ABSTRACT

**Background.** We reviewed the literature of population-based studies regarding heart disease and stroke occurrence among Alaska Natives. The existing literature suggests that differences in cardiovascular mortality rates and risk factors exist in Alaska Natives by ethnicity and residence. However, data sources are largely limited to mortality data and small community-based studies.

**Objectives.** Because cardiovascular disease occurrence has not been well studied among Alaska Natives, it is important to avoid sweeping generalizations about the increasing or decreasing prevalences of cardiovascular disease and risk factors.

**Results.** Recent mortality rates from heart disease (of all types) among Alaska Natives are similar to rates for U.S. whites, and mortality rates from stroke among Alaska Natives are higher than rates for U.S. whites. Mortality rates from ischemic heart disease have been relatively constant among Alaska Natives over the past 20 years, while over the same time period, rates declined dramatically among U.S. Whites. The ischemic heart disease mortality rates among Alaska Native males are now comparable to rates among U.S. White males.

**Conclusions.** Although available data indicate no increase in mortality from ischemic heart disease in Alaska Natives, the relatively constant death rates over the recent 20 years, compared with declining rates elsewhere in the U.S., and the high prevalence of risk factors for ischemic heart disease calls for increased descriptive epidemiologic studies of the incidence and prevalence of cardiovascular disease outcomes. In addition, analytic epidemiologic studies are needed to examine the relationship between lifestyle, especially subsistence and traditional lifestyles, and cardiovascular disease outcomes.

**Keywords:** Cardiovascular Diseases, Heart Diseases, Cerebrovascular Accident, Epidemiology, Risk Factors, Alaska

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INTRODUCTION

In the 1950's infectious diseases caused the majority of deaths among Alaska Natives; by the 1980’s, injuries, heart disease, and cancer had become the most important causes of death (1). We reviewed the literature of population-based studies regarding heart disease and stroke incidence, prevalence, mortality, as well as the prevalence of the risk factors for these conditions. In addition, new data on mortality rates and on the self-reported prevalences of risk factors are presented.

Alaska Natives comprise the largest minority population in Alaska. In the 2000 census, 98,043 individuals designated themselves as Alaska Native only; an additional 21,198 designated themselves as Alaska Native in combination with one or more other races. Among Alaska Natives, approximately 55% are Eskimo, 32% Indian, and 13% Aleut. Each group has traditionally occupied a particular geographic region of Alaska. The diversity of Alaska Natives needs to be considered when evaluating the literature. Differences in diet, lifestyle, socioeconomic status, and location of residence all play a role in the prevalence of cardiovascular disease and its risk factors.

METHODS

The literature on cardiovascular disease among Alaska Natives was reviewed using PubMed (National Library of Medicine), published bibliographies (2,3), and published and unpublished reports available at the Alaska Native Medical Center, Anchorage, Alaska.

In addition to reviewing the published literature, updated data on mortality and risk factor prevalence are included. Additional analyses of mortality data were done on death certificate data files from the Alaska Bureau of Vital Statistics. Data were analyzed for Alaska Natives who were residents of Alaska and died during the time period 1979-1998. A person was counted as Alaska Native if the race code indicated Alaska Native, Eskimo, Aleut, Indian, Canadian Eskimo or Indian, or a mixture of Alaska Native groups. Estimates of the Alaska Native population were obtained from the Indian Health Service. Data were age-adjusted to the U.S. 1940 standard million population. For comparison purposes, data were obtained for U.S. Whites from CDC Wonder (4).
Current data on risk factors for cardiovascular disease among Alaska Natives were obtained from the Alaska Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS, conducted by the Alaska Division of Public Health in cooperation with the National Centers for Disease Control and Prevention (CDC), is a monthly telephone survey that utilizes a standard protocol and interviewing methods developed by the CDC. Alaska uses a stratified sample randomly selecting equal numbers from five geographic regions. This method purposely oversamples the nonurban areas of Alaska where a large proportion of Alaska Natives reside (5). Approximately 2000 persons are interviewed each year including 400 Alaska Natives.

**Heart Disease (ICD-9 390-398, 402, 404-429)**

During the time period 1989-1998, heart disease (of all types) ranked third in the leading causes of death among Alaska Natives, accounting for 16.5% of all deaths (6). Heart disease was the 6th leading cause listed on hospital discharge among tribally run Indian Health Service funded facilities in Alaska in FY 1997 (7).

**Mortality**

The earliest population-based information available regarding heart disease mortality among Alaska Natives covered the time period 1955-65. That study, which excluded deaths from acute rheumatic fever, found that heart disease mortality rates among Alaska Natives aged 40 years and older were approximately 50% lower than comparable rates for the U.S (8). The lowest rates of heart disease death were found in the southwestern and northern areas of the state, which were inhabited mainly by Eskimos. When the data were analyzed by ethnicity, the lowest rates were indeed found among Eskimos, although the data were only statistically significant for those aged 40-64.

A study by Davidson, et al. found that during the time period 1979-1988, Alaska Natives had slightly lower mortality rates from heart diseases of any type, as compared to U.S. Whites (rate ratio = 0.83) (9). Examining the data by type of heart disease, it was found that Alaska Natives had lower mortality rates from ischemic heart disease and higher rates than both U.S. and Alaskan Whites for cardiomyopathy, rheumatic heart disease, non-rheumatic val-
vascular disease and other heart diseases. When comparing the results to those from 1955-65, the authors found that in almost all regions, heart disease death rates had increased for adults over age 40 years (8,9).

A recent analysis of Alaska Native mortality rates found that, between 1979 and 1998, there was no significant change in the overall heart disease mortality rate among Alaska Natives, whereas the heart disease mortality rate among U.S. Whites fell by 32% (6). During the time period 1994-1998, there was no significant difference between the heart disease rates of Alaska Natives and U.S. Whites. Differences by age groups were noted, in that, compared to U.S Whites, Alaska Natives in the 25-44 year age group had a thirty percent higher mortality rate from heart disease, those in the 45-54 year age groups had a forty percent higher mortality rate, and those in the 75+ year age group had a twenty percent lower mortality rate from heart disease (6). The age-related differences may reflect either age or birth cohort effects, and deserve further analyses.

Rheumatic Heart Disease (ICD-9 390-398)

History
The rates of acute rheumatic fever among Alaska Natives during the 1950s, 60s and 70s were among the highest reported in the United States. The annual mean incidence was estimated to be 3.9/10,000 during 1967-68 and 2.2/10,000 during the time period 1968-73 (10,11). The highest rates of rheumatic fever in Alaska were found in the Alaska Area Native Health Service Units located along the west coast of Alaska: Bethel, Kanakanak and Kotzebue, and the age group most commonly affected was 5-19 year olds (12). Between 1958 and 1970, an average of 28 cases of acute rheumatic fever occurred in Alaska Natives each year (13). During the 1970s, studies initiated by the Centers for Disease Control found that increased availability of throat cultures and subsequent antibiotic treatment for acute pharyngitis in villages reduced the incidence of rheumatic fever (12,14). As the number of throat cultures performed increased, the number of rheumatic fever cases fell dramatically (15). During the 12-year period 1990-2001, only 18 total cases of rheumatic fever were reported to the Alaska Division of Public Health (16).

Because of the high incidence of rheumatic fever, rheumatic heart disease has been prevalent among Alaska Natives. Centers for Disease Control studies found that carditis occurred in 63% of hospitalized rheumatic fever cases occurring between 1968 and 1973 (11). In 1973,
the prevalence of rheumatic heart disease was 61.8 cases per 10,000 population, with the highest frequency among Eskimos (11). The geographic distribution of the rheumatic heart disease cases paralleled the incidence of rheumatic fever, with the highest prevalences in the Bethel and Kanakanak Service Units (11).

Mortality
Davidson et al found that mortality rates from rheumatic heart disease among Alaska Natives (1979-88) were about twice the rate found among Alaskan Whites and 2.5 times the rate found among U.S. Whites (9). Recent analyses of deaths from rheumatic heart disease from 1979-1998 are shown in Figure 1. During the 20-year period 1979-1998, the mortality rates for rheumatic heart disease fell among Alaska Natives, but remain about 5-fold higher than U.S. White rates. In both populations, recent mortality rates are higher for Alaska Native women than men.

![Figure 1. Average annual mortality rates from rheumatic heart disease among Alaska Natives and US whites 1979-98.](image_url)

Current Status
More recent estimates of the prevalence of rheumatic heart disease among Alaska Natives are not available. Clinical experience is that the disease is still prevalent. Efforts are underway at the Alaska Native Medical Center to establish a heart disease and stroke registry to track
the incidence and prevalence of these conditions, including rheumatic heart disease, among Alaska Natives.

**Ischemic Heart Disease (ICD-9 410-414)**

*History*

Atherosclerosis existed in pre-contact Alaska, as shown through paleopathologic studies (17). Nonetheless, it has generally been thought that ischemic heart disease is relatively rare among Alaska Natives, in particular, among Eskimos (18,19). Hypotheses regarding the lower rates range from a genetic predisposition to the traditional lifestyle characterized by a high consumption of marine mammals and a high level of physical activity (19).

However, a recent article questioned historical reports of low rates of ischemic heart disease among Greenland Eskimos (20). Several factors need to be considered when reviewing the data. First, few studies exist that examine the incidence (or prevalence) of ischemic heart disease in the Alaska Native population. In 1986, T.K. Young noted (with regard to the circumpolar Eskimo/Inuit populations): "In contrast to solid descriptive studies demonstrating the low incidence of ischemic heart disease among Eskimos, there are considerably more studies attempting to explain why there is such a low incidence!" (21). Although a few more descriptive epidemiologic studies have been published since 1986, statements about the incidence and prevalence of heart disease and its trends are often made with little supporting evidence. Second, Alaska covers a huge area, equal to one-fifth of the entire landmass of the United States, and Alaska Natives are a diverse group, consisting of Eskimos, Aleuts and Indians. Detailed studies of ischemic heart disease and its risk factors performed in one area of the state may have little relevance to a community in another area of the state. Finally, ischemic heart disease is an important cause of morbidity and mortality among Alaska Natives. Ischemic heart disease represents about 60% of all heart disease deaths, and was the underlying cause of death for 50 Alaska Natives in 1999 (22). From a public health perspective, the prevention of ischemic heart disease is important.

*Mortality*

Middaugh found that the average annual age-adjusted death rate from ischemic heart disease (ICD-9 codes 410-414) among Alaska Natives was approximately 60% lower than that for other Alaskans during the
time period 1980-86 (23). Another study looking at the time period 1981-1983 found the Alaska Native mortality rate for ischemic heart disease to be 65% of the U.S. rate (24).

Davidson, et al. found that the mortality rate from ischemic heart disease among Alaska Natives was approximately 60% that of Alaskan Whites during the time period 1979-88 (9). Eskimos had significantly lower rates of ischemic heart disease than Aleuts, in particular, men less than 40 years of age; rates for Indians were intermediate between Eskimos and Aleuts.

Nobmann, et al. documented that mortality rates from ischemic heart disease among Alaska Native men and women during the time period 1980 through 1992 were lower than rates for the U.S. population; however rates for Alaska Native and U.S. men were converging, largely because of declining rates among U.S. men (25).

Recent mortality statistics for ischemic heart disease are shown in Figure 2. During the 1980s, mortality rates from ischemic heart disease increased among Alaska Native men and women, and then began to decline during the mid-1990s. At the same time, rates declined dramatically among U.S. Whites. During the time period 1994-1998, the mortality rate for Alaska Native men was close to that of U.S. white men, reaching 90% of the U.S. rate for white men, whereas the rate for Alaska Native women was still approximately 50% of the U.S. White rate.

Figure 2. Average annual mortality rates from ischemic heart disease among Alaska Natives and US whites 1979-98. Age-adjusted to US 1940 population. ICD-9 codes 410-414. Data sources: Alaska data: Alaska Division of Public Health, Bureau of Vital Statistics; US whites: CDC Wonder (www.cdc.gov); US data for midpoint of intervals (1981, 1986, 1991, 1996).
Incidence/Prevalence

The only study found on the incidence of ischemic heart disease among Alaska Natives was conducted among persons with diabetes, covering the time period 1986-93 (26). In a study of 1004 Alaska Natives with diabetes, comprising 4,255 person-years of experience, 52 confirmed and possible myocardial infarctions were diagnosed. The rates for myocardial infarction incidence were highest among men and among Aleuts, and lowest among Eskimos. The rates found in that study exceeded those reported for some diabetic populations (Nurses Health Study and Southwestern American Indians), but were slightly lower than those reported for other diabetic populations (National Mortality Followback survey and National Health and Nutrition Examination Study follow-up survey). During the time period studied, ischemic heart disease accounted for 21% of deaths among Alaska Natives with diabetes, as compared to 8.3% of deaths among all Alaska Natives.

The prevalence of ischemic heart disease was studied in a small population of Yup’ik Eskimos living on St. Lawrence Island in western Alaska (27). Among 65 people screened, 10 (15%) met criteria for definite coronary artery disease, using Strong Heart Criteria (28). This prevalence was higher than expected based on published reports on the prevalence of coronary artery disease among American tribal members from the Dakotas, Oklahoma and Arizona included in the Strong Heart Study (28).

Other Studies related to Ischemic Heart Disease

Newman, et al. reported that Alaska Natives have a lower prevalence and extent of atherosclerotic lesions on the coronary arteries and aorta compared to non-Natives; the findings were based on autopsies of 245 Alaska Natives and non-Natives who underwent forensic autopsy during 1989-1993 (29,30). Findings from the autopsy studies, while interesting, are limited as are all necropsy studies, because they neither represented all deaths nor were they population-based. Although one of the studies did control for tobacco use, none were able to control for other potential confounders, such as alcohol use.
Other Heart Diseases

Davidson, et al. reported increased mortality rates among Alaska Natives for cardiomyopathy, non-rheumatic valvular disease and other heart diseases, compared to US Whites (9). More recent analyses covering the time period 1989-98 found that Alaska Natives were 3 times more likely to die of valvular heart disease (ICD-9 424) than U.S. Whites (6).

Finley, et al reported rates of infective endocarditis in Alaska Natives that were twice contemporary U.S. rates, including high rates of pneumococcal endocarditis which was virtually nonexistent elsewhere (31). Other systematic studies of the incidence or prevalence of these conditions in the Alaska Native population have not been published.

Cerebrovascular Disease (ICD-9 430-438)

Cerebrovascular disease was the fifth leading cause of death among Alaska Natives during the time period 1989-98, accounting for 4.5% of all deaths (6). It has been suggested that, in contrast to ischemic heart disease, cerebrovascular disease is increased among indigenous people of the North (20). However, few studies could be found on cerebrovascular disease to support this observation.

Mortality

Middaugh reported that mortality rates for cerebrovascular disease were similar to rates for Alaskan Whites during the time period 1980-86 (23). Welty and Coulehan reported that the cerebrovascular disease mortality rate for Alaska Natives was slightly higher than the U.S. rate during the time period 1980-1983 (24).

During the 20 year period 1979-1998, mortality from cerebrovascular disease increased by 17% among Alaska Natives (Figure 3) (3). In contrast, mortality from cerebrovascular disease among U.S. Whites decreased by 31%. Death rates for cerebrovascular disease among Alaska Natives were about 1.5 times that of the US white rate during the time period 1994-1998. The differences were most apparent among women (6).
Incidence/Prevalence

Schraer, et al. reported that among Alaska Natives with diabetes, the incidence of confirmed stroke was 10.6 per 1,000 person-years (26). Eskimos experienced the highest rate of stroke, followed by Aleuts and Indians. Stroke incidence rates were higher among women than among men. Compared to the data for stroke among other diabetic populations, the incidence of stroke among men was similar, while among women, the rate was higher.

A population-based study on the incidence of stroke was conducted in the Yukon-Kuskokwim region, covering the years 1990-1998 (32). The study included primarily Eskimos. Researchers reviewed the charts of all patients with newly diagnosed stroke. The incidence of stroke was found to be similar to that reported by the Mayo Clinic for a U.S. White population. The distribution by type of stroke (79% ischemic, 12% hemorrhagic, 5% subarachnoid hemorrhage, and 4% unknown) was also similar to that reported for a US population.

Risk Factors for Heart Disease and Stroke

It is beyond the scope of this paper to completely review the literature on risk factors for heart disease and stroke among Alaska Natives. What follows is a summary of the most recent pertinent information. Many of the articles cited contain excellent reviews of the literature.
Tobacco

Tobacco use continues to be a serious health problem among Alaska Natives. Although tobacco was not part of traditional Alaska Native culture or religious ceremonies, it was readily incorporated after its introduction by Europeans 200 years ago (33,34). Tobacco use has included cigarettes as well as smokeless tobacco, the latter most evident in rural areas and even in very young children (35,36). Surveys of the population indicate that Alaska Native adults and youth have the highest rates of use of tobacco in Alaska (37,38). Current smoking status among Alaska Natives (1991-93) was shown to be inversely related to educational status and income (39). Approximately 42% of Alaska Native adults are current smokers, compared to 24% of non-Natives (5).

Diet

A diet high in marine mammals and fish has been hypothesized to be partially responsible for the relatively low ischemic heart disease mortality rates among Alaska Natives (23). However, information on diet among Alaska Natives is limited. Studies that have been conducted tend to concentrate on small communities, rather than on a representative sample of Alaska Natives. Nobmann prepared an extensive review of the literature on diet and cardiovascular disease among Alaska Natives as part of a doctoral thesis (40).

One of the few diet studies designed to cover a representative group of Alaska Natives was conducted during the time period 1987-1988 (41). A total of 351 Alaska Natives (Eskimos, Aleuts and Indians) completed 24-hour diet recall surveys. Participants completed between 1 and 5 surveys during the 18-month course of the study. Alaska Natives reported a mean daily average consumption of fish and shellfish of 109 grams, compared to 17 grams in the NHANES II study in the US population. Among Alaska Natives, fish and shellfish ranked fourth in the list of frequently consumed foods, although coffee/tea, sugar and white bread/rolls/crackers were the first three on the list. Alaska Natives consumed less beef, milk, salads, vegetables, orange juice and alcohol beverages than the NHANES II sample. The mean energy intake was higher for Alaska Natives, but the relative distribution of calories from fat and carbohydrates was similar for Alaska Natives and the NHANES II participants. The most common contributors of fat (based on grams) in the Alaska Native diet were
fish, agutuk (Eskimo ice cream), beef, seal oil, whale blubber, chicken, butter and margarine. The percentage of energy from fat was similar to that reported by Heller and Scott in the 1950s (42). The study showed that Native foods were still eaten frequently in 1987-1988, but that non-traditional foods available in stores were also consumed. A study conducted among 74 Alaska Native women residing in Anchorage found that only 27% reported eating traditional Native foods at least once during the 24-hour recalls (43). The most frequent item mentioned was salmon.

Studies comparing Yup’ik Eskimo and Athabascan Indian communities during 1987-88 in Southwest Alaska found that indigenous foods, such as seal oil and fish, were consumed on a daily basis by 20-25% of the Yup’ik population (44,45). Indians were more likely to eat wild game and salmon than seal oil. The studies showed a negative association between consumption of seal oil and/or salmon and the prevalence of impaired glucose tolerance and diabetes. Athabascan Indians were less likely to consume traditional foods, and more likely to have diabetes. Older people were more likely to consume traditional food, whereas younger people were more likely to eat protein from non-indigenous sources and low-nutrient density carbohydrates.

A detailed diet history, using 24-hour recall and annual food frequency questionnaires was conducted in 1992 among 64 Siberian Yup’iks living in western Alaska (25). That study found that 15% of the foods reported on the 24-hour recalls were traditional Native foods. The most common foods reported were coffee/tea, sugar, bread/crackers/rolls, and sea mammals, similar to the 1987-88 results for all Alaska Natives, with the exception that fish (not sea mammals) was the fourth choice when the study included all Alaska Natives. One-quarter of the energy consumed was from Native foods. This percent of energy from Native foods was substantially less than that found during the 1950s.

Studies in the Siberian Yup’ik population did not demonstrate correlations between intake of sea mammal and fish, and plasma lipid levels; however, intake of monounsaturated fat, found in whale muktuk, was negatively correlated with LDL levels among men (46). In addition, intake of wild birds was negatively correlated with LDL-HDL ratio. Although the study sample was small in these studies, the results support the hypothesis that consumption of traditional foods is important for maintaining cardiovascular health among Siberian Yup’iks.
Parkinson, et al, found that Yup’ik Eskimos living in southwestern Alaska had higher plasma levels of omega-3 fatty acids than non-Natives living in the same area. In addition, fatty acid concentrations were higher in Native participants who lived in coastal villages than among those who lived in river villages, and paralleled the consumption of marine mammal oil and marine fish (47).

In summary, studies regarding the content of the Alaska Native diet have shown that fish and/or marine mammals are consumed in quantities larger than the average U.S. diet. However, eating patterns appear to be changing and the content of the diet varies by many demographic factors, including age, ethnicity and geographic area of residence. Furthermore, analytic epidemiologic studies measuring the relationship between consumption of Alaska Native traditional foods and cardiovascular disease outcomes have not yet been conducted.

**Diabetes and Overweight**

Naylor, et al. provide a detailed literature review of the diabetes incidence, prevalence, and mortality among Alaska Natives (48). The increasing prevalence of overweight among Alaska Natives is also described in that report.

**Lack of Physical Activity**

It has been hypothesized that the increase in the proportion of overweight among Alaska Natives can be attributed to a decrease in traditional physical activity required for a subsistence lifestyle (49). Adler, et al. collected information on traditional physical activities (dog sledding, walking, handsaw use, carrying water by hand, rowing a boat, washing clothes by hand) and their non-traditional counterparts (use of motorized vehicle, chainsaw use, carrying water by vehicle, motor boat use, washing clothes by machine) in 15 Yup’ik Eskimo and Athabascan Indian villages during the time period 1987-88 (49). Eskimos were more likely to be categorized in high and moderate levels of physical activity, whereas Athabascans were more likely to be categorized into the low levels. This finding is interesting, as additional reports from this study have found that Eskimos were more likely to eat traditional foods and were less likely to have diabetes and hypertension, although overweight and obesity occurred at similar rates in the two groups (45,50,51).
As physical activity required for traditional tasks has decreased, there has not been a corresponding increase in leisure time physical activity. In 1999, 32% of Alaska Natives reported no leisure time physical activity in the past month, as compared to 22% of non-Natives (1998 BRFSS). More detailed studies of physical activity among Alaska Natives are needed.

Hypertension
Hypertension was reported to be rare among Alaska Natives in the 1950s (52,53). Broussard, et al. reported rates of hypertension for American Indians and Alaska Natives by Indian Health Service Area in 1987; the Alaska Area had the lowest prevalence of all the areas (54). One exception was a study of Aleuts living on St. Paul Island, which found hypertension prevalences among adults of 61% (1966-67) and 51% (1976) (55).

However, in 1997 hypertension was the eighth leading cause of outpatient visits among tribally run Indian Health Service funded facilities in Alaska (26,418 visits (7). The same factors leading to an increase in obesity and diabetes are also increasing the prevalence of hypertension. In a study of hypertension among Athabascan Indians and Yup’ik Eskimos, hypertension was found to be associated with overweight, eating a non-indigenous diet, mechanized activities and glucose intolerance (51). Among those screened, 23.8% had blood pressures $\geq 140/90$. Athabascan Indians were more likely to have hypertension than were Eskimos. A small study of Siberian Yup’ik Eskimos found that 27% met criteria for hypertension (either on medication or blood pressures $\geq 140/90$) (56).

In 1999, 24% of Alaska Natives reported that they had been told that they have high blood pressure, compared to 21% of non-Natives (5). The prevalence of self-reported hypertension among Alaska Natives now appears to be similar to that of the overall Alaska and U.S. populations.

Cholesterol/Lipid levels
Most studies that have examined lipid levels among populations of Alaska Natives have been conducted in a few small communities. Researchers conducted studies on the cholesterol metabolism of Eskimos living in the Point Hope region during the 1960s (57,59). At that time, it was hypothesized that the metabolism of Eskimos
might differ from that of Caucasians, explaining the difference in atherosclerosis rates. The studies found that Eskimos eating their native diet had a mean serum cholesterol level of 221, with low triglycerides. Eskimo students at boarding school eating a diet similar to a U. S. diet had lower cholesterol levels, and higher triglyceride levels.

A study conducted on St. Lawrence Island among Siberian Yup’ik Eskimos during the early 1990s found that the mean serum cholesterol levels were 242 for females and 223 for males; LDL levels were 161 for females and 149 for males; HDL levels were 67 for females and 58 for males (60). Triglycerides were low. The mean levels were higher than those found in a 1958 study in the same village.

The St. Lawrence Island study also reported an absence of the apo E2 genotype that is associated with type III hyperlipoproteinemia or dysbetalipoproteinemia. In addition, an autopsy study of Alaska Natives also reported a low frequency of the E2 allele but did observe an association of apo E4 alleles with coronary atheroma (61).

More studies systematically examining lipid levels among Alaska Natives are needed, especially those that also collect information on diet and lifestyle factors.

**Implications for Future Research**

The diversity of lifestyles and multiple ethnicities of Alaska Natives present both opportunities and challenges for future research. The varying lifestyles between rural and urban settings offer an opportunity to examine the relationships between lifestyle and genetics. However, comparison of multiple ethnicities and lifestyle may require larger sample sizes, making studies more expensive.

It is important to avoid sweeping generalizations about the increasing or decreasing prevalences of cardiovascular disease and risk factors without better descriptive epidemiology. The existing literature suggests that differences in cardiovascular mortality rates and risk factors exist in Alaska Natives by ethnicity and residence. Studies in Alaska Natives with diabetes found that rates of myocardial infarction were lowest among Eskimos whereas Eskimos experienced the highest rates of stroke. Studies in communities found that Yup’ik Eskimos were more likely to eat a traditional diet
and to engage in physical activities, and less likely to have hypertension and diabetes than were Athabascan Indians. No published studies were found on Alaska Natives living in Southeast Alaska, and few were found on Alaska Natives living in urban areas.

Current National Institutes of Health supported research in Alaska includes a study in northwest Alaska, Genetics of Coronary Artery Disease in Alaska Natives (GOCADAN) of 1200 individuals among 40 families. In addition to measuring traditional and novel risk factors for atherosclerosis, a genome-wide linkage study of 400 genetic loci at 10 centimorgan intervals will be performed for each individual to identify promising areas for new gene polymorphisms related to either atherosclerosis or its risk factors.

Another National Institutes of Health funded study, the Prospective Study of American Indians and Alaska Natives, plans to enroll approximately 2000 Alaska Natives into a cohort study in order to examine the relationship between diet and lifestyle and the subsequent development of chronic diseases.

Such studies do not reduce the need for descriptive epidemiologic studies to monitor the incidence and prevalence of heart disease and stroke in Alaska Natives. Mortality data analyses cannot differentiate between improved medical care versus effective interventions to decrease risk factors. To be most useful, descriptive studies should include persons among the various ethnic groups and geographic regions throughout the state. Currently, the Center for Disease Control and Prevention is funding efforts to develop a cardiovascular disease registry among Alaska Natives so that eventually disease incidence and prevalence rates can be measured.

Additional analytic epidemiologic studies are needed to look at the relationship between subsistence lifestyle and cardiovascular outcomes. Both case-control and cohort studies could be used. The existing literature indicates that a traditional subsistence lifestyle, comprised of traditional physical activities and traditional diet, may be protective against diabetes, impaired glucose tolerance and hypertension. One would expect that such a lifestyle would also be protective against heart disease, but this has not been yet been demonstrated. Furthermore, little is known about the relationship between a traditional lifestyle and stroke occurrence.
CONCLUSIONS

In summary, available mortality data indicate that despite a decline in rheumatic heart disease deaths in Alaska Natives, recent rates are five times higher than in US whites, that mortality from stroke appears higher in Alaska Natives than US whites largely due to the declining rates only in the latter, and that ischemic heart disease mortality in Alaska Native males is now comparable to that in U.S. White males. Although available data indicate no increase in mortality from ischemic heart disease in Alaska Natives, the relatively constant death rates over the recent 20 years, compared with declining rates elsewhere in the U.S, and the high prevalence of risk factors for ischemic heart disease calls for increased descriptive epidemiologic studies of the incidence and prevalence of cardiovascular disease outcomes.

Finally, analytic epidemiologic studies are needed to examine the relationship between lifestyle, especially subsistence and traditional lifestyles, and cardiovascular disease outcomes. Interventions to reduce modifiable risk factors should follow.

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REFERENCES

1. Middaugh JP, Miller J, Dunaway CE, Jenkerson SA, Kelly T, Ingle D, Perham K, Fridley D, Hlady WG, Hendrickson V: Leading Causes of Death in Alaska: 1950, 1980-89: An Analysis of the Causes of Death, Years of Potential Life Lost, and Life Expectancy. Section of Epidemiology, Division of Public Health, Department of Health and Human Services, State of Alaska, 1991.

2. Fortuine R: The Health of the Inuit of North America. A bibliography from the earliest times through 1990. Arctic Med Res 1993;52(Suppl 8).

3. Fortuine R. The Health of the Eskimos. A bibliography 1957-1967. Dartmouth College Libraries. 1968.

4. Friede A, O’Carroll PW, Thralls RB, Reid JA. CDC WONDER on the Web. Proc AMIA Annu Fall Symp 1996:408-12.

5. Health Risks in Alaska among Adults. Alaska Behavioral Risk Factor Survey. 1999 Annual Report. Division of Public Health, Department of Health and Social Services, State of Alaska, 2002.

6. Lanier AP, Ehram G, Sandidge J. Alaska Native Mortality 1989-1998. Office of Alaska Native Health Research, Division of Community Health Services, Alaska Native Tribal Health Consortium, July, 2002.

7. Boedeker B, Foster SD. Alaska Area Profile, Alaska Area Native Health Service, Division of Planning, Evaluation & Health Statistics, Anchorage, Alaska, 2000.

8. Maynard JE, Hammes LM, Kester FE. Mortality due to heart disease among Alaska Natives 1955-65. Public Health Reports 1967;82:714-720.

9. Davidson M, Bulkow LR, Gellin BG. Cardiac mortality in Alaska’s indigenous and non-Native residents. Int J Epidemiol 1993;22:62-71.

10. Goormann JR: A brief look at the incidence of rheumatic fever among Alaska Natives, Alaska Native Area Health Office, Anchorage, Alaska, 1968.

11. Edelen JS, Burks JM: Rheumatic fever and rheumatic heart disease among Alaska Natives: A clinical and epidemiologic analysis. Alaska Activities, Bureau of Epidemiology, Center for Disease Control, Anchorage, Alaska, 1974.

12. Program Notes: Acute rheumatic fever in western Alaska Native children. Arctic Investigations Division, Bureau of Epidemiology, Center for Disease Control, Anchorage, Alaska, 1979.

13. Streptococcal Program: Disease prevention in action. Communicable Disease Bulletin #12. Section of Communicable Disease Control, Department of Health and Social Services, State of Alaska, 1982.

14. Bender TR, Zimmerman RA, Knostman JD, Sherman SA, Price A, Fleshman JK. Streptococcal surveillance in remote Arctic villages. Acta Sociomed Scand Suppl. 1972; Suppl 6:240-8.

15. Streptococcal control program—winning the fight against rheumatic fever. Epidemiology Bulletin #3. Epidemiology Office, Department of Health and Social Services, State of Alaska, 1985.

16. Three Reported Cases of Rheumatic Fever-Spring, 2002. Epidemiology Bulletin #10. Section of Epidemiology, Division of Public Health, Department of Health and Social Services, State of Alaska, 2002.

17. Fortuine R. Chills and Fever: Health and Disease in the Early History of Alaska. University of Alaska Press, Fairbanks, Alaska 1992. p.84.

18. Bjerregaard P, Mulvad G, Pedersen HS. Cardiovascular risk factors in Inuit of Greenland. Int J Epidemiol 1997;26:1182-1190.

19. Bjerregaard P. Rapid sociocultural change and health in the Arctic. Int J Circumpolar Health 2001;60:102-111.

20. Boudreau DA, Scheer WD, Mulvad G, Pedersen HS, Newman WP III. Project meeting report: International workshop on cardiovascular disease and diabetes among indigenous peoples in the circumpolar north. Int J Circumpolar Health 2002;61:70-80.

21. Young TK. Epidemiology and control of chronic diseases in circumpolar Eskimo/Inuit populations. Arctic Med Res 1986;42:25-47.

22. Alaska Bureau of Vital Statistics. 1999 Annual Report. Division of Public Health, Department of Health and Social Services, State of Alaska, 2002.

23. Middaugh JP. Cardiovascular deaths among Alaska Natives 1980-86. Am J Pub Health 1990;80:282-285.

24. Welty TK, Coulehan JL. Cardiovascular disease among American Indians and Alaska Natives. Diabetes Care 1993;16 (Suppl 1):277-283.

25. Nobmann ED, Ebbers SOE, White RG, Schraer CD, Lanier AP, Bulkow LR. Dietary intakes among Siberian Yup’iks of Alaska and implications for cardiovascular disease. Int J Circumpolar Health 1998;57:4-17.
36. Schraer CD, Adler AI, Mayer AM, Halderson KR, Trimble BA. Diabetes complications and mortality among Alaska Natives: 8 years of observation. Diabetes Care 1997;20:314-321.

37. Schraer CD, Ebbesson SO, Adler AI, Cohen JS, Boyko EJ, Nobmann ED. Glucose tolerance and insulin-resistance syndrome among St. Lawrence Island Eskimos. Int J Circumpolar Health 1998; 57(suppl 1): 348-354.

38. Howard BV, Lee ET, Cowan LD, Fabsitz RR, Howard WJ, Oopik AJ, Robbins DC, Savage PJ, Yeh JL, Welty TK. Coronary heart disease prevalence and its relation to risk factors in American Indians. The Strong Heart Study. Am J Epidemiol 1995;142:254-68.

39. Newman WP, Middaugh JP, Guzman MA, Propst MT, Rogers DR. Comparison of atherosclerosis in Alaska Natives and non-Natives. Arch Pathol Lab Med 1997;121:1069-75.

40. Finley JC, Davidson M, Parkinson AJ, Sullivan RW. Pneumococcal endocarditis in Alaska Natives. A population-based experience, 1978 through 1990. Arch Intern Med 1992;152:1641-5.

41. Nobmann ED, Byers T, Lanier AP, Hankin JH, Jackson MY. The diet of Alaska Native adults 1987-1988. Am J Clin Nutr 1992;55:1024-32.

42. Heller CA, Scott EM. The Alaska dietary survey, 1956-61. Anchorage, Alaska. Arctic Health Research Center, Nutrition and Metabolism Section, Public Health Service, DHEW, 1967 (PHS publication 999-AH-2).

43. Murphy NJ, Schraer CD, Murphy NJ. Lower prevalence of impaired glucose tolerance and diabetes associated with daily seal oil or salmon consumption among Alaska Natives. Diabetes Care 1994;17:1498-1501.

44. Murphy NJ, Schraer CD, Thiele MC, Boyko EJ, Bulkow LR, Doty BJ, Lanier AP, Diet change and obesity associated with glucose intolerance in Alaska Natives. J Am Diet Assoc 1995;95:676-682.

45. Parkinson AJ, Cruz AL, Heyward WL, Bulkow LR, Hall D, Barstaed L, Connor WE. Elevated concentrations of plasma omega-3 polyunsaturated fatty acids among Alaskan Eskimos. Am J Epidemiol 1994;95:384-8.

46. Adler AI, Boyko EJ, Schraer CD, Murphy NJ. Dietary intake among Alaska Native women resident of Anchorage, Alaska. Int J Circumpolar Health. 2001;60:123-137.

47. Schraer CD, Adler AI, Murphy NJ. The negative association between traditional physical activities and the prevalence of glucose intolerance in Alaska Natives. Diabet Med 1996;13:555-560.

48. Murphy NJ, Schraer CD, Murphy NJ, Bulkow LR, Doty BJ, Lanier AP, Diet change and obesity associated with glucose intolerance in Alaska Natives. J Am Diet Assoc 1995;95:676-682.

49. Murphy NJ, Schraer CD, Murphy NJ. The negative association between traditional physical activities and the prevalence of glucose intolerance in Alaska Natives. Diabet Med 1996;13:555-560.

50. Murphy NJ, Schraer CD, Murphy NJ, Bulkow LR, Doty BJ, Lanier AP, Diabetes mellitus in Alaskan Yup’ik Eskimos and Athabascan Indians after 25 years. Diabetes Care 1992;15:1390-1392.

51. Murphy NJ, Schraer CD, Theile MC, Boyko EJ, Bulkow LR, Doty BJ, Lanier AP, Diet change and obesity associated with glucose intolerance, diet and mechanized activity. Ethnicity & Health 1997;2:267-75.
52. Scott EM, Griffith IV, Hoskins DD, Whaley RD. Serum cholesterol levels and blood pressure of Alaskan Eskimo men. Lancet 1958;2:667-8.

53. Rodahl K. Relation of diet to blood pressure in the Eskimo. Trans Am Coll Cardiol 1955;4:273-8.

54. Broussard BA, Valway SE, Kaufman S, Beaver S, Gohdes D. Clinical hypertension and its interaction with diabetes among American Indians and Alaska Natives. Diabetes Care 1993;16 (suppl 1):292-296.

55. Torrey EF, Reiff FM, Noble GR. Hypertension among Aleuts. Am J Epidemiol 1979;110:7-14.

56. Schraer CD, Ebbesson SOE, Boyko E, Nobmann E, Adler A, Cohen J. Hypertension and diabetes among Siberian Yup’ik Eskimos of St. Lawrence Island, Alaska. Public Health Reports 1996;III (suppl 2):51-52.

57. Feldman SA, Ho KJ, Lewis LA, Mikkelson B, Taylor CB. Lipid and cholesterol metabolism in Alaskan Arctic Eskimos. Arch Path 1972;94:42-58.

58. Ho KJ, Mikkelson B, Lewis LA, Feldman SA, Taylor CB. Alaskan Arctic Eskimo: responses to a customary high fat diet. Am J Clin Nutr 1972;25:737-745.

59. Feldman SA, Rubenstein AH, Ho K-J, Taylor CB, Lewis LA, Mikkelson B. Carbohydrate and lipid metabolism in the Alaskan Arctic Eskimo. Am J Clin Nutr 1975;28:588-94.

60. Ebbesson SO, Schraer C, Nobmann ED, Ebbesson LO. Lipoprotein profiles in Alaskan Siberian Yup’ik Eskimos. Arctic Med Res 1996;55:165-73.

61. Scheer WD, Boudreau DA, Malcolm GT, Middaugh JP. Apolipoprotein E and atherosclerosis in Alaska Natives. Atherosclerosis 1995;114:197-202