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Nutritional Influences on the Onset and Progression of Age-Related Cataract: A Narrative Review

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NARRATIVE REVIEW

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ABSTRACT

Background: The leading cause of global blindness is cataract, which affects 70 million people worldwide, a number expected to rise with an aging population. In vitro and animal studies indicate that nutritional deficiencies contribute to age-related cataracts (ARC) while suggesting that dietary interventions may mitigate the risk. The complex relationship between ARC and specific nutrients in humans is difficult to validate due to various factors like diet diversity and compliance. Recent research expands beyond antioxidants to examine carbohydrates, fatty acids, proteins, carotenoids, and diet types like the Mediterranean diet and high dairy intake. Understanding nutrition's role in cataract formation remains an ongoing challenge. **Methods:** This narrative review aims to combine findings from studies that analyzed the impact of specific dietary patterns, foods, and nutrients on the development or progression of ARC. **Results:** The review methodically assesses 24 articles. The results suggest notable protective effects associated with various dietary patterns such as the Korean balanced diet, vegetarian diet, "dairy products and vegetables," "traditional," "antioxidant," and "omega-3" patterns. Moreover, consumption of vegetables, fruits, nuts, legumes, skimmed yogurt, coffee, and vitamins appears to correlate positively with reduced incidence of cataracts. **Conclusion:** More investigations are deemed essential to deepen our understanding of these relationships and formulate consistent dietary recommendations for both at-risk populations and individuals already diagnosed with ARC.

Introduction

One of the leading causes of blindness is cataract globally and is considered an epidemic, impacting approximately 70 million people worldwide. With the aging global population, the incidence of visual impairment and blindness due to cataracts is anticipated to increase (Flaxman *et al.*, 2017).

Studies using in-vitro or animal models have stated that certain nutritional deficiencies can contribute to the progression and development of age-related cataracts (ARC). Studies also suggest that dietary interventions may reduce the possibility of ARC (Taylor *et al.*, 1995, Weikel *et al.*, 2014, Wu and Leske, 2000).

The connection between specific nutrient intake or deficiencies and the possibility of ARC in humans is complex and difficult to validate. This complexity arises from the multifaceted nature of

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nutrient absorption, interactions between various nutrients, and differences in diet due to socioeconomic, geographic, and cultural factors, as well as partial compliance with long-term dietary supplements. As a result, isolating a single causative agent is difficult. Furthermore, little is known about the role the intestinal microbiota plays in the progression and development of cataracts, despite its importance in the pathophysiology of uveitis and other disorders (Lin, 2018).

Most of the recent and relevant studies have investigated the roles of carbohydrates, fatty acids, proteins, carotenoids, and nutraceuticals on cataract formation and progression, whereas prior research mainly concentrated on the effect of antioxidants (Chiu *et al.*, 2021); (Martínez-Lapiscina *et al.*, 2010).

Recent and relevant studies have evaluated the impact of various nutritional diet types, for example the Mediterranean diet (García-Layana *et al.*, 2017) and high dairy intake (Camacho-Barcia *et al.*, 2019), on cataract development. Several reviews have previously summarized the existing knowledge on how nutrition influences cataract formation, each focusing on different aspects (McCusker *et al.*, 2016); (Raman *et al.*, 2017) .

Through an emphasis on research and discoveries from the last five years (2019-2024), this study aims to survey the impact of dietary patterns, specific food groups, and nutrients on the frequency and progression of ARCs, with a focus on synthesizing high-quality evidence, identifying gender and age-specific implications, and providing practicable insights for public health nutrition strategies.

Clinical significance of this narrative review

The current narrative review will deliver a thorough overview of the evidence connecting dietary patterns, specific food groups, antioxidant vitamins, carotenoids, and certain minerals to the risk of cataract. By clarifying the roles of these nutrients in metabolism and cellular transport, as well as their influence on the development and progression of cataracts, the aim is to promote advancements in the management and prevention of this condition. Additionally, it is crucial to highlight the potential for applying findings from referenced studies to inform dietary guidelines for at-risk individuals and cataract patients.

Materials and Methods

Relevant literature was identified through systematic searches in PubMed and Cochrane Library using terms such as “cataract,” “age-related cataract,” “diet,” and “nutrition,” supplemented by combinations with “dietary patterns,” “antioxidants,” and “minerals.”

Inclusion and exclusion criteria

1. Human studies on ARCs (both genders),
2. Adults aged 40 and above,
3. English-language articles published within the last five years, and
4. Studies which included animal, and case reports.

To evaluate the quality of evidence, studies were assessed based on

1. Study design (randomized trials, cohort, or observational studies),
2. Population size and diversity, and
3. Risk of bias (e.g., funding sources, sample selection).

A narrative synthesis grouped findings by dietary patterns, food groups, and nutrient-specific effects. The review aimed to provide actionable insights for public health practitioners by aligning dietary recommendations with population-level trends in cataract prevalence. The process of study identification and selection is summarized in **Figure 1.**

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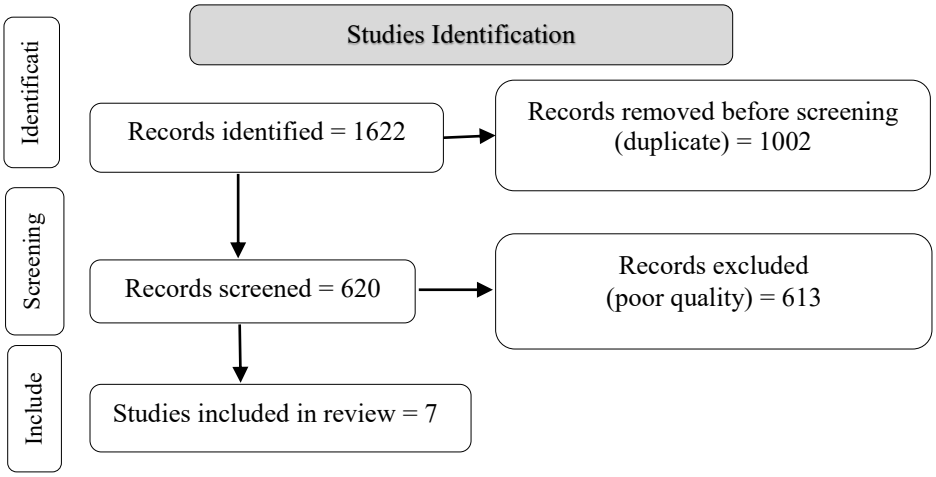

Figure 1. Flow chart for selection of studies in the narrative review.

Results

Impact of various dietary patterns on cataract development

1-Traditional Korean balanced diet

The Korean diet, commonly referred to as the K-diet, emphasizes a calorie-restricted and low-animal-fat nutritional regimen, focusing mainly on vegetables, grains, legumes, and fish. According to Seoul Declaration, the K-diet is characterized by an abundance of cooked rice, kimchi, seasoned vegetables, and medicinal herbs, a moderate intake of fish and pulses, and minimal consumption of red meat. In a traditional Korean balanced diet, carbohydrates primarily come from grains such as rice and barley. Protein is mainly provided by legumes and fish, while fats are procured from vegetable oils for example sesame and perilla oils (Kim *et al.*, 2016) .

A large-scale hospital-based cohort study by examined the relationship between lifestyle-related risk factors, metabolic syndrome (MS), and ARC (Jee and Park, 2021). The study assessed three dietary patterns: the traditional Korean balanced diet (KBD), Western diet (WD), and rice-based diet. Findings indicated that MS participants with high consumption of the KBD had a 20% lower prevalence of ARC compared to those with low consumption. Notably, the KBD was the only dietary pattern to show a significant inverse association with ARC risk among MS groups. In contrast, neither the Western diet nor the rice-based diet was associated with ARC risk in any population, regardless of MS status (Jee and Park, 2021).

2-Traditional and dairy-products-and-vegetables dietary patterns

The 2021 study by Amini *et al.* compared the incidence of ARCs among individuals who adhere to different dietary patterns, including a traditional diet and a vegetable-based diet. The "dairy products and vegetables" pattern was defined by a high intake of dairy products, vegetables, tea, and fats, and low salt and spice consumption. The "traditional pattern" was characterized by high consumption of lamb, mutton, beef, fats, and low intake of white meat, legumes, bread, rice, and other grains. Moreover, the "carbohydrate and simple sugar pattern" involved high consumption of fresh and processed fruits, vegetables, and sugar, but low intake of nuts and seeds. The "nuts, seeds and simple sugar" pattern mainly included nuts, seeds, and sugar. Therefore, the study found that both the "dairy products and vegetables" pattern and the "traditional" pattern had a protective effect against ARC. Conversely, the "carbohydrate and simple sugar pattern" was related with a greater risk of developing ARC (Amini *et al.*, 2021).

3-Vegetarian diet

A vegetarian diet is primarily plant-based and

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may exclude some or all animal products, depending on the specific type of vegetarianism.

Chiu *et al.* conducted a prospective cohort study where vegetarians were identified as people who had not eaten meat or fish for at least one month before the survey (Chiu *et al.*, 2021). Results indicated that compared to a non-vegetarian diet, the vegetarian diet included higher amounts of vegetables (especially soy and nuts), whole grains, dietary fiber, folate, and vitamins A and C, but did not significantly differ in fruit, processed grains, or supplement consumption. After modifying factors such as demographics, lifestyle, and health conditions (including hypertension, diabetes, hyperlipidemia, corticosteroid use, and body mass index), the Taiwanese vegetarian diet was found to be highly related with a 20% reduced risk of ARC. The relation was particularly notable among the overweight participants (BMI≥24 kg/m^2 in Taiwan) (Chiu *et al.*, 2021)).

Effect of diverse food products on cataract formation

1-Fruits and vegetables

The large cohort study conducted by in Japan examined the consumption of total vegetables, cruciferous vegetables, green and yellow vegetables, and fruit, and their association with ARC prevalence (Adachi *et al.*, 2021). The study found that male contestants with the highest consumption of total vegetables and cruciferous vegetables had a 23% and 26% lower prevalence of ARC, respectively, compared to those with the lowest consumption. This relation was even more pronounced among male smokers, with a 33% and 29% lower prevalence of ARC for the greatest versus the lowest intake of whole vegetables and cruciferous vegetables. The effect was also stronger in men over 60 years old compared to younger men for cruciferous vegetables. Conversely, in female participants, highest vegetable intake was associated with an increased prevalence of ARC. Females in the highest intake group had a 28% higher prevalence of ARC compared to those in the lowest group. Among non-smoking women, the highest vegetable intake was linked to a 27% higher prevalence of ARC. No significant relation was found between the consumption of green and yellow vegetables or fruit and ARC in either sex (Adachi *et al.*, 2021).

2-Dairy products

A study explored the relationship between the intake of various dairy products (total, whole, and skimmed milk; total, whole, and skimmed yogurt; and cheese) and the risk of ARC (Camacho-Barcia *et al.*, 2019). Over a follow-up period exceeding five years, the findings revealed that participants with higher intakes of skimmed yogurt had a reduced risk of requiring cataract surgery. Additionally, the second tertile of total yogurt intake showed a lower cataract risk. These were the only dairy products in the study that demonstrated a protective effect against ARC (Camacho-Barcia *et al.*, 2019)

3-Wholegrain and legume foods

The Australian cohort study found no important relation between total wholegrain intake and any type of ARC incidence. Additionally, the consumption of specific wholegrain foods such as brown rice, breakfast cereal, whole meal/multigrain bread, or oatmeal did not show any statistically important association with ARC prevalence. However, the highest intake of legumes compared to the lowest demonstrated a protective effect against posterior subcapsular cataracts (PSC), though no significant trend was observed in this association. No associations were found between pulse intake and the incidence of cortical or nuclear cataracts (Tan *et al.*, 2020).

4-Coffee

In the study researchers explored the indirect association between lifestyle factors and the prevalence of ARC among over 40,000 participants (Jee *et al.*, 2020). They investigated the relationship between nutritional diet and polygenetic risk scores (PRS) to assess the genetic influence on ARC risk. Participants were categorized based on their nutrient intake levels. The study revealed that higher coffee intake was significantly linked to a reduced prevalence of ARC compared to lower coffee consumption.

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Additionally, the incidence of ARC increased progressively from low-PRS to high-PRS groups. This indicates that consuming more than 3 grams of coffee per day may help protect against ARC, particularly in individuals with a high PRS for higher coffee intake (Jee *et al.*, 2020). Details of various dietary patterns, related studies, and their key findings on age-related cataract development are summarized in **Table 1**.

Table 1. Various dietary patterns/food products, the studies and authors, and their key findings regarding the impact on age-related cataract development.

Dietary pattern / Food product	Reference	Key findings
Traditional Korean balanced diet	(Jee and Park, 2021)	The K-diet, characterized by vegetables, grains, legumes, and fish, was related with a 20% lower prevalence of ARC in participants with MS.
Traditional and dairy-products-and-vegetables dietary patterns	(Amini *et al.*, 2021)	The "dairy products and vegetables" and "traditional" nutritional patterns were protective against ARC, while a "carbohydrate and simple sugar" pattern increased ARC risk.
Vegetarian diet	(Chiu *et al.*, 2021)	The vegetarian diet was related with a 20% reduced risk of ARC, especially among overweight participants (BMI ≥ 24).
Fruits and vegetables	(Adachi *et al.*, 2021)	High vegetable intake, particularly cruciferous vegetables, was related with a 23% and 26% lower prevalence of ARC in male participants. However, higher vegetable intake was linked to increased ARC in females.
Dairy products	(Camacho-Barcia *et al.*, 2019)	Higher consumption of skimmed yogurt was related with a reduced risk of cataract surgery, indicating a protective effect against ARC.
Wholegrain and legume foods	(Tan *et al.*, 2020)	No important link was found between wholegrain intake and ARC. However, high legume consumption showed a protective effect against PSC.
Coffee	(Jee *et al.*, 2020)	Higher coffee consumption (over 3 grams per day) was linked to a reduced prevalence of ARC, especially in individuals with high PRS for ARC.

***ARC**: Age-related cataract; **MS**: Metabolic syndrome; **BMI**: Body mass index; **PSC**: Posterior subcapsular cataracts.*

Discussion

The findings from this narrative review clearly indicate a significant connection between diet and the incident of ARC. Specifically, a higher intake of plant-based foods such as vegetables, fruits, legumes, and nuts, along with skimmed yogurt, coffee, and fish, seems to notably lower the prevalence of ARC (Adachi *et al.*, 2021); (Camacho-Barcia *et al.*, 2019); (Lee *et al.*, 2022). Interestingly, the analysis of the studies reveals that obtaining vitamins through diet is more beneficial than through supplements, particularly for vitamin E, B9, and β-carotene (Jiang *et al.*, 2019). Furthermore, some studies emphasize the greater health benefits of a ketogenic and vegetarian diet, along with nutritional diet patterns that are rich in antioxidants and omega-3 fatty acids (Amini *et al.*, 2021); (Jee and Park, 2021).

The lack of impact of the Mediterranean diet on reducing the incidence of ARC is puzzling, especially considering its components. This diet primarily consists of plant-based foods rich in unsaturated fatty acids and antioxidants. Moreover, a study comparing the total antioxidant capacity (TAC) and total oxidant capacity (TOC) between cataract patients and a healthy control group found that patients with ARC had unfavorable levels (Heidari *et al.*, 2021). Nonetheless, it is significant to acknowledge that individual studies have reported both positive and negative associations between the Mediterranean-Style Dietary Pattern Score (MSDPS) and ARC.

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In the study the control group's adherence to a low-fat diet might have obscured the benefits of the Mediterranean diet itself, as the research primarily aimed to identify correlations related to the intake of EVOO and nuts (García-Layana *et al.*, 2017). The recommendations for a fat-restrictive diet were not coincidental but were based on the American Heart Association's 2002 Guidelines. These guidelines advocated for a diet rich in vegetables, fruits, grains, low-fat or skimmed dairy products, fish, pulses, and white and lean meats. According to the reviewed literature, most of these recommended foods have demonstrated beneficial effects on the incidence or progression of ARC (Adachi *et al.*, 2021); (Camacho-Barcia *et al.*, 2019).

The guidelines also recommended limiting saturated fat intake to less than 10% of daily calories, keeping cholesterol intake below 300 mg per day, and reducing trans fatty acid utilization through dietary substitutes. Furthermore, they emphasized the need to decrease salt and alcohol consumption. It is significant to note that the study may not have been intended to evaluate whether the Mediterranean diet could impact the early stages of cataracts, as cataracts can grow gradually over time before necessitating surgical removal (Camacho-Barcia *et al.*, 2019).

A factor worth considering in future studies on the impact of diets regarding disease progression is the increasing globalization and resulting homogenization of lifestyles and eating habits across populations. Historically, diets were influenced by the local availability of food products (Lăcătușu *et al.*, 2019). Analysing the above, it may be beneficial to utilize existing tools for assessing diet quality before selecting and recommending a specific dietary regimen for a patient's diet therapy. Nonetheless, further research is mandatory to elucidate the contributions of not only individual elements but also the entire Mediterranean diet on the incidence or risk of ARC. Expanding knowledge in this area could complement existing treatments and enhance the quality of life for the elderly in the future.

The notable strength is its identification of gaps in the literature regarding uniform dietary recommendations for the elderly to mitigate or slow ARC progression.

There are several limitations on this narrative review. Comparability is limited by the use of varied observational studies, which add variation in cataract categorization, population demographics, and dietary assessment techniques. Language bias is introduced when non-English researches are excluded, and validity may be impacted if variables like smoking or sun exposure are not taken into account. Inconsistencies are further highlighted by the conflicting results about the Mediterranean diet. Finally, the narrative approach is not as rigorous as systematic reviews, which limits the generalizability of the findings and the robustness of causal inferences.

Conclusions

There is a strong link between certain lifestyle factors and the prevalence of cataracts, offering an opportunity to develop effective guidelines for prevention. Adopting such recommendations can provide long-term benefits - not only by preserving visual acuity and enhancing quality of life for older adults, but also by reducing financial burdens on individuals and communities. These insights can assist eye care practitioners and nutritionists in educating patients about the role of diet in cataract development. Additionally, identifying vitamin deficiencies can support more accurate diagnoses and encourage healthier habits that help prevent the disease. The findings from this analysis can inform improved dietary recommendations for individuals with cataracts, potentially slowing disease progression and enhancing overall well-being.

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Authors' contribution

Both authors contributed equally to the conception, literature review, analysis, and writing of the manuscript.

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Conflict of Interest

The authors declared no conflict of interest.

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