# Mortality and life expectancy in relation to long-term cigarette, cigar and pipe smoking: The Zutphen Study

Martinette T Streppel, Hendriek C Boshuizen, Marga C Ocké, Frans J Kok, Daan Kromhout

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Correspondence to:
Ms M T Streppel, Centre for Nutrition and Health, National Institute for Public Health and the Environment (RIVM), PO Box 1, NL-3720 BA Bilthoven, The Netherlands; martinet. streppel@rivm.nl

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**Study objective:** To study the effect of long-term smoking on all-cause and cause-specific mortality, and to estimate the effects of cigarette and cigar or pipe smoking on life expectancy.
**Design:** A long-term prospective cohort study.
**Setting:** Zutphen, The Netherlands.
**Participants:** 1373 men from the Zutphen Study, born between 1900 and 1920 and studied between 1960 and 2000.
**Measurements:** Hazard ratios for the type of smoking, amount and duration of cigarette smoking, obtained from a time-dependent Cox regression model. Absolute health effects of smoking are expressed as differences in life expectancy and the number of disease-free years of life.
**Main results:** Duration of cigarette smoking was strongly associated with mortality from cardiovascular disease, lung cancer and chronic obstructive pulmonary disease, whereas both the number of cigarettes smoked as well as duration of cigarette smoking were strongly associated with all-cause mortality. Average cigarette smoking reduced the total life expectancy by 6.8 years, whereas heavy cigarette smoking reduced the total life expectancy by 8.8 years. The number of total life-years lost due to cigar or pipe smoking was 4.7 years. Moreover, cigarette smoking reduced the number of disease-free life-years by 5.8 years, and cigar or pipe smoking by 5.2 years. Stopping cigarette smoking at age 40 increased the life expectancy by 4.6 years, while the number of disease-free life-years was increased by 3.0 years.
**Conclusions:** Cigar or pipe smoking reduces life expectancy to a lesser extent than cigarette smoking. Both the number of cigarettes smoked and duration of smoking are strongly associated with mortality risk and the number of life-years lost. Stopping smoking after age 40 has major health benefits.

Smoking has been recognised as a health hazard for many years. Smoking causes a wide range of diseases, including cancer, chronic obstructive pulmonary disease (COPD) and cardiovascular diseases (CVD), and smoking cessation has impressive health benefits.[1–3] Cigarette smoking cessation decreases the risk of diseases and also increases life expectancy. Even stopping at age 60 gains about 3 years of life expectancy.[4] Much less is known about the adverse effects of long-term cigar or pipe smoking.[5–7]

Smoking has both long- and short-term effects. As smoking habits change during life, information on long-term smoking history is required to obtain correct estimates of the long-term health effects of smoking. Because in most studies the level of detail on smoking history is limited, the impact of various aspects of the smoking history remains unclear. Leffondré *et al*[8] show the importance of information on smoking duration, intensity and time since cessation in this respect. Although smoking duration has been associated with mortality before, most studies focused on cancer mortality rather than on CVD and COPD mortality.[9–15]

In epidemiological studies, hazard ratios are commonly used to express the impact on mortality. Hazard ratios express effects for one exposure group relative to the effect of the unexposed group—that is, the reference group—but do not give information regarding absolute public health effects. Therefore, life expectancies should be calculated. Although concepts like life expectancy are more informative and readily grasped by all, they are not reported frequently.

The objective of this study is to assess the relationships between long-term cigarette, cigar or pipe smoking, and duration and the number of cigarettes smoked, and mortality. To obtain accurate effect estimates, we used repeated measures of smoking habits collected in a 40-year period and adjusted for potential confounders. In addition to hazard ratios, we present our results also in terms of changes in life expectancy at age 40 and the number of disease-free years of life due to cigarette and cigar or pipe smoking.

## MATERIALS AND METHODS
### Study population
The Zutphen Study was started as the Dutch contribution to the Seven Countries Study, a longitudinal study of the relationships between diet, other risk factors and chronic diseases.[16] The Zutphen Study has been carried out since 1960 among middle-aged men in Zutphen, an old industrial town in the eastern part of the Netherlands with about 25 000 inhabitants. In 1960, a random sample was drawn of 1088 men born between 1900 and 1919 and residing for at least 5 years in Zutphen. Of these, 878 (81%) men participated in the Zutphen Study and 872 men took part in both dietary and medical examinations. The examinations were repeated in 1965, 1970, 1985, 1990, 1995 and 2000. In 1985, the group of 554 survivors was extended with a new random sample of men of the same age. Of the 1266 men who were invited, 939 (74%) men participated and 825 (65%) men took part in both dietary and medical examinations. These examinations were repeated in 1990, 1995 and 2000.

Baseline data were collected in 1960 before the Helsinki Declaration was developed, and oral informed consent was obtained in view of follow-up data. In 1985 and 1990, the study was approved by the Medical Ethics Committee of the

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**Abbreviations:** BMI, body mass index; COPD, chronic obstructive pulmonary disease; CVD, cardiovascular disease; DM, diabetes mellitus; MI, myocardial infarction

**Table 1** Characteristics of men participating in the Zutphen Study by year of measurement

|  | 1960 | 1965 | 1970 | 1985 | 1990 | 1995 | 2000 |
|---|---|---|---|---|---|---|---|
| Number of participants |  |  |  |  |  |  |  |
| 1960 cohort | 872 | 721 | 615 | 349 | 231 | 114 | 51 |
| 1985 cohort | — | — | — | 476 | 306 | 161 | 68 |
| Cumulative number of deaths |  |  |  |  |  |  |  |
| 1960 cohort | — | 48 | 109 | 429 | 561 | 670 | 766 |
| 1985 cohort | — | — | — | — | 97 | 232 | 364 |
| Age (years) | 49 (6) | 54 (5) | 59 (5) | 71 (5) | 75 (5) | 80 (4) | 83 (3) |
| Overall smoking (%) |  |  |  |  |  |  |  |
| Never and long-term ex-smoker* | 6 | 6 | 9 | 26 | 50 | 60 | 72 |
| Recent ex-smoker† | 6 | 11 | 15 | 31 | 17 | 16 | 14 |
| Cigarettes and cigars or pipes | 52 | 35 | 25 | 7 | 4 | 2 | 0 |
| Cigarettes | 23 | 26 | 29 | 23 | 19 | 16 | 6 |
| Cigars or pipes | 14 | 21 | 23 | 13 | 10 | 6 | 8 |
| Duration of cigarette smoking (years)‡ |  |  |  |  |  |  |  |
| 1960 cohort | 29 (11) | 34 (14) | 34 (14) | 39 (18) | 40 (19) | 42 (20) | 37 (21) |
| 1985 cohort | — | — | — | 33 (21) | 32 (22) | 29 (22) | 28 (20) |
| Energy without alcohol (kcal) | 3082 (673) | 2921 (673) | 2539 (539) | 2147 (507) | 2029 (459) | 2033 (469) | 1992 (457) |
| Alcohol (percentage users) | 36 | 59 | 69 | 70 | 66 | 68 | 75 |
| BMI (kg/m$^2$) | 24.1 (2.7) | 24.9 (2.7) | 25.2 (2.8) | 25.5 (3.1) | 25.5 (3.2) | 25.3 (3.4) | 26.0 (3.3) |

Values are represented as mean (SD), unless indicated otherwise.
*Never and long-term ex-smokers are defined as men who never smoked or stopped smoking ≥10 years ago.
†Recent ex-smokers are defined as men who stopped smoking <10 years ago.
‡Mean duration of cigarette smoking includes the men who never smoked (duration = 0).

University of Leiden, The Netherlands, and in 1995 and 2000, by the Medical Ethics Committee of the Netherlands Organisation for Applied Scientific Research (TNO).

### Assessment of smoking habits

Information on smoking habits was collected using standardised questionnaires. From 1960 until 1990, detailed information was gathered on type and amount of smoking (cigarette, cigar and pipe). The 1995 and 2000 questionnaires combined cigar and pipe smoking, and participants were asked whether they still smoked and how much they smoked per day. In 1960 and 1985, information on the age at smoking initiation and, in case of former smokers, age at cessation was collected for cigarette smoking. Duration of cigarette smoking was calculated using information on duration of smoking at baseline and information on smoking in the following measurement years. In addition, we calculated time until death or censoring since smoking cessation. As the number of men who smoked a pipe was small, men who smoked a cigar, pipe or both were considered as one group. Additionally, we created an overall smoking variable, combining cigarette and cigar or pipe smoking. This study has a relatively small sample size and the number of never smokers is very small. Consequently, for cigarette, cigar or pipe and overall smoking, men were divided into categories of never or long-term ex-smokers—that is, stopped smoking ≥10 years ago, recent ex-smokers—that is, stopped smoking <10 years ago, and current smokers. At the start of this study, the number of current smokers was very high and decreased remarkably during 40 years of follow-up. As similar trends in smoking habits were seen in the general Dutch population, the information on smoking habits was considered valid.

### Assessment of potential confounders

Information on food consumption was collected using the cross-check dietary history method, adapted to the Dutch situation.[17][18] Energy and alcohol intake was calculated using food composition tables close to the year of measurement. The

participants were divided into two groups according to alcohol use (yes or no). Alcohol use was defined as having at least 1 g of alcohol intake per day, which is equivalent to about one alcoholic beverage per week.

During medical examinations, the weight and height of men were measured and body mass index (BMI) was calculated (kg/m$^2$). Information about the prevalence and history of myocardial infarction (MI), stroke, diabetes mellitus (DM) and cancer was collected throughout the study. Men were classified into four levels of socioeconomic status (manual workers, non-manual workers, small business owners and professionals) according to occupation at baseline.

### Case assessment

Participants were followed until death, or censoring on 30 June 2000. During the study, six participants were lost to follow-up and were censored after their last physical examination. The final causes of death were ascertained by one clinical epidemiologist, and coded according to the International Classification of Diseases, Eighth Revision (codes 410.0–414.9 for coronary heart disease, codes 390.0–459.9 for CVD, codes 140.0–208.9 for cancer, codes 162.0–162.9 for lung cancer and codes 490.0–492.9 and 496 for COPD). As the underlying cause of death in elderly people is often difficult to ascertain, we included primary, secondary and tertiary causes of death in our analyses.

### Statistical analysis

Cox proportional hazard analyses were performed with age as the time variable, with smoking information updated at each measurement round. In addition, we modelled the effects of duration of cigarette smoking (per 10 years), the number of cigarettes smoked (per 10 cigarettes per day) and time since cigarette smoking cessation (per 5 years), both separately as well as combined.[8] As many smokers quit at the time of serious illness, the number of cigarettes smoked was adjusted for ever smoking (yes or no). The duration of smoking and the time
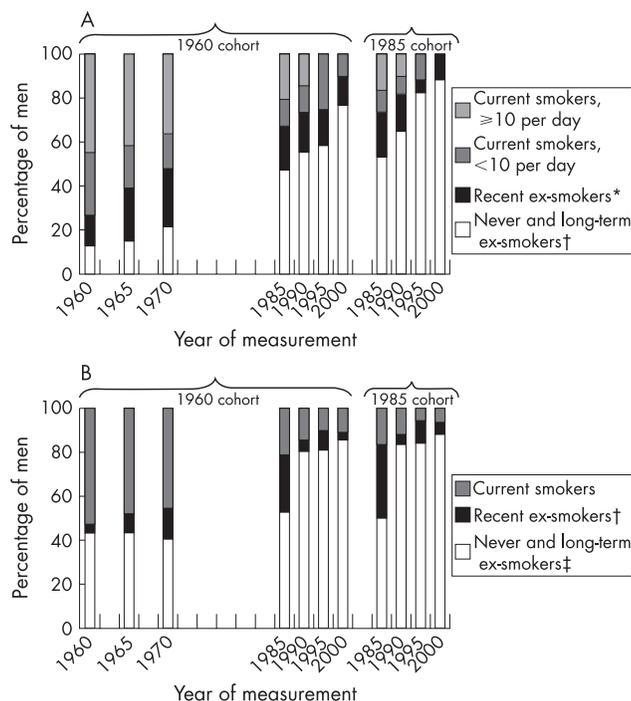
**Figure 1** Changes in cigarette (A) and exclusive cigar or pipe (B) smoking within the Zutphen Study, during 40 years of follow-up. Changes in exclusive cigar or pipe smoking were studied among those men who were never or long-term ex-cigarette smokers. *Recent ex-smokers are defined as men who stopped smoking <10 years ago; †never and long-term ex-smokers are defined as men who never smoked or stopped smoking ≥10 years ago.

since cigarette smoking cessation were adjusted for age at initiation.

We determined differences in life expectancies at age 40 and the number of disease-free years of life between current smokers and never or long-term ex-smokers, by calculating the area under survival curves. For disease-free years of life, survival until the age of onset of MI, stroke, DM or cancer was used. Smokers who stopped smoking during follow-up were excluded from the analyses from the moment they stopped, and men who started smoking during follow-up were included in the analyses from the moment they started. The differences in life expectancy and the number of disease-free years of life due to cigar or pipe smoking were studied among men who were never or long-term ex-cigarette smokers. In addition, we calculated differences in life expectancy and the number of disease-free years of life for different ages at cigarette smoking cessation (age 40, 50, 60 or 70 years) compared with continuing smoking at that age and for every 10 cigarettes per day increase. A Cox proportional hazard model, with age as the time variable, was used to obtain the survival curves, adjusted for baseline covariates. For those men who started the study in 1960, values in 1960 were used as baseline values, whereas, for those who started the study in 1985, values in 1985 were used as baseline values. 95% CIs were obtained using the bootstrap method.[19]

For Cox proportional hazard models, the PHREG procedure of SAS/STAT software V.9.1 was used. The covariates in multivariate models included energy intake (kcal/day), use of alcohol (yes/no), BMI (kg/m$^2$) and baseline socioeconomic status (manual workers, non-manual workers, small business owners and professionals), and were updated at each measurement round. We adjusted for the prevalence of MI (yes/no), stroke (yes/no), DM (yes/no) and cancer (yes/no), updating this information at each measurement round, to account for the

possibility that smokers quit smoking because of serious illness. Furthermore, cigarette smoking was adjusted for cigar or pipe smoking. All available data were used for the analysis.

## RESULTS

Table 1 shows the major characteristics of the men participating in the Zutphen Study during 40 years of follow-up (mean follow-up of all participants: 28 years). During follow-up, 1130 of the 1373 men died: CVD was the primary cause of death in 36% of all deaths, and coronary heart disease in 20% of all deaths. Total cancer, lung cancer and COPD were the primary cause in respectively, 26%, 10% and 4% of all deaths, respectively. Of the men who were included in the study in 1960, 74% smoked cigarettes in 1960. Among those men who were still alive in 2000, 12% were current cigarette smokers (fig 1A). The percentage of current smokers was lower among the men who were newly included in 1985. Moreover, the current smokers in 1960 had an average cigarette smoking duration of 17 years during 40 years of follow-up. For the current smokers in 1985, this figure was 7 years. Among smokers, the number of cigarettes smoked per day decreased from 13 to 3 cigarettes in the period 1960–2000. In 1960, the percentage of cigar or pipe smokers among those men who were never or long-term ex-cigarette smokers was 54% (fig 1B). These exclusive cigar or pipe smokers smoked, on average, three cigars and six pipes per day. Again, the percentage of exclusive cigar or pipe smokers was lower among men who were newly included in 1985. The percentage of alcohol users doubled from 36% in 1960 to 75% in the period 1985–2000. Average energy intake, without alcohol, decreased substantially from 3082 kcal/day to 1992 kcal/day. Average BMI increased from 24.1 kg/m$^2$ in 1960 to 26.0 kg/m$^2$ in 2000.

Using updated information at each measurement round and after adjustment for potential confounders, smoking was strongly associated with all-cause and cause-specific mortality (table 2). Hazard ratios (HRs) for current cigarette smoking varied between 1.40 (95% CI 1.07 to 1.83) for cancer mortality and 2.90 (1.80 to 4.68) for COPD mortality. The associations between recent ex-smoking and mortality were weaker, and varied between 1.15 (0.84 to 1.57) and 2.98 (1.78 to 5.01) for cancer and COPD mortality, respectively. In general, the associations between smoking and mortality were stronger for overall smoking compared with cigarette smoking. Furthermore, for cardiovascular mortality we found a significant and inverse interaction between smoking status and survival age. This indicates that the association between smoking status and cardiovascular mortality weakens with a higher survival age.

Every 10-year increase in cigarette smoking duration was strongly associated with mortality from all causes (HR at mean survival age 1.12), CVD (HR 1.15), lung cancer (HR at mean survival age 1.31) and COPD (HR 1.38), independent of the number of cigarettes smoked (table 3). In addition, every 10 cigarettes per day increase was associated with all-cause mortality (HR 1.11), independent of smoking duration (table 3). When studying the association between duration of cigarette smoking and lung cancer mortality, we found a significant and inverse interaction with survival age. This indicates that the association between duration of cigarette smoking and mortality weakens with a higher survival age. Moreover, omitting the adjustment for the prevalence of chronic diseases attenuated our results slightly, but the overall conclusions remained the same, except for cancer mortality. For total cancer mortality, the HR for every 10 cigarettes per day increase increased from 1.14 (0.97 to 1.32) to 1.24 (1.06 to 1.43) and the HR for every 10-year increase in cigarette smoking duration increased from 1.07 (0.96 to 1.19) to 1.11 (1.01 to

**Table 2**  Smoking in relation to mortality* within the Zutphen Study, according to updated covariates at each measurement round

| | | Overall smoking | | Cigarette smoking | |
|---|---|---|---|---|---|
| | Smoking state | Crude HR (95% CI) | Adjusted HR (95% CI)† | Crude HR (95% CI) | Adjusted HR (95% CI)† |
| All cause | Recent ex-smoker‡ | 1.57 (1.31 to 1.89) | 1.47 (1.21 to 1.77) | 1.51 (1.28 to 1.78) | 1.39 (1.17 to 1.65) |
| | Current smoker | 1.78 (1.53 to 2.08) | 1.69 (1.44 to 1.99) | 1.70 (1.48 to 1.96) | 1.60 (1.38 to 1.86) |
| Total cardiovascular | Recent ex-smoker | 1.40 (1.09 to 1.80) | 1.51 (1.15 to 1.99)§ | 1.41 (1.12 to 1.76) | 1.38 (1.09 to 1.74) |
| | Current smoker | 1.55 (1.26 to 1.91) | 1.78 (1.41 to 2.24)§ | 1.56 (1.29 to 1.89) | 1.66 (1.35 to 2.03) |
| Coronary heart disease | Recent ex-smoker | 1.37 (0.96 to 1.95) | 1.27 (0.89 to 1.83) | 1.42 (1.04 to 1.95) | 1.33 (0.96 to 1.85) |
| | Current smoker | 1.35 (1.01 to 1.82) | 1.54 (1.13 to 2.10) | 1.41 (1.07 to 1.86) | 1.59 (1.18 to 2.13) |
| Total cancer | Recent ex-smoker | 1.74 (1.24 to 2.44) | 1.28 (0.91 to 1.82) | 1.54 (1.15 to 2.08) | 1.15 (0.84 to 1.57) |
| | Current smoker | 1.93 (1.45 to 2.57) | 1.51 (1.11 to 2.05) | 1.81 (1.40 to 2.33) | 1.40 (1.07 to 1.83) |
| Lung cancer | Recent ex-smoker | 2.80 (1.44 to 5.44) | 2.00 (1.02 to 3.92) | 2.29 (1.35 to 3.88) | 1.72 (1.00 to 2.95) |
| | Current smoker | 3.86 (2.17 to 6.87) | 2.93 (1.60 to 5.35) | 3.25 (2.08 to 5.08) | 2.34 (1.47 to 3.75) |
| COPD | Recent ex-smoker | 2.15 (1.21 to 3.85) | 2.29 (1.27 to 4.13) | 2.96 (1.78 to 4.92) | 2.98 (1.78 to 5.01) |
| | Current smoker | 2.43 (1.48 to 4.00) | 2.23 (1.32 to 3.76) | 3.30 (2.09 to 5.21) | 2.90 (1.80 to 4.68) |

COPD, chronic obstructive pulmonary disease.
*Because of missing data, the number of events may be smaller than the number mentioned in table 1.
†Hazard ratio adjusted for energy intake, alcohol use, body mass index, baseline socioeconomic status, prevalence of myocardial infarction, stroke, diabetes mellitus and cancer; cigarette smoking is additionally adjusted for cigar or pipe smoking.
‡Recent ex-smokers are defined as men who stopped smoking <10 years ago.
§Hazard ratios were calculated using mean survival age (76 years).

1.22), whereas for lung cancer mortality these HRs changed from 1.14 (0.90 to 1.44) to 1.32 (1.11 to 1.58) and from 1.31 (1.07 to 1.60) to 1.25 (1.06 to 1.47), respectively. As duration of smoking and the time since cessation were strongly and inversely correlated ($\rho \leqslant -0.78$), we were not able to include both in the same model. The separate associations of time since cigarette smoking cessation with mortality were opposite to the

association for smoking duration (data not shown). Age at initiation of cigarette smoking did not independently contribute to mortality risk and was therefore left out of the models.

Figure 2 shows the adjusted survival curve used for determining life expectancies at age 40. Current cigarette smoking reduced life expectancy by 6.8 years and the number of disease-free years of life—that is, years free from MI, stroke,

**Table 3**  Modelling cigarette smoking history in relation to mortality* within the Zutphen Study, according to updated covariates at each measurement round

| | Crude HR (95% CI)† | Adjusted HR (95% CI)‡ | Adjusted HR (95% CI)§ |
|---|---|---|---|
| **All cause** | | | |
| No of cigarettes smoked (per 10 cigarettes/day) | 1.22 (1.13 to 1.32) | 1.10 (1.00 to 1.20) | 1.11 (1.01 to 1.21) |
| Duration (per 10 years) | 1.11 (1.08 to 1.14) | 1.13 (1.07 to 1.18) | 1.12 (1.06 to 1.18) |
| **Total cardiovascular** | | | |
| No of cigarettes smoked (per 10 cigarettes/day) | 1.11 (1.00 to 1.24) | 0.99 (0.88 to 1.13) | 1.06 (0.93 to 1.20) |
| Duration (per 10 years) | 1.09 (1.04 to 1.13) | 1.13 (1.06 to 1.21) | 1.15 (1.07 to 1.23) |
| **Coronary heart disease** | | | |
| No of cigarettes smoked (per 10 cigarettes/day) | 1.12 (0.97 to 1.30) | 1.05 (0.88 to 1.25) | 1.17 (0.98 to 1.39) |
| Duration (per 10 years) | 1.07 (1.01 to 1.14) | 1.08 (0.98 to 1.20) | 1.10 (1.00 to 1.21) |
| **Total cancer** | | | |
| No of cigarettes smoked (per 10 cigarettes/day) | 1.36 (1.20 to 1.54) | 1.25 (1.08 to 1.45) | 1.14 (0.97 to 1.32) |
| Duration (per 10 years) | 1.17 (1.10 to 1.24) | 1.12 (1.02 to 1.22) | 1.07 (0.96 to 1.19) |
| **Lung cancer** | | | |
| No of cigarettes smoked (per 10 cigarettes/day) | 1.65 (1.38 to 1.98) | 1.36 (1.10 to 1.70) | 1.14 (0.90 to 1.44) |
| Duration (per 10 years) | 1.42 (1.26 to 1.61) | 1.29 (1.09 to 1.52) | 1.31 (1.07 to 1.60)¶ |
| **COPD** | | | |
| No of cigarettes smoked (per 10 cigarettes/day) | 1.18 (0.95 to 1.48) | 0.81 (0.62 to 1.07) | 0.99 (0.73 to 1.33)¶ |
| Duration (per 10 years) | 1.34 (1.20 to 1.49) | 1.51 (1.28 to 1.78) | 1.38 (1.17 to 1.63) |

COPD, chronic obstructive pulmonary disease.
*Because of missing data, the number of events may be smaller than the number mentioned in table 1.
†Crude HR, hazard ratio for separate models for duration and the number of cigarettes (adjusted for ever smoking (yes/no)).
‡HR for multivariate models including duration of cigarette smoking and the number of cigarettes smoked, adjusted for ever smoking.
§HR for multivariate models with additional adjustment for cigar or pipe smoking, energy intake, alcohol use, body mass index, baseline socioeconomic status and the prevalence of myocardial infarction, stroke, diabetes mellitus and cancer.
¶HRs were calculated using mean survival age (76 years).
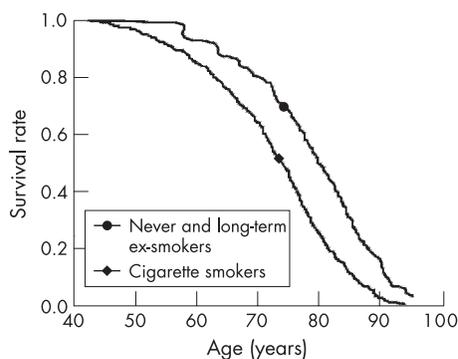
**Figure 2** Survival curves for cigarette smokers and never and long-term ex-smokers within the Zutphen Study, adjusted for baseline energy intake, alcohol use, body mass index, prevalence of myocardial infarction, stroke, diabetes mellitus and cancer, socioeconomic status, and cigar or pipe smoking.

DM and cancer—by 5.8 years. For current overall smoking, the adjusted difference in life expectancy between smokers and never or long-term ex-smokers was comparable to cigarette smoking (table 4). Among the exclusive cigar or pipe smokers, life expectancy was reduced by 4.7 (1.5 to 8.0) years and the number of disease-free years of life by 3.7 (−1.7 to 9.1) years. After adjustment for potential confounders, the total number of life-years lost due to cigar or pipe smoking was 4.7 (1.4 to 8.0) years and the number of disease-free life-years lost was 5.2 (−1.5 to 12.0) years.

In addition, the number of total and disease-free years of life lost increased when more cigarettes were smoked (table 4). The adjusted number of total life-years lost ranged from 2.1 years for men who smoked 11–20 cigarettes per day to 8.8 years for men who smoked >30 cigarettes per day, whereas the number of disease-free life-years lost ranged from 2.1 years to about 10.6 years. Men who stopped smoking at age 40 gained 4.6 life-years, compared with men who continued smoking at that age

(table 4), while the gained life-years were 2.5–3.3 years among men who stopped smoking at age 50, 60 or 70 years. The number of disease-free years of life gained by stopping smoking after age 40 were less compared with the total number of life-years gained, but still 0.3–3.0 years.

## DISCUSSION

Our results clearly show the importance of amount, duration and type of smoking in relation to mortality. Average cigarette smoking reduced life expectancy at age 40 by about 7 years, and heavy cigarette smoking reduced life expectancy even more. The average cigar or pipe smoker lost about 5 life-years. Smoking decreased total life expectancy, and also decreased the number of disease-free years of life, but to a smaller extent. Moreover, stopping cigarette smoking at age 40 increased the total life expectancy by about 5 years and the number of disease-free years of life by about 3 years.

The major strength of this study was the collection of detailed information on smoking habits at each of seven examination rounds during 40 years of follow-up. This enabled us to study the long-term effects of cigarette as well as cigar or pipe smoking on mortality and life expectancy. Moreover, detailed data on potential confounders made it possible to study the independent effect of smoking. Adjustment for potential confounders reduced the number of life-years lost by half a year.

This study also has weaknesses. Firstly, the Zutphen Study had a relatively small study population, which may have led to less precise results. Secondly, the number of never smokers was also very small, and we were therefore forced to combine men who stopped smoking for ⩾10 years with men who never smoked in our reference group. Because studies suggested that mortality risk after 10 years of smoking cessation is comparable to that in never smokers,[2 20] we used this cut-off value. However, more recent studies showed that mortality risk is comparable to that in never smokers only after 10–15[21–24] or more[24–26] years of cessation, and so the differences in life expectancy might have been underestimated. Thirdly, the Zutphen Study started in 1960 with 872 men. The cohort of

**Table 4** Differences in life expectancy (in years) due to smoking within the Zutphen Study, crude and adjusted for potential confounders

| | Total life expectancy | | Disease-free years of life | |
|---|---|---|---|---|
| | Crude difference (95% CI) | Adjusted difference (95% CI)* | Crude difference (95% CI) | Adjusted difference (95% CI)* |
| Current overall smoking† | −6.8 (−9.1 to −4.5) | −6.5 (−11.5 to −1.4) | −5.8 (−8.5 to −3.1) | −5.9 (−8.6 to −3.1) |
| Current cigarette smoking† | −7.5 (−10.1 to −4.9) | −6.8 (−9.3 to −4.3) | −5.9 (−8.8 to −3.0) | −5.8 (−8.6 to −2.9) |
| No of cigarettes smoked† | | | | |
| 1–10 | −4.3 (−7.0 to −1.6) | −4.3 (−7.1 to −1.4) | −2.8 (−5.6 to 0.1) | −2.9 (−5.9 to 0.0) |
| 11–20 | −2.3 (−4.0 to −0.5) | −2.1 (−4.1 to −0.2) | −2.1 (−4.7 to 0.5) | −2.1 (−4.6 to 0.3) |
| 21–30 | −5.7 (−8.5 to −2.8) | −5.8 (−8.6 to −2.9) | −8.1 (−11.3 to −4.9) | −8.2 (−11.3 to −5.0) |
| >30 | −8.9 (−14.0 to −3.8) | −8.8 (−13.9 to −3.7) | −11.0 (−16.2 to −5.7) | −10.6 (−14.9 to −6.3) |
| Stopped at age‡ (years) | | | | |
| 40 | 5.5 (3.3 to 7.6) | 4.6 (2.3 to 6.8) | 3.6 (0.9 to 6.4) | 3.0 (0.4 to 5.6) |
| 50 | 3.8 (2.3 to 5.4) | 3.3 (1.9 to 4.7) | 2.6 (0.7 to 4.5) | 1.7 (−0.2 to 3.5) |
| 60 | 3.3 (2.2 to 4.4) | 2.8 (1.7 to 4.0) | 1.2 (−0.2 to 2.7) | 0.7 (−0.9 to 2.3) |
| 70 | 2.6 (1.8 to 3.4) | 2.5 (1.6 to 3.4) | 0.5 (−1.1 to 2.0) | 0.3 (−1.3 to 1.9) |

*Difference adjusted for baseline energy intake, alcohol use, body mass index, prevalence of myocardial infarction, stroke, diabetes mellitus and cancer, and socioeconomic status. Current cigarette smoking was additionally adjusted for cigar or pipe smoking.
†The number of life-years lost compared with never or long-term ex-smokers—that is, men who stopped smoking ⩾10 years ago.
‡The differences represent the number of life-years lost compared with continuing smoking at that age.

men who survived until 1985 was expanded with an additional cohort of 559 men. However, as this additional cohort of men was from the same birth cohort as the men who started the study in 1960, it is unlikely that bias was introduced.

Our findings confirmed results from others that also showed an increase in all-cause mortality risk with cigarette smoking duration and the number of cigarettes smoked.[9 13–15 20 23 27–30] After the adjustment for the prevalence of MI, stroke, DM and cancer, only cigarette smoking duration was found to be associated with lung cancer mortality. By omitting this adjustment for chronic disease prevalence, both smoking duration as well as the number of cigarettes smoked were found to be strongly associated with total cancer and lung cancer mortality. This result confirms those from other studies.[9–11 15 20 28–30] In addition, we confirmed the results of other studies which showed dose–response relationships between smoking duration and COPD mortality.[9 15]

In accordance with other studies,[6 7] the effects of cigar or pipe smoking on mortality were weaker compared with the effects of cigarette smoking. To our knowledge, we are the first to report on the effects of exclusive cigar or pipe smoking on life expectancy. This study found that the effects on life expectancy observed for cigar or pipe smoking were close to those observed for cigarette smoking. Exclusive cigar or pipe smoking reduced life expectancy by about 5 years, whereas cigarette smoking reduced life expectancy by about 7 years.

In the British Doctors Study,[4] the Framingham Heart Study[31] and the Cancer Prevention Study II,[32] the reduction in life expectancy due to smoking was about 9 years. The difference in the reduction in life expectancy compared with this study may be due to several factors. Firstly, life expectancy within these studies was assessed at different ages. Secondly, men who stopped smoking ≥10 years ago were not included in the reference group. Thirdly, the adjustment for possible confounders was not carried out in these studies and, finally, the average amount smoked might have been higher compared with that in this study. Both the British Doctors Study[29] as well as our study found that heavy cigarette smokers lost 9–10 life-years, indicating that the amount smoked is associated with reductions in life expectancy.

In accordance with the British Doctors Study[4] and the Cancer Prevention Study II,[32] we found that smoking cessation has beneficial effects on life expectancy. These studies as well as this study found a substantial increase in life expectancy of about 3 years when stopping smoking at age 60. The main focus in smoking prevention programmes is preventing smoking initiation. The results from this and other studies indicate that the persuasion of smokers to quit smoking, even later in life, should be another important focus from a public health perspective.

In this study, the reduction in the number of disease-free years of life due to smoking was comparable between the different types of smoking. Other studies also addressed the differences in the number of disease-free years of life.[31 33 34]

## What this study adds

Cigarette smoking has been recognised as a health hazard for many years, but much less is known about the adverse effects of long-term cigar and pipe smoking. This study shows that long-term average cigarette smoking reduces life expectancy by 7 years and long-term heavy cigarette smoking reduces life expectancy by 9 years. Cigar or pipe smoking reduces life expectancy by 5 years. Adjustment for potential confounders reduces the number of life-years lost due to smoking by half a year.

Although these studies defined disease-free years of life differently from this study and did not distinguish between different types of smoking, the overall conclusions were similar. Never smokers and quitters live longer than continuing smokers, and they also spend more years of life in better health.

In summary, cigarette and cigar or pipe smoking reduces life expectancy and the number of disease-free years of life. However, the number of life-years lost due to cigar or pipe smoking is fewer compared with cigarette smoking. Both the number of cigarettes smoked and smoking duration are strongly associated with mortality risk and the number of life-years lost. Although our results indicate that the effects will be larger the earlier one quits, even stopping at age 60 has major benefits on life expectancy.

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## Authors' affiliations
**Martinette T Streppel, Frans J Kok, Daan Kromhout,** Wageningen University, Wageningen, The Netherlands
**Martinette T Streppel, Hendriek C Boshuizen, Marga C Ocké,** National Institute for Public Health and the Environment (RIVM), Bilthoven, The Netherlands

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# ELECTRONIC PAGES .................................................................................................

## Tobacco Control Online: www.tobaccocontrol.com

The following electronic only article is published in conjunction with this issue of Tobacco Control.

### Asian herbal-tobacco cigarettes: ''not medicine but less harmful''?

**Aiyin Chen, Stanton Glantz, Elisa Tong**

**Objective:** To describe the development and health claims of Asian herbal-tobacco cigarettes.

**Methods:** Analysis of international news sources, company websites, and the transnational tobacco companies' (TTC) documents. PubMed searches of herbs and brands.

**Results:** Twenty-three brands were identified, mainly from China. Many products claimed to relieve respiratory symptoms and reduce toxins, with four herb-only products advertised for smoking cessation. No literature was found to verify the health claims, except one Korean trial of an herb-only product. Asian herbal-tobacco cigarettes were initially produced by China by the 1970s and introduced to Japan in the 1980s. Despite initial news about research demonstrating a safer cigarette, the TTC analyses of these cigarettes suggest that these early products were not palatable and had potentially toxic cardiovascular effects. By the late 1990s, China began producing more herbal-tobacco cigarettes in a renewed effort to reduce harmful constituents in cigarettes. After 2000, tobacco companies from Korea, Taiwan, and Thailand began producing similar products. Tobacco control groups in Japan, Taiwan, and Thailand voiced concern over the health claims of herbal-tobacco products. In 2005, China designated two herbal-tobacco brands as key for development.

**Conclusion:** Asian herbal-tobacco cigarettes claim to reduce harm, but no published literature is available to verify these claims or investigate unidentified toxicities. The increase in Asian herbal-tobacco cigarette production by 2000 coincides with the Asian tobacco companies' regular scientific meetings with TTCs and their interest in harm reduction. Asia faces additional challenges in tobacco control with these culturally concordant products that may discourage smokers from quitting.

(*Tobacco Control* 2007;**16**:e3) www.tobaccocontrol.com/cgi/content/full/16/2/e3