 to 1.12) |
| 15-21 mg | 36 832 | 495 | 1.0 | 1.0 |
| ≥22 mg | 6 089 | 135 | 1.48 (1.22 to 1.79) | 1.46 (1.21 to 1.77) |
| Unclassifiable | 21 579 | 373 | 1.13 (0.99 to 1.30) | 1.16 (1.01 to 1.32) |
| **Excluding prevalent smoking related diseases†** | | | | |
| 0-7 mg | 4 026 | 47 | 1.04 (0.76 to 1.42) | 0.97 (0.71 to 1.32) |
| 8-14 mg | 17 527 | 181 | 0.95 (0.78 to 1.14) | 0.93 (0.77 to 1.12) |
| 15-21 mg | 24 653 | 282 | 1.0 | 1.0 |
| ≥22 mg | 3 967 | 69 | 1.38 (1.06 to 1.79) | 1.36 (1.05 to 1.77) |
| Unclassifiable | 14 624 | 214 | 1.12 (0.93 to 1.34) | 1.15 (0.96 to 1.38) |
| **Smoked current brand for ≥5 years** | | | | |
| 0-7 mg | 2 328 | 42 | 1.18 (0.86 to 1.63) | 1.09 (0.79 to 1.50) |
| 8-14 mg | 16 362 | 238 | 1.04 (0.88 to 1.21) | 1.02 (0.87 to 1.19) |
| 15-21 mg | 29 796 | 426 | 1.0 | 1.0 |
| ≥22 mg | 5 777 | 131 | 1.47 (1.20 to 1.78) | 1.45 (1.19 to 1.77) |
| Unclassifiable | 13 405 | 230 | 1.11 (0.94 to 1.30) | 1.12 (0.95 to 1.31) |
| **Smoked current brand for ≥10 years** | | | | |
| 0-7 mg | 817 | 15 | 1.16 (0.69 to 1.96) | 1.11 (0.66 to 1.86) |
| 8-14 mg | 9 313 | 145 | 1.08 (0.89 to 1.32) | 1.06 (0.88 to 1.29) |
| 15-21 mg | 23 775 | 339 | 1.0 | 1.0 |
| ≥22 mg | 5 513 | 128 | 1.53 (1.25 to 1.88) | 1.52 (1.24 to 1.87) |
| Unclassifiable | 9 881 | 173 | 1.13 (0.94 to 1.35) | 1.14 (0.95 to 1.37) |
| **8 mg in very low tar category** | | | | |
| 0-8 mg | 11 441 | 173 | 1.11 (0.93 to 1.32) | 1.07 (0.90 to 1.27) |
| 9-14 mg | 21 846 | 308 | 1.02 (0.89 to 1.17) | 1.00 (0.87 to 1.15) |
| 15-21 mg | 38 527 | 563 | 1.0 | 1.0 |
| ≥22 mg | 6 439 | 150 | 1.44 (1.20 to 1.73) | 1.43 (1.19 to 1.71) |
| Unclassifiable | 22 615 | 410 | 1.10 (0.97 to 1.25) | 1.12 (0.98 to 1.27) |
| **15 mg in low tar category** | | | | |
| 0-7 mg | 6 243 | 103 | 1.17 (0.94 to 1.46) | 1.11 (0.89 to 1.38) |
| 8-15 mg | 38 436 | 549 | 1.01 (0.89 to 1.15) | 1.00 (0.88 to 1.14) |
| 16-21 mg | 27 135 | 392 | 1.0 | 1.0 |
| ≥22 mg | 6 439 | 150 | 1.44 (1.19 to 1.74) | 1.43 (1.18 to 1.72) |
| Unclassifiable | 22 615 | 410 | 1.09 (0.95 to 1.26) | 1.12 (0.97 to 1.28) |

*Covariates included age when started smoking (see tables 1-4 on bmj.com); education (≤high school graduate, some college or vocational school, college graduate or higher, missing); race (white, non-white, missing); marital status (married, not married, missing); current or most recent job (blue collar, not blue collar, missing); weekly intake of vegetables and citrus fruits (categorised by fifths, and missing); use of vitamin A, E, and C (<15 times/month, ≥15 times/month, missing); occupational asbestos exposure (exposed <10 years; ≥10 years); and, in right column, cigarettes smoked/day (see tables 1-4 on bmj.com).
†Prevalent smoking related diseases included emphysema, chronic bronchitis, heart disease or use of heart medication, stroke, diabetes, pain in legs, or sick at time of survey.

In both men and women, the findings were essentially unchanged when people with emphysema and other diseases attributable to smoking were excluded, when the analyses were restricted to people who had smoked their current brand for a minimum of five or 10 years, or when the boundaries of the very low or low tar categories were altered slightly (see bmj.com).

## Discussion

Although smokers of non-filter high tar cigarettes with tar ratings ≥ 22 mg had the highest risk of lung cancer, we detected no difference in risk among people who smoked medium tar cigarettes (15-21 mg), low tar cigarettes (8-14 mg), or very low tar cigarettes (≤ 7 mg). This pattern persisted after we adjusted for demographic characteristics, dietary habits, and occupational and medical histories. Moreover, our results were robust in sensitivity analyses that were restricted to people who had smoked their current brand for a minimum of 10 years or excluded smokers with emphysema and other smoking related diseases (see bmj.com). Similarly, the findings were essentially unchanged by minor variations in the boundaries of the low tar and very low tar categories or by omission of the number of cigarettes smoked a day as a covariate.

We observed the smoking habits of all participants in the cancer prevention study only at enrolment in 1982. However, among the 13% of participants who were re-enrolled in the CPS-II nutrition cohort,[10] those who smoked very low tar and low tar cigarettes in 1982 were more likely to have quit smoking by 1992. If this finding of differential cessation applies to the entire cohort, then our estimates understate the actual risk of lung cancer associated with continued smoking of low tar and very low tar cigarettes.

### Non-linear relation between tar levels and risk of lung cancer

Our findings challenge the assumption that the association between tar rating and lung cancer risk is necessarily linear. As the data points for current smokers in figures 1 and 2 show, extrapolations based on comparisons of only the highest and lowest tar groups, or parametric models in which tar yield is a continuous linear variable, can obscure a non-linear relation between tar levels and risk of disease. Indices of lifetime cumulative tar exposure[15 16] are especially problematic because they confound tar yield with the number of cigarettes smoked a day and the number of years of smoking.

By the end of follow up in 1988, low tar and very low tar cigarettes had been on the US market for about two decades. Participants in the cancer prevention study who smoked very low tar cigarettes had used their current brand for an average of four to five years, while those who smoked low tar cigarettes had smoked their current brand for an average of seven to eight years. We did not attempt to analyse the tar levels of brands that participants recalled smoking in the past. Because the median age at entry was 53-54 years, most current smokers in the cohort could not have smoked low tar or very low tar brands exclusively over their lives. Accordingly, we could not evaluate the effect of the exclusive use of low and very low tar cigarettes from adolescence onward.

### Findings consistent with other evidence

Our finding that there was no difference in the risk of lung cancer between people who smoked medium tar filter, low tar filter, and very low tar filter cigarettes is consistent with evidence of compensatory smoking. Addicted smokers who switch from a higher to lower tar cigarette can maintain their nicotine intake by blocking ventilation holes, increasing the puff volume or the time during which the smoke is retained in the lungs, and smoking more cigarettes.[17] As a result, the actual dose of toxicants to the smoker may be much higher than is predicted by machine measured yields. Changes in inhalation patterns induced by lower tar

## What is already known on this topic

Nearly all previous epidemiological studies of risk of lung cancer in relation to the type of cigarette smoked have compared smokers of high tar non-filter cigarettes (≥22 mg tar) with those of medium tar filter cigarettes (15-21 mg)

No large, long term prospective epidemiological study has specifically compared the risk of lung cancer in smokers of medium tar filter brands with the risk in smokers of low tar (8-14 mg) and very low tar (≤7 mg) filter brands

## What this study adds

The risk of lung cancer was no different in people who smoked medium tar cigarettes, low tar cigarettes, or very low tar cigarettes

Men and women who smoked non-filtered cigarettes with tar ratings ≥22 mg had even higher risks of lung cancer

All current smokers, regardless of the tar level of their current brand, had substantially greater risks of lung cancer than those people who had never smoked or who had quit smoking

cigarettes may increase the surface area of the lung exposed to carcinogens in smoke and thus result in greater deposition of submicron sized particles deeper into the airways.[18] An increase in the depth of inhalation may have contributed to the marked increase among smokers in the incidence of adenocarcinoma of the lung (a cancer that arises in the more peripheral tissues of the lung) in the United States and other countries.[19] In fact, adenocarcinoma of the lung was found to be more strongly associated with cigarette smoking in the second cancer prevention study (1982-8) than in the first (1960-72).[19] Finally, changes in tobacco curing and blending have increased the delivery of carcinogenic, tobacco specific nitrosamines[1 20] even as average tar yields have declined. Tar yield is a relatively weak predictor of a brand's delivery of carcinogenic, tobacco specific nitrosamines.[21]

While our finding that smokers of high tar non-filter cigarettes had higher risks of lung cancer may reflect unmeasured differences between smokers of non-filter and filter cigarettes,[18] it is none the less consistent with many other case-control and cohort studies (see bmj.com for detailed references). Reducing the use of high tar non-filter cigarettes may thus provide limited public health benefits in those countries where such products are commonly used. Although non-filter cigarettes currently represent no more than 1% of cigarette sales in the United States and the United Kingdom,[22 23] they comprised about 20% of cigarettes sold in China,[24] 15% in France, and 6-20% in Eastern Europe as late as 1996.[22]

Contributors: See bmj.com

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Competing interests: JEH has testified as an expert witnesses on behalf of plaintiffs in tobacco-related litigation. MJT has testified as an uncompensated expert on behalf of plaintiffs and the American Cancer Society in tobacco related cases.

**Table 2** Multivariate analyses of mortality from lung cancer of women who were current smokers, according to tar level of cigarette smoked in 1982*

| | No of participants | No of deaths | Hazard ratio (95% CI) Without cigarettes/day as covariate | Hazard ratio (95% CI) With cigarettes/day as covariate |
|---|---|---|---|---|
| **Entire cohort** | | | | |
| 0-7 mg | 15 524 | 120 | 0.98 (0.80 to 1.21) | 0.89 (0.72 to 1.10) |
| 8-14 mg | 48 821 | 336 | 0.95 (0.82 to 1.11) | 0.94 (0.81 to 1.10) |
| 15-21 mg | 44 124 | 329 | 1.0 | 1.0 |
| ≥22 mg | 4 079 | 64 | 1.64 (1.26 to 2.15) | 1.60 (1.22 to 2.09) |
| Unclassifiable | 11 722 | 73 | 0.72 (0.56 to 0.93) | 0.74 (0.57 to 0.96) |
| **Excluding history of emphysema** | | | | |
| 0-7 mg | 15 176 | 114 | 1.00 (0.80 to 1.24) | 0.91 (0.73 to 1.13) |
| 8-14 mg | 48 034 | 319 | 0.96 (0.82 to 1.12) | 0.95 (0.81 to 1.11) |
| 15-21 mg | 43 396 | 310 | 1.0 | 1.0 |
| ≥22 mg | 3 966 | 58 | 1.60 (1.21 to 2.12) | 1.56 (1.18 to 2.07) |
| Unclassifiable | 11 489 | 68 | 0.71 (0.55 to 0.93) | 0.73 (0.56 to 0.96) |
| **Excluding prevalent smoking related diseases†** | | | | |
| 0-7 mg | 10 546 | 73 | 0.99 (0.76 to 1.30) | 0.90 (0.68 to 1.18) |
| 8-14 mg | 32 773 | 187 | 0.88 (0.72 to 1.08) | 0.87 (0.71 to 1.07) |
| 15-21 mg | 28 909 | 195 | 1.0 | 1.0 |
| ≥22 mg | 2 511 | 33 | 1.50 (1.04 to 2.18) | 1.49 (1.02 to 2.15) |
| Unclassifiable | 7 650 | 36 | 0.61 (0.42 to 0.87) | 0.63 (0.44 to 0.90) |
| **Smoked current brand for ≥5 years** | | | | |
| 0-7 mg | 5 136 | 45 | 1.04 (0.75 to 1.43) | 0.92 (0.66 to 1.27) |
| 8-14 mg | 23 678 | 186 | 1.06 (0.87 to 1.29) | 1.06 (0.87 to 1.28) |
| 15-21 mg | 29 117 | 219 | 1.0 | 1.0 |
| ≥22 mg | 3 464 | 57 | 1.74 (1.30 to 2.33) | 1.70 (1.27 to 2.28) |
| Unclassifiable | 4 185 | 31 | 0.92 (0.63 to 1.34) | 0.92 (0.63 to 1.34) |
| **Smoked current brand for ≥10 years** | | | | |
| 0-7 mg | 1 613 | 16 | 1.16 (0.69 to 1.94) | 1.07 (0.64 to 1.80) |
| 8-14 mg | 12 626 | 111 | 1.14 (0.89 to 1.45) | 1.16 (0.91 to 1.48) |
| 15-21 mg | 21 070 | 161 | 1.0 | 1.0 |
| ≥22 mg | 3 268 | 55 | 1.81 (1.33 to 2.47) | 1.79 (1.32 to 2.44) |
| Unclassifiable | 2 195 | 16 | 0.89 (0.53 to 1.50) | 0.87 (0.52 to 1.47) |
| **8 mg in very low tar category** | | | | |
| 0-8 mg | 18 123 | 131 | 0.91 (0.74 to 1.12) | 0.83 (0.68 to 1.02) |
| 9-14 mg | 46 222 | 325 | 0.98 (0.84 to 1.14) | 0.97 (0.83 to 1.13) |
| 15-21 mg | 44 124 | 329 | 1.0 | 1.0 |
| ≥22 mg | 4 079 | 64 | 1.64 (1.26 to 2.15) | 1.60 (1.22 to 2.09) |
| Unclassifiable | 11 722 | 73 | 0.72 (0.56 to 0.93) | 0.74 (0.57 to 0.96) |
| **15 mg in low tar category** | | | | |
| 0-7 mg | 15 524 | 120 | 0.93 (0.74 to 1.17) | 0.86 (0.69 to 1.08) |
| 8-15 mg | 66 734 | 461 | 0.89 (0.76 to 1.05) | 0.91 (0.77 to 1.07) |
| 16-21 mg | 26 211 | 204 | 1.0 | 1.0 |
| ≥22 mg | 4 079 | 64 | 1.56 (1.18 to 2.07) | 1.54 (1.16 to 2.04) |
| Unclassifiable | 11 722 | 73 | 0.68 (0.52 to 0.89) | 0.72 (0.54 to 0.94) |

*Covariates included age when started smoking (see tables 1-4 on bmj.com); education (≤high school graduate, some college or vocational school, college graduate or higher, missing); race (white, non-white, missing); marital status (married, not married, missing); current or most recent job (blue collar, not blue collar, missing); weekly intake of vegetables and citrus fruits (categorised by fifths, and missing); use of vitamin A, E, and C (<15 times/month, ≥15 times/month, missing); occupational asbestos exposure (exposed <10 years; ≥10 years); and, in right column, cigarettes smoked/day (see tables 1-4 on bmj.com).
†Prevalent smoking related diseases included emphysema, chronic bronchitis, heart disease or use of heart medication, stroke, diabetes, pain in legs, or sick at time of survey.

Ethical approval: Approved by the institutional review board at Emory University.

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# Review of prevalence data in, and evaluation of methods for cross cultural adaptation of, UK surveys on tobacco and alcohol in ethnic minority groups

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## Abstract

**Objective** To assess the adequacy of cross cultural adaptations of survey questions on self reported tobacco and alcohol consumption in the United Kingdom.

**Design** Assessment of consistency of data between studies identified through literature review. Studies evaluated with 12 guidelines developed from the research literature on achieving cross cultural comparability.

**Results** The literature review identified 18 key studies, five of them on national samples. Survey instruments were obtained for 15 of these. The comparison of prevalence data in national surveys showed some important discrepancies, greater for tobacco than for alcohol. For example, prevalence of cigarette smoking in Bangladeshi women was 6% in a national survey in 1994 and 1% in a national survey in 1999; in Chinese men it was 31% in a survey in 1993-4 and 17% in one in 1999; in African-Caribbean men it was 29% in a 1992 survey and 42% in one in 1993-4. The most guidelines met by any study was three, although one study partly met a fourth. Two studies met no guidelines. Only four studies consulted with ethnic minority communities in developing the questionnaire, none checked each language version with all others, and two stated the questionnaire had not been validated.

**Conclusions** Surveys have not followed best practice in relation to measurement of risk factors in cross cultural settings. There is inconsistency in the prevalence data on smoking provided by different major national UK studies. Users of such data should be aware of their limitations. Research is needed to help achieve linguistic equivalence of survey questions in cross cultural research.

## Introduction

Cancers and cardiovascular disease are dominant causes of death in Britain's ethnic minority groups.[1] The prevention of such disorders requires accurate information about health related behaviour such as the amount and pattern of consumption of tobacco and alcohol. Such information is usually acquired by self completed questionnaires or schedules administered by interviewers, sometimes validated by biochemical and other tests.

Most survey instruments on tobacco and alcohol consumption by ethnic minorities were developed for English speaking people and translated into other languages. To compare data across language groups the items on the questionnaire, the instructions given, and the responses obtained should be conceptually and

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