

Healthy Lifestyle Factors and Low Mortality in the Cancer Prevention Study, 1982-1988

James E. Enstrom, PhD, MPH, FFACE
Scientific Integrity Institute and UCLA
Los Angeles, CA 90024
jenstrom@ucla.edu

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Abstract

Seven healthy lifestyle factors have been examined in relationship to mortality from cancer, coronary heart disease, and total mortality in the 1982 American Cancer Society (ACS) Cancer Prevention Study (CPS II). This epidemiologic analysis of 1,102,612 subjects, with 68,038 deaths and 6,423,513 person-years of follow-up during 1982-1988, reveals surprisingly low death rates among all subjects and among the healthiest subgroups. Compared with 1985 US whites, the age-adjusted death rate ratios for all causes for the CPS II subjects were 0.606 (0.600-0.612) for all white males and 0.548 (0.542-0.554) for all white females. The ratios were 0.343 (0.328-0.358) for males and 0.316 (0.302-0.330) for females among the subjects who have never smoked and who have regular exercise, at least a high school education, moderate body mass index, 7-8 hours of nightly sleep, and are married. Similarly low ratios were found for all cancer and coronary heart disease deaths. The healthiest subjects had up to 10.7 years of increased life expectancy compared with US whites. The initial healthiness of the subjects contributed the most to their low death rates. Proportional hazards regression found that smoking, exercise, and education level had strong relationships to mortality. These findings have important implications for disease prevention.

Introduction

Healthy lifestyle factors have major implications for health in the US because the major chronic diseases, particularly cancer and coronary heart disease, are largely preventable. Unhealthy lifestyles are major risk factors for various chronic diseases and premature death. One of the earliest studies found that health factors were strongly associated with total mortality in Alameda County, California (1,2). The health factors included smoking, alcohol, exercise, proper weight for height, and sleep. Other studies in California Mormons (3,4) and Alameda County adults (5) have found mortality benefits for factors like marriage and church attendance. Estimates have been made that these healthy lifestyle factors reduce premature deaths by about 60% and increase life expectancy by up to 18 years relative to those with unhealthy lifestyle factors (4,6-8).

This study provides detailed evidence on the impact of individual and combined healthy lifestyle factors on mortality and life expectancy in the CPS II cohort. Smoking, particularly cigarette smoking, is the factor that has been examined in the greatest detail in CPS II. A comprehensive presentation of smoking patterns and smoking-related mortality in CPS II was published in 1997 (9). Also, CPS II mortality has previously been related to exercise and relative weight (10) and to sleep (11). The focus here is on seven health factors that have been consistently related to total mortality in numerous cohort studies: smoking, exercise, education, body mass index, sleep, marriage, and church attendance. This is the first effort to systematically examine all seven factors in the CPS II cohort, with the goal of determining the minimum death rate and maximum life expectancy associated with these factors. Other variables have not been analyzed.

Methods

The 1982 American Cancer Society Cancer Prevention Study (CPS II) was designed to examine factors related to the causes and prevention of cancer in the US. Starting in September 1982, 77,000 ACS volunteer researchers enrolled 1,206,377 subjects from 50 States, the District of Columbia, Puerto Rico, and Guam (12). The author is one of these researchers. Each subject voluntarily consented to complete a confidential 4-page health questionnaire. The questionnaire included questions in these subject areas: personal demographics; family history of cancer; history of diseases; current physical condition; personal habits, particularly smoking history; diet; medications and vitamins; occupations and exposures. Most of the questionnaires were completed in September and October of 1982. The CPS II Fact Sheet shown to enrollees contained these sentences: "By completing the questionnaire, you will join one million other Americans who are helping us advance our knowledge of the causes and prevention of cancer. Such knowledge will enable us to work toward the goal of preventing cancer and saving thousands of lives." (13)

The CPS II subjects were selected from among the friends, neighbors, and acquaintances of the researchers. Enrollment was based on those who were part of a household, excluding persons in institutions or military service and itinerants who would be difficult to trace. Researchers sought to enroll all household members 30 years of age or older if at least one family member was 45 years or older. Participants were older, whiter, somewhat more educated, more frequently married, and more middle class than the general U.S. population (12). CPS-II subjects were mostly born between 1900 and 1939. Each researcher personally followed their enrollees to determine their current address and mortality status in the fall of 1984, 1986, and 1988. It was possible to successfully trace 98.4% of the subjects. This is likely the largest prospective cohort study of US subjects who each completed a detailed health questionnaire.

This analysis was done using 1989 computer files containing the original 1982 ACS CPS II de-identified questionnaire data and six-year follow-up data on deaths from September 1, 1982 through August 31, 1988 (13). These files, along with detailed documentation, were obtained by the author from a source with appropriate access to the CPS II data. This research is exempt from human subjects or ethics approval because it involves only statistical analysis of existing de-identified data. Human subjects approval was originally obtained by ACS in 1982 when each subject volunteered to participate in CPS II.

Seven well-established health-related variables have been analyzed in detail: smoking status, exercise, education level, body mass index (BMI), sleep, marital status, and church attendance. The questionnaire variables were coded with the following values: age at entry in individual years from 30-99 based on month and year of birth as of September 1, 1982; sex of male [2] or female [1]; race of white only; smoking status of never [3], former [2], or current, including cigarettes, cigars, and pipes [1]; exercise of never [4], some [3], moderate [2], heavy [1]; education level of no or some high school [4], high school graduate [3], some college [2], college graduate or more [1]; body mass index (BMI in kg/m²) based on height (inches) and weight (pounds): 20≤BMI<30 [1], BMI<20 or BMI≥30 [2]; sleep (hours per night): 7-8 [1], <7 or >8 [2]; marital status: married [1], not married [2]; church attendance: more than weekly [1], weekly [2], less than weekly [3], never [4]. Other variables, like alcohol consumption, diet, and occupational exposures were not included. Never smokers were the primary focus of this analysis because of their low death rates. The CPS II Questionnaires for males and females are posted on the ACS website (<https://www.cancer.org/research/population-science/cancer-prevention-and-survivorship-research-team/acs-cancer-prevention-studies/cancer-prevention-study-2.html>). Questionnaires and code books for males and females are also posted on my ScientificIntegrityInstitute.org website (13).

This analysis was initially based on the 846,776 CPS II white subjects with valid responses to the above seven health factors. The relative strength of the relationship of each health factor [HF] to mortality has been assessed with Cox proportional hazards regression using the SAS PHREG Procedure (https://documentation.sas.com/doc/en/pgmsascdc/v_075/statug/statug_phreg_overview.htm). After it was determined that church attendance did not substantially contribute to a lower death rate after adjustment for the other six health factors, the remainder of the analysis was based on the 1,102,612 white subjects with valid responses to the other six health factors. Five-year age-specific death rates (per 100,000 person-years) among CPS II white subjects aged 30+ years were computed based on the number of deaths and person-years at risk by attained age from September 1, 1982 through August 31, 1988 (9,14). Age-adjusted death rates were calculated from the age-specific death rates using the 2000 US Standard Population for attained ages 30+ years and 35-64 years (15). Life expectancy from age 30 years was calculated using the abridged life table method for 5-year age-specific death rates (16,17).

Mortality ratios were determined based on comparison of 1982-1988 CPS II white death rates with the 1985 US white death rates. The mortality rates and ratios were determined for all causes, all cancer (ICD9 140-208) and ischemic heart disease, also known as coronary heart disease (CHD), (ICD9 410-414). The Ninth International Classification of Diseases (ICD9) was used during 1982-1988 (14). The 95% confidence interval (CI) for each ratio was calculated based on the number of deaths in each CPS II subgroup (<https://blogs.sas.com/content/iml/2024/05/01/estimate-proportion-sas.html>). Ratios have been calculated for current, former, and never smokers. Furthermore, ratios by smoking status have been calculated for these five health factor (HF) combinations: 1 HF=moderate or heavy exercise, 2 HF=1 HF and at least high school education; 3 HF=2 HF and $20 \leq \text{BMI}(\text{kg}/\text{m}^2) < 30$; 4 HF=3 HF and sleep 7-8 hours; 5 HF=4 HF and married.

Most of this analysis included persons with prevalent cancers reported at the time of enrollment, persons who were sick at entry, and persons who resided throughout the entire US. One part of the analysis was done for persons without cancer at entry, persons who were not sick at entry, and persons who were enrolled by the ACS Division for California, which is Division 6 of 58 ACS Divisions. Although some Division 6 enrollees resided outside of California, the vast majority of them lived in California.

Results

Table 1 shows the distribution of health factors for CPS II subjects with age, sex, smoking, and 5 HF values: all white males, all white females, white males with 5 HF, and white females with 5 HF.

Table 2 shows the Cox proportional hazards regression results for the entire CPS II cohort for age, sex, and the seven health factors. The hazard ratio and 95% confidence interval (CI) and chi-square is shown for each health factor for all deaths and all cancer deaths. In addition to age and sex, smoking, exercise, and education had the strongest relationship to mortality, but BMI, sleep, marital status, and church attendance also had relationships. Except for age, each health factor had two or four levels, as defined above. The chi-square value for each health factor is somewhat dependent on the number of levels chosen, but the relative strength of each factor remains basically the same. Smoking and exercise had the strongest relationship for all deaths and smoking had by far the strongest relationship for all cancer deaths.

Church attendance was examined as a health factor and increased attendance was associated with lower death rates when analyzed as a single variable. But this factor did not have a measurable effect

on mortality when the 5 HF were included first in the analysis. Diet, alcohol use, drug use, and occupational and environmental exposures were not analyzed. Many of these unused variables had substantial missing values.

Table 3 compares the CPS II white males with 1985 US white males and finds the following age-adjusted death rate ratios for all causes: 0.606 for all subjects, 0.780 for current smokers, 0.599 for former smokers, 0.461 for all never smokers, and 0.343 for the never smokers with 5 HF. For males aged 35-64 years, the ratios are 0.311 for all never smokers and 0.226 for the never smokers with 5 HF. Table 4 compares the CPS II white females with 1985 US white females and find the following ratios for all deaths: 0.548 for all subjects, 0.484 for all never smokers, 0.316 for the never smokers with 5 HF. For females aged 35-64 years, the ratios are 0.458 for all never smokers and 0.343 for the never smokers with 5 HF. Never smokers with 5 HF comprise 10.8% of all the males and 16.0% of all the females in CPS II. Never smokers with 5 HF have about 57% of the death rate of all CPS II subjects and about 70% of the death rate of all never smokers. Current smokers with 5 HF and former smokers with 5 HF also have reduced death rates relative to all current smokers and all former smokers..

For CSP II white never smokers with 5 HF relative to 1985 US whites, remaining life expectancy from age 30 years is about 10.7 years greater for males and about 6.9 years greater for females. Specifically, remaining life expectancy was 44.0 years for 1985 US white males, 49.9 years for all CPS II white males, 53.0 years for CPS II white male never smokers, and 54.7 years for CPS II white male never smokers with 5 HP. Remaining life expectancy was 50.1 years for 1985 US white females, 54.1 years for all CPS II white females, 55.4 years for CPS II white female never smokers, and 57.0 years for CPS II white female never smokers with 5 HP. For comparison, remaining life expectancy from age 30 years in 2023 was 47.5 years for US white males and 51.8 years for US white females (17).

Examination was done of “very healthy never smokers,” those never smokers with heavy exercise, 16+ years of education, $20 \leq \text{BMI}(\text{kg}/\text{m}^2) < 25$, 7 hours of sleep, and married. This subgroup had somewhat lower mortality ratios than never smokers with 5 HP, but only 3.5% of the males and 0.7% of the females had these strict health factors. Many of their mortality ratios were unstable and had large confidence intervals. These results are not presented.

Table 5 shows that the male cancer ratios are: 0.855 for all subjects, 0.536 for all never smokers, 0.450 for never smokers with 5 HF. For males aged 35-64 years, the cancer ratios are 0.361 for never smokers and 0.285 for never smokers with 5 HF. Table 6 shows that the female cancer ratios are: 0.842 for all subjects, 0.726 for all never smokers, and 0.583 for never smokers with 5 HF. For females aged 35-64 years, the cancer ratios are 0.692 for all never smokers and 0.531 for never smokers with 5 HF.

Table 7 shows that the male CHD ratios are: 0.702 for all subjects, 0.561 for all never smokers, 0.383 for never smokers with 5 HF. For males aged 35-64 years, the cancer ratios are 0.324 for never smokers and 0.250 for never smokers with 5 HF. Table 8 shows that the female CHD ratios are: 0.534 for all subjects, 0.487 for all never smokers, and 0.267 for never smokers with 5 HF. For females aged 35-64 years, the CHD ratios are 0.257 for all never smokers and 0.133 for never smokers with 5 HF.

Table 9 shows total death ratios for three subgroups of CPS II males and females: California Division 6 subjects, subjects Not Sick at Entry, and subjects with No Cancer at Entry. Note that the CPS II never smokers in these subgroups had total death ratios that are reduced relative to all CPS II never smokers and that the reductions associated with the 5 HF remained similar. It is particularly interesting that among never smokers with 5 HF, the California Division 6 subjects had a total death rate ratio (0.291) that is 11.6% lower than the death rate ratio for the entire cohort (0.329). This finding indicates that the California subjects are particularly healthy.

To confirm the validity of the CPS II data file that has been used in this analysis, comparison was made with age-specific death rates published by ACS investigators in 1997. Appendix Table 1 shows essentially exact agreement between the current CPS II database calculations and 1997 death rates for all causes of death for never smokers, both male and female. The total number of deaths and the total age-adjusted death rate for CPS II never smokers agree to within 0.5% with the corresponding values found in 1997 (9). This comparison confirms that the two databases are essentially identical.

Appendix Table 2 presents a sample calculation of death rate ratios: an age-specific and age-adjusted death rate comparison of all CPS II white males and white females with the corresponding 1985 US death rates (14). Note that the CPS II/US mortality ratio is $12.513/20.648 = 0.606$ for all white males and $6.944/12.674 = 0.548$ for all white females, as shown in Tables 3 and 4.

Discussion

CPS II subjects following healthy lifestyle practices have experienced extensive cancer and other disease prevention as measured by the ratio of their death rate to the corresponding US death rate. The healthiest CPS II never smokers have ratios as low as 0.226 for all deaths, 0.285 for all cancer deaths, and 0.133 for all CHD deaths. These previously unpublished findings are directly relevant to the original purpose of CPS II to identify factors that cause and prevent cancer. The maximum cancer mortality reduction found in this analysis exceeds the level of potential cancer prevention found in a recent ACS analysis not based on CPS II (18). These results add to the findings for other low-risk group populations that follow good health practices (1-8). Because of the very large size of the cohort, it has been possible to make detailed comparisons with several CPS II subgroups and with US whites. The seven health factors are well defined and stable over the six-year follow-up period. The association between health factors and mortality may reflect an influence of the habits on subsequent mortality or an influence of sickness or impending mortality on the factors. However, Table 9 indicates that the relationships remain similar when initially sick persons and persons with cancer are removed. The largest contribution to the low CPS II death rates is the initial healthiness of those who enrolled in this cohort study. This healthy respondent effect is being investigated in detail. Also, further analysis could reveal even stronger evidence regarding cancer and other disease prevention in this large well done epidemiologic cohort. The findings presented demonstrate substantial disease prevention based on seven well-defined health factors.

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Data Availability Statement

The author is willing to explore collaboration with investigators who are interested in the CPS II data. The CPS II Questionnaires, Code Books, and SAS Programs are posted at the links indicated in the text.

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Table 1. Distribution of five health factors and other key variables among the CPS II white males, white females, white male Never Smokers with 5 HF, and white female Never Smokers with 5 HF.

Variable	White CPS II Males		White CPS II Females	
	Never Smokers With 5 HF	Total Subjects	Never Smokers With 5 HF	Total Subjects
Sample size	51425	476992	100362	625620
Race (% white)	100	100	100	100
Age on quest (mean in years)	56.8	57.7	55.3	56.8
Age as of 09/01/1982	56.8	57.7	55.3	56.9
Smoking status				
Current		28.5		21.2
Former		45.9		22.6
Never	100	25.6	100	56.2
Exercise				
None		2.1		2.2
Slight		22.1		24.1
Moderate	84.2	64.1	93.5	67.8
Heavy	15.8	11.7	6.5	5.9
Education Level				
Less than High School		15.3		12.9
High School	22.1	20.2	38.9	31.3
Vocational School, Some College	48.5	45.6	50.7	45.6
College, Graduate School	29.4	18.9	10.4	10.2
Height (mean in inches)	70.2	70.1	64.4	64.3
Weight (mean in pounds)	176.4	180.8	141.1	144.0
Body Mass Index (BMI) (mean in kg/m ²)	25.1	25.9	23.9	24.5
<20 kg/m ²		2.5		10.3
20 kg/m ² ≤BMI<30 kg/m ²	100	87.4	100	79.0
≥30 kg/m ²		10.1		10.7
Sleep				
7-8 hours	100	73.6	100	72.7
Marital Status				
Married	100	94.7	100	76.4
Church Attendance				
At Least Weekly	65.0	54.7	73.3	64.4
Sick at Entry	5.2	9.7	6.5	10.4
Cancer at Entry	9.0	9.7	10.1	11.7

Table 2. CPS II proportional hazards regression and maximum likelihood estimate for all deaths and all cancer deaths for age, sex, and seven health factors. Healthiest level, hazard ratio, 95% confidence limit, and chi-square are shown for each health factor.

All 46,599 deaths among 846,776 subjects with age, sex, and seven health factors

Health Factor	Healthiest Category	Hazard Ratio	95% Confidence Limits		Chi-Square
			Lower	Upper	
Age (30-105 years)		1.096	1.095	1.097	35856.6
Sex (female, male)	Female	1.877	1.837	1.918	3258.9
Smoking (3 levels)	Never	1.356	1.339	1.373	2247.3
Exercise (4 levels)	Heavy	1.466	1.446	1.487	2873.4
Education (4 levels)	At Least College Grad	1.133	1.122	1.144	649.1
BMI (2 levels)	20<=BMI(kg/m ²)<30	1.312	1.282	1.342	527.4
Sleep (2 levels)	7-8 Hours Nightly	1.175	1.152	1.198	263.9
Marital Status (2 levels)	Married	1.076	1.048	1.104	30.1
Church Attendance (4 levels)	More than Weekly	1.061	1.051	1.070	171.0

All 10,470 cancer deaths among 846,776 subjects with age, sex, and seven health factors

Health Factor	Healthiest Category	Hazard Ratio	95% Confidence Limits		Chi-Square
			Lower	Upper	
Age (30-105 years)		1.080	1.077	1.082	5584.2
Sex (female, male)	Female	1.743	1.667	1.823	592.4
Smoking (3 levels)	Never	1.744	1.699	1.790	1729.4
Exercise (4 levels)	Heavy	1.231	1.193	1.269	177.9
Education (4 levels)	At Least College Grad	1.148	1.125	1.172	174.9
BMI (2 levels)	20<=BMI(kg/m ²)<30	1.192	1.133	1.254	45.9
Sleep (2 levels)	7-8 Hours Nightly	1.123	1.077	1.171	29.9
Marital Status (2 levels)	Married	1.022	0.965	1.082	0.6
Church Attendance (4 levels)	More than Weekly	1.068	1.049	1.088	48.6

Table 3. Age-adjusted death rates for 1982-1988 CPS II white males versus 1985 US white males, based on deaths and person-years (p-y) by attained age, using 2000 US Standard Population. Results are shown for smoking status and these five health factors (HF): regular exercise, 12+ years of education, $20 \leq \text{BMI}(\text{kg}/\text{m}^2) < 30$, 7-8 hours of sleep, and married. In table below n HF means n health factors combined in the order shown.

	1982-1988 CPS II Deaths/ 1982 Subjects	CPS II Death Rate (deaths/1000 p-y)	CPS II/US Ratio & 95% CI	Life Expectancy at Age 30 (Years)
Ages 30+ Years				
1985 US White Male Death Rate and Life Expectancy		20.648		44.0
1982-1988 CPS II White Male Deaths, Subjects, Death Rate, Death Rate Ratio, Life Expectancy by Health Factors				
All Cause Deaths				
All subjects	39621/476992	12.513	0.606 (0.600-0.612)	49.9
Current smokers	12188/131761	16.114	0.780 (0.767-0.794)	46.2
Current Smokers with 5 HF	3020/47006	11.153	0.540 (0.521-0.560)	
Former smokers	18746/212634	12.364	0.599 (0.590-0.607)	49.9
Former Smokers with 5 HF	5021/86715	8.916	0.432 (0.420-0.444)	
Never smokers	6901/118666	9.527	0.461 (0.451-0.472)	53.0
Never Smokers with 1 HF	4817/91983	8.235	0.399 (0.388-0.410)	
Never Smokers with 2 HF	3515/79566	7.782	0.377 (0.365-0.390)	
Never Smokers with 3 HF	3019/70253	7.572	0.367 (0.354-0.380)	
Never Smokers with 4 HF	2200/54343	7.260	0.352 (0.337-0.367)	
Never Smokers with 5 HF	2055/51425	7.078	0.343 (0.328-0.358)	54.7
Ages 35-64 Years				
1985 US White Male Death Rate		6.732		
1982-1988 CPS II White Male Deaths, Subjects, Death Rate Ratio, by Health Factors				
All Cause Deaths				
All subjects	1548/351850	3.614	0.537 (0.527-0.547)	
Current smokers	4975/105864	5.340	0.793 (0.771-0.816)	
Current Smokers with 5 HF	1409/39181	3.711	0.551 (0.523-0.581)	
Former smokers	4257/152289	3.216	0.478 (0.464-0.491)	
Former Smokers with 5 HF	1468/64975	2.161	0.321 (0.305-0.338)	
Never smokers	1573/85910	2.095	0.311 (0.296-0.327)	
Never Smokers with 1 HF	1107/65261	1.961	0.291 (0.274-0.309)	
Never Smokers with 2 HF	958/59087	1.909	0.283 (0.265-0.302)	
Never Smokers with 3 HF	792/52002	1.748	0.260 (0.242-0.278)	
Never Smokers with 4 HF	601/40591	1.633	0.243 (0.224-0.263)	
Never Smokers with 5 HF	562/38892	1.519	0.226 (0.207-0.245)	

Table 4. Age-adjusted death rate ratios for 1982-1988 CPS II white females versus 1985 US white females for deaths and person-years (p-y) by attained age, using 2000 US Standard Population. Results are shown for smoking status and these five health factors (HF): regular exercise, 12+ years of education, $20 \leq \text{BMI}(\text{kg}/\text{m}^2) < 30$, 7-8 hours of sleep, and married.

	1982-1988 CPS II Deaths/ 1982 Subjects	CPS II Death Rate (deaths/1000 p-y)	CPS II/US Ratio & 95% CI	Life Expectancy at Age 30 (Years)
Ages 30+ Years				
1985 US White Female Death Rate and Life Expectancy	12.674			50.1
1982-1988 CPS II While Female Deaths, Subjects, Death Rate Ratio, Life Expectancy by Health Factors				
All Cause Deaths				
All subjects	28417/625620	6.944	0.548 (0.542-0.554)	54.2
Current smokers	6220/124048	10.027	0.791 (0.772-0.811)	51.1
Current Smokers with 5 HF	1015/33707	6.950	0.548 (0.515-0.583)	
Former smokers	5281/132015	7.382	0.582 (0.567-0.598)	54.0
Former Smokers with 5 HF	919/43688	3.993	0.315 (0.295-0.336)	
Never smokers	14152/329173	6.131	0.484 (0.476-0.492)	55.4
Never Smokers with 1HF	8354/241319	4.917	0.388 (0.380-0.396)	
Never Smokers with 2HF	6079/205642	4.675	0.369 (0.360-0.378)	
Never Smokers with 3HF	4506/163279	4.309	0.340 (0.330-0.350)	
Never Smokers with 4HF	3118/122840	4.126	0.326 (0.314-0.337)	
Never Smokers with 5 HF	2005/100362	4.006	0.316 (0.302-0.330)	57.0
Ages 35-64 Years				
1985 US White Death Rate		3.639		
1982-1988 CPS II Deaths, Subjects, Death Rate Ratio, by Health Factors				
All Cause Deaths				
All subjects	7958/462807	2.120	0.582 (0.570-0.595)	
Current smokers	2733/102717	3.130	0.860 (0.828-0.893)	
Current Smokers with 5 HF	629/30266	2.462	0.677 (0.625-0.732)	
Former smokers	1742/103055	2.107	0.579 (0.552-0.607)	
Former Smokers with 5 HF	439/37443	1.490	0.409 (0.372-0.450)	
Never smokers	2987/232668	1.666	0.458 (0.442-0.475)	
Never Smokers with 1 HF	1983/169846	1.519	0.418 (0.399-0.436)	
Never Smokers with 2 HF	1755/152282	1.496	0.411 (0.392-0.431)	
Never Smokers with 3 HF	1319/121019	1.454	0.399 (0.378-0.422)	
Never Smokers with 4 HF	969/92986	1.318	0.362 (0.340-0.386)	
Never Smokers with 5 HF	843/82157	1.248	0.343 (0.320-0.367)	

Table 5. Age-adjusted cancer death rates for 1982-1988 CPS II white males versus 1985 US white males, based on deaths and person-years (p-y) by attained age, using 2000 US Standard Population. Results are shown for smoking status and these five health factors (HF): regular exercise, 12+ years of education, $20 \leq \text{BMI}(\text{kg}/\text{m}^2) < 30$, 7-8 hours of sleep, and married.

	1982-1988 CPS II Deaths/ 1982 Subjects	CPS II Death Rate (deaths/1000 p-y)	CPS II/US Ratio & 95% CI
Ages 30+ Years			
1985 US White Cancer Death Rate		4.576	
1982-1988 CPS II Cancer Deaths, Subjects, Death Rate Ratio by Smoking and Health Factors			
All Cancer Deaths			
All subjects	12823/476992	3.914	0.855 (0.840-0.870)
Current smokers	4500/131761	5.684	1.242 (1.206-1.279)
Former smokers	6045/212634	4.071	0.890 (0.867-0.912)
Never smokers	1833/118666	2.451	0.536 (0.511-0.561)
Never smokers with 5 HF	642/51425	2.058	0.450 (0.416-0.486)
Ages 35-64 Years			
1985 US White Cancer Death Rate		1.862	
1982-1988 CPS II Cancer Deaths, Subjects, Death Rate Ratio by Smoking and Health Factors			
All Cancer Deaths			
All subjects	4348/351850	1.317	0.707 (0.686-0.729)
Current smokers	1904/105864	1.898	1.020 (0.974-1.066)
Former smokers	1830/152289	1.309	0.703 (0.671-0.736)
Never smokers	530/85910	0.673	0.361 (0.332-0.394)
Never smokers with 5 HF	200/38892	0.531	0.285 (0.247-0.328)

Table 6. Age-adjusted cancer death rate ratios for 1982-1988 CPS II white females versus 1985 US white females for deaths and person-years (p-y) by attained age, using 2000 US Standard Population. Results are shown for smoking status and these five health factors (HF): regular exercise, 12+ years of education, $20 \leq \text{BMI}(\text{kg}/\text{m}^2) < 30$, 7-8 hours of sleep, and married.

	1982-1988 CPS II Deaths/ 1982 Subjects	CPS II Death Rate (deaths/1000 p-y)	CPS II/US Ratio & 95% CI
Ages 30+ Years			
1985 US White Cancer Death Rate		2.880	
1982-1988 CPS II Cancer Deaths, Subjects, Death Rate Ratio by Smoking and Health Factors			
All Cancer Deaths			
All subjects	11535/625620	2.425	0.842 (0.827-0.858)
Current smokers	2819/124048	3.582	1.244 (1.198-1.290)
Former smokers	2440/132015	2.676	0.929 (0.893-0.967)
Never smokers	5335/329173	2.092	0.726 (0.707-0.746)
Never smokers with 5 HF	1123/100362	1.678	0.583 (0.549-0.618)
Ages 35-64 Years			
1985 US White Cancer Death Rate		1.594	
1982-1988 CPS II Cancer Deaths, Subjects, Death Rate Ratio by Smoking and Health Factors			
All Cancer Deaths			
All subjects	4836/462807	1.315	0.825 (0.802-0.849)
Current smokers	1502/102717	1.725	1.082 (1.028-1.138)
Former smokers	1119/103055	1.398	0.877 (0.826-0.930)
Never smokers	1926/232668	1.104	0.692 (0.662-0.724)
Never smokers with 5 HF	587/82157	0.846	0.531 (0.489-0.575)

Table 7. Age-adjusted coronary heart disease (CHD) death rates for 1982-1988 CPS II white males versus 1985 US white males, based on deaths and person-years (p-y) by attained age, using 2000 US Standard Population. Results are shown for smoking status and these five health factors (HF): regular exercise, 12+ years of education, $20 \leq \text{BMI}(\text{kg}/\text{m}^2) < 30$, 7-8 hours of sleep, and married.

	1982-1988 Deaths/ 1982 Subjects	CPS II Death Rate (deaths/1000 p-y)	CPS II/US Ratio & 95% CI
Ages 30+ Years			
1985 US White CHD Death Rate		6.130	
1982-1988 CPS II CHD Deaths, Subjects, Death Rate Ratio by Smoking and Health Factors			
All CHD Deaths			
All subjects	12444/476992	4.301	0.702 (0.689-0.714)
Current smokers	3520/131761	5.175	0.844 (0.817-0.873)
Former smokers	5908/212634	4.302	0.701 (0.684-0.720)
Never smokers	2390/118666	3.437	0.561 (0.538-0.584)
Never smokers with 5 HF	721/51425	2.349	0.383 (0.356-0.412)
Ages 35-64 Years			
1985 US White CHD Death Rate		1.779	
1982-1988 CPS II CHD Deaths, Subjects, Death Rate Ratio by Smoking and Health Factors			
All CHD Deaths			
All subjects	3635/351850	1.097	0.617 (0.597-0.637)
Current smokers	1551/105864	1.672	0.940 (0.894-0.988)
Former smokers	1521/152289	0.989	0.556 (0.528-0.585)
Never smokers	484/85910	0.577	0.324 (0.296-0.354)
Never smokers with 5 HF	184/38892	0.444	0.250 (0.215-0.288)

Table 8. Age-adjusted coronary heart disease (CHD) death rate ratios for 1982-1988 CPS II white females versus 1985 US white females for deaths and person-years (p-y) by attained age, using 2000 US Standard Population. Results are shown for smoking status and these five health factors (HF): regular exercise, 12+ years of education, $20 \leq \text{BMI}(\text{kg}/\text{m}^2) < 30$, 7-8 hours of sleep, and married.

	1982-1988 CPS II Deaths/ 1982 Subjects	CPS II Death Rate (deaths/1000 p-y)	CPS II/US Ratio & 95% CI
Ages 30+ Years			
1985 US White CHD Death Rate		3.456	
1982-1988 CPS II White CHD Deaths, Subjects, Death Rate Ratio by Smoking and Health Factors			
All CHD Deaths			
All subjects	6280/625620	1.847	0.534 (0.521-0.548)
Current smokers	1158/124048	2.510	0.726 (0.685-0.769)
Former smokers	1008/132015	2.043	0.591 (0.555-0.629)
Never smokers	3422/329173	1.683	0.487 (0.471-0.503)
Never smokers with 5 HF	330/100362	0.922	0.267 (0.239-0.297)
Ages 35-64 Years			
1985 US White CHD Death Rate		0.501	
1982-1988 CPS II White CHD Deaths, Subjects, Death Rate Ratio by Smoking and Health Factors			
All CHD Deaths			
All subjects	911/462807	0.203	0.406 (0.380-0.433)
Current smokers	377/102717	0.390	0.779 (0.702-0.861)
Former smokers	175/103055	0.185	0.369 (0.316-0.428)
Never smokers	300/232668	0.129	0.257 (0.229-0.288)
Never smokers with 5 HF	62/82157	0.067	0.133 (0.102-0.170)

Table 9. Ratios of age-adjusted death rates for 1982-1988 CPS II whites versus 1985 US whites, for California ACS Division 6 Subjects, Subjects Not Sick at Entry, Subjects with No Cancer at Entry. Results are shown for smoking status and these five health factors (HF): regular exercise, 12+ years of education, $20 \leq \text{BMI}(\text{kg}/\text{m}^2) < 30$, 7-8 hours of sleep, and married. The 95% Confidence Interval (CI) for each death rate ratio is shown in parentheses.

	All CPS II Subjects	California Division Subjects	Subjects Not Sick at Entry	Subjects with No Cancer at Entry
White Males Ages 30+ Years				
CPS II Deaths/Subjects	39621/476992	3386/41675	28181/421638	30987/428438
All Subjects	0.606	0.558 (0.540-0.577)	0.507 (0.501-0.513)	0.589 (0.553-0.565)
Current smokers	0.780	0.814 (0.763-0.867)	0.677 (0.663-0.691)	0.722 (0.708-0.737)
Former smokers	0.599	0.550 (0.524-0.576)	0.487 (0.478-0.495)	0.541 (0.532-0.550)
Never smokers	0.461	0.403 (0.371-0.437)	0.394 (0.383-0.405)	0.430 (0.419-0.442)
Never Smokers with 5 HF	0.343	0.309 (0.265-0.358)	0.321 (0.306-0.337)	0.316 (0.301-0.332)
White Females Ages 30+ Years				
CPS II Deaths/Subjects	28417/625620	2573/55327	19358/542409	20034/548375
All Subjects	0.548	0.517 (0.497-0.538)	0.450 (0.443-0.456)	0.478 (0.471-0.484)
Current smokers	0.791	0.734 (0.677-0.795)	0.687 (0.667-0.707)	0.723 (0.702-0.744)
Former smokers	0.582	0.553 (0.511-0.597)	0.461 (0.445-0.477)	0.499 (0.483-0.516)
Never smokers	0.484	0.442 (0.416-0.468)	0.396 (0.388-0.404)	0.418 (0.410-0.427)
Never Smokers with 5 HF	0.316	0.271 (0.229-0.319)	0.298 (0.283-0.312)	0.280 (0.266-0.296)
White Both Sexes Ages 30+ Years				
CPS II Deaths/Subjects	68036/1102612	5959/97002	47539/964047	51021/976813
All Subjects	0.579	0.541 (0.527-0.555)	0.483 (0.479-0.488)	0.526 (0.522-0.531)
Current smokers	0.784	0.782 (0.744-0.822)	0.680 (0.669-0.692)	0.722 (0.710-0.734)
Former smokers	0.595	0.551 (0.529-0.574)	0.482 (0.474-0.489)	0.532 (0.524-0.540)
Never smokers	0.476	0.428 (0.408-0.449)	0.395 (0.389-0.402)	0.422 (0.416-0.429)
Never Smokers with 5 HF	0.329	0.291 (0.261-0.326)	0.309 (0.299-0.320)	0.299 (0.288-0.310)

Appendix Table 1. Age-specific and age-adjusted total deaths and death rates (per 100,000) for CPS II never smokers in this analysis compared with 1997 NCI Smoking and Tobacco Control Monograph 8 Appendix Tables 29 and 30 (9). US Standard 2000 Population from age 35 years.

CPS II Male Never Smokers

Enstrom 2026					NCI Monograph 1997 Appendix Table 29		US Standard 2000 Population
Age	Deaths	Subjects At Entry	Person- years	Death Rate	Deaths	Death Rate	
35-39	15	3555	21911.8	68.5	16	72.9	0.1580
40-44	23	5088	22353.8	102.9	21	93.7	0.1601
45-49	103	20146	67082.6	153.5	102	151.8	0.1411
50-54	277	22482	127595.9	217.1	283	221.4	0.1228
55-59	480	21013	132158.9	363.2	487	367.7	0.0948
60-64	817	19633	120880.0	675.9	815	672.6	0.0759
65-69	1111	14755	101888.0	1090.4	1120	1096.7	0.0670
70-74	1301	8988	71350.3	1823.4	1321	1846.6	0.0622
75-79	1377	4852	40291.6	3417.6	1389	3441.2	0.0528
80-84	900	1847	17938.9	5518.8	981	5466.5	0.0349
85+	887	845	8068.1	10993.9	899	11141.6	0.0303
Total	7381	123204		1054.5	7434	1059.9	1.0000
Enstrom 2026/NCI 1997 0.993				Enstrom 2026/NCI 1997 0.995			

CPS II Female Never Smokers

Enstrom 2026					NCI Monograph 1997 Appendix Table 29		US Standard 2000 Population
Age	Deaths	Subjects At Entry	Person- years	Death Rate	Deaths	Death Rate	
35-39	40	10015	49526.6	80.8	40	80.6	0.1580
40-44	94	24074	84868.9	110.8	93	109.3	0.1601
45-49	252	48408	207847.4	121.2	255	122.4	0.1411
50-54	559	55719	309032.0	180.9	564	182.1	0.1228
55-59	918	58854	344847.2	266.2	927	268.2	0.0948
60-64	1415	53678	339719.3	416.5	1401	411.4	0.0759
65-69	1840	40008	279941.2	657.3	1871	666.5	0.0670
70-74	2200	27651	205697.4	1069.5	2216	1073.9	0.0622
75-79	2462	16896	134850.0	1825.7	2487	1838.7	0.0528
80-84	2263	7744	70983.1	3188.1	2245	3154.2	0.0349
85+	3295	4377	41188.0	7999.9	3331	8069.2	0.0303
Total	15338	347424		687.6	15430	690.0	1.0000
Enstrom 2026/NCI 1997 0.994				Enstrom 2026/NCI 1997 0.997			

Appendix Table 2. Age-specific and age-adjusted total deaths and death rates (per 100,000) for CPS II white males and white females and for 1985 US white males and white females. US Standard 2000 Population from age 30+ years for age-adjusted rates. These calculations document key values in Tables 3 and 4.

CPS II White Males					1985 US Vital Statistics White Males	US Standard 2000 Population
Age	Deaths	Subjects At Entry	Person- years	Death Rate	Death Rate	
30-34	29	7553	18084.7	160.4	163.2	0.1220
35-39	47	9291	49294.8	95.3	202.8	0.1387
40-44	115	16077	64173.8	179.2	290.2	0.1406
45-49	570	68860	221561.2	257.3	459.1	0.1239
50-54	1733	85716	453633.1	382.0	768.4	0.1078
55-59	3348	91272	529283.1	632.6	1259.3	0.0832
60-64	5735	80634	511283.6	1121.7	1973.7	0.0666
65-69	7114	57661	403084.8	1764.9	2987.3	0.0589
70-74	7564	34626	270850.6	2792.7	4677.6	0.0546
75-79	6574	17020	145918.5	4505.2	7137.1	0.0464
80-84	4067	5937	58209.5	6986.8	10998.7	0.0307
85+	2725	2345	23151.6	11770.2	18788.9	0.0266
Total	39621	476992		1251.3	2064.8	1.0000

CPS II/USVS
0.606

CPS II White Females					1985 US Vital Statistics White Females	US Standard 2000 Population
Age	Deaths	Subjects At Entry	Person- years	Death Rate	Death Rate	
30-34	29	11673	27459.0	105.6	65.9	0.1220
35-39	72	18848	84733.3	85.0	95.2	0.1387
40-44	185	46013	162572.0	113.8	153.5	0.1406
45-49	632	91999	395143.3	159.9	258.0	0.1239
50-54	1373	104359	583107.5	235.5	424.8	0.1078
55-59	2297	107907	640347.6	358.7	689.8	0.0832
60-64	3399	93681	608141.7	558.9	1058.4	0.0666
65-69	4191	68408	482348.5	868.9	1609.9	0.0589
70-74	4501	43675	340408.6	1322.2	2521.4	0.0546
75-79	4350	23874	203791.2	2134.5	4039.2	0.0464
80-84	3321	10004	96131.2	3454.7	6892.4	0.0307
85+	4067	5179	50800.4	8005.8	14579.4	0.0266
Total	28417	462807		694.4	1267.4	1.0000

CPS II/USVS
0.548