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Factors Influencing the Incidence of Myopia

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ABSTRACT

Myopia is a refractive error in which a distance object looks blurry. It happens when the light is focused in front of the retina. It is increasing day by day. There are estimates indicating that by 2050, approximately half of the global population might develop myopia, and roughly 10% could experience high levels of myopia. The incidence of myopia varies geographically; changes in lifestyle and urbanization have an impact on its prevalence. Myopia may be more common in urban areas due to restricted access to outdoor activity, especially in East and Southeast Asia. Environmental, lifestyle, and genetic factors interact in a complex way to influence myopia. Here ditary factors are important; the probability of developing myopia is increased if parents have the condition. Another important factor in the development of myopia is the environment. Reading and other prolonged, intense near work activities, like screen time; have been linked to a higher risk of myopia. Understanding the complex nature of myopia is crucial. This article will review the factors causing myopia and the relative significance or weighting of various factors in the development of myopia.

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Introduction

Myopia is also known as near-sightedness, in which a distance object looks blurry. It happens when the light is focused in front of the retina (Figure 1). It is occurring when there is a mismatch or abnormality in the way the various optical components of the eye work together to focus light onto the retina, the key optical components involved in this process are the cornea, the crystalline lens, and the eye's axial length (AL). There are two types of myopia Physiological and Pathological myopia. A correlation failure of the refraction components in a normal eye leads to physiological myopia. Excessive axial elongation mainly affecting the posterior pole and ora-equatorial area is the cause of pathologic myopia. Ophthalmoscopy evidence of this process includes the formation of posterior staphylomas and changes to the peripheral fundus. Ocular refraction is primarily determined by heredity, although a variety of factors can cause both transient and permanent myopias [1]. The most prevalent eye condition globally is myopia [2]. There are estimates indicating that by 2050, approximately 50% of the global population might develop myopia, and roughly 10% could experience high levels of myopia [3]. Over the past few decades, multiple studies have found valuable insight into the prevalence patterns and the factors that cause the development of myopia. From 1972 to 2004, there has been a significant rise in the prevalence of myopia in the United States, with the percentage increasing from 25% to 44% [4,5]. The prevalence of myopia is different in different countries; it is dependent on the rural environment and the urban environment (Table 1). In Asian urban areas, myopia prevalence exceeds 80% [6]. In underdeveloped regions like Sherpa in Nepal, the prevalence of myopia is lower [7]. There are many factors that cause myopia; hereditary and environmental factors are the two main causes. There have been few studies that have employed a longitudinal approach to thoroughly investigate the development of myopia with careful observation, and these studies have offered valuable insights into the potential causes of myopia, or the number of factors involved in the occurrence of myopia.



Figure 1: Image formation in Myopia

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Table 1: Prevalence of Myopia						
Author	Country	Prevalence of Myopia (no of population).	Year of Publication			
Krishnaiah et al. [8]	India	34.6%, N-3642	2009			
Raju et al. [9]	India	31%, N-2508	2004			
Shah et al. [10]	Pakistan	36.5%, N-14490	2008			
Bourne et al. [11]	Bangladesh	23.8%, N-11189	2004			
Murthy et al. [12]	New Delhi, India	7.4%, N - 6447	2002			
Dandona et al. [13]	Andhra Pradesh, India.	4.1%, N - 4074	2002			
Pokharel et al. [14]	Mechi Zone, Nepal	1.2%, N - 5067	2000			
Sapkota et al. [15]	Kathmandu, Nepal	19%, N - 4282	2008			
Tarczy-Hornoch et al. [16]	USA	16.8%, N - 5396	2006			
Midelfart et al. [17]	Norway	35%, N - 3137	2002			
Logan et al. [18]	England	29.4%, N - 327	2011			
Ip et al. [19]	Australia	11.9%, N- 2353	2010			
Gopalakrishnan A et al. [20]	India	17.5%, N - 14342	2021			
Tongtong Liet al. [21]	China	54.71%, N - 864828	2023			
Hsu et al. [22]	Taiwan	36.4%, N- 11590	2016			

Factor Causing Myopia

Parental Myopia: Numerous studies have investigated the relationship between a parent's myopia and the likelihood that their child will also develop myopia [23,24,25], Children who have one myopic parent (OR = 1.87) or two myopic parents (OR = 2.40) are statistically significantly more likely to develop myopia, according to a new meta-analysis of 16 studies examining the relationship between parental myopia and juvenile myopia [26]. People with one or both myopic parents are at an increased risk of developing myopia themselves, as the condition tends to run in families (Table2). Research is still ongoing to determine which specific genetic variables affect myopia.

Table 2: Contribution of Genetics into Myopia						
Author	factor	No. of Patient (Prevalence %)	Year of Study			
Jeremy A Guggenheim.[27]	Genetics	315-63%	2006			
Robert Wojciechowskiet al. [28]	Genetics	759–61%	2011			
Framingham Offspring Eye Study Groupet al. [29]	Genetics	1585 -60%	1996			
Akbar Fotouhiet al. [30]	Genetics	4565-27.5%	2007			
K Zadnik et.al. [31]	Genetics	716–18%	1994			
Rafael Iribarrenet al. [32]	Genetics	157-57.9%	2005			

Environmental Factor: Environmental variables can have a crucial impact on the development and progression of myopia. Among these elements are:

- Lack of Outdoor Activity: Increased outdoor time has been demonstrated to be protective against the development of incident myopia [33]. According to animal studies, ultraviolet light may prevent axial elongation by stabilizing the sclera [34]. There were 51 articles in all, published between 2002 and 2015. They concluded that increased outdoor time has a protective effect against the onset but not the progression of myopia.
- Educational Pressure: Myopia is frequently linked to high levels of academic pressure, a lot of reading, and extended periods of near work, especially in younger students. Saw et al. found that among 210 Chinese children aged 8 to 9, myopic children do more near-work activities overall (2.7± 0.7 hrs/day) compared to non-myopes $(2.3 \pm 1 \text{ hrs/day})$ (p = 0.0027) [35]. Ten studies demonstrated that children aged 6 to 18 who engage in more near-work activities appear to have a higher prevalence of myopia [36]. Findings from five cross-sectional studies on the relationship between near-work

activities and myopia risk were inconclusive and did not provide consistent results [37].

- Screen Time: Using computers, cellphones, and tablets for extended periods of time can cause myopia, especially in young children and teenagers .The odds of myopia at age 9 were increased by the combined effect of near work, which included computer use, reading time, and reading distance [38]. For children ages 2 to 5, the American Academy of Pediatrics advises limiting screen time to one hour per day of high-quality content. For children ages 6 and older, the organization suggests consistent limits, but it does not specify any amounts [39].
- Dim Lighting: Reading or doing close-up work in poorly lit areas increases the risk of myopia and eve strain. There is evidence that myopic inhibition may be influenced by the spectral composition and chromaticity of ambient light. Since not all wavelengths are equally focused on the retina due to the eye's longitudinal chromatic aberration, the contrast of wavelengths focused away from the retina is diminished. The retinal image becomes chromatically blurry due to hyperopic defocus which lessens the contrast of long-wavelength

components more than other conditions. This phenomenon may serve as a guide for the axial elongation of the eye [40].

• Ethnic Group: Compared to many other ethnic groups, East Asians tend to have a higher prevalence of myopia. A study says that myopic progression was faster in Asian American children than in black, Hispanic, or Native American children, and that it was faster in girls of all racial and ethnic backgrounds at younger ages [41].

Author	factor	No. of Patient (Prevalence %)	Year of Study		
He et al. [42]	Environmental factor.	1903 - 30.4%	2015		
Jin et al. [43]	Environmental factor.	391 - 3.7%	2015		
Wu et al. [44].	Environmental factor.	571 - 8.41%	2013		
Ju-Xiang Jin et al. [45]	Environmental factor.	3051 - 3.70%	2015		

 Table 3: Contribution of Environment into Myopia

• Food Habit: Research on the connection between eating habits and myopia is still ongoing. Although there isn't a single food that can treat or prevent myopia, eating a balanced, healthy diet can improve eye health in general. According to some researchers, compared to vegetarians, non-vegetarians appear to have a lower prevalence of myopia (Table 4).

Table 4: Contribution of Food Habit into Myopia

Chunjie Yin et al. [46]	Food Habit (Non-vegetarian)	7423 - 22.5%	2023
Sood R.S. And Sood A. [47]	Food Habit (Non-vegetarian)	148 - 6%	2012
Sami Leeet al. [48]	Health Condition (Obesity)	1114 - 4.65%	2022
Siofra Christine Harringtonet al. [49]	Health Condition (Obesity)	1626 – 2.7 %	2019
Ju-Xiang Jin et al. [45]	Environmental factor.	3051 - 3.70%	2015

Discussion

In the past, some eye care specialists have held the opinion that myopia is an inherited abnormality, while others have held the opinion that environmental factors cause myopia. However, research done on humans and animals over the past 40 years indicates that both genetic and environmental factors play a role in the development of myopia [50]. Children who have one myopic parent (OR = 1.87) or two myopic parents (OR = 2.40) are statistically significantly more likely to develop myopia, according to a recent meta-analysis of 16 studies examining the relationship between parental myopia and juvenile myopia [51]. Ocular axial elongation has been associated with multiple genetic loci [52]. Research on the human population indicates that genetic factors contribute to at least 70% of the variation in refraction [53]. It is evident that having myopia in both parents raises the likelihood of developing myopia [54]. Spending more time outside has been demonstrated to be protective against the development of incident myopia [55]. When compared to control eyes, spending 76 minutes a day outside reduced the incidence of myopia by 50%, according to the study's dose-response analysis [56]. Myopia more common in urban areas as compared to rural area in India [57]. According to a recent meta-analysis review of 25 papers

examining the connection between myopia and outdoor time, spending more time outside protected against myopia but had no effect on the rate at which myopia developed in eyes that were already myopic. Some studies find a link between time spent on near tasks and the development of Myopia [58,59]. SAVES and X-PRES are two studies that did not find any link between the amount of time spent on near tasks and the development of myopia [60,61]. We need more surveys and studies to analyse the contributing factors to childhood myopia. More research is necessary to fully understand the intricate relationship that exists between a person's genetic makeup, behavioural patterns, and risk factors for myopic progression in patients. It was unclear if there is an interaction between these factors or if they operate independently. We need more research to determine which specific genetic variables affect myopia. We need to find out the possible processes that underlie the benefits of spending time outside to control myopia. We need more research to find out the connection between eating habits and myopia. Till now, more research has been done to control myopia progression, but we need to control the development of myopia and find the interaction between these factors, or whether they operate independently. These are all the requirements needed to control the development of myopia, its progression, and reduce its prevention until 2050.

Conclusion

Myopia is primarily caused by two factors: genetics and the environment (Reading and other prolonged, intense near work activities, like screen time, have been linked to a higher risk of myopia). Myopia more common in urban areas with restricted access to outdoor areas, especially in East and Southeast Asia, the incidence of myopia varies geographically; changes in lifestyle and urbanization have an impact on its prevalence. Till now, more research has been done to control myopia progression, but we need to control the development of myopia and find the interaction between these factors, or whether they operate independently.

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