The Role of Antioxidants in Myopia: A Literature Review

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ABSTRACT

Myopia is an increasingly prevalent global public health concern associated with significant visual and socioeconomic burdens. Emerging evidence suggests that oxidative stress may contribute to myopia development, prompting interest in the potential protective role of dietary antioxidants. This systematic literature review aimed to evaluate the relationship between antioxidant intake, oxidative stress, and myopia outcomes.

A systematic search was conducted across PubMed, Web of Science, and Google Scholar following PRISMA guidelines. Eligible studies included peer-reviewed human research published within the last 15 years that examined antioxidants, oxidative stress, and myopia-related outcomes. A narrative synthesis approach was used due to heterogeneity in study designs and outcome measures.

Overall, the evidence was mixed and inconclusive. Some interventional studies published between 2019 and 2023 reported that lutein, zeaxanthin, and crocetin may help reduce axial elongation, while also improving retinal biomarkers such as macular pigment optical density and visual performance. Vitamins and trace elements, showed no clear or consistent associations with myopia outcomes. Anthocyanins were associated with improvements in visual function but did not demonstrate effects on axial length. In contrast, healthier diet patterns were more consistently linked to lower myopia risk, while pro-inflammatory diets were associated with increased risk. Oxidative stress markers were generally elevated in myopic individuals, suggesting a potential role in myopia pathophysiology, although causality remains unclear.

In conclusion, antioxidants may support retinal health and show limited potential in slowing axial elongation, but current evidence remains insufficient to establish a definitive role in myopia control.

Keywords: *myopia, oxidative stress, antioxidants, dietary patterns*

Introduction

Myopia, or nearsightedness, is a refractive error characterized by the elongation of the axial length of the eye, resulting in blurred distance vision. Through the years, myopia has become a major global public health concern due to its rapidly increasing prevalence and its association with serious ocular complications. The concern is particularly pronounced in East and Southeast Asia where prevalence rates among school-aged children and young adults can exceed 80% (Morgan et al., 2012). It is projected by Holden et al. (2016) that by 2050, nearly half of the world's population could be affected by myopia. WHO (2019) estimates that the number of people with myopia will increase from 1.95 billion in 2010 to 3.36 billion in 2030. During the same period, the number of people with high myopia is projected to rise from 277.2 million in 2010 to 516.7 million in 2030.

The increasing prevalence of myopia is associated with economic, social, and healthcare burdens. Direct costs include vision correction, clinical consultations, and surgical interventions, while indirect costs relate to reduced productivity and quality of life of myopic individuals (Chua & Foster, 2020; Han et al., 2023; Rose et al., 2000). In addition to these burdens, myopia is associated with a range of sight threatening complications such as cataract, glaucoma and myopic maculopathy (Morgan et al., 2012). These complications have fueled increasing interest in identifying risk factors that may help prevent or slow myopia progression.

The development of myopia is widely recognized as multifactorial, involving both genetic and environmental influences. Environmental factors such as prolonged near work, increased screen time, and reduced outdoor exposure have been consistently associated with higher myopia risk (National Academies of Sciences, Engineering, and Medicine [NASEM], 2024).

Recent advances in ocular biology have highlighted the importance of biochemical and molecular mechanisms underlying myopia development. Among these, oxidative stress has gained increasing attention as a contributing factor. Oxidative stress refers to an imbalance between the production of reactive oxygen species (ROS) and the body's antioxidant defense systems (Bohm et al., 2023). Excessive ROS can damage cells, cause lipid peroxidation, and disrupt normal cellular signaling. In ocular tissues, oxidative stress has been shown to interfere with retinal signaling pathways involved in regulating eye growth (Mérida et al., 2020). These disruptions may promote axial elongation, which is a hallmark feature of myopia progression.

Given the role of oxidative stress in ocular tissue dysfunction, interest in the potential protective role of antioxidants has increased. Antioxidants, which are abundant in a variety of plant-based foods such as fruits, vegetables, nuts, and whole grains, can neutralize free radicals and limit oxidative damage (Ames et al., 1993). Nutrients such as vitamin C, vitamin E, carotenoids, and polyphenols have been shown to support retinal health and may influence pathways involved in eye growth (Krinsky & Johnson, 2005; Matias-Pérez et al., 2024).

Dietary intake of antioxidant-rich foods therefore represents a potentially accessible and non-invasive strategy for mitigating oxidative stress. However, the current evidence remains incomplete. Studies vary in design, population, and measured outcomes, and while some experimental and epidemiological studies suggest a protective association, others have reported limited or inconclusive findings (Chen et al., 2025; Xu, 2025).

This literature review aims to examine the relationship between antioxidant and myopia progression. Specifically, this thesis seeks to evaluate current research in exploring the role of oxidative stress in the development of myopia, and in identifying the effects of dietary antioxidants on eye growth. As a result, this review will provide a clearer understanding of the potential role of diet in addressing the growing burden of myopia.

Need of the study

Research on antioxidants and myopia has increased in recent years, but the evidence still remains unclear and inconsistent. This study is needed to evaluate existing findings and to provide a clearer understanding whether antioxidants have meaningful effects on myopia outcomes. The significance of this study lies in its potential to guide future research and support a more holistic understanding of myopia management.

METHOD

Aim of the study

This study aims to know if antioxidants affect myopia progression. Specifically, it aims:

1. To evaluate studies that investigate dietary or supplemental antioxidants and their potential effects on myopia progression.
2. To examine the role of oxidative stress in the development and progression of myopia.
3. To highlight gaps in knowledge and propose directions for future research in clinical optometry.

Inclusion criteria

Studies were included if they have met the following criteria:

- Peer-reviewed original research articles
- Human studies
- Observational studies, randomized controlled trials, and experimental studies
- Studies examining oxidative stress, antioxidants, or dietary intake in relation to myopia, refractive error or axial length
- Articles published in English
- Studies published within the last 15 years
- Full text available

Exclusion criteria

Studies were excluded if they met the following criteria:

- Not peer reviewed
- Did not directly relate to myopia progression or oxidative stress
- Focused solely on genetic, surgical, or optical interventions for myopia
- Did not include outcome measures related to myopia progression
- Full text was not available

Study Design

This study employed a systematic literature review design to synthesize existing evidence on the relationship between antioxidants, oxidative stress, and myopia progression. The review followed established guidelines based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to ensure transparency, reproducibility, and methodological rigor.

Given the variability in study designs, populations and outcome measures, a narrative synthesis approach was utilized to summarize and interpret findings across studies.

Search Strategy

A comprehensive and systematic literature search was conducted across multiple electronic databases to identify relevant peer-reviewed studies.

Databases Searched

The following electronic databases were searched:

- PubMed
- Web of Science
- Google Scholar

Search Terms

Search terms were developed using a combination of keywords and Boolean operators related to myopia, antioxidants, oxidative stress, and dietary factors. The following terms have been used:

- "myopia" OR "nearsightedness"
- "antioxidants" OR "oxidative stress"
- "diet" OR "nutrition" OR "food intake"
- "vitamins" OR "carotenoids" OR "polyphenols"
- "lutein" OR "zeaxanthin" OR "anthocyanin"
- "myopia progression" OR "axial length" OR "axial elongation"

These terms were combined using Boolean operators (AND, OR) to refine search strategy. In addition to database searches, manual searches of reference lists from relevant articles were also conducted to identify additional studies that may not have been extracted through electronic searches.

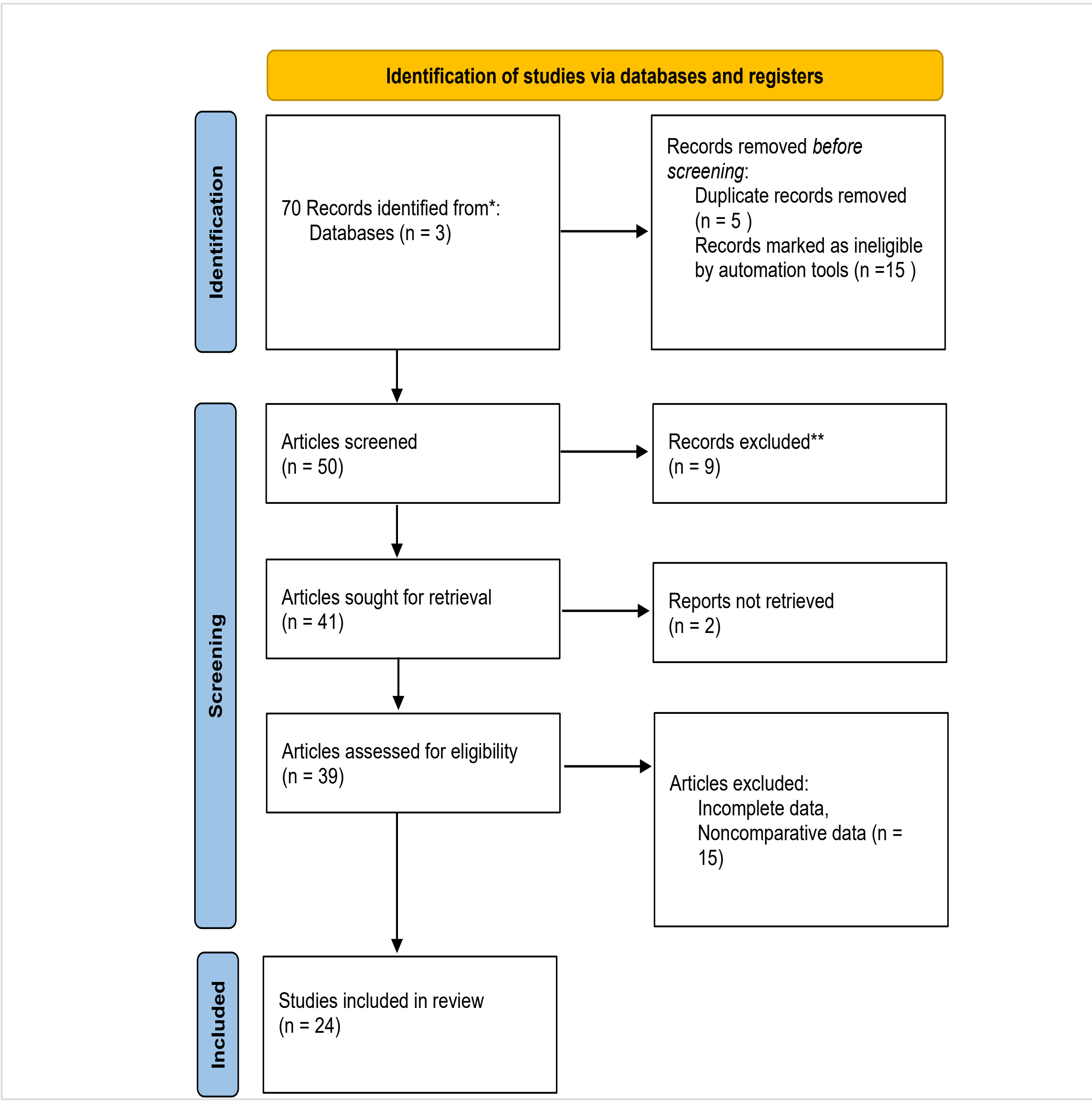
Study Selection

All the identified records were initially screened based on the titles and abstracts to assess their relevance. Full text articles were then retrieved and evaluated according to the predefined inclusion and exclusion criteria of this study. Duplicate records were then removed prior to screening.

The study selection process was guided by the PRISMA framework to ensure a systematic and transparent approach.

Figure 1.

PRISMA flow diagram for study selection.



Data Extraction and Synthesis

Relevant data were extracted from each included study, including the study design, population characteristics, type of antioxidant exposure and myopia related outcomes.

A narrative synthesis approach was used to summarize findings due to the variability in methodologies and outcome measure across studies. Studies were grouped thematically according to antioxidant type, dietary patterns, and oxidative stress indicators.

Findings were analyzed descriptively to identify patterns, consistencies, and discrepancies across studies, rather than to establish causal relationships.

RESULTS

The studies included in this review comprised a combination of observational and interventional designs investigating the relationship between antioxidants and myopia outcomes. These studies varied in methodology, population characteristics, outcome measures, including refractive error, axial length and retinal biomarkers. Table 1 summarizes the main characteristics of the studies included in this review. Overall, these studies demonstrated a mixed and largely inconclusive findings regarding the relationship of antioxidants and myopia. Across studies, variability was observed in the measurement of antioxidant exposure, including dietary intake assessments, serum biomarker analysis, and supplementation trials. Additionally, differences in age groups, geographic populations and study designs contributed to heterogeneity in findings. While some studies suggested a potential protective association, other studies have reported a null or even contradictory results. The complexity of the relationship between antioxidants and myopia has been highlighted.

Antioxidants and Myopia

1. Antioxidant Vitamins (Vitamin A, C, and E)

1.1 Vitamin A

The evidence examining antioxidant vitamin A has showed inconsistent and conflicting findings across different study designs.

Zhang et al. (2022) conducted a cross-sectional study examining serum vitamin A levels among 7,033 participants and reported a borderline significant association with high myopia. However, when the confounding variables have been adjusted, the association was no longer statistically significant. This suggests that the observed relationship may be influenced by other factors. On a different cross-sectional study, Mikoluc et al. (2024) has found that individuals with high myopia had significantly lower retinol (vitamin A) levels compared to controls.

In contrast, a large population-based dataset of 15, 899 participants in South Korea were used by Lee (2025) where they reported an inverse association between circulating vitamin A levels and myopia prevalence. Higher vitamin A levels were associated with lower odds of myopia. Subgroup analysis further indicated that there was a gender specific association; higher vitamin A levels were linked to a reduced prevalence of myopia in women and reduced prevalence of high myopia in men. With this, a possible demographic variation in the relationship has been suggested.

Despite this findings, longitudinal evidence did not support a causal relationship. A cohort study by Ng et al. (2020) tracked 642 individuals from adolescence into early adulthood. No significant association was found between dietary vitamin A intake during adolescence and refractive outcomes in early adulthood. Similarly, Xiao et al. (2024), in a cross-sectional analysis of serum antioxidant levels, have reported no significant association between vitamin A levels and either myopia or high myopia.

Taken together, the findings for Vitamin A suggests no consistent or causal relationship with myopia. The discrepancies were likely influenced by study design, population differences, and methods of exposure assessment.

1.2 Vitamin C

Evidence for Vitamin C was limited and variable; with some studies suggesting protective effects and others reporting null findings. Kim and Choi (2024a) reported an inverse association between dietary vitamin C intake and myopia prevalence; with higher intake associated a reduction in myopia prevalence. This finding suggests a potential protective role of Vitamin C.

However, this finding was not consistently replicated. Chen et al. (2025), in a large cross-sectional analysis of 3, 759 participants, found no statistically significant association between vitamin C intake and myopia or astigmatism. Xiao et al. (2024) has similarly reported no significant relationship between circulating vitamin C levels and myopia outcomes in their population-based analysis.

This inconsistency across studies may reflect differences in dietary assessment methods, population characteristics, and control for confounding variables. Overall, the evidence for Vitamin C remains inconclusive and insufficient to establish a clear association with myopia outcomes.

1.3 Vitamin E

Findings for vitamin E were also found to be inconsistent and inconclusive. Conflicting results have been observed across studies.

Xiao et al. (2024) reported no significant association between serum vitamin E levels and myopia in a large population-based analysis. In contrast, Mikoluc et al. (2024), in a cross-sectional study, found that individuals with high myopia had significantly lower α-tocopherol (vitamin E) levels compared to controls. The possible association might be with the severity of myopia rather than myopia prevalence. Conversely, Chen et al. (2025) have reported higher dietary vitamin E intake among individuals with high myopia, further complicating the interpretation of results. These conflicting findings may be attributable to differences in study design, measurement of exposure (dietary vs. serum levels), and population characteristics.

Overall, the evidence for Vitamin E does not demonstrate a consistent relationship with myopia, and its role remains unclear.

2. Trace Elements

Trace elements have been investigated as potential contributors to antioxidant defense and ocular health. However, the available evidence remains limited and inconsistent. Zinc has been the most frequently studied. But other trace elements have also been explored only in a limited number of studies, often as part of broader micronutrient analyses rather than as primary exposures.

2.1 Zinc

Zinc was the most commonly investigated trace element in relation to myopia; although findings were inconsistent and inconclusive. Fedor et al (2019) analyzed hair samples of children and adolescents with myopia and have observed that the average serum zinc levels were lower in myopic individuals compared with their non-myopic controls ($p < .001$). A possible association between zinc deficiency and myopia was suggested.

In contrast, Burke et al (2020) found no association between serum zinc levels and myopia in their study of adolescents aged 12-19 years old. Similarly, Ba et al (2024) reported variable findings, with no statistically significant associations observed between zinc levels and myopia across different analyses.

These discrepancies may be attributed to differences in biological sample types (e.g., hair versus serum), study populations and analytical methods. Overall, no clear relationship between zinc and myopia prevalence or progression was established.

2.2 Iron

Evidence regarding iron and myopia is extremely limited. Iron has primarily been assessed as part of general nutritional or micronutrient status rather than as an independent variable of interest.

Iron was included among multiple micronutrients analyzed by Xiao et al (2024) in their cross-sectional study evaluating serum antioxidant profiles; however no significant association between iron levels and myopia outcomes was identified. Similarly, Chen et. al (2025) examined dietary intake patterns that included micronutrients such as iron but did not report any statistically significant relationship between iron intake and myopia prevalence.

Overall, due to lack of focused investigation, the role of iron remains unclear and no evidence has been found to support a direct association with myopia.

2.3 Selenium

Selenium has been investigated primarily in the context of its role in antioxidant enzyme systems, although direct evidence linking selenium to myopia is limited and inconclusive. Fedor et al. (2019) reported no statistically significant differences in selenium levels between myopic and non-myopic individuals.

In a study assessing broader antioxidant and micronutrient profiles, selenium was included among several trace elements; however, it was not identified as an independent predictor of myopia after controlling for confounding variables (Xiao et al., 2024).

Additionally, the population-based analyses of dietary intake of Chen et al (2025) also did not report significant associations between selenium intake and myopia outcomes.

Thus, while selenium plays a recognized role in oxidative defense, there is no demonstration of a clear relationship with myopia development or progression.

2.4 Copper

Copper was evaluated alongside zinc in the same study by Fedor et al. (2019). The results have indicated no differences in copper levels between myopic and non-myopic individuals.

Similarly, Xiao et al (2024) did not identify copper as significant factor associated with myopia in their serum-based analysis. Chen et al (2025) likewise did not report a significant association between dietary copper intake and myopia outcomes.

With this, current evidence does not support a consistent relationship between copper and myopia.

2.5 Manganese

Manganese has been rarely examined in the context of myopia. Fedor et al. (2019) also did not observe statistically significant differences between myopic and non-myopic controls.

Additionally, manganese was also not identified as a significant factor in other studies including the broader micronutrient analyses conducted by Xiao et al (2024) and Chen et al (2025). The limited number of studies and lack of replication make it difficult to determine the relevance of manganese in myopia.

3. Carotenoids

Carotenoids have been examined in both observational and interventional studies, with more consistent effects observed on retinal biomarkers than on refractive outcomes. A systematic review of randomized controlled trials further concluded that although carotenoid supplementation may improve retinal function and visual performance, there is no consistent evidence of clinically meaningful reductions in myopia progression (Martinez-Perez & Oliveira, 2025). Similarly, a cross-sectional study by Xiao et al. (2024) has examined serum carotenoid levels and found no significant associations between most carotenoids (including lutein and zeaxanthin) and myopia after adjusting for confounding variables.

3. 1 Lutein and Zeaxanthin

Evidence from randomized control trials have demonstrated more consistent findings for intermediate outcomes. Lutein supplementation trials reported significant increases in macular pigment optical density (MPOD) level over 6 months. MPOD is a marker of retinal antioxidant status, particularly among individuals without advanced axial elongation. (Yoshida et al, 2023). It has been further confirmed on a meta-analysis study by Pei et al. (2026) that a combined supplementation of lutein and zeaxanthin among adolescents has a beneficial impact towards myopia prevention. There was reduction in axial length, increase in MPOD and enhancement in visual acuity with the supplementation.

On the contrary, the population-based analyses of dietary intake of Chen et al (2025) did not report significant associations between lutein and zeaxanthin intake and myopia prevalence.

3.2 Crocetin

Crocetin supplementation demonstrated more promising results. Mori et al (2019) in randomized controlled trials involving children with myopia, have reported a significant reduction in axial elongation and smaller changes in refractive error compared to control group.

4. Anthocyanins

Anthocyanins demonstrated consistent associations with myopia related outcomes. Observational studies have reported that higher dietary anthocyanin intake was associated with significantly lower risks of myopia. Chen et al (2024) also reported that high intake was associated with reduction in myopia risk among adolescents. Specific anthocyanin subtypes such as cyanidin, petunidin, and delphinidin were independently associated with reduced myopia prevalence.

Randomized controlled trials further supported functional benefits. Utami et al (2024) tested the effectiveness of anthocyanin supplementation by using Bilberry extract. This study demonstrated improvements in contrast sensitivity, mesopic and scotopic vision, and reduced visual fatigue following supplementation.

However, these studies did not demonstrate significant effects on axial length or refractive error progression, suggesting that anthocyanins primarily influence visual function rather than structural changes associated with myopia.

5. Dietary Patterns and Overall Nutrition

Compared to individual nutrients, dietary patterns have showed more consistent associations with myopia risk.

Li et al (2026) in a large cross-sectional study of 24,797 children and adolescents, reported that high adherence to healthy dietary patterns characterized by nuts, tubers, vegetables, legumes, whole grains, and aquatic products was associated with reduced myopia risk. Similarly, Yin et al (2023) identified dietary patterns rich in fruits, vegetables, grains and protein sources as protective, with higher adherence associated with significantly lower risk of myopia.

In contrast, unhealthy dietary patterns have also been associated with myopia risk. A study of Kim and Choi (2024b), where they analyzed data from 24, 345 children, have reported that high sodium intake was associated with 2.06-fold increase in myopia development risk. This study also identified lower intake of beneficial nutrients such as omega-3 fatty acids and retinol among myopic individuals.

Pro-inflammatory dietary patterns were also linked to higher myopia prevalence. Ye et al (2024) further demonstrated that pro-inflammatory dietary patterns were associated with increased myopia risk. Higher dietary inflammatory index (DII) scores were significantly associated with increased prevalence of myopia; with individuals in the highest quartile showing substantially higher risk compared to those in the lowest quartile.

A recent systematic review and meta-analysis further support the role of broader dietary factors, indicating that macronutrient composition, including high carbohydrate and sodium intake, may increase myopia risk, whereas protein intake may have a protective effect (Xu. 2025). However, these findings remain heterogenous and should be interpreted with caution.

Oxidative Stress and Myopia

Several studies included in this review suggest that oxidative stress may play a role in the development and progression of myopia. Oxidative stress occurs when there is an imbalance between the production of reactive oxygen species (ROS) and the body's ability to neutralize them through antioxidant defenses. This imbalance has been linked to cellular damage and changes in ocular function (Coviltir et al., 2019; Francisco et al., 2015)

The retina appears to be especially vulnerable to oxidative stress. Due to its high oxygen demand, constant exposure to light, and active metabolism, it particularly prone to the generation of ROS. These conditions may contribute to oxidative imbalance in the myopic eyes and potentially affect retinal circulation. (Coviltir et. al., 2019). Francisco et al. (2015) further reported that oxidative damage in retinal tissues may influence cellular signal pathways involved in ocular growth and remodeling, supporting a potential link between oxidative stress and axial elongation.

Alterations in oxidative stress markers such as 8-hydroxy-2'-deoxyguanosine (8-OHdG), have been observed in highly myopic eyes compared to non-myopic controls (Coviltir et al., 2019). This indicates that there is increased oxidative DNA damage for myopic eyes as opposed to non-myopic individuals. Similarly, Francisco et al. (2015) reported increased levels of lipid peroxidation products and reduced antioxidant enzyme activity in myopic individuals. A reduced ability to counteract oxidative damage in myopic individuals have been suggested.

Population based and observational studies also support these findings. Wu et al. (2024) reported that higher oxidative balance scores were associated with an increased likelihood of myopia, demonstrating a dose-response relationship. However, other large-scale analyses of circulating antioxidant markers have shown inconsistent results. Xiao et al (2024) and Chen et al (2025) found no significant independent associations between oxidative biomarkers and myopia after adjusting for confounding variables.

Trace elements that are involved in antioxidant defense also appear to be affected. Studies have reported lower zinc levels and altered copper to zinc (Cu/Zn) ratios in individuals with myopia, which may indicate disruptions in antioxidant systems (Coviltir et al., 2019; Fedor et al. 2019). Francisco et al. (2015) also highlighted the role of trace elements in maintaining oxidative balance. Imbalances in these micronutrients was highlighted to contribute to increased oxidative stress and retinal vulnerability to damage.

At the tissue level, oxidative stress has been linked to structural changes associated with myopia progression. Increased ROS production may contribute to reduced retinal blood flow, localized hypoxia, and changes in scleral tissue. All of which are associated with axial elongation (Coviltir et al., 2019; Francisco et al., 2015).

Overall, the available evidence indicates a possible association between oxidative stress and myopia, particularly in relation to retinal changes and antioxidant imbalance. However, most findings are derived from observational studies and a clear cause and effect relationship has not yet been established.

Table 1.

Summary of included studies examining antioxidants, oxidative stress and myopia

Study (Author, Year)	Study Design	Sample	Variable Examined	Main Findings
Zhang et al. (2022)	Cross-sectional	N = 7,033	Serum Vitamin A	Borderline association; not significant after adjustments
Lee (2025)	Cross-sectional	N = 15,899	Circulating Vitamin A	Higher vitamin A associated with lower odds of myopia
Ng et al. (2020)	Cohort	N = 642	Dietary Vitamin A	No significant association
Xiao et al. (2024)	Cross sectional	N = 1,620	Serum antioxidants (A, C, E, Trace elements)	No significant associations after adjustment
Kim & Choi (2024a)	Cross sectional	N = 18,077	Dietary Vitamin C	Higher vitamin c, lower myopia risk
Chen et al. (2025)	Cross-sectional	N = 3,759	Dietary antioxidants	No significant associations
Mikoluc et al. (2024)	Cross-sectional	N = 80	Vitamin A (retinol), Vitamin E (a-tocopherol)	Lower Vitamin A and E in high myopia
Fedor et al. (2019)	Observational	N = 92	Zinc, Selenium, Copper, Manganese	Lower zinc levels in myopic individuals
Burke et al. (2022)	Cross-sectional	N = 304	Zinc	No association
Ba & Li (2025)	Review	Mixed	Diet and myopia	Myopia association with

				vitamins and trace elements.
Martinez-Perez & Oliveira (2025)	Review	Mixed	Carotenoids	Carotenoids improve retinal function, no effect on progression
Yoshida et al. (2023)	RCT	N = 44	Lutein/zeaxanthin	Improved MPOD; no effect on progression
Pei et al. (2026)	Review	Mixed	Lutein/zeaxanthin supplementation	Reduced axial elongation
Mori et al. (2019)	RCT	N = 69	Crocetin supplementation	Reduced axial elongation
Utami et al. (2024)	RCT	N = 1	Bilberry (anthocyanins)	Improved contrast sensitivity; no structural change
Chen et al. (2024)	Cross-sectional	N = 839	Anthocyanin	Higher anthocyanin intake associated with low incidence of myopia
Li et. al. (2026)	Cross-sectional	N = 24,797	Healthy dietary patterns	Protective association
Yin et al. (2023)	Cross-sectional	N = 7,423	Diet (fruits, vegetables, protein)	Lower risk with healthy diet
Kim & Choi (2024b)	Cross sectional	N = 24,345	Dietary habits	High sodium intake, higher risk (2.05x)
Ye et al. (2024)	Cross-sectional	N = 7,191	Dietary inflammatory index	Higher inflammation, higher myopia risk

Wu et al. (2024)	Cross-sectional	Population based	Oxidative balance score	Higher oxidative imbalance, higher myopia risk
Xu (2025)	Review	Mixed	Macronutrients	Proteins showed protective effect
Coviltir et. al. (2019)	Review	Mixed	Oxidative stress markers	Increased oxidative stress and reduced antioxidant defense in myopia
Francisco et al. (2015)	Review	Mixed	Oxidative stress, lipid peroxidation	Oxidative damage linked to retinal changes and eye growth

DISCUSSION

This systematic review aimed to determine whether antioxidants influence myopia progression, to examine the role of oxidative stress, and to identify gaps in current research. Overall, the findings indicate that the relationship between antioxidant intake and myopia is complex and remains inconclusive. Across different antioxidant categories, the evidence was highly variable. Some studies suggested protective associations, while others reported no effect or even contradictory findings.

One important observation is that several associations weakened after adjusting for confounding variables. This suggests that antioxidant intake may not act as an independent factor, but instead reflects broader lifestyle patterns. Individuals who consume antioxidant rich diets may also be likely to engage in healthier behaviors such as increased outdoor activity or reduced screen time; which are habits known to influence myopia risk. As a result, isolating the specific effect of antioxidants have become challenging.

Another issue on this finding is that focusing on individual nutrients, such as Vitamin C or zinc for example, may be too narrow. Nutrients do not act in isolation but rather they interact within complex biological systems. This is explained by Townsend et al. (2023) as nutrient synergy, where nutrients consumed together provides a greater efficacy on the body rather than when consumed alone.

In this review, overall dietary patterns have showed more consistent associations with myopia risk than single nutrients. Diets rich in fruits, vegetables, whole grains, and aquatic products were generally associated with lower myopia risk, whereas diets high in sodium or pro-inflammatory components were linked to increased risk (Li et al., Ye et al., 2024). Emmetropes were also found to have better dietary consumption compared to myopic individuals (Shetty et al., 2023).

Moreover, dietary habits are shaped by cultural, regional and environmental factors. As noted by Kim and Choi (2024a), Western diets are typically characterized by higher intake of processed foods, red meat and dairy, whereas Eastern diets tend to emphasize rice, vegetables, fish, and soy products. Urban environments are also associated with greater consumption of convenience foods, while rural settings are more closely linked to fresh and minimally processed diets. These variations highlight that diet is embedded within a broader lifestyle context, reinforcing the need to interpret nutritional findings within a holistic framework.

Taken together, these findings support the view that myopia is not primarily a nutritional disease. Instead, it is a multifactorial condition influenced by genetic predisposition, environmental exposure, and behavioral factors such as near work and time spent outdoors (NASEM, 2024). Given this complexity, it is unlikely that a single factor, including antioxidant intake, can independently determine the development or progression of myopia.

A key insight from this review is the distinction between functional improvements and structural outcomes when it comes to myopia. Evidence included from the included studies shows that antioxidant supplementation particularly lutein, zeaxanthin, crocetin, and anthocyanins, can improve retinal biomarkers and visual performance. Improvements from these supplementations are increased MPOD and enhanced visual sensitivity. However, these benefits are largely functional and do not consistently translate into reductions in axial elongation, which is the primary structural change underlying myopia progression. Notably, only lutein, zeaxanthin, and crocetin have shown some evidence of reducing axial elongation. While these findings suggest a potential role in myopia control, the limited number of studies and lack of consistent replication make it difficult to draw firm conclusions about their effectiveness.

These findings suggest that antioxidants may support retinal integrity and help the eye cope with physiological stress, but they appear to have limited influence on the biological mechanisms during ocular growth. For example, earlier research has shown that anthocyanin supplementation (anthocyanosides) can reduce visual fatigue-induced myopia. This effect may be considered supportive or preventive at a functional level (Nakaishi et al., 2000). In practical terms, antioxidants may support overall visual function, but they are unlikely to prevent axial elongation on their own.

While the direct effects of antioxidant intake remain unclear, the role of oxidative stress provides a more coherent explanation for the observed findings. The retina is particularly vulnerable to oxidative damage due to its high oxygen consumption, continuous exposure to light, and active metabolic processes (Coviltir et al., 2019). Increased levels of oxidative stress markers have been reported in myopic individuals (Francisco et al., 2015). These findings suggest that oxidative stress is involved in the underlying biological processes of myopia and may contribute to retinal dysfunction and ocular tissue changes.

A possible explanation for this relationship lies in the biological role of antioxidants in modulating oxidative stress within ocular tissues. Antioxidants function by neutralizing reactive oxygen species (ROS), thereby reducing oxidative damage to retinal cells. In the context of myopia, increased ROS levels may disrupt retinal homeostasis, impair microcirculation, induce localized hypoxia, which can activate signaling pathways involved in scleral remodeling and axial elongation (Coviltir et al., 2019; Francisco et al., 2015). Vitamin E and C were noted by Bohm et al. (2023) as part of the antioxidant defense system that counteracts the destructive effects of ROS. Along with carotenoids and polyphenols, they may help mitigate these effects by stabilizing cellular membranes and reducing lipid peroxidation. Additionally, certain carotenoids, including lutein and zeaxanthin, contribute to macular pigment density. These may protect retinal tissues from light-induced oxidative damage (Yoshida et al., 2023).

However, while these mechanisms support a theoretical protective role, current evidence suggests that antioxidant activity is more closely associated with improvements in retinal function rather than structural changes such as axial elongation. This may explain why antioxidant is linked to better visual performance but does not consistently result in reduced myopia progression.

Despite these insights, it remains unclear whether oxidative stress is a cause or a consequence of myopia. It is possible that as the eye elongates, structural and vascular changes increase oxidative stress, creating a cycle that further affects ocular tissues. This may partly explain why some studies fail to find a strong independent association.

Based on the overall findings, antioxidants do not appear to have a strong or consistent effect on myopia progression when considered in isolation. However, they may still play a supportive role by contributing to retinal health and reducing oxidative stress. This suggests that antioxidants should not be viewed as a primary intervention for myopia control, but rather as part of a broader, multifactorial approach that includes environmental and behavioral strategies.

Conclusion

This review examined whether antioxidant-rich foods influence myopia progression and explored the role of oxidative stress in this relationship. Overall, the evidence does not consistently support a direct protective role of antioxidants in slowing myopia. Although a few studies suggest possible benefits, the findings vary across populations and study designs, limiting the strength of any clear conclusion. Among the antioxidants reviewed, only lutein, zeaxanthin, and crocetin showed more consistent indications of a potential effect in reducing axial elongation.

However, antioxidants may still play a supportive role in maintaining retinal health and reducing oxidative stress. Evidence from this review indicates that oxidative stress is likely involved in the development of myopia, although it remains unclear whether it is a cause or a consequence of the condition.

Importantly, myopia should be understood as a multifactorial condition influenced by genetic, environmental, and behavioral factors. As such, antioxidant intake alone is unlikely to be an effective strategy for myopia control. Instead, it should be considered as part of a broader approach that includes lifestyle factors such as increased outdoor activity.

Future research should focus on well-designed longitudinal and experimental studies to clarify the role of antioxidants and oxidative stress in myopia. Further investigation into the underlying biological mechanisms may also help improve understanding and guide potential interventions.

In conclusion, while antioxidant-rich foods contribute to overall eye health, their role in preventing or slowing myopia progression remains uncertain.

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