Sedentary Lifestyle and State Variation in Coronary Heart Disease Mortality

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Synopsis

Using linear regression, the authors demonstrated a strong association between State-specific coronary heart disease mortality rates and State prevalence of sedentary lifestyle (r^2 = *0.34;* P = *0.0002) that remained significant after controlling for the prevalence of diagnosed hypertension, smoking, and overweight among the State's population.*

This ecologic analysis suggests that sedentary lifestyle may explain State variation in coronary heart disease mortality and reinforces the need to include physical activity promotion as a part of programs in the States to prevent heart disease.

In 1953, Morris and colleagues reported that men with physically active jobs had a lower incidence of coronary heart disease (CHD) than did men with jobs requiring little or no physical activity (*1*). Since then, multiple studies have demonstrated a similar relationship between physical activity and CHD (*2,3*) or change in physical activity and CHD (*4*). In a recent study, a positive effect of low-to-moderate levels of physical fitness on all-cause mortality as well as CHD mortality was reported, suggesting that even modest increases in physical activity among sedentary persons can result in significant health benefits (*5*).

The results of these and other studies have led the American Heart Association to publish a position paper encouraging the general population to increase physical activity (*6*).

Some studies have found substantial State-to-State variation in physical inactivity, or sedentary lifestyle, in the United States (*7,8*) as well as considerable geographic variation in CHD mortality (*9–11*). In this study, we assessed the extent to which variation in the State-to-State prevalence of sedentary lifestyle may contribute to variation in CHD mortality.

Methods

This ecological study used two data sources—mortality data from the National Underlying Cause of Death files for 1988 and risk factor data from the 1988 Behavioral Risk Factor Surveillance System (BRFSS). Mortality data for men and women between ages 20 and 74 years were summarized by State of residence, year of death, sex, and 5-year age groups for the CHD cause-of-death categories (ICD-9 codes 410–414 and 429.2) (*12*). All mortality data were age-adjusted to the 1980 census data by the direct method.

The BRFSS provides estimates of the prevalence of health practices related to the leading causes of morbidity and mortality in the United States (*13*) by using a relatively low-cost telephone survey method (*14*). The questionnaire includes a set of core questions that are used in every State. Sedentary lifestyle in this analysis was defined as either no leisure-time physical activity in the past month or irregular physical activity (less than 3 times per week or less than 20 minutes per session).

We considered three potentially confounding variables related to sedentary lifestyle or CHD mortality—hypertension, smoking, and overweight. Because there were no blood pressure measurements, persons defined as hypertensive were those who reported being told by a physician on more than one occasion that they had high blood pressure or who were currently taking antihypertensive medication. Current smokers were defined as persons who had smoked at least 100 cigarettes and were smokers at the time of the interview. Using the respondents' self-reported weight and height, we defined them as overweight if they had a body mass index calculated by kilograms of weight divided by height in meters squared of 27.8 or higher for men and 27.3 or higher for women. These definitions were consistent with those currently used to monitor lifestyle characteristics (*15*).

Using the computer program SESUDAAN (*13*) and the BRFSS data from the 37 States that conducted surveys in 1988, we generated State-specific estimates of the prevalence of sedentary behavior, hypertension, current smoking, and overweight. These prevalence estimates were age-adjusted to the 1980 census data by the direct method. For the regression analyses, each of the 37 participating States was a unit of analysis. The dependent variable was each State's age-adjusted CHD mortality rate. The independent variables were the age-adjusted, State-specific prevalences of risk factors from the BRFSS.

Results

In 1988, the age-adjusted CHD mortality rates ranged from 232.5 per 100,000 in Hawaii to 387.1 per 100,000 in New York (table 1). The prevalence of sedentary lifestyle ranged from 46 percent in Montana to 74 percent in New York (table 1). Using linear regression, we found a significant association between CHD mortality and the prevalence of sedentary lifestyle (r^2 = 0.34, P = 0.0002). The results did not vary by sex.

Because CHD mortality rates vary considerably by age, we stratified the data into four age groups. These separate regression analyses indicated that sedentary lifestyle was associated with CHD mortality in all age groups, but the associations were strongest in the 35–49 and 50–64 age groups (table 2).

We addressed potential confounding by using a multiple regression analysis that included State-specific prevalence estimates of hypertension, current smoking, and overweight. Overall, the model improved (r^2 = 0.55, P < 0.001), and, although smoking (regression coefficient = 0.39, P = 0.01) had the strongest effect on the model, sedentary lifestyle remained significantly associated with CHD mortality (regression coefficient = 0.32, P = 0.03). Using a stepwise procedure, only smoking and sedentary lifestyle remained in the model.

Table 1. State-specific age-adjusted[1] coronary heart disease (CHD) mortality rates and sedentary lifestyle prevalence, 1988

State[2]	*CHD mortality rate*[3]	*Rank*	*Percent sedentary*	*Rank*
New York	387.1	1	74.2	1
Michigan	374.7	2	55.0	25
West Virginia	353.9	3	65.7	6
Illinois	350.4	4	58.2	21
Ohio	342.0	5	64.0	10
North Carolina	341.8	6	64.2	11
Kentucky	340.5	7	67.4	4
South Carolina	340.3	8	66.2	5
Oklahoma	337.9	9	60.6	14
Tennessee	337.5	10	68.0	2
Indiana	325.4	11	60.8	13
Rhode Island	321.9	12	65.1	7
Maine	316.7	13	59.2	18
California	312.5	14	49.5	35
Wisconsin	306.9	15	55.0	26
Georgia	304.3	16	64.8	9
Maryland	303.1	17	64.9	8
Florida	302.4	18	52.6	31
Missouri	302.3	19	60.1	16
Iowa	301.3	20	58.8	19
Massachusetts	298.1	21	53.1	29
New Hampshire	294.5	22	56.3	24
Connecticut	289.0	23	57.1	22
South Dakota	288.1	24	57.1	23
Arizona	286.6	25	53.1	30
Washington	281.1	26	46.5	36
Alabama	281.0	27	58.5	20
North Dakota	265.8	28	59.1	17
Texas	262.6	29	60.4	15
District of Columbia	262.5	30	68.0	3
Nebraska	257.3	31	61.3	12
Minnesota	253.5	32	54.5	27
Idaho	251.4	33	51.7	32
Montana	245.5	34	46.3	33
Utah	240.5	35	50.5	34
New Mexico	239.6	36	51.7	33
Hawaii	232.5	37	53.2	28

[1] Age-adjusted to population in the 1980 census.
[2] Only the 37 States included in the 1988 BRFSS are listed.
[3] Per 100,000.

Discussion

The current study demonstrates an association of sedentary lifestyle with State variation in CHD mortality even after adjusting for variation in the prevalence of smoking, overweight, and hypertension among the population. The plausibility of this aggregate level association between sedentary lifestyle and CHD mortality is strengthened by the evidence of physical inactivity and CHD mortality at the individual level (*2,3*). We cannot rule out the possibility, however, that other factors operative at the aggregate level are influencing CHD mortality rates and may also confound our results (*17*).

Several other studies have identified aggregate level factors that were associated with CHD mortality. Using data from the BRFSS, Winkelstein (*18*) demonstrated that State-to-State differences in the prevalence of smoking were correlated with mortality rates from ischemic heart disease. In 1986, Simons conducted an ecological analysis to determine the contribution of cholesterol variation to variation in CHD mortality rates among countries (*19*). The investigators found that 55 percent of the variation

Table 2. Summary of linear regression results for 37 States: coronary heart disease mortality and sedentary lifestyle, by age groups

Age groups	*Model r^2*	*P value*
Entire sample	0.34	0.0002
20–34 years	0.10	0.05
35–49 years	0.41	0.0001
50–64 years	0.38	0.0001
65–74 years	0.18	0.0087

could be explained by regional differences in the ratio of total cholesterol to high-density lipoprotein cholesterol. On the basis of their findings of substantial variation in ischemic heart disease mortality by "State economic areas," Wing and coworkers suggested that differences in community characteristics might explain some of this variation (*20*).

There are limitations to this analysis that must also be considered. Our measure of sedentary lifestyle has not been validated in a large sample. However, the test-retest reliability of the BRFSS question regarding regular physical activity (kappa = 0.65; $P < 0.001$) suggests acceptable reliability of this measure (*21*). In our analysis, however, we did not use regular physical activity but sedentary lifestyle, which we would expect to have higher reliability. Also, in this analysis, we make the assumption that the prevalence of the risk factor (sedentary lifestyle) among the State's population has not changed substantially over time. This assumption is supported by analysis of the 26 States that have been participating in BRFSS since 1986. A Spearman ranked correlation using BRFSS data on sedentary lifestyle (*15*) found correlations of 0.7 between the State rankings in 1986–87 and 0.9 in 1987–88. However, we cannot account for the possible contribution of a "phase lag" between sedentary lifestyle and CHD mortality.

We would have wanted to have some measure of socioeconomic status to include as a control variable. Using age-adjusted educational attainment might have diluted the differences among the States for that variable. We also would have wanted to report the results by ethnicity, but the population of nonwhites for most States was too small for reliable estimates.

In summary, these data support the mounting evidence pointing to the deleterious effects of physical inactivity. These findings also highlight the need to target sedentary lifestyle in State CHD prevention programs.

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