Int J Clin Exp Med 2016;9(11):21574-21579
www.ijcem.com /ISSN:1940-5901/IJCEM0034167

Original Article

Association between dietary fruit intake and age-related cataract: a meta-analysis

Ruijuan Guan[1], Qiang Zhang[2], Rong Zhang[1], Xiaoying Zhang[1], Ling Li[1]

Departments of [1]Ophthalmology, [2]Neurosurgery, Qinghai Provincial People's Hospital, Xining, China

Received June 21, 2016; Accepted August 19, 2016; Epub November 15, 2016; Published November 30, 2016

Abstract: *Background*: There is no consensus on the association between dietary fruit intake and age-related cataract. The aim of this study is to conduct a systematic review and meta-analysis to analyze the relationship between dietary fruit intake and age-related cataract risk. *Methods*: We searched the PubMed and Web of knowledge to identify all studies that assessed the association between dietary fruit intake and age-related cataract risk through January 1, 2016. Relative risk (RR) and 95% confidence intervals (CI) with random-effect model were used to combine the results. Publication bias was estimated using Egger's regression asymmetry test. *Results*: Eight related articles met our selection criteria and contained a total of 6218 cases and 111093 participants. Our meta-analysis results revealed that highest level of dietary fruit intake could significantly reduce the age-related cataract (RR=0.80, 95% CI=0.68-0.93, P=0.005; I^2=47.5%, $P_{\text{for heterogeneity}}$=0.064). Subgroup analysis by ethnicity showed that the association was only significant in European populations (RR=0.60, 95% CI=0.45-0.81), but not in the other populations else. Significant associations were also found in prospective studies and case-control studies. *Conclusions*: Our meta-analysis showed strong evidence that highest dietary fruit intake could reduce the risk of age-related cataract, especially in European populations.

Keywords: Fruit intake, age-related cataract, meta-analysis

Introduction

Visual impairment and blindness from cataract is an important public health problem throughout the world. Age-related cataract accounts for about half of the 32 million cases of blindness worldwide [1]. Besides, the number of people blind from cataract is increasing due to changes in the demographic structure of populations, especially the increased life expectancy [2]. Thus, it is important to identify the protective factors for age-related cataract and may help to enhance the quality of life for older people.

Up to now, many original studies were conducted to assess the associations between dietary fruit intake and age-related cataract risk; whether dietary highest level of fruit intake could reduce age-related cataract was still unclear [3-5]. The protection mechanisms that higher fruits intake reduce risk of age-related cataract may have the following several aspects. First of all, lutein and zeaxanthin, which are highly concentrated in fruits, are the predominant carotenoids in the lens [6]. The two substances could protect our eyes from photodamage in vitro [7], and to be associated with reduced risk of cataract. Besides, most fruit are rich in vitamin C, which can explain their protective role in cataract formation [8]. Hence, we conducted a meta-analysis to clarify these conflicting results and obtain a comprehensive association between dietary fruit intake and age-related cataract.

Materials and methods

Literature search and study selection

The databases of PubMed and Web of knowledge were searched electronically (last updated search in January 1, 2016) for published studies reporting a relationships between dietary fruit intake and age-related cataract risk. The following keywords and search terms were used: 'fruit' OR 'dietary' OR 'diet' AND 'lens opacities' OR 'cataract' in the English lan-

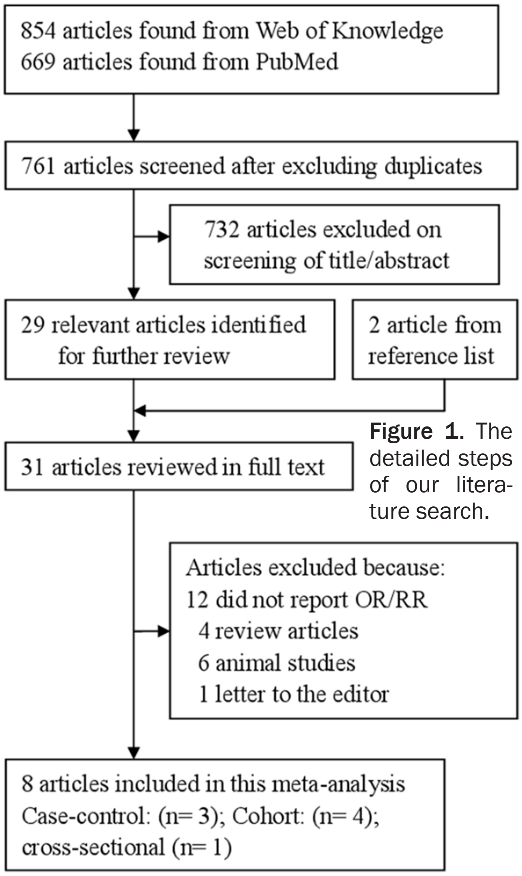

Figure 1. The detailed steps of our literature search.

guage. Eligible texts were retrieved from the above data. In addition, we reviewed references of relevant articles.

Eligible studies should meet the following criteria: (1) human study, (2) case-control study or cohort study or randomized clinic trial or cross-sectional study, (3) the exposure was dietary fruit intake, (4) the outcomes was age-related cataract, (5) the relative risk (RR) with 95% confidence interval (CI) for highest fruit consumption versus lowest category with risk of age-related cataract was provided.

Exclusion criteria included: (1) animal study, (2) repeated or overlapped publications, (3) review, (4) lacking RRs (or ORs) or corresponding 95% CIs.

Data extraction

We used a standardized data extraction form to collect the data. The following information was extracted from each of the included studies: the first author' last name, year of publication, study population, study design, mean age of the participants, sample size and RR (or OR) estimates with corresponding 95% CI for the highest versus lowest categories of fruit. Two independent authors conducted all of the above procedures, and any disagreements were resolved by discussion.

Statistical analysis

The RR with 95% CI was used to assess the association between dietary fruit intake and risk of age-related cataract. Random-effects model was used to combine the results, which considers both within-study and between-study variation [9]. Homogeneity testing was performed with the Q and I^2 statistics [10]. Meta-regression analysis was performed to assess the potentially important covariates that might exert substantial impact on between-study heterogeneity [11]. Additionally, the subgroup analyses of study design and geographic locations were conducted to identify the between-study heterogeneity between dietary fruit intake and age-related cataract risk. Sensitivity analysis was used to investigate the influence of a single study on the overall effect estimate by omitting one study at a time during repeated analyses [12]. The Egger regression asymmetry test [13] and Begg funnel plot were used to assess the evidence of the publication bias. In the present study, *P*-values less than 0.05 were considered statistically significant. All statistical analyses were performed using Stata 10.0 (Stata Corp, College Station, Texas, USA).

Results

Literature search and study characteristics

Figure 1 presents the study inclusion process. A total of 669 articles from PubMed and 854 articles from Web of knowledge were initially retrieved. From the retrieved studies, 762 studies were excluded because of duplicates. There are 732 articles were further excluded after review the title or abstract. Two articles are searched from reference list. Furthermore, 4 review articles, 12 articles lacking of RR or OR, 6 reported animal studies, one letter to the editor were further excluded. At the end, 8 articles [3-5, 8, 14-17] comprising 6218 cataract cases and 111093 participants were included in our meta-analysis. **Table 1** presents the general data and characteristics for the included studies.

Table 1. Characteristics of studies on fruit consumption and age-related cataract risk

First author, (year)	Country	Study design	Cases, (age)	RR (95% CI) for highest versus lowest category	Adjustment for covariates
Brown et al. (1999)	United States	Cohort	824, (45-75)	0.87 (0.68-1.11)	Adjusted for age, time period, diagnosis of diabetes, cigarette smoking, BMI, area of US residence, aspirin use, energy intake, physical activity, alcohol intake, routine eye exams, and profession.
Christen et al. (2005)	United States	Cohort	2067, (≥45)	0.89 (0.75-1.06)	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.
Christen et al. (2008)	United States	Cohort	2030, (≥45)	0.93 (0.80-1.08)	Adjusted for age, randomized treatment assignment, smoking, alcohol use, BMI, exercise, postmenopausal hormone use, history of hypertension, history of hypercholesterolemia, history of diabetes, family history of myocardial infarction before the age of 60, history of eye exam in the last 2 years.
Ojofeitimi et al. (1999)	Nigeria	Case-control	31, (20-70)	0.77 (0.12-1.34)	Adjusted for age and sex.
Pastor-Valero et al. (2013)	Spain	Cross-sectional	433, (≥65)	0.56 (0.31-1.03)	Adjusted for sex, age, energy intake, marital status, smoking, alcohol consumption, physical activity, use of supplement, energy intake, obesity and history of diabetes.
Tan et al. (2008)	Australia	Cohort	312, (≥49)	0.62 (0.28-1.37)	Adjusted for age, sex, hypertension, smoking, diabetes, education, use of inhaled steroids, and use of vitamin C supplements.
Tavani et al. (1996)	Italy	Case-control	207, (25-80)	0.9 (0.5-1.6)	Adjusted for age, sex, education, smoking status, diabetes, body mass index, and calorie intake.
Theodoropoulou et al. (2014)	Greece	Case-control	314, (45-85)	0.53 (0.39-0.72)	Adjusted for age, sex, body mass index, years of education, smoking habits and duration of smoking, and total energy intake.

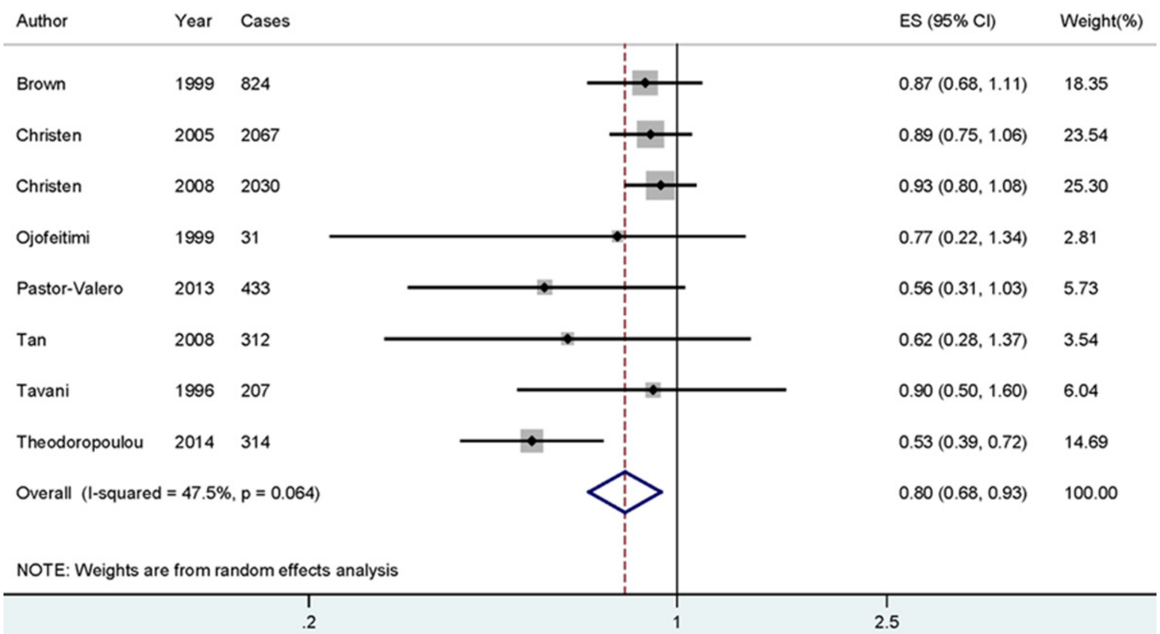

Figure 2. The multivariate-adjusted risk of age-related cataract for the highest versus lowest categories of fruit consumption.

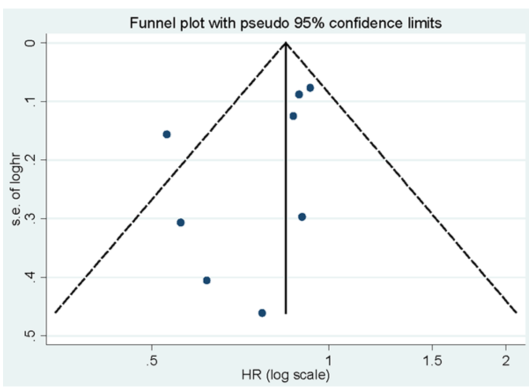

Figure 3. Begg funnel plot for the association between dietary fruit intake and age-related cataract.

Meta-analysis of findings

Data from 8 articles were analyzed in a random-effects model to combine the association between dietary fruit intake and age-related cataract risk. The combined results suggested that highest level of dietary fruit intake could significantly reduce the risk of age-related cataract (RR=0.80, 95% CI=0.68-0.93, P=0.005; I^2=47.5%, $P_{\text{for heterogeneity}}$=0.064). **Figure 2** presents the results of this analysis.

Subgroup analysis indicated that highest fruit level versus lowest level was significantly inverse associated with the risk of age-related cataract in European populations [summary RR=0.60, 95% CI=0.45-0.81, I^2=20.8%], but not in America [summary RR=0.91, 95% CI=0.82-1.00, I^2=0.0%] or the other population [summary RR=0.68, 95% CI=0.38-1.24, I^2=0.0%]. For the subgroup analysis by study design, the pooled results suggested that there is significant association between dietary fruit intake and age-related cataract risk both in case-control studies [summary RR=0.65, 95% CI=0.45-0.92, I^2=20.8%] and cohort studies [summary RR=0.90, 95% CI=0.81-0.99, I^2=20.8%].

According to the Egger's regression asymmetry test and Begg funnel plot (**Figure 3**), no evidence of publication bias (P=0.164) was found.

Sensitivity analysis showed that when one of the included studies was omitted, the combined RR was not changed significantly (**Figure 4**).

Discussion

Our study illustrated that there was significant difference significant association between dietary fruit intake and age-related cataract risk. The inverse associations were also found both in prospective studies and case-control

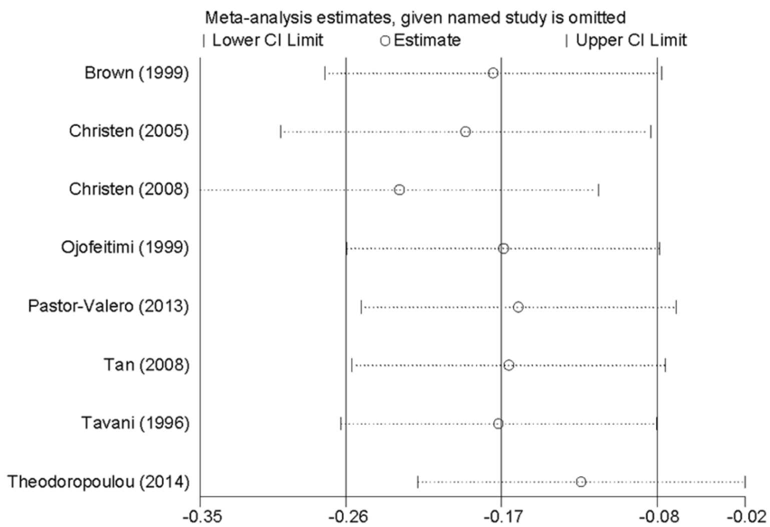

Figure 4. Sensitivity analysis of the association between dietary fruit intake and age-related cataract.

studies. We also find that highest level of dietary fruit intake could reduce the risk of age-related cataract in European populations, but not in America populations and other populations.

However, our results showed moderate heterogeneity among the studies. The paper had reported that between-study heterogeneity is common in the meta-analysis [18]. We then used meta-regression with the covariates of publication years, study design and geographic locations to explore the causes of heterogeneity. No significant finds was found in the above analysis. Furthermore, subgroup analyses were conducted to explore the source of the between-study heterogeneity. When we divided the studies into study design, the between-study heterogeneity was low in cohort studies, and no between-study heterogeneity was found in case-control studies.

To our knowledge, this is the first meta-analysis and systemic review to investigate the association between dietary fruit intake and age-related cataract risk. We reviewed many reports in order to add strength to our study. The highlight of this study was that we found an inverse association between dietary fruit intake and risk of age-related cataract. Subgroup analyses of study design and geographic locations were also conducted to assess the relationships between dietary fruit intake and age-related cataract risk. There are 6218 cataract cases and 111093 participants included in this meta-analysis, and this will enhance the statistical power of this study. However, several limitations of our study still exist. First, some original studies did not adjust for potentially relevant confounders. Any of these factors could lead to bias in the results. Second, the association was only significant in the Europe populations, but not in the other populations. Due to this limitation, the results are applicable to the Europe, but cannot be extended to populations elsewhere. More studies originating in other countries are required to investigate the association between dietary fruit intake and risk of age-related cataract. Third, the statistical heterogeneity that appeared in our pooled analysis and subgroup analyses would also have a small effect on the reliability of our results.

Conclusions

We have demonstrated that highest level of dietary fruit intake could reduce the risk of age-related cataract, especially in European populations.

Disclosure of conflict of interest

None.

Address correspondence to: Ling Li, Department of Ophthalmology, Qinghai Provincial People's Hospital, No. 2 Chengdong District, Xining 810007, China. E-mail: liling_2016@sina.com

References

[1] Gunnlaugsdottir E, Arnarsson A and Jonasson F. Five-year incidence of visual impairment and blindness in older Icelanders: the Reykjavik Eye Study. Acta Ophthalmol 2010; 88: 358-66.
[2] Thylefors B. A global initiative for the elimination of avoidable blindness. Am J Ophthalmol 1998; 125: 90-3.
[3] Brown L, Rimm EB, Seddon JM, Giovannucci EL, Chasan-Taber L, Spiegelman D, Willett WC and Hankinson SE. A prospective study of carotenoid intake and risk of cataract extraction in US men. Am J Clin Nutr 1999; 70: 517-24.

[4] Christen WG, Liu S, Schaumberg DA and Buring JE. Fruit and vegetable intake and the risk of cataract in women. Am J Clin Nutr 2005; 81: 1417-22.

[5] Christen WG, Liu S, Glynn RJ, Gaziano JM and Buring JE. Dietary carotenoids, vitamins C and E, and risk of cataract in women: a prospective study. Arch Ophthalmol 2008; 126: 102-9.

[6] Yeum KJ, Taylor A, Tang G and Russell RM. Measurement of carotenoids, retinoids, and tocopherols in human lenses. Invest Ophthalmol Vis Sci 1995; 36: 2756-61.

[7] Chitchumroonchokchai C, Bomser JA, Glamm JE and Failla ML. Xanthophylls and alpha-tocopherol decrease UVB-induced lipid peroxidation and stress signaling in human lens epithelial cells. J Nutr 2004; 134: 3225-32.

[8] Theodoropoulou S, Samoli E, Theodossiadis PG, Papathanassiou M, Lagiou A, Lagiou P and Tzonou A. Diet and cataract: a case-control study. Int Ophthalmol 2014; 34: 59-68.

[9] DerSimonian R and Laird N. Meta-analysis in clinical trials. Control Clin Trials 1986; 7: 177-88.

[10] Higgins JP and Thompson SG. Quantifying heterogeneity in a meta-analysis. Stat Med 2002; 21: 1539-58.

[11] Higgins JP and Thompson SG. Controlling the risk of spurious findings from meta-regression. Stat Med 2004; 23: 1663-82.

[12] Tobias A. Assessing the influence of a single study in the meta-analysis estimate. Stata Tech Bull 1999; 47: 15-7.

[13] Egger M, Davey Smith G, Schneider M and Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ 1997; 315: 629-34.

[14] Ojofeitimi EO, Adelekan DA, Adeoye A, Ogungbe TG, Imoru AO and Oduah EC. Dietary and lifestyle patterns in the aetiology of cataracts in Nigerian patients. Nutr Health 1999; 13: 61-8.

[15] Pastor-Valero M. Fruit and vegetable intake and vitamins C and E are associated with a reduced prevalence of cataract in a Spanish Mediterranean population. BMC Ophthalmol 2013; 13: 52.

[16] Tan AG, Mitchell P, Flood VM, Burlutsky G, Rochtchina E, Cumming RG and Wang JJ. Antioxidant nutrient intake and the long-term incidence of age-related cataract: the Blue Mountains Eye Study. Am J Clin Nutr 2008; 87: 1899-905.

[17] Tavani A, Negri E and La Vecchia C. Food and nutrient intake and risk of cataract. Ann Epidemiol 1996; 6: 41-6.

[18] Munafo MR and Flint J. Meta-analysis of genetic association studies. Trends Genet 2004; 20: 439-44.