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Ophthalmic Epidemiology, 16(3), pp. 163-174.

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Visual Impairment and Eye Care among Alaska Native People

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ABSTRACT

Purpose: To estimate the prevalence of visual impairment, eye disease and eye care in the Alaska Native (AN) population, by demographic and socioeconomic factors. *Methods:* Population-based cross-sectional study of 3,793 Alaska Native (AN) adults aged 18-94 years enrolled in the *Education and Research Towards Health (EARTH)* Study from March 2004-March 2006. Data on self-reported visual impairment, cataract, glaucoma, diabetic eye disease and previous dilated eye examinations were collected using audio computer-assisted self-administered questionnaires. *Results:* The unadjusted prevalence of self-reported visual impairment was 8.7% (95% CI: 7.9-9.7), cataract 5.9% (95% CI: 5.2-6.7), glaucoma 2.5% (95% CI: 2.0-3.0) and diabetic eye disease 1.3% (95% CI: 0.9-1.7). In all cases, age-sex adjusted prevalence estimates for the AN population were greater than available estimates for the general U.S. population. Prevalence of visual impairment and each eye disease increased with age ($P < 0.01$). Additional factors associated with visual impairment were education and annual household income. Overall, 70.0% (95% CI: 68.5-71.6) of participants reported a dilated eye examination within the previous two years. Dilated eye examination within the previous two years was associated with increasing age ($P < 0.001$). However, men and participants with lower formal education were less likely to report recent dilated eye examination. Among those with diabetes, only 67.7% (95% CI: 60.8-74.1) reported a dilated eye examination within the recommended previous one year. *Conclusions:* Self-reported visual impairment, cataract, glaucoma and diabetic eye disease are prevalent in the AN population. These data may be useful in healthcare planning and education programs.

INTRODUCTION

Visual impairment is a major health burden. In the United States, it is estimated that more than 2 million people are visually impaired, with almost another 1 million legally blind.¹ The main causes are cataract, age-related macular degeneration, glaucoma and diabetic retinopathy.² Moreover, visual impairment is a leading cause of disability,³ and is associated with depression, functional decline, decreased quality of life and increased mortality.⁴⁻⁷ To reduce this burden, goals for preventing visual impairment, including increasing the proportion of the population having a regular dilated eye examination, have been incorporated into the national public health objectives, Healthy People 2010.⁸ As working steps toward achieving these national goals, it is necessary to estimate and monitor the prevalence of eye disease and visual impairment in all sectors of the population.

Limited data are available for the Alaska Native population (AN). Prevalence rates for visual impairment and eye disease are usually extrapolated from national studies and may be inaccurate, as various racial/ethnic populations may not be well-represented in such studies. Only two Alaska studies have been conducted to date, primarily on glaucoma among the Inupiaq people (Inuit/Eskimo) of the northwest regions.^{9, 10} These two studies established a high prevalence of angle closure glaucoma in AN people (2.7 and 3.8% of those aged 40 years and over), in particular in women (3.0 and 5.5%) compared to men (0.8 and 2.1%).¹⁰ Otherwise, there is a paucity of data on the prevalence of other eye diseases and visual impairment among AN people.

Research has been challenging because of geographic isolation and concerns about research among AN tribal communities. However, the National Cancer Institute recently supported a pilot study to investigate the protective and risk factors for multiple chronic diseases among American Indian (AI) and AN people, the Education and Research Towards Health (EARTH) study, where Alaska was one of several major study sites.¹¹ As part of the baseline data collection, participants were questioned about visual impairment, certain eye diseases, and eye examinations. The main purpose of this report is to increase our current understanding of eye health in the AN population, utilizing EARTH study data to estimate the prevalence of visual impairment, cataract, glaucoma and diabetic eye disease, by demographic and socioeconomic factors. In addition, we calculate the proportion of AN people who report one important component of eye care, recent dilated eye examination.

MATERIALS AND METHODS

Study population

The study population, data collection methods, and measurement instruments for the EARTH Study have been described in detail elsewhere.¹¹ Briefly, AN participants were recruited from 26 communities, in three distinct geographic areas of Alaska (Southcentral [SC]; Southeast [SE]; and Southwest [SW]), each served by a regional tribal health organization. SC region primarily comprised an urban recruitment site (Anchorage) and one small community; SE and SW regions comprised only small communities and villages. The study was open to all eligible tribal members, as requested by tribal councils. In each community, attempts were made to enroll all residents who met the following criteria: AI/AN person eligible for care in the Alaska Tribal Health System; at least 18 years of age; resident of study area; able to complete the interview and medical tests; and able to give informed consent. Pregnant women and chemotherapy patients were excluded because of possible confounding with several chronic disease predictors of interest in the main study (e.g. medical measures, dietary intake and physical activity). This report is based on initial self-reported data collected from 3,793 AN participants enrolled in the study from March 2004 through March 2006.

Data collection

Participants were asked to complete audio computer-assisted self-interview questionnaires using touch screens. This included an intake questionnaire (demographics and socioeconomics), and comprehensive health and lifestyle questionnaires (medical history, health-related quality of life, physical activity, diet, health risk behaviors, environmental health risks, and cultural factors).

AN participants were asked to respond to additional questions on visual impairment, ocular health, hearing impairment, oral health, depression and care-giving. Questionnaires were adapted

from several existing instruments or developed by study staff in collaboration with tribal members and pilot tested for clarity and understanding. In addition to reading the questionnaires on a computer screen, AN participants were given the option of hearing the questionnaires read in English or Yup'ik. Medical measurements were also collected, specifically height, weight, waist-hip circumference, blood pressure, serum lipid and glucose. The study protocol was approved by the Alaska Area Institutional Review Board (IRB), the Navajo Nation Human Research Review Board, National Indian Health Services IRB, the University of Utah IRB, the research and ethics committees and governing boards of each of the participating regional tribal health organizations, and the tribal councils of each participating community. All people enrolled in the study gave written informed consent prior to participation.

Demographic, socioeconomic, visual impairment and medical variables

Demographic and socioeconomic variables included regional location, age, sex, marital status, education, employment, annual household income, ethnic group and language spoken at home. Questionnaires included the following vision-specific items that were analyzed for this report: self-perceived visual impairment (adapted from the National Eye Institute Visual Functioning Questionnaire);¹² self-reported doctor-diagnosed cataract, glaucoma, diabetic eye disease, and dilated eye examination history (adapted from the Behavioral Risk Factor Surveillance System [BRFSS] survey).¹³ The exact wording of questions, response options, definitions and classification criteria for all vision variables are given in Table 1. For example, participants were classified as having visual impairment if they answered “poor”, “very poor” or “completely blind” to the question, “At the present time, would you say your eyesight using both eyes (with glasses or contact lenses, if you wear them), is excellent, good, fair, poor, or very poor, or are you completely blind?” Those who responded “don’t know / not sure” or “refuse” were excluded

from analysis. As diabetes must be present for diabetic eye disease to exist, and because of the importance of regular dilated eye examination for those with diabetes,¹⁴ responses to the question, “Did a doctor or other health care provider ever tell you that you had diabetes or sugar diabetes?” were evaluated, and participants were classified as having diabetes if they responded “yes” (excluding those who reported diabetes only during pregnancy). Participants were considered to have diabetic eye disease only if they also reported having diabetes. Dilated eye examination history was analyzed for all participants, and more specifically for participants with self-reported diabetes.

Statistical analysis

Analyses were conducted with the Statistical Packages for the Social Sciences (v. 15.0, SPSS Inc., Chicago, IL, 2007). Assumptions underlying all statistical tests used were verified.

Descriptive statistics were calculated to provide an overview of the demographic and socioeconomic characteristics of participants. To evaluate the representativeness of the sample, comparisons were made with U.S. Census 2000 data,¹⁵ for all AI/AN residents in Alaska. Also, the proportion of participants out of all AI/AN residents age 18 years and over, was calculated for each region.

Prevalence rates and corresponding 95% confidence intervals (CI) were calculated for self-reported visual impairment, cataract, glaucoma, diabetic eye disease and previous dilated eye examinations, by selected characteristics. For each variable, participants with missing data or who responded “don’t know / not sure / refuse” were excluded from the analysis. Differences between included and excluded participants were evaluated using the Student’s *t* test and chi-

square test for continuous and categorical data, respectively. Analyses were 2-tailed and $P < 0.05$ was considered statistically significant. For comparison with other studies (in particular, data from the National Health Interview Survey¹⁶), and to account for the younger age of the AN population compared with the general U.S. population,¹⁵ estimates of overall prevalence were age adjusted and age-sex adjusted to the 2000 U.S. Standard Population by direct standardization using the following age groups: 18 to 24 years, 25 to 34 years, 35 to 44 years, 45 to 64 years, and 65 years and older.¹⁷ Male and female prevalence rates were also age adjusted using this method.

Logistic regression analysis was used to assess the association between age (as a continuous variable) and each of the following dichotomous outcome variables: visual impairment, cataract, glaucoma, diabetic eye disease (limited to participants with self-reported doctor-diagnosed diabetes because only people with diabetes can have diabetic eye disease), and recent dilated eye examination (within 2 years). In addition, logistic regression analysis, controlling for age, was used to calculate prevalence odds ratios (ORs) and corresponding 95% CIs for each of the following predictor variables: demographic characteristics (sex, education, annual household income and regional location), self-reported doctor-diagnosed diabetes and recent dilated eye examination. Multivariate logistic regression analysis was then performed to calculate adjusted prevalence ORs and corresponding 95% CIs, with all predictor variables of interest. Multivariate models were determined for visual impairment, cataract, glaucoma, diabetic eye disease (again limited to participants with self-reported doctor-diagnosed diabetes), and recent dilated eye examination. All multivariate models were limited to those 25 years and older in order to include education, as participants younger than 25 years may not have completed their education.

RESULTS

Participant demographic and socioeconomic characteristics

Of the total 3,828 AN EARTH Study participants, 3,793 (99.2%) participants completed the vision-specific questions. Of the 3,793 participants included in this report, 3,793 (100.0%) completed age and sex questions; 3,778 (99.6%) completed marital status questions; 3,755 (99.0%) completed education questions; 3,779 (99.6%) completed employment questions; and 3,243 (85.5%) completed household income questions.

Demographic and socioeconomic characteristics of AN participants compared to the total AN population residing in Alaska (U.S. Census 2000 data¹⁵) are given in Table 2. Proportions of participants by region, ethnic group and language are given in Table 3. The mean (SD) age of participants was 40.3 years (14.9 years); and ranged from 18 to 94 years. Age distribution of participants was similar to that of the total AN population residing in Alaska, based on U.S. Census 2000 data; although those aged over 70 years were slightly under-represented (Table 2). Of 3,793 AN participants, 39% were men and 61% were women (compared to almost equal proportions in the state), and 43% of participants were married. Over one third had graduated from high school and almost 6% had a Bachelor's degree or higher. Forty-five percent were employed and 59% (1,904 of the 3,238 who responded) reported an annual household income greater than \$15,000. Although education and employment characteristics were similar to census data, the sector of the population with annual household income less than \$15,000 was over-represented and the sector with greater than \$50,000 was under-represented in the study sample. However, it should be noted that 555 (15%) participants did not provide income data. The majority of participants came from the SC and SW regions of Alaska, identifying with the

Cup'ik, Inupiaq, Siberian Yup'ik, and Yupik cultural groups (Table 3). Approximately 8% spoke an AN language only, one-quarter spoke both English and an AN language, and over two-thirds spoke English only. The proportion of participants out of all AI/AN residents age 18 years and over in each region (based on U.S. Census 2000 data for the corresponding Alaska Native Regional Corporation [ANRC]),¹⁵ was as follows: SC 6.3% (1,384 of 22,070 Cook Inlet ANRC AI/AN residents); SE 9.4% (885 of 9,435 Sealaska ANRC AI/AN residents); and SW 13.7% (1,524 of 11,162 Calista ANRC AI/AN residents).

Visual impairment and eye disease

Of all participants, 5% or fewer gave a response of “don't know / not sure” or “refuse” to the questions on visual impairment and eye disease, and were excluded from analyses. The final number of participants included in each analysis was as follows: visual impairment, $n = 3,786$ (99.8%); cataract, $n = 3,702$ (97.6%); glaucoma, $n = 3,681$ (97.0%); and diabetic eye disease, $n = 3,606$ (95.1%). With regard to previous dilated eye examination, 481 participants were “not sure” and excluded, leaving 3,312 (87.3%) for analysis. For the cataract and glaucoma analyses, participants who were excluded (responded “don't know / not sure” or “refuse” to the question), were older ($P \leq 0.01$), more likely to be male ($P < 0.05$) and had less formal education ($P < 0.001$), compared with participants who were included (responded “yes / no”). Although participants excluded from the diabetic eye disease analyses were again more likely to be male ($P = 0.01$), and had less education ($P < 0.001$), there was no significant difference between included and excluded participants in age ($P = 0.35$). For dilated eye examination history, similar sex and education differences were found between included and excluded participants; however, excluded participants were younger than included participants ($P < 0.001$). For all eye disease

and dilated eye examination questions, there were no significant differences between included and excluded participants with respect to annual household income category ($P \geq 0.13$).

Prevalence rates for self-reported visual impairment and eye disease are given in Table 4. The overall prevalence of self-reported visual impairment was 8.7% (95% CI: 7.9-9.7), cataract 5.9% (95% CI: 5.2-6.7), glaucoma 2.5% (95% CI: 2.0-3.0) and diabetic eye disease 1.3% (95% CI: 0.9-1.7). The age-sex adjusted prevalence of self-reported visual impairment was 10.0% (95% CI: 9.3-10.8), cataract 9.5% (95% CI: 8.6-10.3), glaucoma 3.5% (95% CI: 2.9-4.1) and diabetic eye disease 1.9% (95% CI: 1.5-2.2). Of the participants with self-reported diabetes, (192 of 3,697 who responded to the question on diabetes, or 5.2% [95% CI: 4.5-5.9]), 175 responded to the question on diabetic eye disease. Forty-six reported having diabetic eye disease; thus, the unadjusted prevalence of diabetic eye disease among participants with self-reported diabetes was 26.3% (95% CI: 20.2-33.2).

Among participants aged 40 years and over, unadjusted prevalence rates were visual impairment 11.5% (95% CI: 10.1-13.0), cataract 10.9% (95% CI: 9.5-12.3), glaucoma 4.5% (95% CI: 3.6-5.5) and diabetic eye disease 2.4% (95% CI: 1.8-3.2). The prevalence of each condition increased with age ($P < 0.01$), as shown in Figure 1.

A greater proportion of men reported visual impairment compared with women (age adjusted prevalence = 11.3% [95% CI: 9.4-13.2] and 8.9% [95% CI: 7.6-10.2], respectively). Likewise, more men than women reported diabetic eye disease (age adjusted prevalence = 2.6% [95% CI: 1.4-3.7] and 1.3% [95% CI: 0.7-1.9], respectively). However, the reverse trend was observed for

cataract and glaucoma with a greater proportion of women reporting these eye diseases compared with men (Table 4).

Education was associated with visual impairment, with prevalence of visual impairment greater among participants with less than high school education than among participants with a Bachelor's degree or higher (OR adjusted for age = 3.92 [95% CI: 2.02-7.60], $P < 0.001$).

Regional differences were observed for cataract. The highest unadjusted prevalence of cataract was among participants living in the SE region (8.9%, 95% CI: 7.2-11.0) and the lowest among those living in the SW region (4.4%, 95% CI: 3.5-5.6). Compared to the SW region, the odds of cataract among SE participants and SC participants were significantly greater (OR adjusted for age = 1.75 [95% CI: 1.20-2.57], $P < 0.01$ and 2.12 [95% CI: 1.45-3.11], $P < 0.001$; respectively).

Prevalence of self-reported cataract was significantly higher among participants reporting dilated eye examination within 2 years compared with those reporting dilated eye examination ≥ 2 years ago or never (OR adjusted for age = 3.20 [95% CI: 2.03-5.04], $P < 0.001$), as was prevalence of self-reported glaucoma (OR adjusted for age = 1.88 [95% CI: 1.05-3.40], $P = 0.03$).

Dilated eye examinations

Overall, 70.0% (95% CI: 68.5-71.6) of participants reported a dilated eye examination within the previous 2 years, 17.9% (95% CI: 16.6-19.2) 2 or more years ago, and 12.0% (95% CI: 11.0-13.2) reported never having a dilated eye examination (Table 5). Age-sex adjusted prevalence rates were similar: 69.7%, 18.2% and 12.0% for self-reported dilated eye examination within the previous 2 years, ≥ 2 years ago, and never, respectively. Of the participants aged ≥ 65 years,

73.7% (95% CI: 67.8-79.0) reported a dilated eye examination within the previous 2 years. The proportion who reported an examination within the previous 2 years increased with age ($P < 0.001$), ranging from 63.0% of participants aged 18-29 years to 77.8% of those aged 80 years or over. Fewer men than women reported dilated eye examination within the previous 2 years (age adjusted prevalence = 65.5% [95% CI: 62.6-68.3] and 73.6% [95% CI: 71.6-75.6]; respectively). Also, the odds of reporting an examination in the previous 2 years was lower among those with less than a high school education compared to participants with a Bachelor's degree or higher (OR adjusted for age = 0.45 [95% CI: 0.31-0.67], $P < 0.001$). History of dilated eye examination varied little with income or region of residence (Table 5).

Of the participants with self-reported doctor-diagnosed diabetes, the unadjusted proportion who reported a dilated eye examination in the previous 1 and 2 years was 67.7% (95% CI: 60.8-74.1) and 84.9% (95% CI: 79.0-89.6), respectively. Of participants who reported ever having visual impairment, cataract, glaucoma or diabetic eye disease, the unadjusted prevalence of dilated eye examination within the previous 2 years was 69.8% (95% CI: 64.3-74.8), 88.0% (95% CI: 84.5-93.0), 83.7% (95% CI: 74.9-90.4) and 87.0% (95% CI: 75.1-94.4), respectively. Compared to those without any of these eye diseases, recent (within 2 years) self-reported dilated eye examination was greater only among those reporting cataract (OR adjusted for age = 2.70 [95% CI: 1.74-4.19], $P < 0.001$).

Multivariate models

Multivariate models for visual impairment, eye disease and recent dilated eye examination are given in Table 6. In the multivariate model of visual impairment, age group, education and income were important predictors. The adjusted odds of visual impairment was 1.87 to 2.82

times higher for older age groups than for the group aged 25-39 years, 4.85 times higher for those with less than high school education than for those with a Bachelor's degree or higher, and the odds for those with annual household income \leq \$15,000 was 0.60 times the odds for those with annual household income $>$ \$50,000.

In the multivariate models of cataract and glaucoma, the most important predictor was age group (Table 6). Recent dilated eye examination and region of residence were also significant predictors of cataract. The adjusted odds of cataract was 2.81 times higher for participants who reported recent dilated eye examination (within 2 years) than for those who reported dilated eye examination \geq 2 years ago or never, and almost twice as high for participants residing in either the SC or SE region than for those residing in the SW region.

There were several significant predictors of diabetic eye disease among participants with diabetes. Table 6 shows that compared to the youngest age group (25-39 years), the group aged 60-69 years had the highest odds of diabetic eye disease (OR adjusted = 17.43). Furthermore, the adjusted odds of diabetic eye disease was 4.81 times higher for diabetic men than for diabetic women, 4.30 times higher for diabetic participants with annual household income \leq \$15,000 than for those with annual household income $>$ \$50,000, and 6.30 times higher for those with annual household income \$35,000-\$50,000 than for those with annual household income $>$ \$50,000. Compared with participants with diabetes residing in the SW region, approximately 75% fewer participants with diabetes residing in either the SC or SE region reported diabetic eye disease (OR adjusted = 0.23 and 0.26, respectively).

In the multivariate model of recent dilated eye examination (within 2 years), age group, sex, education, diabetes, cataract, and glaucoma were significant predictors (Table 6). The adjusted odds of recent dilated eye examination was 1.47 times higher for the group aged 50-59 years than for the group aged 25-39 years. After adjusting for other variables, men were less likely than women to have a recent dilated eye examination (OR adjusted = 0.75), as were those with high school education or less compared to participants with a Bachelor's degree or higher (OR adjusted = 0.50). The adjusted odds of recent dilated eye examination was 2.07, 2.91 and 3.17 times higher for participants with diabetes, glaucoma and cataract, respectively, than for those without each of these diseases (Table 6).

DISCUSSION

Visual impairment is a recognized global public health issue.¹⁸ Prevalence data are needed to estimate the extent of the problem in the AN population specifically, as little data are available. This is important because many eye diseases are treatable and a considerable proportion of visual impairment can be avoided or controlled.^{19, 20} As eye disease increases with age and the AN population like other populations is aging,^{1, 21} the issue will likely become of greater importance in the near future. National Healthy People 2010 public health goals include decreasing the prevalence of visual impairment due to cataract, glaucoma and diabetic eye disease, and increasing the proportion of the population having a regular dilated eye examination.⁸ We have presented data on the prevalence of self-reported visual impairment, cataract, glaucoma, diabetic eye disease and history of dilated eye examination among people living in three regions of Alaska.

In the population studied, we found the prevalence of self-reported visual impairment was 8.7% for people aged 18 years or over, or an estimated 6,174 AN people living in Alaska (based on U.S. Census data).¹⁵ The age-sex adjusted prevalence was 10.0% (95% CI: 9.3-10.8%), somewhat higher than the 1997-2002 national survey estimates of visual impairment among the AI/AN population living throughout the U.S. (8.2% [95% CI: 6.5-9.9]),²² somewhat less than the more recent 2002-2005 AI/AN estimates (13.5% [95% CI: 10.6-16.4]),¹⁶ and slightly higher than national estimates for the general U.S. adult population (9.3% [95% CI: 8.9-9.7]).¹⁶ Consistent with other self-report surveys and with examination-based studies of the general population,^{1, 16} we found visual impairment increased with age. Although more men than women reported visual impairment, the difference was not significant after adjustment for other factors (age, education,

annual household income, region of residence, recent dilated eye examination and diabetes). In a multivariate model, formal education and income were the significant predictors of self-reported visual impairment. As in other studies,^{16, 23, 24} we found visual impairment was more prevalent among participants with less than high school education than among participants with higher education. It is possible that insufficient knowledge and finances may be barriers to obtaining appropriate eye care and spectacles.^{16, 25} Indeed, after adjustment for other factors, we found that recent dilated eye examination was inversely associated with level of education. However, the association between annual household income and visual impairment was in the opposite direction to that expected and found in previous studies.^{16, 23, 24} Visual impairment was less prevalent among participants in the lowest income group compared with those in the highest income group. This inconsistency may be because 15% of participants did not provide income data, or because of the limited distribution of income in this study population. Further investigation is required to evaluate a possible association between income and visual impairment.

Of the self-reported eye diseases investigated, cataract was the most prevalent (age-sex adjusted prevalence = 9.5% [95% CI: 8.6-10.3]), followed by glaucoma (age-sex adjusted prevalence = 3.5% [95% CI: 2.9-4.1]) and diabetic eye disease (age-sex adjusted prevalence = 1.9% [95% CI: 1.5-2.2]), as found in the general population of North America, Western Europe and Australia,¹ and the AI/AN population of Oregon, Washington and Idaho.²⁶ Compared with estimates from the National Health Interview Survey for the general U.S. adult population (age adjusted prevalence = 8.6% [95% CI: 8.2-9.0], 2.0% [95% CI: 1.8-2.2] and 0.7% [95% CI: 0.5-0.9] for cataract, glaucoma and diabetic retinopathy, respectively),¹⁶ the findings of this study suggest a higher prevalence of these eye diseases among the AI/AN people in the three regions of Alaska

surveyed. The prevalence of each eye disease investigated—cataract, glaucoma and diabetic eye disease—increased with age, as in other populations.^{16, 27-32}

Within Alaska, we found self-reported cataract was more prevalent in the SC and SE regions compared with the SW region, after adjustment for other factors, including age, sex, education, annual household income, recent dilated eye examination and diabetes. The reason for this is not clear and may be due to genetic, environmental and/or life-style factors.

Similar to previous reports from two examination-based studies conducted in northern regions of Alaska,^{9, 10} the unadjusted prevalence of self-reported glaucoma was high in the more southern regions we sampled (4.5% of those aged ≥ 40 years). Previous studies indicate a higher prevalence of angle-closure glaucoma among AN people compared to many other groups throughout the world.^{33, 34} Type of glaucoma was not specified in this study. It is possible participants had angle closure glaucoma, open angle glaucoma or another type of glaucoma. As studies in other populations have found that more than half of those with open angle glaucoma are unaware of it,^{34, 35} the actual prevalence of all glaucoma among AN people may be greater than that found in this self-report study.

Among participants who reported having diabetes, the unadjusted prevalence of diabetic eye disease was high, 26.3%. Even so, our self-reported findings are again likely to underestimate the problem, as almost one third of people with diabetes may be unaware that they have diabetes,³⁶ and possibly diabetic eye disease.^{37, 38} To our knowledge, there are no published data on diabetic eye disease among AN people for comparison with our findings. However, some of our results for AN people with self-reported diabetes are consistent with findings for people with diabetes in

the general U.S. population.¹⁶ For example, the prevalence of self-reported diabetic eye disease increased with age, peaking in the age group 60-69 years and thereafter declining. This pattern may be due to the association of diabetic eye disease with more severe diabetes and reduced survival among older people with diabetes.^{16, 39, 40} Among participants with diabetes, additional factors associated with diabetic eye disease were male sex, lower annual household income and region of residence. After adjustment for other factors, prevalence of diabetic eye disease was lower among participants in the SC and SE region compared with the SW region. As for regional differences in the prevalence of cataract, the reason for regional differences in self-reported diabetic eye disease is not clear and warrants further investigation.

A Healthy People 2010 national goal is to increase the proportion of those aged 18 years or over who have a dilated eye exam at appropriate intervals.⁸ National data collected thus far indicate 55% of the general U.S. population aged 18 years or over report a dilated eye examination within the previous 2 years, and a target objective of 58% has been set.⁴¹ In comparison, our finding that 70% of participants aged 18 years or over reported a dilated eye examination within the previous 2 years, suggests that the target is being met in the AN population studied. However, the American Academy of Ophthalmology recommends dilated eye examination every 2-4 years for all risk-free people aged 40-54 years, every 1-3 years for those aged 55-64 years, every 1-2 years for those over the age of 65 years.¹⁴ Our results indicate that more than 26% of AN people aged ≥ 65 years did not have a dilated eye examination within the previous 2 years, and so there remains a substantial need for eye care in this age group.

In this study, the adjusted odds of reporting having a recent dilated eye examination was highest for the group aged 50-59 years compared to the youngest group (aged 25-39 years), perhaps

mostly due to presbyopia, cataract and glaucoma. Indeed, the results of multivariate analysis indicate that cataract, glaucoma and diabetes were associated with recent dilated eye examination. Other associated factors were sex and education. Consistent with previous studies,^{23,25} prevalence of recent dilated eye examination was lower among men than women, and lower among participants with less education than among those with higher education. Although we did not find an association with household income, an association has been found in other studies.^{23,25} Again, it should be noted that perhaps this was because several participants in our study did not provide income data and the distribution of income data was limited.

More than 80% of participants in this study who reported ever having cataract, glaucoma or diabetic eye disease also reported having a dilated eye examination within the previous 2 years. However, of those who reported visual impairment, only 70% reported recent dilated eye examination. Although 85% of participants who reported diabetes reported a dilated eye examination within the previous 2 years, we found that approximately only two-thirds reported a dilated eye examination within the previous 1 year. As an annual dilated eye examination is strongly recommended for all people with diabetes to prevent visual impairment and blindness,¹⁴ we suggest that eye care awareness programs and increased eye care services for AN people with diabetes may be needed.

A number of study limitations require consideration. First, the sample was one of convenience and perhaps not fully representative of the AN population. Although the age distribution, education and employment characteristics were similar to census data, AN people aged over 70 years were under-represented, a sector of the population known to be at high risk for visual impairment and eye disease.^{1,16} In future, oversampling older age groups may provide more

accurate estimates of prevalence, in particular for chronic and later onset disease such as cataract and glaucoma. In addition, there was a higher proportion of women and a higher proportion with annual household income less than \$15,000 in the study sample compared with census data. It is also likely that non-ambulatory persons were under-represented. Second, these data were self-reported and may have been influenced by recall bias and inaccuracies (including participant uncertainty about the name of an eye disease, misinterpretation of the diagnosis, or lack of communication of the diagnosis from a healthcare provider). Also, the findings may under-represent actual prevalence rates due to lack of awareness; early signs of eye disease are often asymptomatic, and approximately one-third of all participants had not been examined recently. Although a random sample, population-based observational study would be ideal, such a study would be costly and difficult given the remote location of many AN communities. Third, data were not obtained on the cause and severity of visual impairment, the specific type of cataract, glaucoma or diabetic eye disease. Also, under-corrected refractive error and age-related macular degeneration, two leading causes of visual impairment,^{1, 26, 42} as well as trauma and other important causes were not investigated. However, given the current lack of available data for the AN population, we suggest these data are important. This is the first study to provide visual impairment, eye disease and eye care data for a large sample of the AN population in three regions of Alaska.

Based on the findings of this study, it would seem important to further investigate the causes and severity of self-reported visual impairment, and to investigate the regional differences in cataract and diabetic eye disease. Also, the barriers to obtaining eye care services should be determined for the AN population, in particular for men, those who report visual impairment, those with diabetes and people with lower socioeconomic status.

Conclusions

The prevalence of visual impairment, cataract, glaucoma and diabetic eye disease is high among the AN population. AN people may benefit from culturally sensitive eye health promotion programs that address known risk factors for these problems (e.g. ultraviolet radiation exposure, smoking, nutrition and, blood glucose and blood pressure control),⁴³ and that emphasize regular eye examinations (particularly for elders, people with diabetes, those with a family history of eye disease, and those with symptoms),^{19, 20} with increased access to eye care for all. Data obtained from this study provide a baseline for developing such programs and for planning the eye care services required to prevent unnecessary visual impairment and improve eye health among AN people in the future.

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TABLES AND FIGURES

Table 1. Definition and classification of self-reported visual impairment, cataract, glaucoma, diabetic eye disease, and dilated eye examination history—based on questions asked in the Education and Research Towards Health Study

Variable	Question	Response Options*	Classification
Visual impairment	At the present time would you say your eyesight using both eyes (with glasses or contact lenses, if you wear them) is excellent, good, fair, poor, or very poor or are you completely blind?	excellent, good, fair, poor, very poor, completely blind, don't know / not sure, refuse	VISUAL IMPAIRMENT if response = poor, very poor, completely blind
Cataract	Did a doctor or other health care provider ever tell you that you had cataracts?	yes, no, don't know / not sure, refuse	CATARACT if response = yes
Glaucoma	Did a doctor or other healthcare provider ever tell you that you had glaucoma?	yes, no, don't know / not sure, refuse	GLAUCOMA if response = yes
Diabetic eye disease†	Has a doctor ever told you that diabetes has affected your eyes or that you had retinopathy?	yes, no, don't know / not sure, refuse	DIABETIC EYE DISEASE if response = yes
Dilated eye examination history	When was the last time you had an eye examination in which the pupils were dilated? This would have made you temporarily sensitive to bright light.	within the past month, within the past year, within the past 2 years, 2 or more years ago, never, don't know / not sure, refuse	EXAMINED WITHIN 1Y if response = within past month or year EXAMINED WITHIN 2Y if response = within past month, year or 2 years EXAMINED 2Y AGO OR MORE if response = 2 or more years ago NEVER EXAMINED if response = never

*Participants who responded don't know / not sure or refuse were excluded from analysis.

†Only those also with self-reported doctor-diagnosed diabetes, unrelated to pregnancy, (participants responding "yes" to "Did a doctor or other health care provider ever tell you that you had diabetes or sugar diabetes?" were included; those responding, "yes, but only when I was pregnant", "no", "don't know/not sure", or "refuse" were excluded).

Table 2. Demographic and socioeconomic characteristics for Alaska Native adult participants of the Education and Research Toward Health (EARTH) Study compared with all Alaska Natives in Alaska (U.S. Census 2000 data)

Characteristic	EARTH Study n	EARTH Study %	Census* %
Total	3793	100.0	
Age, years†			
18-29	1077	28.4	27.9
30-39	786	20.7	24.6
40-49	942	24.8	22.4
50-59	567	14.9	12.6
60-69	268	7.1	6.9
70-79	122	3.2	4.0
≥ 80	31	0.8	1.6
≥ 40	1930	50.9	47.5
Sex†			
Male	1492	39.3	49.2
Female	2301	60.7	50.8
Marital status‡			
Married	1618	42.8	39.0
Not married	2160	57.2	61.0
Education§			
Less than high school	843	22.5	27.2
High school graduate (or equivalent)	1393	37.1	40.7
Some college or associate degree	1309	34.9	26.0
Bachelor's degree or higher	210	5.6	6.1
Employment			
Employed	1709	45.2	48.8
Annual household income¶			
≤ \$15,000	1334	41.2	20.4
\$15,001-\$25,000	523	16.2	16.1
\$25,001-\$35,000	444	13.7	13.7
\$35,001-\$50,000	440	13.6	15.8
≥ \$50,001	497	15.3	34.0

*Data set: Census 2000 American Indian and Alaska Native Summary File – Sample Data; Geographic Area: Alaska; Tribes alone or in any combination: American Indian and Alaska Native alone or in any combination.

†Census 2000 data for population 18 years and over.

‡Census 2000 data for population 15 years and over. EARTH data missing for 15 participants. Married = now married or living as married; not married = separated, widowed, divorced or never married.

§Census 2000 data for population 18 years and over. EARTH data missing for 38 participants. Less than high school = grade 1-11 or never attended; high school graduate including equivalent; some college or Associate degree = some vocational / technical school, technical school degree/certificate, some college but no degree or Associate degree; Bachelor's degree or higher = Bachelor's degree or graduate of professional degree (Master's, Doctorate, JD, DDS etc.).

|| Census 2000 data for population 16 years and over. EARTH data missing for 14 participants. Employed = currently employed for wages or self-employed.

¶Census 2000 data for households. EARTH data missing for 555 participants.

Table 3. Alaska Native adult participants of the Education and Research Toward Health Study by region, ethnic group and language*

Total	3793 (100.0)
Alaska region	
Southcentral	1384 (36.5)
Southeast	885 (23.3)
Southwest	1524 (40.2)
Ethnic group†	
Aleut	322 (8.5)
Athabascan	384 (10.2)
Cup'ik / Inupiaq / Siberian Yup'ik / Yup'ik	2331 (61.7)
Tlingit / Haida / Tsimshian	1086 (28.8)
Lower 48 American Indian	203 (5.4)
Language spoken at home‡	
AN language only	300 (7.9)
English only	2525 (66.6)
Both English and AN language	952 (25.1)
Other	13 (0.3)

*All values n (%). AN = Alaska Native

†Participants chose all that apply; Data missing for 17.

‡Data missing for 3 participants.

Table 4. Prevalence of self-reported visual impairment, cataract, glaucoma and diabetic eye disease among Alaska Native participants of the Education and Research Toward Health Study by selected demographic variables, dilated eye examination and self-reported diabetes*

Characteristic	Visual Impairment			Cataract			Glaucoma			Diabetic Eye Disease		
	n	%	95% CI	n	%	95% CI	n	%	95% CI	n	%	95% CI
Total	330	8.7	7.9-9.7	219	5.9	5.2-6.7	92	2.5	2.0-3.0	46	1.3	0.9-1.7
Age adjusted†		9.8	8.7-10.9		9.6	8.5-10.8		3.6	2.8-4.4		1.8	1.2-2.3
Age-sex adjusted†		10.0	9.3-10.8		9.5	8.6-10.3		3.5	2.9-4.1		1.9	1.5-2.2
Age, years‡												
18-29	64	5.9	4.7-7.5	3	0.3	0.1-0.8	1	0.1	0.0-0.4	0	0.0	0.0-0.2
30-39	45	5.7	4.3-7.5	13	1.7	1.0-2.8	7	0.9	0.4-1.8	2	0.3	0.1-0.8
40-49	86	9.1	7.4-11.1	40	4.3	3.2-5.8	20	2.2	1.4-3.3	8	0.9	0.4-1.7
50-59	69	12.2	9.7-15.1	48	8.7	6.5-11.2	25	4.6	3.0-6.5	16	2.9	1.8-4.6
60-69	32	12.0	8.5-16.3	58	23.0	18.2-28.5	22	8.7	5.7-12.7	12	4.8	2.6-7.9
70-79	24	19.7	13.4-27.4	42	37.2	28.7-46.3	10	9.3	4.9-15.8	4	3.6	1.2-8.4
≥ 80	10	32.3	17.9-49.7	15	57.7	38.7-75.0	7	25.9	12.4-44.3	4	14.3	4.4-27.0
≥ 40	221	11.5	10.1-13.0	203	10.9	9.5-12.3	84	4.5	3.6-5.5	44	2.4	1.8-3.2
Sex§												
Male	148	9.9	8.5-11.5	74	5.1	4.1-6.4	29	2.0	1.4-2.8	23	1.6	1.1-2.4
Female	182	7.9	6.9-9.1	145	6.4	5.5-7.5	63	2.8	2.2-3.6	23	1.0	0.7-1.5
Age adjusted male†		11.3	9.4-13.2		7.8	6.0-9.6		2.8	1.6-3.9		2.6	1.4-3.7
Age adjusted female†		8.9	7.6-10.2		10.6	9.1-12.1		4.1	3.8-4.4		1.3	0.7-1.9
Education												
Less than high school	140	16.7	14.3-19.3	75	9.3	7.4-11.4	37	4.6	3.3-6.2	16	2.1	1.2-3.3
High school graduate	104	7.5	6.2-9.0	58	4.3	3.3-5.5	25	1.9	1.2-2.7	10	0.7	0.4-1.3
Some coll. / assoc. deg.	75	5.7	4.6-7.1	65	5.0	3.9-6.3	25	1.9	1.3-2.8	17	1.3	0.8-2.1
Bachelor's deg. / higher	10	4.8	2.5-8.3	17	8.2	5.0-12.5	4	1.9	0.7-4.5	2	1.0	0.2-3.1
Annual household income¶												
≤ \$15,000	112	8.4	7.0-10.0	82	6.3	5.1-7.7	31	2.4	1.7-3.3	20	1.6	1.0-2.4
\$15,001-\$25,000	45	8.6	6.5-11.4	26	5.1	3.4-7.3	13	2.5	1.4-4.2	4	0.8	0.3-1.9
\$25,001-\$35,000	39	8.8	6.4-11.7	23	5.3	3.5-7.7	10	2.3	1.2-4.0	4	1.0	0.3-2.3
\$35,001-\$50,000	38	8.6	6.3-11.5	24	5.6	3.7-8.1	11	2.6	1.4-4.4	7	1.7	0.8-3.3
≥ \$50,001	58	11.8	9.1-14.8	38	7.9	5.7-10.6	13	2.7	1.5-4.5	6	1.3	0.5-2.6
Alaska region**												
Southcentral	109	7.9	6.6-9.4	76	5.6	4.5-6.9	24	1.8	1.2-2.6	15	1.1	0.7-1.8
Southeast	74	8.4	6.2-9.5	78	8.9	7.2-11.0	25	2.9	1.9-4.1	15	1.7	1.0-2.8
Southwest	147	9.7	8.3-11.2	65	4.4	3.5-5.6	43	3.0	2.2-3.9	16	1.1	0.7-1.8
Dilated eye examination††												
Within 2 years	203	8.8	7.7-10.0	183	8.1	7.0-9.3	72	3.2	2.5-4.0	40	1.8	1.3-2.4
≥ 2 years ago or never	88	8.9	7.3-10.8	25	2.6	1.7-3.6	14	1.4	0.8-2.3	6	0.6	0.3-1.3
Condition‡‡												
Diabetes	27	14.1	9.7-19.5	30	16.0	11.3-20.2	12	6.5	3.6-10.8	46	26.3	20.2-33.2
No diabetes	289	8.3	7.4-9.2	179	5.2	4.5-6.0	77	2.3	1.8-2.7	NA	NA	NA

*Total n = 3793. CI = confidence interval; NA = not applicable. Number of participants with missing data: visual impairment, 7; cataract, 91; glaucoma, 112; and diabetic eye disease, 188.

†Direct method of adjustment using the 2000 U.S. Standard Population.

‡Prevalence of all self-reported conditions—visual impairment, cataract, glaucoma and diabetic eye disease—increased with age ($P < 0.01$).

§Prevalence of self-reported visual impairment was significantly greater among men compared with women (OR adjusted for age = 1.32, 95% CI: 1.05-1.67; $P = 0.02$), as was diabetic eye disease (OR adjusted for age = 2.23, 95% CI: 1.10-4.53; $P = 0.03$).

|| Less than high school = grade 1-11 or never attended; high school graduate including equivalent; some coll. / Assoc. deg. = some vocational/technical school, technical school degree/certificate, some college but no degree or Associate degree; Bachelor's deg. / higher = Bachelor's degree or graduate of professional degree (Master's, Doctorate, JD, DDS etc.). Data for participants aged 18 years and over; it is possible participants younger than 25 years may not have completed their education. Education data missing for 38 participants, (responded "don't know / not sure" or "refuse"). Prevalence of visual impairment was significantly greater among participants with less than high school education compared with participants with a Bachelor's degree or higher (OR adjusted for age = 3.92, 95% CI: 2.02-7.60; $P < 0.001$).

¶Income data missing for 555 participants, (responded "don't know / not sure" or "refuse").

**Prevalence of cataract was significantly greater among participants living in the Southcentral region compared with the Southwest region (OR adjusted for age = 2.12, 95% CI: 1.45-3.11; $P < 0.001$), and greater among participants living in the Southeast region compared with the Southwest region (OR adjusted for age = 1.75,

95%: CI 1.20-2.57; $P < 0.01$).

††Number of participants with missing data for self-reported dilated eye examination and/or each eye disease: visual impairment, 487; cataract, 555; glaucoma, 569; and diabetic eye disease, 632. Prevalence of self-reported cataract was significantly greater among participants reporting dilated eye examination within 2 years compared with those reporting dilated eye examination ≥ 2 years ago or never (OR adjusted for age = 3.20, 95% CI: 2.03-5.04; $P < 0.001$), as was prevalence of self-reported glaucoma (OR adjusted for age = 1.88, 95% CI: 1.05-3.40; $P = 0.03$).

‡‡Self-reported doctor-diagnosed diabetes, not associated with pregnancy. By definition, diabetic eye disease was conditional upon having diabetes. Number of participants with missing data for diabetes and/or each eye disease: visual impairment, 102; cataract, 170; glaucoma, 191; and diabetic eye disease, 256.

Table 5. Prevalence of self-reported dilated eye examinations among Alaska Native participants of the Education and Research Toward Health Study by selected demographic variables and self-reported conditions*

Characteristic	within 2 years			2 years ago or more			never		
	n	%	95% CI	n	%	95% CI	n	%	95% CI
Total	2320	70.0	68.5-71.6	593	17.9	16.6-19.2	399	12.0	11.0-13.2
Age adjusted†		70.6	69.4-71.8		17.8	16.5-19.2		11.6	10.4-12.7
Age-sex adjusted†		69.7	68.7-70.8		18.2	17.3-19.1		12.0	11.3-12.7
Age, years‡									
18-29	548	63.0	59.7-66.1	175	20.1	17.6-22.9	147	16.9	14.5-19.5
30-39	484	69.3	65.8-72.7	123	17.6	14.9-20.6	91	13.0	10.7-15.7
40-49	594	70.7	67.6-73.7	143	17.0	14.6-19.7	103	12.3	10.2-14.6
50-59	403	76.3	72.6-79.8	95	18.0	14.9-21.4	30	5.7	3.9-7.9
60-69	196	79.7	74.3-84.3	37	15.0	11.0-19.9	13	5.3	3.0-8.6
70-79	74	71.8	62.6-79.8	18	17.5	11.1-25.7	11	10.7	5.8-17.7
≥ 80	21	77.8	59.8-90.2	2	7.4	1.6-21.7	4	14.8	5.2-31.5
≥ 40	1288	73.9	71.8-75.9	295	16.9	15.2-18.7	161	9.2	7.9-10.7
≥ 65	174	73.7	67.8-79.0	41	17.4	13.0-22.6	21	8.9	5.8-13.0
Sex§									
Male	829	65.4	62.8-68.0	250	19.7	17.6-22.0	188	14.8	13.0-16.9
Female	1491	72.9	71.0-74.8	343	16.8	15.2-18.4	211	10.3	9.1-11.7
Age adjusted male†		65.5	62.6-68.3		20.3	17.8-22.7		14.2	12.2-16.3
Age adjusted female†		73.6	71.6-75.6		16.5	14.8-18.2		9.9	9.3-10.5
Education									
Less than high school	458	66.0	62.4-69.4	137	19.7	16.9-22.8	99	14.3	11.8-17.0
High school graduate	779	65.4	62.7-68.1	219	18.4	16.3-20.7	193	16.2	14.2-18.4
Some coll. / assoc. deg.	892	74.8	72.3-77.2	202	16.9	14.9-19.2	198	8.2	6.8-9.9
Bachelor's deg. / higher	165	80.9	75.1-85.8	32	15.7	11.2-21.1	7	3.4	1.5-6.6
Annual household income¶									
≤ \$15,000	827	71.0	68.4-73.6	210	18.0	15.9-20.3	127	10.9	9.2-12.8
\$15,001-\$25,000	319	71.0	66.7-75.1	69	15.4	12.3-18.9	61	13.6	10.7-17.0
\$25,001-\$35,000	279	70.8	66.2-75.1	70	17.8	14.2-21.8	45	11.4	8.6-14.8
\$35,001-\$50,000	268	69.3	64.5-73.7	4	19.1	15.4-23.3	45	11.6	8.7-15.1
≥ \$50,001	294	67.3	62.8-71.6	89	20.4	16.8-24.3	54	12.4	9.5-15.7
Alaska region									
Southcentral	859	70.0	67.4-72.5	229	18.7	16.6-20.9	139	11.3	9.6-13.2
Southeast	567	72.0	68.7-75.0	124	15.7	13.3-18.4	97	12.3	10.2-14.7
Southwest	894	68.9	66.4-71.4	240	18.5	16.5-20.7	163	12.6	10.8-14.5
Condition**									
Diabetes	146	84.9	79.0-89.6	17	9.9	6.1-15.0	9	5.2	2.5-8.9
Visual impairment	203	69.8	64.3-74.8	61	21.0	16.6-25.9	27	9.3	6.3-13.0
Cataract	183	88.0	84.5-93.0	18	8.7	5.4-13.0	7	3.4	1.5-6.5
Glaucoma	72	83.7	74.9-90.4	10	11.6	6.1-19.6	4	4.7	1.6-10.7
Diabetic eye disease	40	87.0	75.1-94.4	5	10.9	4.3-22.2	1	2.2	0.2-9.7

*Total n = 3312; dilated eye examination data missing for 481 participants (responded "don't know / not sure" or "refuse"). CI = confidence interval.

†Direct method of adjustment using the 2000 U.S. Standard Population.

‡Prevalence of self-reported dilated eye examination within the previous 2 years (compared with ≥ 2 years ago or never) increased with age ($P < 0.001$).

§Prevalence of self-reported dilated eye examination within the previous 2 years was significantly less among men compared with women (OR adjusted for age = 0.71, 95% CI: 0.61-0.82; $P < 0.001$).

|| Less than high school = grade 1-11 or never attended; high school graduate including equivalent; some coll. / Assoc. deg. = some vocational/technical school, technical school degree/certificate, some college but no degree or Associate degree; Bachelor's deg. / higher = Bachelor's degree or graduate of professional degree (Master's, Doctorate, JD, DDS etc.). Data for participants aged 18 years and over; it is possible participants younger than 25 years may not have completed their education. Education data for 31 participants missing, (responded "don't know / not sure" or "refuse"). Prevalence of self-reported dilated eye examination within the previous 2 years was significantly less among participants with less than high school education compared with participants with a Bachelor's degree or higher (OR adjusted for age = 0.45, 95% CI: 0.31-0.67; $P < 0.001$).

¶Income data missing for 481 participants (responded "don't know / not sure" or "refuse").

**Number of participants with missing data for each eye disease/condition: visual impairment, 6; cataract, 74; glaucoma, 88; diabetic eye disease, 151; and diabetes (not associated with pregnancy), 205. All conditions were self-reported. By definition, diabetic eye disease was conditional upon having diabetes. Prevalence of self-reported dilated eye examination within the previous 2 years was significantly greater among participants reporting cataract compared with those reporting no cataract (OR adjusted for age = 2.70, 95% CI: 1.74-4.19; $P < 0.001$); also for participants reporting diabetes (not associated with pregnancy) compared with those reporting no diabetes (OR adjusted for age = 2.05, 95% CI: 1.36-3.09; $P = 0.001$).

Table 6. Multivariate associations with self-reported visual impairment, cataract, glaucoma, diabetic eye disease and dilated eye examination (within 2 years) among Alaska Native participants of the Education and Research Toward Health Study*

Characteristic	Visual Impairment		Cataract		Glaucoma		Diabetic Eye Disease†		Dilated Eye Examination (within 2 years)	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age, years										
25-39 (Ref.)	1.00		1.00		1.00		1.00		1.00	
40-49	1.94*	1.31-2.89	3.45*	1.72-6.92	2.67*	1.08-6.61	2.06	0.32-13.37	1.12	0.89-1.40
50-59	2.59*	1.69-3.69	7.48*	3.77-14.85	5.68*	2.35-13.76	4.57	0.74-28.07	1.47*	1.10-1.97
60-69	1.87*	1.09-3.21	20.84*	10.33-42.03	8.32*	3.25-21.31	17.43*	2.20-137.98	1.45	0.96-2.20
≥ 70	2.82*	1.54-5.17	56.09*	26.10-120.53	9.20*	3.23-26.22	5.47	0.56-53.16	0.91	0.52-1.60
Sex										
Male	1.03	0.76-1.39	0.93	0.64-1.34	0.63	0.37-1.10	4.81*	1.76-13.14	0.75*	0.61-0.91
Female (Ref.)	1.00		1.00		1.00		1.00		1.00	
Education										
Less than high school	4.85*	2.24-10.52	1.28	0.64-2.56	2.86	0.81-10.16	0.51	0.07-3.82	0.49*	0.31-0.78
High school graduate	1.91	0.88-4.12	0.96	0.49-1.89	1.70	0.48-6.04	1.27	0.16-10.06	0.50*	0.32-0.76
Some coll. / assoc. deg.	1.52	0.71-3.27	0.77	0.40-1.49	1.47	0.43-5.10	1.49	0.22-9.90	0.78	0.51-1.18
Bachelor's deg. / higher (Ref.)	1.00		1.00		1.00		1.00		1.00	
Annual household income										
≤ \$15,000	0.60*	0.40-0.91	0.92	0.56-1.48	0.87	0.41-1.84	4.30*	1.20-15.36	1.33	0.98-1.79
\$15,001-\$25,000	0.83	0.51-1.34	0.57	0.31-1.05	1.04	0.44-2.46	1.14	0.23-5.66	1.25	0.88-1.77
\$25,001-\$35,000	0.61	0.36-1.02	0.59	0.31-1.13	0.87	0.35-2.13	1.03	0.20-5.14	1.30	0.90-1.87
\$35,001-\$50,000	0.58	0.34-.99	0.70	0.38-1.31	0.83	0.32-2.14	6.30*	1.24-32.02	1.33	0.92-1.92
≥ \$50,001 (Ref.)	1.00		1.00		1.00		1.00		1.00	
Alaska region										
Southcentral	1.08	0.76-1.52	1.98*	1.24-3.16	0.66	0.36-1.24	0.23*	0.07-0.80	0.95	0.75-1.20
Southeast	0.82	0.55-1.22	1.93*	1.21-3.08	0.76	0.41-1.41	0.26*	0.08-0.86	1.02	0.79-1.33
Southwest (Ref.)	1.00		1.00		1.00		1.00		1.00	
Dilated eye examination										
Within 2 years	1.01	0.73-1.39	2.81*	1.72-4.61	1.95	1.00-3.80	2.36	0.59-9.53	NA	
≥ 2 years ago or never (Ref.)	1.00		1.00		1.00		1.00			
Condition										
Diabetes	1.09	0.65-1.81	1.16	0.70-1.93	1.45	0.74-2.99	NA		2.07*	1.17-3.67
No diabetes (Ref.)	1.00		1.00		1.00				1.00	
Visual impairment	NA		NA		NA		NA		0.97	0.68-1.38
No visual impairment (Ref.)									1.00	
Cataract	NA		NA		NA		NA		3.17*	1.81-5.55
No cataract (Ref.)									1.00	
Glaucoma	NA		NA		NA		NA		2.91*	1.13-7.53
No glaucoma (Ref.)									1.00	
Diabetic eye disease†	NA		NA		NA		NA		0.94	0.30-2.88
No diabetic eye disease (Ref.)									1.00	

*Ref. = reference group; NA = not applicable. ORs adjusted for all other variables in the model (i.e. all listed characteristics except those labeled NA); all models limited to participants aged ≥ 25 years in order to include education, as those younger than 25 years may not have completed their education. P < 0.05 (two-tailed). †Limited to participants with self-reported doctor-diagnosed diabetes.

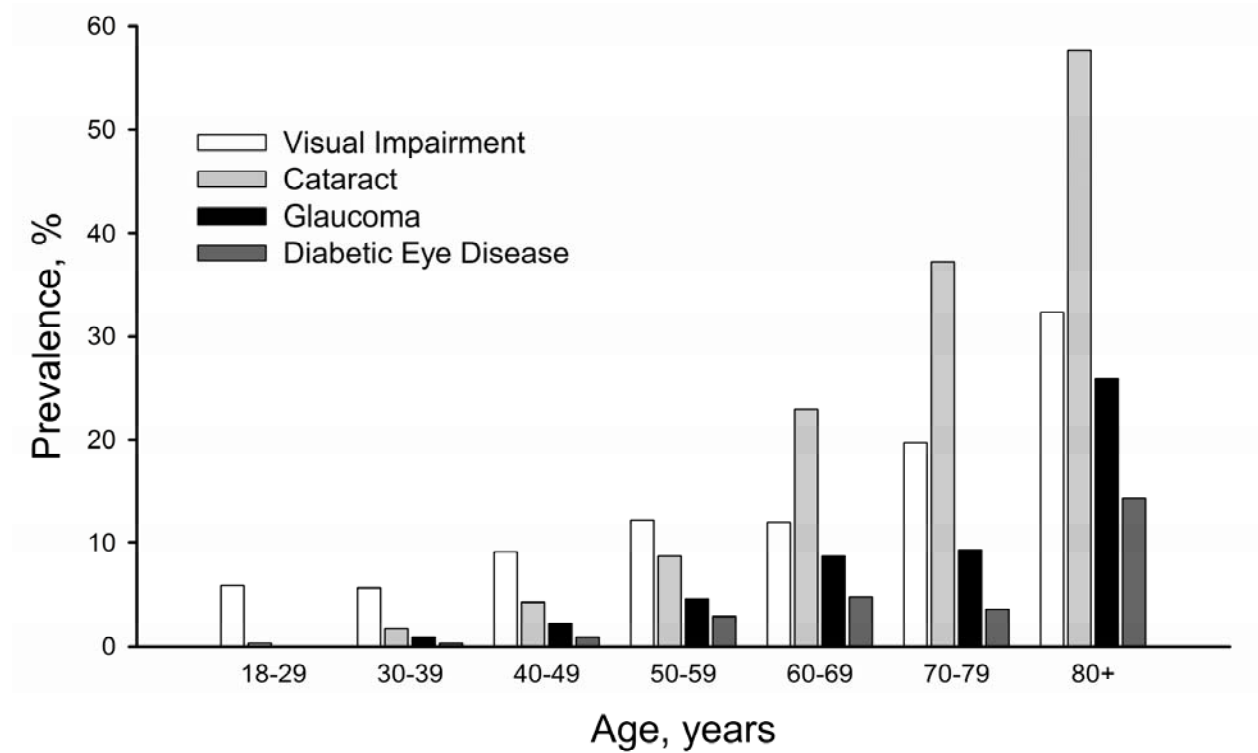


Figure 1. Prevalence (unadjusted) of self-reported visual impairment, cataract, glaucoma and diabetic eye disease among Alaska Native participants of the Education and Research Towards Health Study by age.