Fruit and vegetable intake and the risk of cataract in women[1–3]

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ABSTRACT

Background: Prospective data on cataract in relation to total fruit and vegetable intake are limited.

Objective: We aimed to examine whether higher fruit and vegetable intake reduces the risk of cataract and cataract extraction in a large, prospective cohort of women.

Design: Fruit and vegetable intake was assessed at baseline in 1993 among 39 876 female health professionals with the use of a validated, semiquantitative food-frequency questionnaire. A total of 35 724 of these women were free of a diagnosis of cataract at baseline and were followed for incident cataract and cataract extraction. Cataract was defined as an incident, age-related lens opacity responsible for a reduction in best-corrected visual acuity to 20/30 or worse, based on self-report confirmed by medical record review. Individuals, rather than eyes, were the unit of analysis.

Results: During an average of 10 y of follow-up, 2067 cataracts and 1315 cataract extractions were confirmed. Compared with women in the lowest quintile of fruit and vegetable intake, women with higher intakes had modest 10–15% reduced risks of cataract (*P* for trend $<$ 0.05). For cataract extraction, no significant inverse trend was observed (*P* for trend $=$ 0.12).

Conclusion: These prospective data suggest that high intake of fruit and vegetables may have a modest protective effect on cataract. *Am J Clin Nutr* 2005;81:1417–22.

KEY WORDS Cataract, cataract extraction, fruit and vegetables, prospective cohort, Women's Health Study

INTRODUCTION

Basic science and animal research studies support a role for oxidative mechanisms in the etiology of cataract (1, 2). Thus, observational epidemiologic studies of dietary factors in cataract have focused on the amount of antioxidant nutrients contained in the diet. The most common approaches have been to examine the intake of specific nutrients or the serum concentrations of nutrients or biomarkers of fruit and vegetable intake. The results of these studies have been mixed. Whereas most studies report an inverse association between cataract and one or more antioxidant nutrients, the data for individual nutrients across studies have been inconsistent (2–4).

An alternative approach is to examine the development of cataract in relation to specific foods or food groups, such as total fruit and vegetable intake. This approach enables an assessment of the combined effects of antioxidant nutrients together with the effects of other components of the diet, such as other micronutrients, phytochemicals, and fiber. Several studies have examined the association of cataract with foods (5–13), but only one study used prospective data to examine cataract in relation to total fruit and vegetable intake (11).

We analyzed data from a large, prospective cohort of US female health professionals to assess the association of total fruit and vegetable intake with the risk of subsequent cataract. Because cigarette smoking is an established risk factor for cataract and an important source of oxidative stress (14–17), we also examined a priori whether the observed associations were modified by smoking status at baseline.

SUBJECTS AND METHODS

Subjects

The Women's Health Study (WHS) is an ongoing randomized, double-blind, placebo-controlled trial of low-dose aspirin and vitamin E in the primary prevention of cardiovascular disease and cancer among 39 876 apparently healthy female health professionals aged $\geq$45 y (18). Detailed information on fruit and vegetable intake was provided by 39 127 (98%) of the randomly assigned participants, who completed a 131-item validated semiquantitative food-frequency questionnaire (SFFQ) at baseline in 1993 (19). For this analysis we excluded participants who reported total energy intake$<$600 kcal/d or $>$3500 kcal/d, or who had $>$70 blanks on the SFFQ. Of the remainder, 35 724 participants had no diagnosis of cataract at baseline and were included. This study was conducted according to the ethical guidelines of Brigham and Women's Hospital.

Assessment of fruit and vegetable intake

All participants were requested to complete an SFFQ that included 29 vegetable items and 15 fruit items. For each fruit or vegetable, a standard unit or portion size was specified and participants were asked how often, on average, during the previous year they had consumed that amount. Nine responses were possible, which ranged from "never" to "≥6 times/d." Responses to

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the individual food items were converted to average daily intakes of each fruit and vegetable item for each subject, and the average daily intakes of individual fruit and vegetables were summed to compute total fruit and vegetable intake (19). In similar populations, the SFFQ was shown to have high validity as a measure of long-term average dietary intakes (20).

Other covariates

Information on possible risk factors for cataract was collected on the WHS baseline questionnaire. Information included age (in y), height and weight (expressed as body mass index; in kg/m^2), smoking status (never, past, or current), alcohol use (rarely or never, 1–3 drinks/mo, 1–6 drinks/wk, or ≥1 drink/d), frequency of exercise (rarely or never, <1 times/wk, 1–3 times/wk, or ≥4 times/wk), parental history of myocardial infarction at age <60 y (no or yes), history of hypertension (no or yes), history of diabetes (no or yes), history of hypercholesterolemia (no or yes), menopause status (no or yes), postmenopausal hormone use (never, past, current), multivitamin use (no or yes), use of vitamin C supplements (no or yes), and history of an eye exam in the past 2 y (no or yes).

Ascertainment and definition of endpoints

Information on the occurrence of any relevant events, including cataract, was collected on annual questionnaires. After the report of a cataract diagnosis or extraction, the subjects were requested to provide written consent and to identify the treating ophthalmologist or optometrist. The ophthalmologists and optometrists were contacted by mail and requested to complete a cataract questionnaire to supply information about the presence of lens opacities, date of diagnosis, visual acuity loss, cataract extraction, other ocular abnormalities that could explain visual acuity loss, cataract type, and etiology (including age-related, traumatic, congenital, inflammatory, or surgery- or steroid-induced). As an alternative to completing the questionnaire, the ophthalmologists and optometrists were given the option of providing the relevant medical records. Medical record information was obtained for >91% of the participants who reported a cataract.

Endpoints were incident cataract and extraction of incident cataract. An incident cataract was defined as a self-report of a cataract that was confirmed by medical record review to have been first diagnosed after randomization, to be age-related in origin, and to be responsible for a decrease in best-corrected visual acuity to 20/30 or worse. In the presence of alternate ocular pathology, a lens opacity was considered a cataract if, in the judgment of the ophthalmologist or optometrist, the opacity was of sufficient severity to reduce visual acuity to 20/30 or worse when considered alone. Extraction was defined as the surgical removal of an incident cataract. Women who developed a non-age-related cataract or a cataract that did not reduce visual acuity to 20/30 or worse were included in the analyses as noncases.

Data analysis

Individuals, rather than eyes, were the unit of analysis because eyes were not examined independently, and participants were classified according to the status of the worse eye based on disease severity. Participants contributed person-years of follow-up until the time of diagnosis of cataract or censoring (death or February 2004, whichever came first). Fruit and vegetable intake was considered as a categorical variable (in quintiles), and we computed incidence rates of cataract by dividing the number of incident cases by person-years of follow-up in each quintile of fruit and vegetable intake. Estimates of relative risk (RR) were computed as the rate of cataract in a specific quintile of intake divided by the corresponding rate in the lowest quintile (reference). Crude RR estimates were obtained by adjusting for age (in y) and randomized treatment assignment in Cox proportional hazards regression models (21). Multivariate RRs were obtained by further adjusting for smoking, alcohol use, history of diabetes, history of hypertension, history of hypercholesterolemia, body mass index, physical activity, parental history of myocardial infarction, menopause status, postmenopausal hormone use, use of multivitamins or vitamin C supplements, total energy intake, and history of an eye exam in the past 2 y. For each RR, two-sided *P* values and 95% CIs were calculated (22). Tests of linear trend across increasing quintiles of fruit and vegetable intake were conducted by assigning the medians of intakes in quintiles (servings/d) treated as a continuous variable.

We also analyzed subgroup data according to baseline smoking status (current or noncurrent). Tests of interaction were performed to evaluate the statistical significance of any modifying effect of baseline smoking status on the association of fruit and vegetable intake with cataract. Data were analyzed with SAS (version 8; SAS Institute Inc, Cary, NC).

RESULTS

The reported mean (±SD) daily intake of fruit and vegetables at baseline was 6.0 ± 3.3 total servings, including 2.1 ± 1.4 servings of fruit and 3.9 ± 2.4 servings of vegetables. The median intake of fruit and vegetables ranged from 2.6 servings/d in the lowest quintile to 10 servings/d in the highest quintile. The distribution at baseline of possible risk factors for cataract according to quintiles of fruit and vegetable intake is shown in **Table 1**. Women with a high fruit and vegetable intake were older and were less likely to be current smokers. They also exercised more, had higher caloric intakes, and were more likely be postmenopausal, to use postmenopausal hormones, to use multivitamin supplements and supplements of vitamin C, and to report having had an eye exam in the past 2 y.

During an average of 10 y of follow-up, 2067 cases of incident cataract and 1315 cases of cataract extraction were confirmed. Compared with women in the lowest quintile of fruit and vegetable intake, women in quintiles 2–5 had only mildly reduced (≈10%) risks of cataract in an age- and treatment-adjusted analysis, and the test of linear trend across quintiles was not statistically significant (*P* for trend = 0.10) (**Table 2**). After adjustment for other potential confounders, RR estimates were lowered slightly, and the test of trend was significant (*P* for trend < 0.05). Analyses that separately examined the intake of all fruit or all vegetables similarly indicated a reduced risk of cataract of ≈10% for women in the highest, compared with women in the lowest, quintile of intake; however, there was no significant trend across quintiles (Table 2). The data for cataract extraction also indicated that women with higher intake of fruit and vegetables had RRs slightly <1.0, but there was no statistically significant trend of decreasing risk across increasing quintiles of intake (**Table 3**).

The relation of fruit and vegetable intake to the risks of cataract and cataract extraction was not significantly modified by smoking

TABLE 1
Baseline characteristics according to quintiles of fruit and vegetable intake in the Women's Health Study[1]

	Quintile of fruit intake						Quintile of vegetable intake					
	1 (*n* = 7165)	2 (*n* = 7131)	3 (*n* = 7156)	4 (*n* = 7128)	5 (*n* = 7144)	*P* for trend[2]	1 (*n* = 7150)	2 (*n* = 7145)	3 (*n* = 7142)	4 (*n* = 7150)	5 (*n* = 7137)	*P* for trend[2]
Median intake (servings/d)	0.6	1.3	1.9	2.6	3.8		1.5	2.5	3.4	4.5	6.8	
Age (%)						<0.001						<0.001
45–54 y	72.6	67.5	62.4	59.0	55.4		68.3	66.0	62.3	61.3	59.0	
55–64 y	23.4	27.0	30.5	31.9	33.4		25.7	28.1	30.2	30.4	31.8	
65–74 y	3.9	5.4	6.9	8.6	10.6		5.8	5.7	7.2	8.0	8.7	
≥75 y	0.1	0.2	0.2	0.5	0.6		0.2	0.3	0.3	0.3	0.5	
Average age (y)	52.5 ± 5.7[3]	53.3 ± 6.1	54.0 ± 6.3	54.6 ± 6.6	55.3 ± 7.0	<0.001	53.2 ± 6.2	53.5 ± 6.2	54.1 ± 6.5	54.3 ± 6.6	54.6 ± 6.7	<0.001
Cigarette smoking (%)						<0.001						<0.001
Never	41.9	48.1	51.9	54.8	58.6		50.1	51.5	51.3	50.9	51.5	
Past	33.6	36.8	37.2	36.9	34.4		32.4	34.3	36.2	37.2	38.7	
Current	24.5	15.1	10.9	8.3	7.0		17.5	14.2	12.4	11.9	9.8	
Alcohol use (%)						0.005						<0.001
≥1 drink/d	11.4	11.1	10.3	9.5	8.9		7.9	9.1	10.8	11.5	11.8	
1–6 drinks/wk	28.5	30.8	33.0	34.1	34.0		26.4	31.6	33.6	34.9	33.9	
1–3 drinks/mo	12.7	13.2	14.1	13.4	13.1		13.7	14.2	13.5	12.4	12.8	
Rarely or never	47.5	44.9	42.5	43.0	44.1		51.9	45.0	42.2	41.3	41.6	
Physical exercise (%)						<0.001						<0.001
≥4 times/wk	6.2	8.7	10.6	12.1	15.8		7.4	8.9	10.2	11.4	15.5	
1–3 times/wk	23.6	28.9	32.8	35.4	36.9		25.5	28.4	32.3	34.8	36.6	
<1 time/wk	20.4	21.1	20.6	20.1	18.5		19.2	20.4	20.4	21.2	19.6	
Rarely or never	49.8	41.4	36.0	32.4	28.8		48.0	42.3	37.2	32.7	28.3	
Postmenopausal hormone use (%)						<0.001						<0.001
Never	51.8	49.6	47.9	47.1	46.7		51.3	49.5	47.9	47.6	46.6	
Past only	9.8	9.3	9.0	9.2	10.3		9.2	9.2	9.4	10.0	9.8	
Current	38.4	41.1	43.2	43.7	43.1		39.5	41.3	42.7	42.4	43.6	
Multivitamin use (%)						<0.001						<0.001
Never	14.1	12.8	12.4	11.8	12.8		14.5	12.1	12.3	12.2	12.8	
Past only	61.9	59.6	58.3	55.7	54.6		57.4	59.0	58.2	58.5	57.1	
Current	24.0	27.6	29.2	32.5	32.6		28.0	28.9	29.5	29.3	30.2	
Current use of vitamin C supplements (%)	6.8	8.9	9.1	10.3	12.1	<0.001	8.4	8.9	9.4	9.8	10.6	<0.001
Mean energy intake (kcal)	1432 ± 484	1579 ± 472	1707 ± 468	1832 ± 482	2094 ± 518	<0.001	1379 ± 440	1589 ± 452	1707 ± 461	1859 ± 479	2110 ± 536	<0.001
BMI (kg/m^2)	26.4 ± 5.4	26.2 ± 5.0	26.1 ± 4.9	25.7 ± 4.8	25.6 ± 4.8	<0.001	26.1 ± 5.2	26.1 ± 5.1	25.8 ± 4.9	25.9 ± 4.9	26.1 ± 5.1	0.11
History of hypertension (%)[4]	24.8	23.6	24.7	23.8	26.3	0.057	24.3	23.9	24.0	24.4	26.6	0.002
History of diabetes (%)	2.4	2.3	2.1	2.1	2.5	0.94	2.1	2.3	2.0	2.1	2.9	0.02
History of high cholesterol (%)[5]	28.1	28.3	28.4	28.9	29.7	0.023	28.5	28.3	29.0	28.4	29.2	0.41
Postmenopausal (%)	45.8	48.6	53.2	55.5	58.0	<0.001	48.9	49.9	52.5	54.0	55.8	<0.001
Family history of myocardial infarction (%)	14.0	13.7	12.7	12.6	12.4	0.001	13.4	13.2	12.9	12.8	13.1	0.51
Eye exam in past 2 y (%)	79.0	81.4	82.4	83.7	83.6	<0.001	79.6	81.3	82.0	83.5	83.7	<0.001

[1] *Fruit* was defined as a composite score of all the fruit items on the questionnaire, including apple, pear, orange, grapefruit, peach, banana, strawberry, blueberry, cantaloupe, raisin, prune, and fruit juices. *Vegetable* was defined as a composite score of all the vegetable items on the questionnaire, including cruciferous vegetables, dark-yellow vegetables, tomatoes, green leafy vegetables, legumes, corn, mixed vegetables, celery, eggplant, mushroom, and beet.

[2] Based on a test of linear trend. For categorical variables, linear trend was assessed with the Jonckheere-Terpstra test.

[3] $\bar{x}$ ± SD (all such values).

[4] Hypertension was defined as a reported systolic blood pressure of ≥140 mm Hg, a diastolic blood pressure of ≥90 mm Hg, or a history of treatment for high blood pressure.

[5] High cholesterol was defined as a reported high cholesterol, a reported blood cholesterol concentration of ≥240 mg/dL, or a history of treatment with cholesterol-lowering medication.

status at baseline (*P* for interaction > 0.20). In a comparison of extreme quintiles, the RR of cataract was 0.71 (95% CI: 0.44, 1.16; *P* for trend = 0.07) and the RR of cataract extraction was 0.68 (95% CI: 0.37, 1.24; *P* for trend = 0.09) in current smokers. In noncurrent smokers, the RR of cataract was 0.84 (95% CI: 0.69, 1.02; *P* for trend = 0.18) and the RR of cataract extraction was 0.89 (95% CI: 0.70, 1.14; *P* for trend = 0.39).

DISCUSSION

These prospective data, from female health professionals followed for an average of 10 y, indicated that >3.4 servings/d of fruit and vegetables is associated with modest 10–15% reduced risks of cataract and cataract extraction. The apparent modest relation did not change significantly after adjustment for smoking and other

TABLE 2
Relative risk (and 95% CI) of cataract according to quintiles of fruit and vegetable intake in the Women's Health Study

	Quintile of intake					
	1[1]	2	3	4	5	*P* for trend
All fruit and vegetables						
Median intake (servings/d)	2.6	4.1	5.4	7.0	10.0	
Cases of cataract	360	374	414	447	472	
n	7145	7145	7145	7145	7144	
Age- and treatment-adjusted risk	1.00	0.94 (0.81, 1.08)	0.90 (0.79, 1.04)	0.91 (0.79, 1.04)	0.88 (0.77, 1.01)	0.10
Multivariate-adjusted risk[2]	1.00	0.93 (0.80, 1.09)	0.89 (0.76, 1.04)	0.87 (0.74, 1.03)	0.83 (0.70, 0.99)	0.048
All fruit						
Median intake (servings/d)	0.6	1.3	1.9	2.6	3.8	
Cases of cataract	341	359	419	459	489	
n	7165	7131	7156	7128	7144	
Age- and treatment-adjusted risk	1.00	0.91 (0.79, 1.06)	0.95 (0.82, 1.10)	0.92 (0.80, 1.06)	0.87 (0.75, 1.00)	0.07
Multivariate-adjusted risk[2]	1.00	0.95 (0.80, 1.11)	1.00 (0.85, 1.18)	0.97 (0.83, 1.14)	0.89 (0.75, 1.06)	0.19
All vegetables						
Median intake (servings/d)	1.5	2.5	3.4	4.5	6.8	
Cases of cataract	384	375	427	428	453	
n	7150	7145	7142	7150	7137	
Age- and treatment-adjusted risk	1.00	0.93 (0.81, 1.07)	0.95 (0.83, 1.09)	0.93 (0.81, 1.07)	0.91 (0.80, 1.05)	0.28
Multivariate-adjusted risk[2]	1.00	0.94 (0.81, 1.10)	0.96 (0.83, 1.12)	0.94 (0.80, 1.10)	0.88 (0.74, 1.04)	0.15

[1] Referent category.
[2] Adjusted for age, randomized treatment assignment, smoking, alcohol use, history of diabetes, history of hypertension, history of hypercholesterolemia, BMI, physical activity, parental history of myocardial infarction, menopausal status, postmenopausal hormone use, use of multivitamins or vitamin C supplements, total energy intake, and history of an eye exam in the past 2 y in Cox proportional hazards regression models.

possible risk factors for cataract. Among the subgroup of women who were current smokers at baseline, the inverse association of cataract with fruit and vegetable intake appeared to be slightly stronger, although the interaction with smoking was not statistically significant when tested in multivariate models.

Several possible limitations of the study need to be considered. Misclassification of fruit and vegetable intake is always a major concern in any epidemiologic study of diet. In the WHS, information on fruit and vegetable intake was reported through a self-administered SFFQ collected at baseline. Because of the

TABLE 3
Relative risk (and 95% CI) of cataract extraction according to quintiles of fruit and vegetable intake in the Women's Health Study

	Quintile of intake					
	1[1]	2	3	4	5	*P* for trend
All fruit and vegetables						
Median intake (servings/d)	2.6	4.1	5.4	7.0	10.0	
Cases of cataract extraction	221	238	272	290	294	
n	7145	7145	7145	7145	7144	
Age- and treatment-adjusted risk	1.00	0.97 (0.81, 1.17)	0.97 (0.81, 1.16)	0.95 (0.80, 1.14)	0.88 (0.74, 1.05)	0.14
Multivariate-adjusted risk[2]	1.00	1.00 (0.82, 1.22)	0.98 (0.81, 1.20)	0.94 (0.77, 1.15)	0.86 (0.69, 1.08)	0.12
All fruit						
Median intake (servings/d)	0.6	1.3	1.9	2.6	3.8	
Cases of cataract extraction	214	222	275	295	309	
n	7165	7131	7156	7128	7144	
Age- and treatment-adjusted risk	1.00	0.90 (0.75, 1.09)	0.99 (0.83, 1.18)	0.94 (0.78, 1.12)	0.86 (0.72, 1.03)	0.12
Multivariate-adjusted risk[2]	1.00	0.94 (0.77, 1.16)	1.07 (0.88, 1.31)	0.98 (0.80, 1.20)	0.90 (0.73, 1.12)	0.33
All vegetables						
Median intake (servings/d)	1.5	2.5	3.4	4.5	6.8	
Cases of cataract extraction	234	228	292	282	279	
n	7150	7145	7142	7150	7137	
Age- and treatment-adjusted risk	1.00	0.93 (0.77, 1.11)	1.06 (0.90, 1.26)	1.00 (0.84, 1.20)	0.92 (0.77, 1.09)	0.42
Multivariate-adjusted risk[2]	1.00	0.98 (0.80, 1.20)	1.14 (0.95, 1.38)	1.04 (0.86, 1.27)	0.91 (0.73, 1.13)	0.31

[1] Referent category.
[2] Adjusted for age, randomized treatment assignment, smoking, alcohol use, history of diabetes, history of hypertension, history of hypercholesterolemia, BMI, physical activity, parental history of myocardial infarction, menopausal status, postmenopausal hormone use, use of multivitamins or vitamin C supplements, total energy intake, and history of an eye exam in the past 2 y in Cox proportional hazards regression models.

prospective design, however, measurement error in the assessment of fruit and vegetable intake was unlikely to be associated with the assessment of cataract endpoints. On the other hand, random or nondifferential misclassification, which would tend to underestimate any association of fruit and vegetable intake with risk of cataract, may have contributed to the weak associations observed. Changes in dietary practices during follow-up may have further contributed to the modest protective effect of fruit and vegetable intake observed in this study. Random misclassification of the cataract endpoint was reduced by the use of medical records to confirm the self-reports and by the use of strict diagnostic criteria that included a reduction in best-corrected visual acuity to 20/30 or worse because of cataract. Nonrandom or differential misclassification of cataract could occur if fruit and vegetable intake was associated with the frequency of medical contacts and, thus, with the likelihood of having an existing cataract diagnosed. In the WHS, women who reported a higher intake of fruit and vegetables were more likely to report having had an eye exam in the past 2 y. We included a term for the baseline report of an eye exam in the past 2 y in the multivariate analyses to control for possible surveillance bias. Finally, women with a higher intake of fruit and vegetables differed in several additional respects from those with a lower intake (Table 1). Although we did control for a number of measured confounders, other potential confounders that were either unmeasured or unknown may have contributed to the findings. Nonetheless, the relative homogeneity of the study population with respect to educational attainment and socioeconomic status should have minimized the possibility that other unknown confounding factors distorted the primary association between fruit and vegetable intake and risk of cataract.

To our knowledge, only 3 other studies examined the categories of all fruit and vegetable intake and the risk of cataract, and the results were inconclusive. One was a small, clinic-based, case-control study of 77 persons with cataract and 35 control subjects. In that study, those subjects with an average daily intake of fruit and vegetables above the 20th percentile (approximate cutoffs: 1.5 servings of fruit, 2 servings of vegetables, and 3.5 servings of fruit and vegetables) had a decreased risk of any type of cataract of ≥60%, compared with those below this frequency, after adjustment for age, sex, race, and diabetes (5). There was no information in that study on whether the risk of cataract continued to decrease with a higher frequency of fruit and vegetable intake. Cross-sectional data for 479 Nurse's Health Study participants aged 52–73 y (163 with a nuclear opacity in one or both eyes) indicated a moderately reduced odds of prevalent nuclear opacity for those reporting a high intake of fruit [odds ratio (OR) for the comparison of high (median: 3.9 servings) and low (median: 1.3 servings) quartiles: 0.58 (95% CI: 0.32,1.05); P for trend = 0.31] but not vegetables [OR for the comparison of high (median: 5.7 servings) and low (median: 2.4 servings) quartiles: 0.82 (95% CI, 0.47,1.42); P for trend = 0.99] in analyses adjusted for age, pack-years smoked, body mass index, vitamin C supplement use, and several other possible risk factors for cataract (13). In the Beaver Dam Eye Study, cross-sectional data for 1919 adults aged 43–84 y showed that a high intake of fruit and vegetables was associated with a reduced risk of prevalent nuclear sclerosis in men [OR for comparison of high (median: 4.9 servings) and low (median: 2.3 servings) quintiles: 0.68 (95% CI, 0.43,1.09); P for trend = 0.07] but not in women [OR for the comparison of high (median: 5.3 servings) and low (median: 2.9 servings) quintiles: 0.97 (95% CI: 0.65,1.46); P for trend = 0.90] in analyses adjusted for age, pack-years of smoking, and heavy alcohol use (7). Prospective data in that cohort, based on 5 y of follow-up during which 246 incident nuclear cataracts were identified, indicated no significant reduction in risk of cataract for those with high intake of vegetables (OR for the comparison of high and low quintiles: 0.7; 95% CI: 0.4, 1.2; P for trend = 0.39), and a possible elevated risk of cataract for those with high intake of fruit (OR: 1.8; 95% CI: 1.0, 3.3; P for trend = 0.07) after adjustment for age, energy intake, and pack-years of smoking (11). Separate results for men and women were not provided in that analysis. The results of our study, which is the largest to report on the category of all fruit and vegetable intake, suggest only a small overall benefit, if any, on cataract for women who consume >3.4 servings/d of fruit and vegetables.

We found no evidence to indicate that the association of fruit and vegetable intake with the risk of cataract was significantly modified by baseline smoking status. Cigarette smoking is an established risk factor for cataract (14–17), and available evidence supports a direct deleterious effect of smoking on the human lens (23–27). In addition, cigarette smoking is known to decrease plasma concentrations of ascorbate and, perhaps, lutein/zeaxanthin (28–32). Thus, cigarette smoking may indirectly aid cataract formation by lowering the plasma concentrations of nutrients that are important to the maintenance of lens transparency. Consumption of a diet rich in fruit and vegetables could, at least in theory, partially offset this effect of smoking on plasma nutrients. Results of other studies that examined antioxidant nutrients and cataract have not been consistent on this point: some suggest a stronger association in smokers (11, 33, 34) and others suggest a stronger association in nonsmokers (6, 9, 10).

In conclusion, these prospective data from a large cohort of well-nourished female health professionals indicate that a higher intake of fruit and vegetables was associated with only a slightly reduced risk of cataract. Additional observational studies in this and other cohorts and ongoing trials of dietary supplements may yet identify specific components of the diet that markedly reduce cataract formation. In the meantime, the possible beneficial effects of fruit and vegetables on the risk of many chronic diseases, including cataract, have a strong biological basis and warrant the continued recommendation to increase total intakes of fruit and vegetables.

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