

Health Factors and Low Mortality in the Cancer Prevention Study, 1983-1987

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Introduction. The impact of several health-related variables on reducing cancer and total mortality in the 1982-1988 American Cancer Society (ACS) Cancer Prevention Study (CPS II) have been analyzed for the first time. A large cohort of 1,206,377 subjects from 50 states was enrolled in 1982 by ACS using 77,000 volunteers. This independent epidemiologic analysis of 57,642 deaths and 5,359,400 person-years of follow-up is based on a 1989 version of CPS II data (1).

Methods. Age-specific and age-adjusted death rates during 1983-1987 among CPS II whites aged 30-99 years have been calculated based on number of deaths and person-years by attained age (2). These rates have been compared with corresponding 1985 US white death rates and abridged life tables (3). Six well-established health-related variables have been analyzed: smoking status, education level, exercise, body mass index (BMI), sleep, and marital status (4). The relative strength of each variable to mortality has been assessed with Cox proportional hazards regression (https://www.sas.com/en_us/home.html). The optimum health group is 'healthy never smokers,' who are defined at entry to be those never smokers with 12+ years of education, regular exercise, $20 \leq \text{BMI} < 30 \text{ kg/m}^2$, 7-8 hours of sleep, and married.

Results. Table 1 compares the 475,792 CPS II white males with US white males and finds these age-adjusted death rate ratios for all causes: 0.62 for all subjects, 0.47 for all never smokers, 0.34 for healthy never smokers. For males 35-64 years of age, the ratios are 0.32 for all never smokers and 0.23 for healthy never smokers. The male cancer ratios are: 0.78 for all subjects, 0.50 for all never smokers, 0.44 for healthy never smokers. For males aged 35-64, the cancer ratios are 0.37 for never smokers and 0.30 for healthy never smokers. For 624,973 CPS II white females, ratios for all causes of death are: 0.56 for all subjects, 0.50 for all never smokers, 0.31 for healthy never smokers. The female cancer ratios are: 0.84 for all subjects, 0.73 for all never smokers, and 0.61 for healthy never smokers. For females aged 35-64, the cancer ratios are 0.72 for all never smokers and 0.57 for healthy never smokers. Relative to 1985 US whites aged 30 years, remaining life expectancy is about 11 years greater for healthy never smoker males and about 7 years greater for healthy never smoker females. Table 2 shows the results of Cox proportional hazards regression for the entire CPS II cohort regarding the relative importance of the health-related factors for all deaths and all cancer deaths. In addition to age and sex, smoking status, exercise, and education were the most significant variables, but BMI, sleep and marital status also contributed.

Discussion. These findings indicate that CPS II subjects following several healthy practices have experienced extensive cancer and other disease prevention. These CPS II findings reveal very low age-adjusted death rate ratios relative to US whites. Healthy never smokers have ratios as low as 0.23. These findings are directly relevant to the original purpose of CPS II to identify factors that cause and prevent cancer, but they have not been previously published. These results add to the findings for other low-risk groups, such as, active California Mormons and a National Health Interview Survey sample with four good health practices (4) and nurses and health professionals with five healthy practices (5). The maximum cancer mortality reduction found in this analysis exceeds the level of potential cancer prevention found in an ACS analysis not based on CPS II (6). Further analysis could reveal even stronger evidence regarding cancer and other disease prevention in this large detailed epidemiologic cohort.

References

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Table 1. Age-adjusted death rate ratios for 1983-1987 CPS II whites versus 1985 US whites for deaths and person-years (p-y) by attained age, using 2000 US Standard Population. Healthy never smokers are defined as those never smokers with 12+ years of education, regular exercise, $20 \leq \text{BMI} < 30 \text{ kg/m}^2$, 7-8 hours of sleep, and married.

| | 1983-1987 CPS II White Deaths/Subjects | 1983-1987 CPS II White Death Rate (deaths/1000 p-y) | 1985 US White Death Rate (deaths/1000 p-y) | CPS II/US Death Rate Ratio |
|-----------------------|---|---|--|----------------------------------|
| Males | | | | |
| All Deaths | | | | |
| Ages 30+ years | | | | |
| All subjects | 33592/475792 | 12.830 | 20.648 | 0.6214 |
| Never smokers | 5820/118486 | 9.725 | | 0.4711 |
| Healthy Never smokers | 1712/51377 | 6.958 | | 0.3370 |
| Ages 35-65 years | | | | |
| All subjects | 10062/347417 | 3.746 | 6.732 | 0.5565 |
| Never smokers | 1364/84988 | 2.174 | | 0.3229 |
| Healthy Never smokers | 491/38433 | 1.568 | | 0.2329 |
| All Cancer Deaths | | | | |
| Ages 30+ | | | | |
| All subjects | 10932/475792 | 3.552 | 4.576 | 0.7831 |
| Never smokers | 1588/118486 | 2.279 | | 0.5025 |
| Healthy Never smokers | 551/51377 | 1.976 | | 0.4356 |
| Ages 35-65 | | | | |
| All subjects | 3789/347417 | 1.347 | 1.862 | 0.7234 |
| Never smokers | 470/84988 | 0.694 | | 0.3729 |
| Healthy Never smokers | 180/38433 | 0.555 | | 0.2981 |
| Females | | | | |
| All Deaths | | | | |
| Ages 30+ | | | | |
| All subjects | 24050/624973 | 7.131 | 12.674 | 0.5625 |
| Never smokers | 11927/328816 | 6.298 | | 0.4968 |
| Healthy Never smokers | 1694/100330 | 3.913 | | 0.3086 |
| Ages 35-65 | | | | |
| All subjects | 6961/458255 | 2.233 | 3.639 | 0.6136 |
| Never smokers | 2620/230196 | 1.753 | | 0.4816 |
| Healthy Never smokers | 798/81393 | 1.337 | | 0.3674 |
| All Cancer Deaths | | | | |
| Ages 30+ | | | | |
| All subjects | 9913/624973 | 2.421 | 2.880 | 0.8406 |
| Never smokers | 4581/328816 | 2.094 | | 0.7272 |
| Healthy Never smokers | 980/100330 | 1.770 | | 0.6143 |
| Ages 35-65 | | | | |
| All subjects | 4238/458255 | 1.376 | 1.594 | 0.8632 |
| Never smokers | 1691/230196 | 1.152 | | 0.7227 |
| Healthy Never smokers | 525/81393 | 0.903 | | 0.5666 |

Table 2. CPS II proportional hazards regression and maximum likelihood estimate for all deaths and all cancer deaths for age, sex, and six health-related variables: Smoking, Education, Exercise, Body Mass Index, Sleep, Marital Status. Category and Proportion of each variable shown for Healthy Never Smokers.

All 58,754 deaths among 1,000,168 subjects with six health-related variables

| Variable | Category and Proportion as Healthy Never Smoker | | Hazard Ratio | 95% Confidence Limit | | Chi-Square |
|---------------------------|--|---------|-----------------|----------------------|-------|------------|
| | Males | Females | | Lower | Upper | |
| Age (in years) | | | 1.096 | 1.095 | 1.096 | 49706.8 |
| Sex (Male, Female) | | | 1.901 | 1.866 | 1.936 | 4755.6 |
| Smoking (3 levels) | Never 0.257 0.562 | | 1.375 | 1.360 | 1.390 | 3228.2 |
| Exercise (4 levels) | Moderate or Heavy 0.758 0.737 | | 0.667 | 0.659 | 0.675 | 4227.2 |
| Education (4 levels) | At Least High School 0.848 0.871 | | 0.901 | 0.895 | 0.907 | 978.7 |
| BMI (2 levels) | 20<=BMI<30 kg/m ² 0.875 0.791 | | 1.327 | 1.300 | 1.354 | 736.6 |
| Sleep (2 levels) | 7-8 Hours 0.737 0.727 | | 1.174 | 1.154 | 1.195 | 334.1 |
| Marital Status (5 levels) | Married 0.947 0.765 | | 1.051 | 1.041 | 1.061 | 97.3 |

All 13,239 cancer deaths among 1,000,168 subjects with six health-related variables

| Variable | Category and Proportion as Healthy Never Smoker (same as for All Deaths) | | Hazard Ratio | 95% Confidence Limit | | Chi-Square |
|---------------------------|--|--|-----------------|----------------------|-------|------------|
| | | | | Lower | Upper | |
| Age (in years) | | | 1.078 | 1.077 | 1.080 | 7474.8 |
| Sex (Male, Female) | | | 1.803 | 1.735 | 1.872 | 921.5 |
| Smoking (3 levels) | Never | | 1.769 | 1.729 | 1.811 | 2369.8 |
| Exercise (4 levels) | Moderate or Heavy | | 0.804 | 0.783 | 0.826 | 254.9 |
| Education (4 levels) | At Least High School | | 0.894 | 0.882 | 0.907 | 249.8 |
| BMI (2 levels) | 20<=BMI<30 kg/m ² | | 1.222 | 1.168 | 1.277 | 77.7 |
| Sleep (2 levels) | 7-8 Hours | | 1.118 | 1.078 | 1.160 | 35.4 |
| Marital Status (5 levels) | Married | | 1.027 | 1.006 | 1.049 | 6.1 |