LIFESTYLE RISK FACTORS FOR CHRONIC DISEASE IN A MULTIETHNIC POPULATION: AN ANALYSIS OF TWO PROSPECTIVE STUDIES OVER A 20-YEAR PERIOD

Gertraud Maskarinec, MD, PhD; Linda Carlin, PhD; Ian Pagano, PhD; Jennifer Yamamoto, BS; Dianne Shumay, PhD; Lynne R. Wilkens, DrPH; Laurence N. Kolonel, MD, PhD

Objective: This study investigated changes in risk factors in Hawaii over 20 years and compared health behaviors among ethnic groups with well-documented differences in disease risk.

Design: Comparison of scores of a Chronic Disease Risk Index (CDRI) in the population of two large population-based cohorts.

Participants: The respective sample sizes for the two cohorts were 19,319 and 97,746 persons ages ≥40 years of White, Chinese, Filipino, Japanese, and Native Hawaiian ancestry.

Main Outcome Measures: The CDRI included smoking status, alcohol use, meat intake, fruit and vegetable consumption, and body mass index. Mean total and component scores were compared over time and by ethnic group after adjustment for age and education.

Results: We found a reduction in overall CDRI scores, ie, improved health profiles, for both men and women over time. Men, Native Hawaiians, and Whites had higher CDRI scores than women and Japanese, Chinese, and Filipinos due to their higher scores for smoking, alcohol use, and overweight, whereas nutritional intakes were similar in all ethnic categories. Smoking, alcohol use, and overweight increased over time in both men and women, whereas dietary composition appeared to improve.

Conclusions: This analysis suggests an overall reduction in modifiable dietary and lifestyle risk factors in Hawaii over time. Persistent differences by sex and ethnic category indicate that interventions to modify lifestyle factors need to tailor messages to the groups at highest risk. (*Ethn Dis*. 2007;17:597–603)

Key Words: Risk Factors, Ethnicity, Cancer, Chronic Disease, Nutrition, Smoking, Alcohol Use

From the Cancer Research Center of Hawaii, University of Hawaii, Honolulu, HI (GM, IP, JY, DS, LRW, LNK); and Battelle Seattle Research Center, Seattle, WA (LC).

Address correspondence and reprint requests to Gertraud Maskarinec, MD, PhD; Professor; Cancer Research Center of Hawaii; 1236 Lauhala Street, Honolulu, HI 96813; 808-586-3078; 808-586-2984 (fax); gertraud@crch.hawaii.edu

INTRODUCTION

Chronic diseases account for 7 out of 10 deaths and 75% of medical expenses in the United States.[1] A number of lifestyle factors have been linked to the risk for cancer, coronary heart disease, stroke, and type 2 diabetes.[2–4] In addition to smoking, alcohol use, meat intake, fruit and vegetable consumption, overweight and obesity appear to play roles in cancer etiology.[5] Smoking is considered the single most preventable cause of death and disease in the United States. In 1990, one in five deaths was smoking-related, totaling more than 430,000 people. Estimated annual smoking-related medical costs in the United States are in the range of $50–73 billion.[6] Although adult smoking rates have decreased since the 1964 Surgeon General's report highlighted the harmful effects of smoking, smoking prevalence nationwide remains approximately 25% for men and 20% for women.[7] The relationship of alcohol to health is more complicated. Light to moderate drinking has been shown to be beneficial for cardiovascular health.[8] However, heavy alcohol consumption has been associated with liver disease, heart disease, and a higher risk for cancer of the mouth, larynx, pharynx, liver, and esophagus and possibly also colorectal and breast cancer.[5,9–11] In addition, a recent estimate of the economic cost of alcohol abuse by the National Institute on Alcohol Abuse and Alcoholism attributed about $20 million annually to alcohol-related medical expenses.[12] Dramatic increases in overweight and obesity have been seen in the United States during the last 30 years.[13] Currently, 65% of adults are overweight (BMI>25), and 30% are obese (BMI>30).[14] Medical and loss-of-productivity costs attributable to obesity alone in 1995 were estimated to be $99 million. Despite the widespread promulgation of dietary guidelines to promote health, most Americans have increased caloric intake to exceed their caloric expenditure. In addition, they are consuming too much saturated fat and too few vegetables, fruits, and grains.[6]

The Cancer Research Center of Hawaii (CRCH) conducted two large population-based prospective studies, 20 years apart, to investigate the relation between dietary and lifestyle risk factors and cancer. In both studies, the participants provided information about lifestyle and nutritional risk factors. An analysis of the baseline data from the earlier cohort (1970s) included the development of a Chronic Disease Risk Index (CDRI).[15] This index summarized adherence to recommended health guidelines as a combined measure of modifiable health risk factors, including smoking status, alcohol intake, dietary habits, and body mass index (BMI). The scores for the levels of risk were based on previous study results that examined their relation with disease outcomes. A higher CDRI was significantly associated with higher cancer incidence and mortality and higher mortality from coronary heart disease and stroke. The objective of the current study was to investigate changes in lifestyle risk factors over a 20-year period in Hawaii. Given the ethnic

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METHODS

Study Population

Data for the first cohort study, the Hawaii Health Surveillance Program Cohort (HHSPC),[22] were collected during face-to-face interviews as part of an annual household survey conducted by the Hawaii Department of Health (DOH).[23] It included a random 2% sample of the state's population using all housing units in the state as a sampling frame. Because the participation rate was above 80%,[24] the cohort can be considered representative of the general population. From 1975 to 1980, in addition to the standard DOH questionnaire, which included information on education and history of illness, a two-page questionnaire was added for the CRCH, to collect information about dietary habits, smoking history, alcohol intake, and self-reported height and weight.[22] The short dietary questionnaire collected information on how frequently certain common food items (meat, fruits and vegetables, dairy products, etc.) were consumed, but did not allow the estimation of total caloric intake. Although one person provided information for all household members 18 years or older to the DOH, all family members completed their own lifestyle questionnaire. The original HHSPC cohort excluded individuals who were considered transient because it would not have been possible to obtain follow-up information for them. In the present analysis, we truncated the population to those in 40- to 80-year age groups to allow comparison with the later cohort. The resulting dataset had information for 20,864 people. Due to the truncation, only 5.8% of males and 6.5% of females were part of the same household. After excluding the 1,545 (7.4%) individuals with missing information for education, smoking, BMI, or diet, 19,319 persons were available for analysis.

Data for the second cohort study, referred to herein as the Multiethnic Cohort (MEC), were collected between 1993–1996 using a 26-page self-administered mail questionnaire sent to residents of Hawaii and Los Angeles, California.[25] Hawaii residents were identified through state drivers' licenses and voter registration records which, together, cover close to 100% of the population. Whites, Japanese, and Native Hawaiians were the primary targets for recruitment, but a small number of persons of other ethnic backgrounds were also enrolled in the study. Participation in the cohort was limited to people between the ages of 45–75 years in 1993, except for Native Hawaiians who were recruited at ≥42 years of age. The response rates were very similar by ethnic category. They were 46% and 51% for Japanese men and women; 39% and 47% for White men and women; and 36% and 42% for Native Hawaiian men and women. The questionnaire included a detailed dietary history, as well as demographic information, body weight and height, and many other items.[26] The dietary history asked about the consumption of approximately 180 foods in the past year including eight or nine frequency categories and three portion sizes, illustrated with photographs. The dietary protocol was designed to capture more than 85% of the total intake of macronutrients and the major micronutrients from each ethnic group.[26] Nutrient intakes were estimated using the CRCH Food Composition Database.[27] Although the entire MEC dataset consists of 215,251 people, only the 103,899 individuals residing in Hawaii were included in the current analysis. After excluding the 6,153 (5.9%) persons with missing CDRI score and education, 97,746 individuals from the MEC were included in the final analysis. Due to its population-based recruitment strategies and the relatively high response rates, the cohort members are fairly representative of the population in Hawaii; in a comparison with census data, the cohort members showed a very similar distribution of educational achievement.[25]

Study Variables

We selected the same variables from the HHSPC study as were used in the development of the original CDRI,[15] except that we excluded dairy foods because their health effects may be beneficial rather than harmful for some cancers.[5] Comparable variables from the MEC study were checked for consistency with variables from the HHSPC study, and coding modifications were made where necessary.[26] Ethnic classification followed the guidelines used by the Hawaii Department of Health. Respondents to both questionnaires reported multiple ethnic backgrounds for themselves and their parents, but they were not asked about self-identification or socioeconomic status. People with any Hawaiian ancestry were classified as Native Hawaiian. Individuals who reported White and Asian ancestries were classified as the respective Asian category. Determination of ethnicity for people with more than one Asian ethnicity was

Table 1. Scoring for the Chronic Disease Risk Index (CDRI)*

CDRI Component	Score				
	0	1	2	3	4
Smoking	Never smoker	Former smoker	Current ≤1 ppd†	Current 1<ppd≤1.5	Current >1.5 ppd
Alcohol use					
Men	0–7 drinks/week	>7 drinks/week	-	-	-
Women	0–3 drinks/week	>3 drinks/week	-	-	-
Meat intake	1 or less serving/day	>1 serving/day	-	-	-
Fruit and vegetable intake	≥3 servings/day	<3 serving/day	-	-	-
Body mass index	≥18.5 and <25 kg/m^2	<18.5 or >25–<30 kg/m^2	30.0–34.9 kg/m^2	≥35.0 kg/m^2	-

* Range of scores is 0–10.
† Packs per day.

handled differently in the two original studies. In the HHSPC study, which was conducted by interview, the person was classified by the ethnic category mentioned first. In the MEC study, which was a mail questionnaire, the person was classified by the mother's ancestry first or, if necessary, the father's background. In cases where multiple Asian ethnicities were reported, coding was based on the following priority: Japanese, Chinese, Filipino, and Other. Because immigration from Asia to Hawaii primarily took place more than 100 years ago,[28] the majority of our study subjects were born in Hawaii and are, therefore, Asian-Americans. To reduce wordiness, we refer to them as Chinese, Japanese, and Filipinos in this paper.

Smoking status was reported as "never smoker," "former smoker," or "current smoker" (of cigarettes only) in both questionnaires. Current smokers also reported their average number of cigarettes per day. In the HHSPC study, subjects reported whether they drank alcohol (beer, wine, sake, hard liquor), and if so, how many drinks per week. In the MEC study, alcohol consumption was part of the detailed food frequency questionnaire. Based on the frequency and serving size for the five questionnaire items (beer, light beer, white wine, red wine, and hard liquor), we estimated the number of drinks per week. Given the relatively low alcohol intake in this population,[29] we separated never and moderate drinkers from heavy drinkers using three drinks per week for women and seven drinks per week for men as upper limits for moderate drinking. Although the MEC study collected extensive dietary information, inclusion of dietary data from the MEC study was limited by the variables that had been included in the HHSPC study. Dietary variables used in the original CDRI included intake of fresh fruit, raw vegetables and animal products (pork, poultry, beef, processed meats, fish, dried or salted fish, eggs, and milk). For the updated CDRI, we limited the food items to fruits, vegetables, and red meat products including processed meat and pork because the scientific evidence for an association with cancer risk is strongest for these three food groups.[5] Frequency of fruit, vegetable and meat intake without information on serving size was used for both studies because information on serving size was not collected in the HHSPC study. Categorization of BMI was based on current standards as follows: underweight (< 18.5), normal weight (18.5–24.9), overweight (25.0–29.9), obese (30–34.9), and severely obese (35+).[30] Components of the CDRI score were summed to create the overall CDRI (Table 1); the possible range of scores was 0–10.

Statistical Analysis

The demographics of the study populations were examined by computing means, standard deviations, and ranges for age and education as continuous variables and percentages for ethnicity. Subsequent analyses were adjusted for age and education, due to the difference in the distribution of these variables between the two studies. Adjusted mean CDRI total and component scores were computed by calculating their value at the average level of age and education based on linear modeling. These adjusted means were computed by sex and ethnicity and statistically compared over time. Frequency distributions for the CDRI score, smoking and BMI were adjusted by weighting the observations within each study depending on age and education group (see post stratification in Rossi et al[31]). Separate weights were created by sex and ethnicity and assigned within study as follows: PT_{ij} / PH_{ij} and PT_{ij}/ PM_{ij} for the HHSPC and MEC, where PT_{ij}, PH_{ij} and PM_{ij} are the proportions of people in the ith age group and jth education group in the combined population, HHSPC and MEC, respectively. Mathematically, these weights sum to the observed counts by study, sex and ethnicity, though slight departures were seen in practice due to rounding error. Similarly, adjusted overall frequency distributions were created by weighting for age, education, and ethnicity. However, the analyses stratified by ethnic category and sex were weighted for age and

education. All analyses were completed using the SAS statistical software package (SAS Institute, Cary, NC).[32]

RESULTS

The data used for this analysis comprised 19,319 participants (92.5%) from the first cohort study and 97,746 Hawaii participants (94.1%) from the second study (Table 2). The ethnic composition was approximately 40% Japanese, 30% White, 14% Native Hawaiian, 7% Filipino, 2% Chinese, and 4% others. The proportions of Filipino and Chinese participants in the MEC were about one-third and one-fifth of the HHSPC proportions, respectively, due to recruitment targeted at Japanese, White, and Hawaiian participants, rather than the random population sampling of the HHSPC study. The mean age of the MEC study was somewhat higher than of the HHSPC cohort. The mean number of years in school was nearly three years higher in the later study.

We observed differences in mean CDRI overall and component scores by education level (data not shown). Men and women in both studies with the equivalent of a college degree had lower risk scores than those with a high school education and those with some undergraduate education. Among the CDRI components, men in the MEC study with less education smoked more and ate more meat, whereas men with a higher education reported higher alcohol intake. Women in the MEC study also had a higher alcohol intake, but a lower risk for smoking and meat intake with higher educational status. In the HHSPC study, men with less education also tended to smoke more, although this difference was less obvious than for the MEC study, and they tended to have a higher BMI. For women in the HHSPC study, the risk score for BMI decreased and the score for alcohol intake increased with years of school completed.

Table 2. Demographic characteristics of the study population

	HHSPC (1975–1980)		MEC (1993–1996)	
	Men	Women	Men	Women
Number	9,758	9,561	46,400	51,346
Age (years)				
Mean	56.2	55.0	59.1	58.6
Range	40–80	40–98	41–78	42–78
sd	10.1	9.9	9.3	9.2
Education (years)				
Mean	11.1	11.1	14.0	13.9
Range	0–18	0–18	5–18	5–18
sd	4.3	4.0	2.8	2.7
Ethnic category* (%)				
Native Hawaiian	11.8	13.5	12.9	14.9
White	24.5	23.2	34.8	30.2
Japanese	36.0	40.7	42.7	42.6
Filipino	17.9	12.5	5.3	5.2
Chinese	5.6	5.5	0.8	2.8
Other	4.2	4.6	3.7	4.4

* The low proportion of Filipinos and Chinese in the MEC is due to the fact that recruitment was targeted at Whites, Japanese, and Native Hawaiians. The majority of Japanese, Chinese, and Filipinos in this study are Asian-Americans and not recent immigrants.

The adjusted mean CDRI scores were higher for men than for women in both studies and in all ethnic groups (Table 3). We observed a statistically significant decrease in CDRI score from 3.06 to 2.82 (7.8%) for men and from 2.40 to 2.07 (13.8%) for women during the study period. The differences in CDRI scores among ethnic categories were more than two-fold. For both men and women, Native Hawaiians had the highest scores, followed by Whites, and Filipinos. Japanese and Chinese had the lowest scores at both points in time. In all groups, the CDRI scores decreased over the 20-year interval, although the differences were not significant for Chinese men and Native Hawaiian women.

When the total CDRI score was divided into its individual components (Table 4), divergent trends became apparent. Whereas the risk scores increased for smoking (only significant for women), alcohol use, and BMI for both sexes, the scores for the dietary variables

Table 3. Mean CDRI scores adjusted for age and education by ethnic category

	Men			Women		
Ethnic category†	HHSPC (1975–80)	MEC (1993–96)	*P*-value*	HHSPC (1975–80)	MEC (1993–96)	*P*-value*
All	3.06	2.82	<.0001	2.40	2.07	<.0001
White	3.39	2.93	<.0001	2.86	2.42	<.0001
Japanese	2.75	2.55	<.0001	1.85	1.49	<.0001
Chinese	2.66	2.48	.08	2.00	1.67	<.0001
Filipino	3.07	2.66	<.0001	2.39	1.82	<.0001
Native Hawaiian	3.65	3.53	.03	2.99	2.94	.32

* Based on ANOVA.

† The low proportion of Filipinos and Chinese in the MEC is due to the fact that recruitment was targeted at Whites, Japanese, and Native Hawaiians. The majority of Japanese, Chinese, and Filipinos in this study are Asian-Americans and not recent immigrants.

Table 4. Mean CDRI scores adjusted for age, education, and ethnic category

Risk score	Men			Women		
	HHSPC (1975–80)	MEC (1993–96)	*P*-value*	HHSPC (1975–80)	MEC (1993–96)	*P*-value*
Total Score	3.06	2.82	<.0001	2.40	2.07	<.0001
Smoking	.91	.93	0.08	.50	.62	<.0001
Alcohol use	.22	.29	<.0001	.11	.14	<.0001
Meat intake	.55	.19	<.0001	.50	.11	<.0001
Fruit/vegetable intake	.89	.65	<.0001	.86	.54	<.0001
Body mass index	.50	.76	<.0001	.42	.65	<.0001

* Based on ANOVA.

decreased significantly and were responsible for the overall decline in the CDRI score over time. The increase in risk score for smoking is partially due to the proportionate increase in former smokers. Whereas in the HHSPC 23% and 34% of men were former and current smokers, respectively, in the MEC 52% were former smokers and 18% were current smokers. Among women, there were 10% former smokers and 22% current smokers in the HHSPC and 29% former and 15% current smokers in the MEC.

Stratification by ethnic category indicated that the CDRI for smoking decreased slightly among Whites, whereas it increased to different degrees among all other groups (data not shown). Men had higher smoking scores than women in all ethnic groups. For Whites and Native Hawaiians, the difference between men and women was relatively small, whereas among the Asian categories, smoking scores were at least two-fold higher among men than women. The CDRI scores for alcohol rose in all ethnic groups except Native Hawaiians. White men and women together with Native Hawaiian men had by far the highest scores, while alcohol consumption among all women with Asian ancestry was substantially lower than for men.

The CDRI score from meat decreased much more than the score from low fruit and vegetable intake (Table 4). After adjustment for age, education, and ethnicity, the proportion of men who reported more than one serving of meat per day decreased from 55% to 19% and for women from 50% to 11%. In contrast, the proportion of men who consumed less than three servings of fruits and vegetables per day declined from 89% to 65%. The respective values for women were 86% and 54%. There were no substantial differences in CDRI scores for meat and fruits and vegetables by ethnic category and sex except for slightly lower meat scores among women than men. The largest increase in the risk score for both men and women was due to BMI, which was more than 50% higher in the MEC than in the HHSPC. For both sexes, the proportion of individuals with a BMI of 30 kg/m^2 and over increased from 6% to 13%. At the same time, the proportion of men with a BMI between 25 and 30 kg/m^2 rose from 32% to 39% and for women from 17% to 26%. Although the CDRI for BMI in both cohorts was highest for Native Hawaiians, intermediate for Whites, and lowest for Japanese, Chinese, and Filipinos, it increased significantly in all subgroups.

DISCUSSION

Through this analysis, we detected considerable changes in modifiable dietary and lifestyle factors associated with chronic disease risk in Hawaii over 20 years and observed substantial differences in risk behavior across ethnic categories. Although it appears that meat intake has declined and fruit and vegetable consumption has increased for men and women during that period, the prevalence of overweight and obesity rose significantly. The higher BMI for men and women is consistent with BMI changes reported in statewide surveys.[33] The risk score for alcohol and smoking increased slightly, despite a smaller proportion of current smokers in the MEC, as a result of the larger proportion of former smokers in the later study. As shown by a cohort with 50 years of follow-up, former smokers remain at a higher mortality risk for many years.[34]

The large differences in the CDRI score by ethnic category reflect considerable differences in nutrition and behavior that are also apparent in cancer incidence rates in Hawaii, such as the high lung cancer incidence rates among Native Hawaiians.[20] The ethnic differences in risk factors are comparable to other studies, eg, the annual Behavioral Risk Factor Survey System (BRFSS) in Hawaii shows higher rates of smoking, chronic drinking, and overweight and obesity among Native Hawaiians and Whites and lower rates for Filipinos and Japanese.[17] Data from NHANES1 also found relatively higher rates of alcohol use for men and Whites compared to women and other ethnicities.[35] A large multiethnic study of women in the US[36] observed significant differences by ethnic category for vegetable and fruit intake. Chinese women consumed more vegetables and fruits than Whites, but Japanese women did not. Chinese and Japanese also had the lowest saturated fat intake and a lower prevalence of BMIs $> 27\ kg/m^2$ than Whites. Chinese women, but not Japanese women, reported lower alcohol consumption and smoking than other ethnicities. Trends in risk factors in Hawaii show an increasing prevalence of overweight and obesity and no increase in fruit and vegetable intake since 1994 for both men and women and across all

ethnicities.[33] Current smoking showed relatively little change except for a decrease in Japanese after 1994. However, the BRFSS includes all adults age 18 and over, while our studies are limited to subjects 40 years and older.

The differences in data collection procedures and sampling strategies for the two cohorts are serious limitations of this project. The in-person interviews may have elicited different answers than the self-administered, detailed 26-page mailed questionnaire.[26] The improvement in the nutritional risk scores may be due to the more detailed dietary assessment in the MEC than in the HHSPC. If that were true, the overall CDRI may not have declined during the study period and may have even increased. People who completed and returned the mailed questionnaire may represent a more self-selected group with lower smoking rates than those interviewed by the DOH. Since self-selected individuals tend to be more health conscious, the CDRI may actually be higher in the general population than in the cohort. Another serious problem in the current analysis is the validity of the ethnic assignment.[37] Based on self-reports of multiple ethnic backgrounds, we created categories for statistical analysis that do not necessarily agree with the individual's self-identification. Since behavior and nutrition are influenced more by cultural factors than by genetic background, this approach may have led to bias.[38] Unfortunately, this issue was not taken into account at the time of data collection. Similarly, the two studies did not collect sufficiently detailed information on socioeconomic status. Given the importance of socioeconomic factors in understanding disease risk,[39,40] it would be important to examine their effect on differences in risk factors by ethnic category.

Despite these limitations, this analysis had considerable strengths. It took advantage of two large population-based data sets that are considered representative of the general population given the acceptable participation rates.[24,25] The ethnic comparisons are a unique feature of this report; in particular the data for Japanese, Whites, and Native Hawaiians, which constitute more than two-thirds of Hawaii's population, have to be considered valid at the two points in time. This investigation included a relatively large proportion of the state's population. Census figures for 2000 estimate the population 40 years and older in Hawaii at 532,940 persons.[16]

To our knowledge, no trend analysis of a combined risk factor score has been published before. The results show a small improvement in overall risk score that may not necessarily translate into reduced disease risk. For example, the fruit and vegetable consumption in the later cohort is still quite low in comparison to dietary recommendations.[41] The partition of the risk score indicates some improvements in nutrition, but these were largely offset by the dramatic increase in overweight and obesity during the 20-year observation period. A decrease in physical activity over time may partially explain the increasing BMI despite a declining meat intake. Unfortunately, no physical activity data were available for the early study.[42] Although the weights given to the five factors in the CDRI were based on the strength of their relation with disease outcomes,[15] the relative importance of the different factors in the CDRI may not accurately represent their influence on chronic disease. Therefore, a decline in the CDRI even, if it were real, may not lead to a reduction in chronic disease.

In conclusion, we compared an index of lifestyle risk factors between two population-based multiethnic studies in Hawaii surveyed 20 years apart. Although the reduction in overall age and education-adjusted index scores over the 20-year time period has to be interpreted with caution, several noteworthy sex and ethnic differences in overall risk behavior emerged from this comparison. Men, Native Hawaiians and Whites had higher risk scores compared to female and Asian participants, in particular due to higher smoking, alcohol use, and BMI scores. Whereas dietary composition scores appeared to improve, BMI scores increased considerably over time in both men and women. Smoking risk increased and alcohol risk declined. These trends were observed across ethnic groups with the exception of Whites who experienced a decrease in smoking risk and of Native Hawaiians whose alcohol intake did not increase, but was high already in the 1970s. Interventions to modify lifestyle risk for chronic disease need to tailor resources and messages to the audience who may benefit most. Targeting the populations at highest risk (Native Hawaiian men) and those with low but increasing risk (Asian females) through culturally appropriate approaches may be helpful. In addition, understanding the mechanisms that led to a large increase in BMI over 20 years, despite improvements in some aspects of dietary composition, may help public health efforts in the prevention of overweight.

Men, Native Hawaiians and Whites had higher risk scores compared to female and Asian participants, in particular due to higher smoking, alcohol use, and BMI scores.

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REFERENCES

1. National Center for Chronic Disease Prevention and Health Promotion. *Physical*

Activity and Good Nutrition: Essential Elements to Prevent Chronic Diseases and Obesity. Atlanta, GA: Centers for Disease Control and Prevention; 2004.
2. Doll R, Peto R. The causes of cancer. *J Natl Cancer Inst*. 1981;66(6):1197–1312.
3. Ames BN, Gold LS, Willett WC. The causes and prevention of cancer. *Proc Natl Acad Sci USA*. 1995;92(12):5258–5265.
4. Eyre H, Kahn R, Robertson RM, et al. Preventing cancer, cardiovascular disease, and diabetes: a common agenda for the American Cancer Society, the American Diabetes Association, and the American Heart Association. *Circulation*. 2004;109(25):3244–3255.
5. World Cancer Research Fund. *Food, Nutrition and the Prevention of Cancer: A Global Perspective*. Washington, DC: American Institute for Cancer Research; 1997.
6. National Center for Health Statistics. *Healthy People 2000 Final Review*. Hyattsville, MD: Centers for Disease Control and Prevention; 2001.
7. National Center for Health Statistics. *Health, United States, 2004 with Chartbook on Trends in the Health of Americans*. Hyattsville, MD: Centers for Disease Control and Prevention.
8. Poikolainen K. Alcohol and mortality: a review. *J Clin Epidemiol*. 1995;48(4):455–465.
9. Klatsky AL, Armstrong MA, Friedman GD. Alcohol and mortality. *Ann Intern Med*. 1992;117(9):646–654.
10. Singletary KW, Gapstur SM. Alcohol and breast cancer: review of epidemiologic and experimental evidence and potential mechanisms. *JAMA*. 2001;286(17):2143–2151.
11. Rehm J, Gmel G, Sempos C, Trevisan M. Alcohol-related morbidity and mortality. *Alcohol Res Health*. 2003;27(1):39–51.
12. Harwood H. Updating estimates of the economic costs of alcohol abuse in the United States: estimates, update methods, and data. Report prepared by The Lewin Group for the National Institute on Alcohol Abuse and Alcoholism. NIH Publication No. 98-432. Rockville, MD: National Institutes of Health; 1998.
13. National Task Force on the Prevention and Treatment of Obesity. Overweight, obesity, and health risk. *Arch Intern Med*. 2000;160(7): 898–904.
14. Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and trends in obesity among US adults, 1999–2000. *JAMA*. 2002;288(14): 1723–1727.
15. Meng L, Maskarinec G, Lee J, Kolonel LN. Lifestyle factors and chronic diseases: application of a composite risk index. *Prev Med*. 1999;29(4):296–304.
16. Hawaii Department of Business and Economic Development. *2003 State of Hawaii Data Book: A Statistical Abstract*. Available at: http://www.hawaii.gov/DBEDT/index.cfm?section=READ_Databook1075. Last accessed: 2/24/05.
17. Hawaii Department of Health. *2005 State of Hawaii Behavioral Risk Factor Surveillance System*. Available at: http://www.hawaii.gov/health/statistics/brfss/brfss2005/demo05.html. Last accessed: 1/22/07.
18. Yano K, Reed DM, Kagan A. Coronary heart disease, hypertension and stroke among Japanese-American men in Hawaii: the Honolulu Heart Program. *Hawaii Med J*. 1985;44: 297–321.
19. Davis J, Busch J, Hammatt Z, et al. The relationship between ethnicity and obesity in Asian and Pacific Islander populations: a literature review. *Ethn Dis*. 2004;14(1):111–118.
20. American Cancer Society, Cancer Research Center of Hawaii, Hawaii Department of Health. *Hawaii Cancer Facts & Figures 2003–2004*. Atlanta, GA: American Cancer Society; 2004.
21. Haiman CA, Stram DO, Wilkens LR, et al. Ethnic and racial differences in the smoking-related risk of lung cancer. *N Engl J Med*. 2006;354(4):333–342.
22. Kolonel LN. Smoking and drinking patterns among different ethnic groups in Hawaii. *J Natl Cancer Inst Monogr*. 1978;53:81–87.
23. Oyama N, Johnson DB. Hawaii health surveillance program survey methods and procedures. Hawaii State Department of Health. R & S Report No. 54, 1986.
24. Kolonel LN, Hankin JH, Lee J, et al. Nutrient intakes in relation to cancer incidence in Hawaii. *Br J Cancer*. 1981;44(3):332–339.
25. Kolonel LN, Henderson BE, Hankin JH, et al. A multiethnic cohort in Hawaii and Los Angeles: baseline characteristics. *Am J Epidemiol*. 2000;151(4):346–357.
26. Stram DO, Hankin JH, Wilkens LR, Henderson B, Kolonel LN. Calibration of the dietary questionnaire for a multiethnic cohort in Hawaii and Los Angeles. *Am J Epidemiol*. 2000;151(4):358–370.
27. Murphy SP. Unique nutrition support for research at the Cancer Research Center of Hawaii. *Hawaii Med J*. 2002;61(1):15–17.
28. Nordyke EC. *The Peopling of Hawaii*. Honolulu: University of Hawaii Press; 1989.
29. Maskarinec G, Meng L, Kolonel LN. Alcohol intake, body weight, and mortality in a multethnic prospective cohort. *Epidemiology*. 1998;9(6):654–661.
30. World Health Organization. *Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint Consultation*. Geneva: WHO; 2003.
31. Rossi PH, Wright JD, Anderson AD. *Handbook of Survey Research*. London: Academic Press; 1983.
32. SAS Institute Inc. *SAS OnlineDoc 9.1.2*. Cary, NC: SAS Institute Inc; 2004.
33. Hawaii State Department of Health. *Hawaii Behavioral Risk Factor Surveillance Report 1994–2000*. Honolulu: State of Hawaii; 2002.
34. Doll R, Peto R, Boreham J, Sutherland I. Mortality in relation to smoking: 50 years' observations on male British doctors. *BMJ*. 2004;328(7455):1519.
35. Moore AA, Gould R, Reuben DB, et al. Longitudinal patterns and predictors of alcohol consumption in the United States. *Am J Public Health*. 2005;95(3):458–465.
36. Huang MH, Schocken M, Block G, et al. Variation in nutrient intakes by ethnicity: results from the Study of Women's Health Across the Nation (SWAN). *Menopause*. 2002;9(5):309–319.
37. Kaplan JB, Bennett T. Use of race and ethnicity in biomedical publication. *JAMA*. 2003;289(20):2709–2716.
38. Doyle JM. What race and ethnicity measure in pharmacologic research. *J Clin Pharmacol*. 2006;46(4):401–404.
39. Krieger N, Williams DR, Moss NE. Measuring social class in US public health research: concepts, methodologies, and guidelines. *Ann Rev of Pub Health*. 1997;18:341–378.
40. Krieger N, Quesenberry C, Jr., Peng T, et al. Social class, race/ethnicity, and incidence of breast, cervix, colon, lung, and prostate cancer among Asian, Black, Hispanic, and White residents of the San Francisco Bay Area, 1988–92 (United States). *Cancer Causes Control*. 1999;10(6):525–537.
41. U.S. Department of Agriculture, U.S. Department of Health and Human Services. *Nutrition and Your Health: Dietary Guidelines for Americans*. Washington, DC: Government Printing Office; 2005.
42. United States Department of Agriculture. Center for Nutrition Policy and Promotion. *Steps to a Healthier You*. Available at: http://www.mypyramid.gov/. Last accessed: 6/7/2005.

AUTHOR CONTRIBUTIONS

Design concept of study: Maskarinec, Carlin, Pagano
Acquisition of data: Maskarinec, Wilkens, Kolonel
Data analysis and interpretation: Maskarinec, Carlin, Pagano, Yamamoto, Shumay, Wilkens, Kolonel
Manuscript draft: Maskarinec, Carlin, Yamamoto, Shumay, Wilkens, Kolonel
Statistical expertise: Maskarinec, Pagano, Yamamoto, Shumay, Wilkens
Acquisition of funding: Kolonel
Administrative, technical, or material assistance: Carlin
Supervision: Maskarinec, Kolonel