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Persistence of Health Habits and Their Relationship to Mortality[1]

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This paper explores the relationship of seven personal health practices and subsequent mortality in the 9½ years between an initial survey of 6,928 adults made in Alameda County, California, in 1965 and a follow-up survey in 1974. The seven health practices are: never smoking cigarettes, regular physical activity, moderate or no use of alcohol, 7–8 hr sleep/day regularly, maintaining proper weight, eating breakfast, and not eating between meals. When accumulated to form a health practice score from 0 to 7, the number of health practices showed a striking inverse relationship with age-adjusted mortality rates, especially for men. Men following seven health practices had a mortality rate only 28% that of men following zero to three health practices. Women following seven health practices had a mortality rate 43% that of women following zero to three health practices. Both the health practices themselves and their relationship to mortality are shown to be reasonably stable over the 9½-year period of follow-up. These results lend support to the hypothesis that good health practices and not the initial health status of the survey respondents are largely responsible for the observed mortality relationships. These and other methodological issues are explored.

INTRODUCTION

In 1972, data from the Human Population Laboratory of Alameda County, California, showed a strong relationship between seven health habits and the physical health status of a representative sample of the adult population, ascertained by responses to a questionnaire survey in 1965 (4). For example, the "physical health status of those reported following all seven good health practices was consistently about the same as those 30 years younger who followed few or none of these practices." The seven health habits were: never smoking cigarettes, regular physical activity, moderate or no use of alcohol, 7–8 hr sleep regularly, maintaining proper weight, eating breakfast, and not eating between meals. The association of these seven health habits with physical health status was independent of age, sex, and income level.

In 1973, mortality follow-up of the sample population for 5½ years revealed a strong relationship between the same seven health habits and longevity (2). For example, "the expectation of life (average number of years of life remaining) at age 45 for men in the zero to three health practice group was 21.6 years compared with 33.1 years for those in the six to seven health practice group." This difference of more than 11 years may be compared with the increase in the life expectancy of 45-year-old white men in the United States between 1900 and 1970 of only

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3.3 years (6). The difference between the two health practice groups for women was less, a little over 7 years. The age-adjusted mortality association with health practices was stronger "than it was with physical health status or with income level."

Such data, alone, obviously do not prove that following good health practices as compared with not following them will assure 11 years longer life for men and 7 years for women. Drawing causal inferences from statistical data should be undertaken with considerable care and observing certain principles such as those used in determining that cigarette smoking causes lung cancer (11). Some people appear inclined to cite this data favorably (7, 10); others are inclined to deprecate its significance (12). Separate papers have recently analyzed other aspects of this study (5, 13).

Interpretation of the data from the Human Population Laboratory studies concerning the relationship between health habits and mortality immediately raises two important questions. One of these is whether the seven health habits are stable over time or fluctuate considerably. The second is whether the association between health habits and mortality reflects an influence of the habits on subsequent mortality, or an influence of sickness with impending mortality on the habits. In other words, which is the direction of influence? Some data bearing on these two questions have now become available.

METHODS

The 1965 sample of 6,928 noninstitutionalized adults then living in Alameda County was followed for mortality for 9½ years from July 1, 1965, through December 31, 1974 and the status of the survivors was ascertained a second time by questionnaire during 1974. Among the original 6,928 respondents to the 1965 survey, 682 were certified as dead by the time of the 1974 survey and 717 were certified as dead by the end of 1974. The 1974 survey was conducted around the beginning of 1974 but the mortality follow-up has so far been completed through the end of 1974. Hence, 35 deaths which occurred after the 1974 survey are included in the total of 717. Of the 6,246 presumed survivors at the time of the 1974 survey, 5,974 were actually located in 1974, 5,722 of these received a second questionnaire and 4,864 completed and returned it. The 1974 respondents provided essentially the same information on health habits and many other characteristics as they had provided in 1965. In total, 78% of the presumed survivors of the 1965 survey and 85% of the questionnaire recipients completed the 1974 questionnaire. The nonrespondents did not constitute a seriously biased group according to age, sex, income, and other characteristics examined; there is some variation between the health practice scores of all 1965 respondents and those of all persons who completed the 1974 questionnaire, as shown in Table 1. Persons who did not complete the 1974 questionnaire and the small number who could not be located in 1974, as well as those who had died, had somewhat lower health practice scores in 1965 than did those completing the 1974 questionnaire.

The methodology of this 9½-year follow-up is the same as that used for the earlier 5½-year follow-up (2, 3). The entire cohort of 6,928 persons has been searched for death in California through 1974 and deaths known to have occurred outside California have been included. Also, persons not otherwise located have

TABLE 1
DISTRIBUTION OF 1965 HEALTH PRACTICES SCORE AMONG ALL 1965 QUESTIONNAIRE RESPONDENTS AND VARIOUS CATEGORIES OF THE SAME PERSONS IN THE 1974 FOLLOW-UP SURVEY

Health practice score	All 1965 questionnaire respondents	1974 follow-up status of 1965 respondents [% (No.)]			
		Persons who completed 1974 questionnaire	Persons who received but did not complete 1974 questionnaire	Persons who could not be located in 1974	Persons who died before 1974 enumeration
			Males		
0–3	13 (418)	11 (237)	18 (93)	25 (31)	16 (57)
4	23 (723)	23 (490)	22 (117)	26 (32)	23 (84)
5	30 (937)	29 (630)	30 (155)	31 (38)	32 (114)
6–7	34 (1080)	37 (794)	30 (159)	17 (23)	29 (104)
Total	(3158)	(2151)	(524)	(124)	(359)
			Females		
0–3	12 (444)	11 (289)	15 (88)	20 (30)	12 (37)
4	21 (795)	20 (543)	22 (129)	31 (46)	24 (77)
5	31 (1168)	31 (835)	34 (198)	27 (40)	30 (95)
6–7	36 (1363)	39 (1046)	30 (176)	22 (33)	34 (108)
Total	(3770)	(2713)	(591)	(149)	(317)

been searched for death in their state of birth. The 272 persons lost to follow-up as of 1974 are considered to be alive. The coding and processing of questionnaire and mortality data has been done by the Human Population Laboratory staff and is assumed to be essentially error free. The follow-up was done without knowing the health practices of the individual cohort members. Thus, the follow-up status after 9½ years has been determined for 96% of the original cohort and is unbiased by prior knowledge of health habits. Even though the health practice score distribution is somewhat different for 1974 respondents and nonrespondents, the procedures for mortality follow-up were the same for all persons in the original sample. Mortality rates are presented in terms of the standardized mortality ratio (SMR); for any subgroup, that is the ratio of the deaths observed to the deaths expected based on the age-specific mortality rates for the entire cohort. By this definition, the SMR is 100 for all men and all women in the cohort.

It should be noted that the total number of 375 male deaths and 342 female deaths observed in this cohort is about 80–85% of the number of deaths which would be expected based on California and United States mortality rates for the 1965 to 1974 period. This deficiency in deaths observed may be interpreted as due, in part, to the fact that the cohort included only noninstitutionalized questionnaire respondents, who are healthier and have a lower mortality rate than the population as a whole. Using all 8,074 persons in the originally enumerated sample (of whom 6,928 responded) and correcting for the institutionalized population and out-of-state migration, there was good agreement between the total number of deaths observed and expected after 5½ years of follow-up (3).

RESULTS

Table 2 shows the extent of stability in health practices, determined at two specific times: 1965 and 1974. Thus, among men following only zero to three health practices in 1965, 72% were in the same poor (0–3) health practice group or just one step removed from it, i.e., following four health practices, 9 years later. Only 7% had moved from "poor" health practices (0–3) to "good" practices (6–7). Likewise, among those who were following six to seven of the health practices in 1965, more than 60% were doing the same in 1974 and another 27% had dropped only to five health practices; just 3% changed from good (6–7) to poor (0–3) health practices over the 9-year period. Similar data were found for women. Although no information is available for the intervening years, it does seem that the extent to which the health habits are practiced is reasonably stable. There was not much change, particularly from the classification of good to poor, or vice versa. People seemed to maintain about the same number of health habits in 1974 as they did in 1965, the average being 4.9 in both surveys.

For individual health habits, as well as health habit score, data equivalent to those in Table 2 show that people tended to change little between 1965 and 1974. The change in some health habits that did occur over the 9-year period reflected, in part, trends that were occurring in the entire population. Table 3 shows the trends of seven health practices, based on samples of the Alameda County adult populations in 1965 and in 1974. The data in Table 3 come from the 1965 survey of 6,928 persons, from the 1965 and 1974 status of the 4,864 persons from 1965 who

TABLE 2
COMPARISON OF THE HEALTH PRACTICE SCORES IN 1965 AND 1974 FOR ALAMEDA COUNTY RESIDENTS WHO COMPLETED BOTH QUESTIONNAIRES

1965 Health practice score	Percentage (No.) distribution 1974 health practice score				
	0–3	4	5	6–7	Total
			Men		
0–3	33 (78)	39 (93)	21 (50)	7 (16)	100 (237)
4	19 (94)	31 (150)	36 (177)	14 (69)	100 (490)
5	11 (71)	24 (154)	37 (233)	27 (172)	100 (630)
6–7	3 (23)	7 (57)	27 (215)	63 (499)	100 (794)
Total	(266)	(454)	(675)	(756)	(2151)
			Women		
0–3	44 (129)	35 (101)	16 (45)	5 (14)	100 (289)
4	19 (101)	38 (208)	28 (152)	15 (82)	100 (543)
5	9 (78)	29 (238)	38 (315)	24 (204)	100 (835)
6–7	3 (31)	9 (97)	26 (268)	62 (650)	100 (1046)
Total	(339)	(644)	(780)	(950)	(2713)

completed the 1974 follow-up questionnaire, and from a new 1974 survey of 3,119 persons that represented the entire population at that time—a group different from the 1974 respondents among the original 1965 sample.

Over the 9-year period there was a slight trend toward obesity (20% or more above desirable weight/height ratio) and also toward being underweight. Both extremes are associated with a higher mortality rate than the mean weight/height ratio (2). In other words, obesity and its opposite became somewhat more frequent and thus imposed more of a mortality risk on the population in 1974 than in 1965. On the other hand, cigarette smoking declined substantially in the population, with a drop of more than one-fifth among men and about one-sixth among women. These trends noted in Alameda County, both toward obesity and toward cessation of smoking, are consistent with data for the United States as a whole (1, 9). The other habits remained stable except for a slight tendency away from eating breakfast almost every day.

A second question is whether "poor health habits" merely reflected existing sickness and impending death or could possibly be causally related to mortality. That point occurred early in the course of the Human Population Laboratory work. Other epidemiologic studies have also considered it (8). Recently, additional observers have raised the question. For example, Thomas suggests that, "There were surely some who were already ill when the questionnaire arrived. They didn't eat breakfast because they couldn't stand the sight of food. They had lost their appetites, were losing weight, didn't feel up to moving around much and had trouble sleeping" because they had "undetected cancer . . . early kidney failure, or some other organic disease that the questionnaire had no way of picking up" (12).

In any event, the issue remains as to whether sickness resulted in the poor health habits, or the habits influenced the occurrence of sickness and mortality.

TABLE 3

1965 AND 1974 PERCENTAGE DISTRIBUTIONS OF HEALTH HABITS AMONG ALAMEDA COUNTY ADULT POPULATION

	1965 Survey males			1965 Survey females						
		Persons who also responded in 1974			Persons who also responded in 1974		Males		Females	
	Total 1965 respondents	1965 response	1974 response	Total 1965 respondents	1965 response	1974 response	Total 1965 survey	New 1974 survey	Total 1965 survey	New 1974 survey
Cigarette smoking history										
Never	29	31	32	48	47	49	29	35	48	50
Formerly	21	21	33	11	12	17	21	27	11	16
Currently	49	46	35	40	40	33	49	38	40	33
Weight/height ratio (relative to desirable mean)										
5% or more below	15	13	10	31	32	30	15	16	31	33
5% below to 5% above	25	25	23	26	27	23	25	25	26	24
5–20% above	41	44	45	24	23	25	41	38	24	22
20% or more above	18	18	22	18	18	22	18	21	18	22
Hours of sleep										
6 or less	15	14	18	15	13	19	15	19	15	18
7	42	44	42	36	38	37	42	41	36	36
8	36	37	34	39	40	37	36	34	39	38
9 or more	7	6	6	9	9	7	7	6	9	8

Eat breakfast										
Almost every day	66	67	64	64	65	63	66	57	64	59
Rarely or never	33	33	36	36	35	37	33	43	36	41
Eat between meals										
Rarely or occasionally	73	72	76	69	68	70	73	73	69	65
Almost every day	27	28	24	31	32	30	27	27	31	34
Physical activity										
Often active sports	20	23	18	11	12	9	20	18	11	8
Often swim, garden, exercise	38	38	42	41	43	42	38	36	41	38
Sometimes sports or swim	29	29	30	28	29	29	29	35	28	34
Sometimes garden or exercise	7	6	7	11	10	12	7	6	11	11
Never any of above	6	4	4	9	7	9	6	4	9	8
Amount drink										
None	16	14	15	29	25	25	16	15	29	27
1–2 at a time	50	51	53	55	58	59	50	54	55	56
3–4 at a time	24	25	24	13	14	13	24	22	13	14
5+ at a time	10	10	8	3	3	3	10	8	3	3
Total respondents	(3158)	(2151)	(2151)	(3770)	(2713)	(2713)	(3158)	(1409)	(3770)	(1710)

Data from the Human Population Laboratory cannot alone fully resolve the matter, but some data are now available which bear, perhaps importantly, on it. If serious preexisting illness were substantially responsible for the low weight, not being up to moving around much, or trouble sleeping reported in 1965, then one would expect that a very high proportion of the excess mortality would occur within 2½ or at least within 5 years, and that the excess would not persist much after 5 years.

Table 4 indicates that there was a relatively high mortality, about two-and-a-half times the expected, during the first 2½ years, among both men and women who followed zero to three of the health habits. The 21.7 excess deaths (36 − 14.3) in those categories may have been due, in part, to sickness and impending fatality in the respondents who died. That particular excess—21.7 deaths—accounted, however, for only a small proportion of the deaths observed in the total sample. The mortality gradient expressed as a standardized mortality ratio (SMR) associated with numbers of health habits is quite substantial and quite consistent for both sexes during the first 2½ years, the next 3 years, and the last 4 years thus far studied. Although it diminishes slightly, the association does not "wash out" after 2½ or even 5½ years as one would expect if it were due largely to lost appetites, lost weight, lost mobility, and lost sleep occurring as a result of existing sickness and impending death at the beginning of study.

Over the entire 9½-year period, men following six to seven health practices had an SMR only 37% that of men following zero to three health practices. During the final 4 years of observation, 5½ years and more after the start when the influences of impending death on health habits would seem to have been largely vitiated, men with a health practice score of 6−7 still had an SMR only 50% (78/155) that of men with a 0−3 health practice score at the outset in 1965. Women following six to seven health practices had an SMR 50% that of women following zero to three health practices over the entire 9½ years of follow-up, and 60% (75/126) during the final 4 years. For both sexes combined, the SMR values (based on observed and expected deaths) in the three health practice groups are significantly different at the level of $P < 0.01$ for each time period, using χ^2 test with two degrees of freedom. For men and women separately, the SMR values are significantly different at the level of $P < 0.05$ for each sex and time period, except the middle time period for females. There are only two degrees of freedom in the three groups because the total number of expected deaths is defined to equal the total number of observed deaths, as mentioned earlier.

As a point of clarification, the absolute mortality rate in the total sample during the first 2½ years of follow-up was not high. Indeed, it was somewhat less than expected based on mortality rates in the total Alameda County population (3). This fact is in accordance with other prospective studies; they usually show lower than expected mortality rates initially because very sick persons do not usually participate in questionnaire studies (11). What we have observed is that the mortality rate for those following zero to three health practices is relatively high compared with the rate for those in the survey following more health practices.

Table 5 presents sex- and age-specific mortality rates, as well as age-adjusted rates, according to health practice score, over the entire 9½-year period. There is a

TABLE 4

OBSERVED AND EXPECTED DEATHS AND STANDARDIZED MORTALITY RATIOS (SMRs) DURING 9½ YEARS AMONG ALAMEDA COUNTY ADULTS WHO FOLLOWED VARYING NUMBERS OF HEALTH PRACTICES IN 1965[a]

1965 Health Practice Score[b]	Deaths in first 2½ years (7-65 to 12-67) among original cohort			Deaths in next 3 years (1-68 to 12-70) among cohort alive in 1-68			Deaths in last 4 years (1-71 to 12-74) among cohort alive in 1-71			Deaths in total 9½ years (7-65 to 12-74) among original cohort		
	Obs	Exp	SMR	Obs	Exp	SMR	Obs	Exp	SMR	Obs	Exp	SMR
Men												
0–3	22	8.7	253	18	9.5	189	20	12.9	155	60	31.1	193
4–5	47	45.3	104	65	58.4	111	93	83.9	111	205	187.6	109
6–7	20	35.3	57	34	49.0	69	56	71.5	78	110	155.8	71
Women												
0–3	14	5.6	250	11	7.7	143	14	11.1	126	39	24.4	160
4–5	37	37.7	98	58	55.1	105	88	75.0	117	183	167.8	109
6–7	26	33.2	78	44	49.6	89	50	66.8	75	120	149.6	80
Both sexes												
0–3	36	14.3	252	29	17.2	169	34	24.0	142	99	55.5	178
4–5	84	83.0	101	123	113.5	108	181	158.9	114	388	355.4	109
6–7	46	68.5	67	78	98.6	79	106	138.3	77	230	305.4	75

[a] Expected deaths based on age-specific proportions dying in the total male and female samples; using this method of calculation, the number of observed deaths equals the number of expected deaths in the total male and female samples.

[b] Health practice score is number of positive responses to the following items: never smoked cigarettes; drink not more than four drinks at a time; often or sometimes engage in active sports, swim or take long walks, or often garden or do physical exercises; weight for men between 5% under and 20% over desirable weight for height and weight for women not more than 10% over desirable weight for height; usually sleep 7 or 8 hr; eat breakfast almost every day; eat between meals once in a while, rarely, or never.

TABLE 5
MORTALITY RATES (PROPORTION DYING IN 9½ YEARS) BY HEALTH PRACTICE SCORE BY AGE (IN 1965) AND SEX

Health practice score	Men (by age in 1965)					
	Age-adjusted rate[a]	Under 45	45–54	55–64	65–74	75+
0–3	0.200 (60)[b]	0.046 (13)	0.189 (14)	0.379 (11)	0.625 (15)	0.875 (7)
4	0.141 (84)	0.021 (9)	0.109 (17)	0.202 (17)	0.488 (21)	0.952 (20)
5	0.134 (121)	0.013 (7)	0.099 (18)	0.265 (31)	0.494 (38)	0.750 (27)
6	0.110 (91)	0.024 (10)	0.077 (13)	0.189 (21)	0.366 (26)	0.618 (21)
7	0.055 (19)	0.000 (0)	0.018 (1)	0.089 (4)	0.226 (7)	0.467 (7)
Total	0.127 (375)	0.022 (39)	0.099 (63)	0.218 (84)	0.435 (107)	0.719 (82)
	Number of persons in 1965 survey					
0–3	418	283	74	29	24	8
4	723	419	156	84	43	21
5	937	526	181	117	77	36
6	798	413	169	111	71	34
7	282	135	56	45	31	15
Total	3158	1776	636	386	246	114

[a] Age-adjusted by the direct method to the total 1965 survey sample.
[b] Number of deaths upon which rate is based is given in parentheses.

fairly steady decrease in age-adjusted death rate with increasing health practice score. The mortality gradient is steeper for younger men than for older men. Men following seven practices had a mortality rate only 43% that of all men in the survey and only 28% that of men following zero to three practices. Women following seven practices had a mortality rate 62% that of all women in the survey and 43% that of women following zero to three practices. These relationships are consistent with those observed after 5½ years of follow-up (2).

Mortality rates by sex and individual health practice are shown in Table 6, and give an indication of the relationship of the several habits to mortality. To assess the relative importance of the individual habits, a multivariate analysis would, of course, be desirable. That has not been done because of the relatively small number of deaths in the various cells.

Table 7 shows the mortality rates for each sex, according to health practice score for three major groups of causes of death—cancer, total cardiovascular diseases, and all other causes. It is evident that, particularly for men, the mortality gradient persists generally for the major groups of causes of death. The mortality gradient is statistically significant at the $P < 0.05$ level for total cardiovascular diseases and all other causes, but not for cancer. The association between health practice score and total mortality is not attributable to one cause of death or one major group of diseases.

Further evidence bearing on the possible direction of the relationship between mortality and health practices may be seen by examining initial health status. As might be expected, disabled persons experienced a higher mortality rate during

TABLE 5—*continued*

Women (by age in 1965)					
Age-adjusted rate	Under 45	45–54	55–64	65–74	75+
0.123 (39)	0.029 (8)	0.066 (6)	0.200 (10)	0.429 (9)	0.750 (6)
0.108 (79)	0.024 (11)	0.063 (9)	0.175 (18)	0.348 (16)	0.694 (25)
0.082 (104)	0.017 (11)	0.023 (5)	0.121 (15)	0.325 (37)	0.571 (36)
0.077 (91)	0.024 (12)	0.065 (11)	0.087 (12)	0.237 (23)	0.465 (33)
0.053 (29)	0.000 (0)	0.016 (1)	0.077 (4)	0.065 (3)	0.750 (21)
0.086 (342)	0.022 (42)	0.047 (32)	0.126 (59)	0.272 (88)	0.587 (121)
		Number of persons in 1965 survey			
444	274	91	50	21	8
795	468	142	103	46	36
1168	648	219	124	114	63
977	503	168	138	97	71
386	199	61	52	46	28
3770	2092	681	467	324	206

the 9½-years of follow-up than did persons with better physical health status at the outset. The gradient with health practice score, however, persists generally through all degrees of physical health status, as seen in Table 8. The gradients, although fairly consistent, are not statistically significant of the $P < 0.05$ level except for men who had symptoms only or no complaints. Thus it appears again that the mortality–health practice association cannot be explained on the basis of original physical health status.

DISCUSSION

The data presented here indicate support for the idea that following poor health habits leads to earlier death and following good health habits leads to longer life. One can hardly interpret Table 4 as supporting the idea that the excess deaths among those with poorer habits were due largely to existing serious illness and impending death. It does appear that the high relative mortality during the first 2½ years among those with poor health habits could reflect in some part their poor health at the time of interview. The continued and substantially higher mortality throughout the entire 9½ years among those with poor health habits, however, is much more consistent with the notion that poor health habits tend to reduce life expectancy. The drop in gradient during the later years is probably due in some degree to the higher death rate among those with poor health habits during the first 5½ years.

The substantially better mortality experience among those who followed six to seven health habits, compared with those who followed fewer, extended among both men and women through the last 4 years of the 9½-year follow-up period.

TABLE 6
AGE-ADJUSTED MORTALITY RATES (PROPORTION DYING IN 9½ YEARS) BY HEALTH PRACTICE AND SEX

Health practice	Age-adjusted rate[a]	
	Men	Women
Weight/height ratio (relative to desirable mean)		
10% or more below	0.218	0.117
5–10% below	0.156	0.063
5% below to 5% above	0.134	0.079
5–10% above	0.090	0.068
10–20% above	0.103	0.077
20–30% above	0.108	0.077
30% or more above	0.155	0.100
Smoking history		
Never	0.091	0.070
Formerly	0.104	0.120
Now	0.154	0.106
Amount now smoke		
1 pack/day	0.126	0.106
1–1½ pack/day	0.162	0.104
2+ pack/day	0.200	[b]
Amount drink		
None	0.119	0.094
1–2 at one time	0.111	0.074
3–4 at one time	0.122	0.074
5 or more at one time	0.162	[b]
Physical activity		
Often active sports	0.068	[b]
Often swim, garden, exercise	0.118	0.065
Sometimes sports or swim	0.124	0.076
Sometimes garden or exercise	0.150	0.082
Never any of above	0.186	0.161
Eat breakfast		
Almost every day	0.116	0.078
Rarely or sometimes	0.163	0.100
Eat between meals		
Rarely or occasionally	0.119	0.083
Almost every day	0.143	0.081
Hours of sleep		
6 or less	0.156	0.097
7	0.115	0.068
8	0.111	0.081
9 or more	0.139	0.104
Total cohort	0.127	0.086

[a] Age-adjusted by the direct method to the total 1965 survey sample.
[b] Insufficient numbers in some age categories to calculate age-adjusted rate.

TABLE 7

STANDARDIZED MORTALITY RATIOS (BASED ON PROPORTION DYING IN 9½ YEARS) FROM MAJOR GROUP CAUSES OF DEATH, ACCORDING TO HEALTH PRACTICE SCORE FOR EACH SEX[a]

Health practice score	Men by group cause of death			Women by group cause of death		
	Cancer ICD 140–209[b]	Total cardiovascular diseases ICD 390–458	All other causes	Cancer ICD 140–209	Total cardiovascular diseases ICD 390–458	All other causes
0–3	174 (11)	169 (34)	157 (15)	97 (7)	144 (18)	207 (14)
4–5	106 (37)	102 (113)	121 (55)	120 (48)	110 (104)	88 (31)
6–7	74 (20)	82 (72)	55 (18)	77 (25)	82 (70)	90 (25)
Total	100 (68)	100 (219)	100 (88)	100 (80)	100 (192)	100 (70)

[a] Percentage ratio of observed deaths (in parentheses) to expected deaths. Expected deaths based on age-specific proportion of deaths for total persons within each sex and disease category.

[b] ICD indicates Internation Classification of Diseases, Eighth Revision, numbers defining cancer and total cardiovascular diseases.

TABLE 8

STANDARDIZED MORTALITY RATIOS (BASED ON PROPORTION DYING FROM ALL CAUSES IN 9½ YEARS) FOR MEN AND WOMEN WITH VARIOUS DEGREES OF PHYSICAL HEALTH IN 1965, ACCORDING TO HEALTH PRACTICE SCORE[a]

	Men by 1965 physical health status			Women by 1965 physical health status		
	Disabled	Chronic conditions	Symptoms only or no complaints	Disabled	Chronic conditions	Symptoms only or no complaints
0–3	136 (29)	141 (14)	187 (17)	117 (24)	118 (8)	158 (7)
4–5	102 (82)	110 (70)	107 (53)	105 (99)	112 (55)	95 (29)
6–7	79 (34)	80 (42)	75 (34)	84 (43)	84 (38)	97 (39)
Total	100 (145)	100 (126)	100 (104)	100 (166)	100 (101)	100 (75)

[a] Percentage ratio of observed deaths (in parentheses) to expected deaths. Expected deaths based on age-specific proportion of deaths for total persons within each sex and health status category.

That fact supports the hypothesis that following good health habits favors longevity.

In dealing with common diseases of the mid-20th century, it is often possible to arrive at reasonable conclusions about statistical relationships and to take appropriate action without understanding the cellular and other pathologic mechanisms of disease. Obviously, the more advanced our knowledge of mechanisms and of specific therapy, the greater the possibility of being able to cope effectively with disease. Still, substantial health improvements through prevention, over the centuries and up to the present time, have reflected prudent interpretation of the associations noted between ways of living and health. That seems likely to continue.

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REFERENCES

1. "Adult Use of Tobacco—1975." National Clearing House for Smoking and Health, Public Health Service, U.S. Department of Health, Education and Welfare, 1976.
2. Belloc, N. B. Relationship of health practices and mortality. *Prev. Med.* **2**, 67–81 (1973).
3. Belloc, N. B., and Arellano, M. Computer record linkage on a survey population. *Health Serv. Rep.* **88**, 344–350 (1973).
4. Belloc, N. B., and Breslow, L. Relationship of health status and health practices. *Prev. Med.* **1**, 409–421 (1972).
5. Berkman, L. F., and Syme, S. L. Social networks, host resistance, and mortality: a nine-year follow-up study of Alameda County residents. *Amer J. Epidemiol.* **109**, 186–204 (1979).
6. "Facts of Life and Death." National Center for Health Statistics. DHEW Publ. No. (PHS) 79-1222. U.S. Gov. Printing Office, Washington, D.C., 1978.
7. Gori, G. B.,and Richter, B. J. Macroeconomics of disease prevention in the United States. *Science* **200**, 1124–1130 (1978).
8. Hammond, E. C., and Garfinkel, L. The influence of health on smoking habits. *Nat. Cancer Inst. Monogr.* **19**, 269–285 (1966).
9. "Height and Weight of Adults 18–74 Years of Age: United States, 1971-74." DHEW Publ. No. (PHS) 79–1659, National Center for Health Statistics, Hyattsville, Md., 1979.
10. Shapiro, S. Measuring the effectiveness of prevention, II. *Milbank Memorial Fund Quart.* **55**, 291–306 (1977).
11. "Smoking and Health—Report of the Advisory Committee to the Surgeon General of the Public Health Service." Public Health Service Publ. No. 1103. U.S. Gov. Printing Office, Washington, D.C., 1964.
12. Thomas, L. Notes of a biology-watcher on magic in medicine. *New Engl. J. Med.* **299**, 461–463 (1978).
13. Wiley, J. A., and Camacho, T. C. Life-style and future health: evidence from the Alameda County study. *Prev. Med.* **9**, 1–21 (1980).