Relation of Smoking, Drinking, and Physical Activity to Changes in Vision over a 20-Year Period

The Beaver Dam Eye Study

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Objective: To describe the relationships of lifestyle characteristics to changes in vision and incidence of visual impairment (VI) over a 20-year period in the Beaver Dam Eye Study (BDES).

Design: Longitudinal, population-based cohort study.

Participants: A cohort of 4926 persons aged 43 to 86 years participated in the baseline examinations in 1988–1990, and 3721, 2962, 2375, and 1913 persons participated in follow-up examinations in 1993–1995, 1998–2000, 2003–2005, and 2008–2010, respectively.

Methods: Best-corrected visual acuity (BCVA) measured by a modified Early Treatment Diabetic Retinopathy Study protocol.

Main Outcome Measure: Change in number of letters read correctly and incidence of VI based on BCVA in the better eye assessed at each examination over a 20-year period.

Results: The 20-year cumulative incidence of VI was 5.4%. There was a mean loss of 1.6 letters between examinations, with a 20-year loss of 6.6 letters. While adjusting for age, income, and age-related macular degeneration (AMD) severity, being a current or past smoker was related to a greater change in the numbers of letters lost. Persons who had not consumed alcoholic beverages over the past year and sedentary persons had higher odds of incident VI than persons who drank occasionally or who were physically active. For example, in women with early AMD and annual household income less than $10 000, the estimated 20-year cumulative incidence of VI in those who drank occasionally and were physically active was 5.9% compared with 25.8% in women who had not consumed alcoholic beverages over the past year and were sedentary.

Conclusions: Three modifiable behaviors—smoking, drinking alcohol, and physical activity—were associated with changes in vision. Further evidence that changes in these behaviors will result in less loss of vision is needed because of the expected increase in the burden of VI due to the aging of the population. *Ophthalmology 2014;■:1–9 © 2014 by the American Academy of Ophthalmology.*

The number of people with visual impairment (VI) in the year 2000 was estimated to be 2.4 million and was projected to increase by 70% to reach 4.0 million by the year 2020.[1] This increase was thought to be due, in part, to the growing number of people expected to live longer and develop age-related eye conditions, for example, age-related macular degeneration (AMD), age-related cataracts, and glaucoma. Visual impairment is associated with poorer quality of life, and when severe, it may result in a loss of independence.[2] Therefore, it is important to identify modifiable risk factors that can be intervened upon to decrease the burden of VI (defined by best-corrected visual acuity [BCVA] in the better-seeing eye of <20/40).

There is growing evidence of a relationship of smoking to the long-term incidence of AMD, cataract, and glaucoma and less consistent evidence of a deleterious relationship of heavy drinking and sedentary lifestyle to the incidence of age-related eye diseases.[3–14] However, there are few population-based data on the relationship of these modifiable behaviors to the prevalence and incidence of VI.[15–17]

In this report, we examine the relationships of these behaviors to changes in vision and the incidence of VI over a 20-year period in the population-based Beaver Dam Eye Study (BDES) cohort.

Methods

Population

The population has been described in detail in previous reports.[18,19] In brief, there were 5924 eligible individuals aged 43 to 84 years at the time a private census of the population of Beaver Dam, Wisconsin, was performed from September 15, 1987, to May 4, 1988. Of those, 4926 participated in the baseline examination (1988–1990, BDES1); 3721 participated in the 5-year follow-up (1993–1995, BDES2); 2962 participated in the 10-year follow-up (1998–2000, BDES3); 2375 participated in the 15-year follow-up (2003–2005, BDES4); and 1913 participated in the 20-year follow-up (2008–2010, BDES5).[18] Ninety-nine percent of the cohort was Caucasian. Klein et al[18] have described information regarding participation rates and reasons for nonparticipation.

Those who participated in the follow-up were more likely than nonparticipants who were alive at follow-up to be older and, while adjusting for age, more likely to have a higher annual household income, to have more education, to not be institutionalized, and to not have VI, a central cataract, or AMD.

Approval was granted by the institutional review board at the University of Wisconsin. Written informed consent for the use and disclosure of protected health information was obtained from all subjects before being enrolled in the study and before each examination. The study was performed in accordance with the Health Insurance Portability and Accountability Act and the tenets of the Declaration of Helsinki.

At each examination, the visual acuity (VA) measurements from the better-seeing eye were used for the analyses. Visits with unreliable (or unmeasured) VA in 1 of the eyes were not used for analyses. At each visit, approximately 95% of participants had reliable VA.[18] Over the 20 years of follow-up, there were a total of 9648 person-visits (3481 from BDES1 to BDES2, 2532 from BDES2 to BDES3, 2017 from BDES3 to BDES4, and 1618 from BDES4 to BDES5) with reliable VA data available for the analyses of change in the number of letters read correctly.

Measurements

Similar procedures were used at all examinations. Participants underwent a standardized interview and examination at each visit. Information on demographic characteristics and smoking, drinking, and physical activity status was obtained from a questionnaire. Photographs of the ocular fundus[20] and the lens[21] were taken after pharmacologic dilation of the pupil according to protocol and were graded in masked fashion by experienced graders. The protocols for photography and the grading procedures have been described previously.[21] History of cataract surgery was obtained by grading of red reflex photographs corroborated by clinical assessment during the slit-lamp examination.

The Wisconsin Age-Related Maculopathy Grading System[20–23] was used to assess the presence and severity of lesions associated with AMD from the fundus photographs. Grading procedures, lesion descriptions, and detailed definitions for their presence and severity have been described.[20] Early AMD was defined as the presence of soft drusen or any drusen with retinal pigmentary abnormalities (increased retinal pigment or retinal pigment epithelium depigmentation) in the absence of signs of late AMD. Late AMD was defined as the presence of exudative macular degeneration or pure geographic atrophy.

At all examinations, the refraction from a Humphrey 530 refractor (Carl Zeiss Inc., Oberkochen, Germany) was placed in a trial lens frame, and the BCVA was measured for each eye by means of the Early Treatment Diabetic Retinopathy Study protocol with charts R 1 and 2 modified for a 2-m distance.[23,24] If the BCVA was ≤20/40 in either eye, an Early Treatment Diabetic Retinopathy Study refraction was performed for that eye and the VA was measured. The interobserver difference among the examiners for the refraction or the BCVA was low and not clinically appreciable (data not shown). Visual impairment was defined by the BCVA in the better-seeing eye: no impairment (≥20/40) or any VI (<20/40).

Changes were calculated for each 5-year interval between examinations. The number of letters lost (or gained) between examinations was calculated by subtracting the number of letters read correctly at the start from the number of letters read correctly at the end of the interval. Incidence of any VI was calculated for persons with VA of ≥20/40 in 1 or both eyes at the beginning of a 5-year examination. The 5-year intervals were modeled together as described in the "Statistical Analysis" section.

Age and other characteristics were defined at the beginning of an interval. Because all analyses use 1 VA measure (from the better-seeing eye) for a person, the corresponding AMD and central cataract status from this eye were used for analyses. When the VA was the same in both eyes, the AMD and central cataract status from the worse eye were used. For persons in whom the AMD and central cataract status for the analysis eye were not gradable, if the VA in the other eye was similar (<10 letters different), the AMD/central cataract status from the other eye was used.

At the beginning of each examination interval, subjects were classified as nonsmokers if they had smoked <100 cigarettes in their lifetime, as past smokers if they had smoked >100 cigarettes in their lifetime but had stopped smoking before the examination, and as current smokers if they had not stopped smoking. In the questionnaire, 1 serving of alcoholic beverage was defined as 12 fluid ounces (0.355 liters) of beer, 4 fluid ounces (0.118 liters) of wine, or 1.5 fluid ounces (0.044 liters) of liquor or distilled spirits. For each type of alcohol, persons were asked whether they had consumed any in the past year and how many servings they consumed in an average week. The amounts of alcohol from beer, wine, and liquor were summed to obtain average alcohol consumed from any source in 1 week. Persons reporting no consumption in the past year were considered "nondrinkers." Those who had consumed alcohol in the past year but reported zero servings in an average week were considered "occasional" drinkers. Those reporting 1 or more servings in an average week were labeled as "regular" drinkers. A current heavy drinker was defined as a person who self-reported consumption of 4 or more servings of alcoholic beverages daily; a former heavy drinker had consumed 4 or more servings of alcoholic beverages daily in the past but not in the previous year; a non–heavy drinker had never consumed 4 or more servings of alcoholic beverages on a regular, daily basis.

Household income was categorized and based on prior analyses; income categories were combined. Analyses are based on annual household income <$10 000 or ≥$10 000. Participants were asked the following questions regarding physical activity: On average, how many flights of stairs do you climb each day? On average, how many city blocks do you walk each day? At least once a week, do you engage in a regular activity long enough to work up a sweat? If so, how many times per week do you do this? For the purpose of analyses, stair climbing was categorized as 0, 1 to 3 flights, 4 to 6 flights, and >6 flights per day; walking was categorized as 0, 1 to 4 blocks, 5 to 12 blocks, and >12 blocks per day. An active lifestyle was defined as engaging in regular activity with or without sweating 3 or more times per week; a sedentary lifestyle was defined as engaging in regular activity less than 3 times per week.

Statistical Analysis

For both the continuous measure of change (i.e., change in the number of letters read) and the binary measure of change (i.e., incidence of VI), models were fit that used information from each interval with time-updating covariates (all covariates were updated). Generalized estimating equation was used to account for correlation from multiple visits using an unstructured correlation matrix (fit with PROC GENMOD in SAS; SAS Inc., Cary, NC). For the change in the number of letters read, a linear function was used. For incidence of impairment, a logit link function was used. Model selection began with examination of the age, period, and sex relationships, including possible interactions. Change in number of letters was best fit with a quadratic term for age and incidence of impairment with a linear term for age. On the basis of previous findings, we then added total household income, cataract status, AMD severity, and any possible age, sex, and period interactions with those factors.[18] Education also was considered instead of total household income; however, models with income fit significantly better. Some factors were not always significant or were of