

# **Risk factors for near sightedness during early life, childhood and adolescence**

### **ABSTRACT**

Nearsightedness is an important public health issue that affects people all around the world. Nearsightedness is becoming more common, posing a significant socioeconomic burden. High nearsightedness that worsens over time might result in sight-threatening ocular problems. As a result, it's critical to avoid early-onset nearsightedness from escalating to pathological high nearsightedness. Increased outside time, according to recent epidemiological studies, is a significant modifiable environmental component that prevents young children against nearsightedness. Outdoor light intensity, chromaticity during the day, and Vit. D levels may all play a role in this protective effect. This article summarises the possible protective relation between outdoor duration and nearsightedness. In light of new research, various environmental risk factors like nearwork activities, season of birth, smoking habits in parents and order of birth are also explored. This will allow for the implementation of preventative measures such as health education. Nearsightedness has grown significantly more widespread in recent decades across the world, with certain highly educated groups, like students of law and medical fraternity, having nearsightedness rates of up to 80%. An increase in the number of instances of high level of nearsightedness has been seen, which corresponds to the growth in nearsightedness. Myopia is said to be caused by multiple etiologies , High nearsightedness in early life is associated with high nearsightedness prevalence later in adulthood. Environmental variables such as greater scholastic pressure, more desk vocations, and urbanisation may be major drivers in current school nearsightedness trends, as seen by the rapid growth in nearsightedness prevalence observed in several parts of the world.

**Keywords:** vision of children; Nearsightedness; Nearsightedness and its risk factors.

### **INTRODUCTION**

Myopia, often known as nearsightedness, is a eye disorder in which the picture is focused before it reaches the retina. The image is not focussed and produced on the retina, therefore it seems blurry to the patient. For a human to visualise any item properly, an image should be focused clearly onto the inner part of the eye i.e. retina. Nearsightedness can be optically corrected with optimally powered glasses or lenses to assist a clear and focused image on the retina.<sup>[1]</sup>

Because nearsightedness is a major reason of vision loss in individuals all across the globe, it is one of the five immediate priorities for the World Health Organization's (WHO) "Vision 2020" campaign <sup>[2]</sup>. Nearsightedness has grown significantly more widespread in recent decades across the world, with certain highly educated groups, like students of law and

medical fraternity, having nearsightedness rates of up to 80% [3]. An increase in the number of instances of high level of nearsightedness has been seen, which corresponds to the growth in nearsightedness. High nearsightedness is a severe public health concern because it increases the risk of ocular diseases such as myopic retinal degeneration, glaucoma, cataract, visual impairment, blindness, and retinal detachment [4,5]. As a result, it's vital to discover associated risk and preventative variables in development and pathophysiology of nearsightedness. [6].

Myopia is said to be caused by multiple etiologies [7], High nearsightedness in early life is associated with high nearsightedness prevalence later in adulthood [8,9]. Environmental variables such as greater scholastic pressure, more desk vocations, and urbanisation may be major drivers in current school nearsightedness trends, as seen by the rapid growth in nearsightedness prevalence observed in several parts of the world. [7,10].

Near work includes activities like reading, studying (doing homework, writing), computer use/playing video games, and watching television, to name a few. Because of obvious increased visual demands of close activities like reading and susceptibility of nearsightedness to develop over the schooling age, the amount of time children spend on reading as well as performing other near tasks has already been thought to be a prima facie case of nearsightedness development. However, no consistent connection has been found between reading duration and nearsightedness [11,12,13]. As a result, the objective of this research is to investigate the relationship between nearsighted activities and nearsightedness by examining as well as synthesising all relevant and available studies. [6].

## **MATERIALS AND METHODS**

The risk factors and prevalence of nearsightedness in children were found in studies published till June 2021, according to Medline, PubMed and Google Scholar. Prevalence, incidence, nearsightedness, risk factors, refractive error, and visual impairment were implemented in numerous combinations ("prevalence" [All Feilds] OR "incidence" [All Feilds]) AND ( "risk factors" [All Fields] OR "nearsightedness" [MeSH Terms] OR "visual impairment" [All Fieilds] ). The researchers looked at all English-language articles as well as abstracts from non-English publications. As a prospective source of information, reference lists from pertinent publications were also explored, if they were necessary to make conclusions, other research (e.g., older than 5 years) were included in the discussion section. The study technique and data quality, particularly the definition of nearsightedness and risk factors, were scrutinised. There were no attempts to locate previously unpublished information.

We looked for studies that looked at any near-work activities with nearsightedness as an end measure, as well as studies that looked at nearsightedness incidence or progression. Studies involving individuals above the age of 18 have been excluded.

## **RESULTS AND DISCUSSIONS**

According to the National Eye Institute, the most common disease diagnosed in children between the ages of 6 to 14, i.e. when they are in school is Nearsightedness. Because eyes are still growing at this age, their shape may vary [14].

The majority of human nearsightedness develops during the time that children attend school in modern civilizations, but Nearsightedness is uncommon among youngsters who do not attend school <sup>[15]</sup>. This indicates that a school-aged child's nearsightedness develops as a function of their life experiences. Because even though completely abandoning school or education isn't a feasible option for avoiding potential nearsightedness, the part of the difficulty is to start figuring out the changes that occur in children's life when they commence school truly help contribute to nearsightedness. <sup>[16]</sup>.

If a person has been myopic since childhood, they are likely to stay myopic as adults. Another risk factor for nearsightedness is visual stress. This is the result of detailed labour, such as reading or using a computer, causing eye strain. Nearsightedness can also be passed down the generations. If one or both parents are nearsighted, the child's chances of being myopic are six times higher than normal <sup>[12]</sup>.

### **Key Points**

- Nearsightedness commencing school nearsightedness has mostly been seen in the industrialised nations, with just around 1% of the population affected by mostly hereditary types of the condition.
- Both within and between the populations, environmental risk factors have quite a considerable influence on the formation of "school nearsightedness."
- The formation of an increased incidence of nearsightedness is mostly due to changes in exposure to environmental risk factors within populations.
- Educational constraints, possibly best represented in terms of proximity to employment, and restricted time outdoors during daylight hours are the two primary environmental risk factors found.
- These risk factors strongly imply that interventions centred on reducing the quantity of nearsighted work and increasing amount of time spent outside in school hours are thought to be effective in combating the nearsightedness pandemic<sup>[17]</sup>.

### **Age**

An important predictor of nearsightedness is to have a less hyperopic refraction at an early age <sup>[18]</sup>. The largest risk factor for progression of nearsightedness is to have a refraction of -1.25 D at an early age. This group have a considerably greater endpoint amount of nearsightedness, but it also has a faster and more effective rate of development and axial length elongation. <sup>[19]</sup> although it often makes painfully obvious that a young patient with nearsightedness will also have a greater total amount of nearsightedness at stabilisation, the cause for the significantly higher rate is unknown. The average age of nearsightedness stability is 15.61 yrs, and the av. level of nearsightedness during stabilisation is 4.87 D, according to the COMET Group. It was also revealed that the total average amount of nearsightedness increased with each year of delayed stabilisation <sup>[20]</sup>.

### **Parental Nearsightedness**

According to research study, parental nearsightedness, even in one parent, has been commonly associated to a significantly larger frequency of juvenile nearsightedness. It has also been recently suggested that if both parents are myopic, the likelihood of juvenile-onset nearsightedness is six times higher <sup>[21]</sup>. In Australia, incidence nearsightedness in 6-yr-olds drastically raised from 7.8 percent with no parental nearsightedness to 21.4 percent and 22.0

percent with one or both parents having nearsightedness, respectively. Nearsightedness was known to be more common in European Caucasian offspring with myopic parents, also according to the study.<sup>[22]</sup>

Nearsightedness in parents is a risk factor for children to get progressive nearsightedness as well as having nearsightedness themselves. The COMET scientific research, which previously indicated that paternal nearsightedness was connected in some way to myopic advancement and axial length increases, supported this theory.<sup>[23]</sup>

## **Gender**

The research is inconsistent when it comes to determining sex tendency for nearsightedness. In the COMET study [25], there was no difference in males and females. Women exhibited a significant prevalence of nearsightedness than males in the 20–40yr old groups (39.9 percent and 32.6 percent, respectively, P.001), but this was not fairly constant throughout other age groups, according to the both National Health and Nutrition Examination Survey.<sup>[24]</sup>

According to COMET study's analysis, men repeatedly exhibited slower progressive rate of nearsightedness than women, confirming prior debate of a larger overall women incidence of nearsightedness at 20–39 yrs. It's intriguing that there had been nil difference in axial length elongation between men and women. Females had shorter axial lengths as compared to men, however this easily countered by women having steeper corneas<sup>[25]</sup>.

## **Environmental Factors**

Many studies conducted to investigate various environment related or non-genetic variables may influence the development of nearsightedness. The quantity of close work a kid undertakes during the day, like reading or using hand-held devices, has been found to have a poor or non-existent link<sup>[2]</sup>. One of the most prevalent and powerful associations is time spent outside. Spending time outside has been shown in several studies to have a detrimental or protective influence on nearsightedness [22]. Sherwin et al. conducted research and included all of the available research on the connection between outdoor time and nearsightedness in children under the age of 20 in a meta-analysis.<sup>[22]</sup> Their findings not only confirmed that spending more time outside lowers the risk of getting nearsightedness, but they also eventually discovered that each additional hour spent outside each week decreased slightly the risk of developing nearsightedness by 2%. As a result, the greater emphasis has changed away from proximity to work and toward the awareness and understanding that time spent outside may have a greater environmental impact. Children who spend more time outside have a decreased risk of acquiring or having nearsightedness. This provides a practical solution to this issue for nearsightedness prevention, as well as the myriad other advantages related to outdoor acts. Although many research & study has gone to the genetics & inheritance of refractive abnormalities, there is still much to learn<sup>[21]</sup>.

## **Ethnicity**

Ethnicity was previously thoroughly explored as risk factor in progression because of greater prevalence & yearly prevalence rates in Asian individuals<sup>[20]</sup>. According to the COMET Group study, African-Americans stabilised at younger age (thirteen yrs), with lower nearsightedness (4 Diopteres) at stabilisation. Asians took longest (16 years) for stabilise, whereas the Asians had highest nearsightedness (5.5 D) at final moment of stabilisation, according to the same study<sup>[21]</sup>

## Lighting at night

Length of the everyday light and dark phases may negatively affect axial length & refractive error progression. Epidemiological studies have had mixed outcomes. According to a survey of 479 children of 2-16 yrs, those who slept under light on at night showed a significantly greater risk of developing nearsightedness. Nearsightedness in parents was not considered, the children were selected from a limited cohort. Another research of 77 myopic LLB studying revealed that those exposed to 5.6 hrs or less of everyday darkness had increased incidence of nearsightedness development than those students who were exposed to >5.6 hrs of everyday darkness. This conclusion was not same in two group-based study of schoolchildren of the US and Singapore. We recommend birth cohort studies of precise refraction and biometry data, as well as extensive assessments of children's nightlight habits before the age of 2 yrs, be conducted <sup>[2]</sup>.

## Gene - environmental interaction

Prevalence of nearsightedness in specific groups such as the Chinese and the Japanese groups implies that genetics have a role, but abrupt shift of incidence rates over the previous gen also suggests that environment factors play a role too. Monozygotic twins had a higher concordance rate for nearsightedness than dizygotic twins, according to twin studies done in the United Kingdom and Taiwan. On the other hand, heritability is population-specific and varies based on the gene pool. The outcomes of Ashton S9's segregation analysis investigations in Hawaii may be multidimensional, according to his findings. High nearsightedness genetic loci have been discovered (1811.31, 12q 21- 23, 7q36), and genome-wide scans to hunt for nearsightedness gene anomalies are being conducted. More research, like as family based association studies and twin studies, might help us better understand how genes and environment interact <sup>[26]</sup>.

Six long-term studies have discovered a new relationship between near-work activities and nearsightedness progression. Although other research challenged this, still two longitudinal studies found that near-work activities were risk factors for the development of nearsightedness. Pärssinen et al observed that quicker progressive group (-2.9 0.6Diopteres) had a considerably short reading length (22 3.8cm) & more time spend on reading and close work (3.5 0.9hrs/d) than the slower progressive group (-0.5 0.3D) (24.1 4.3 cm, longer reading distance, 2.9 to 0.8 hrs/day spent on reading, respectively) <sup>[27]</sup>. Hepsen et al. studied 117 boys aged an average of 13 to find that 49 percent of those who spent an average of 6 hours per day reading and doing near-work activities developed nearsightedness over in just three years, compared to just 19 percent of the boys in the control group. However, Yi et al discovered, while the intervention group (near and middle vision activity 30 hours per week and outdoor activity >14-15 hours per week) had less myopic progression (0.38 0.15D/yr) than the control population (0.52 0.19D/yr), there was no significant difference in time spent on nearwork activities at the 2-yr mark. Following a two-year study of 153 6-12 yr old children, Saw et al found no sig association between cycloplegic subjective refraction changes and raw nearwork activities after adjusting for age, sex & parental history of nearsightedness. In 835 children aged 6-14 years old from the CLEERE study, Jones-Jordan et al discovered that the number of hours spent doing each near work activity per week, such as reading for pleasure, studying, using a computer, or watching TV, was not significantly associated with annual nearsightedness progression at the p 0.01 level. Scheiman et al. too utilised COMET (Correction of Myopia Evaluation Trial) data to show that for every

additional hr spent on neawork activities per week, the likelihood of having stable nearsightedness by 15 yr decreased by 2%<sup>[28-35]</sup>.

## **CONCLUSION**

Finally, the current study's total prevalence of nearsightedness was rather high, showing, nearsightedness is a public health concern among school-aged children. Women, rising age, nearsightedness in parents, spending less time outside, and spending more time inside were all revealed to be significant factors in nearsightedness. Spending more than 1 hour every day on electronic devices had the influence on nearsightedness risk greatest.

The pathophysiology of near sightedness is yet unknown. We may infer that nearsightedness is a complex disorder with several causes, including gene, environmental (external), and micro environmental variables.

Despite the fact that nearsightedness has hereditary part, with a variety of genes and putative locus associated to the condition, environmental variables including high education, extended close work, exposure to light & a lack of outdoor activities appear to have a substantial impact. Inflammation, as well as the production of particular proteins connected to alterations in collagen fibres, scleral thinning, and axial length elongation, have all been linked to nearsightedness in several studies.

We emphasise that the entire mechanism behind aberrant physiological changes in the formation and progression of nearsightedness would be better understood if the investigation was conducted at the cellular and molecular level, following a thorough review of the most current and relevant research. As a result, further investigation is needed.

A number of genes and possible loci have been discovered, and as we understand more about the causes of nearsightedness, we may be able to identify potential therapy targets to postpone or prevent the onset of nearsightedness and its effects.

## **REFERENCES:**

1. Mathew Recko, Erin Durrie Stahl. Childhood Nearsightedness : Epidemiology, Risk factors & Prevention. Missouri Medicine Journals. 2015; 112(2) : 116-121
2. Pararajasegaram R. VISION 2020- The right to sight: from strategies to action. Am J Ophthalmol. 1999; 128(3): 359-360
3. Lin LL, Shih YF, Lee YC, Hung PT, Hou PK. Changes in ocular refraction and its components among medical students- A 5-year longitudinal study. Optom Vis Sci. 1996; 73(7) : 495-8
4. Pruett RC. Review on Complications associated with posterior staphyloma. Curr Opin Ophthalmol. 1998; 9(3): 16-22
5. Saw SM. How blinding is pathological Nearsightedness ?. Br J Ophthalmol. 2006; 90(5): 525-526

6. Hsiu-Mei Huang, Dolly Shuo-Teh Chang, Pei-Chang Wu. The association between near work activities & nearsightedness in children- A systematic review & Meta Analysis. PLoS One. 2015; 10(10): e0140419
7. Morgan I, Rose K. Review on How genetic is school nearsightedness ?. Prog Retin Eye Res. 2005; 24(1): 1-38
8. Braun CI, Freidlin V, Superduto RD, Milton RC, Strahlman ER. The progression of nearsightedness in school age children: data from the Columbia Medical Plan. Ophthalmic Epidemiol. 1996; 3(1): 13-21
9. Liang CL, Yen E, Su JY, Liu C, Chang TY, Park N, Wu MJ, Lee S, Flynn JT, Juo SH. Impact of family history of high nearsightedness on level and onset of nearsightedness. Invest Ophthalmol Vis Sci. 2004; 45(10): 3446-52
10. Morgan IG, Rose KA. Nearsightedness and international educational performance. Ophthalmic Physiol Opt. 2013; 33(3): 329-338
11. Mutti DO, Itchell GL, Moeschberger ML, Jones LA, Zadnik K. Parental nearsightedness, near work, school achievement and children's refractive error. Invest Ophthalmol Vis Sci. 2002; 43(12): 3633-40
12. Ian G Morgan, Amanda N. French, Kathryn A. Rose. Risk factors for nearsightedness: Putting casual pathways into a social context. ISBN: 978-981-13-8490-5
13. Saw SM, Nieto FJ, Katz J, Schein OD, Levy B, Chew SJ. Factors related to the progression of nearsightedness in Singaporean children. Optom Vis Sci. 2000; 77(10): 549-554
14. Lu B, Congdon N, Liu X. Associations between near work, outdoor activities and nearsightedness among adolescent students in rural china. Arch Ophthalmol. 2009; 127(6): 769-775
15. Low W, Dirani M, Gazzard G, Chan YH, Zhou HJ, Selvaraj P. Family history, near work, outdoor activity and nearsightedness in singapore chinese preschool children. Br J Ophthalmol. 2010; 94(8): 1012-1016
16. Morgan IG, French AN, Ashby RS, et al. The epidemics of nearsightedness : etiology and prevention. Prog Retin Eye Res. 2018; 62: 134-149
17. Ian G Morgan, Pei-Chang Wu, Lisa A. IMI Risk factors for nearsightedness. Investigative Ophthalmology & Visual Sciences. 2021; 62,63
18. Zadnik K, Satariano WA, Mutti DO, Sholtz RI, Adams AJ. The effect of parental history of nearsightedness on children's eye size. JAMA. 1994; 271(17): 1323-7
19. Saw SM, Tong L, Chua WH. Incidence and progression of nearsightedness in Singaporean school children. Invest Ophthalmol. 2005; 46(1): 51-57

20. COMET Group. Nearsightedness stabilization and associated factors among participants in the correction of nearsightedness evaluation trial (COMET). *Invest Ophthalmol Vis Sci.* 2013; 54(13): 7871-84
21. French AN, Morgan IG, Mitchell P, Rose KA. Risk factors for incident nearsightedness in Australian school children. *Ophthalmology.* 2013; 120(10): 2100-8
22. Hyman L, Gwiazda J, Hussein M. Relationship of age, sex and ethnicity with nearsightedness evaluation trial. *Arch Ophthalmol.* 2005; 123(7): 977-87
23. Pacella R, McLellan J, Grice K. Role of genetic factors in the etiology of juvenile-onset nearsightedness based on a longitudinal study of refractive error. *Optom Vis Sci.* 1999; 76(6):381-6
24. Kurtz D, Hyman L, Gwiazda JE. Role of parental nearsightedness in the progression of nearsightedness and its interaction with treatment in COMET children. *Invest Ophthalmol Vis Sci.* 2007; 48(2): 562-70
25. Vitale S, Ellwein L, Cotch MF, Ferris FL. Prevalence of refractive error in US. *Arch Ophthalmol.* 2008; 126(8): 1111-9
26. Pacella R, McLellan J, Grice K. Role of genetic factors in the etiology of juvenile onset nearsightedness based on a longitudinal study of refractive error. *Optom Vis Sci.* 1999; 76(6): 381-6
27. Loman J, Quin GE, Kamoun L, Ying G S, Maguire M G, Hudesman D, Stone RA. Darkness and near work : nearsightedness and its progression in third-year law students. *Ophthalmology.* 2002; 109(5) : 1032-8
28. Pärssinen O, Lyyra AL. Nearsightedness and myopic progression among school children : a three-year follow-up study. *Invest Ophthalmol Vis Sci.* 1993 August 1; 34(9):2794-802. PMID:8344801
29. Scheiman M, Zhang Q , Gwiazda J , Hyman L , Harb E , Weissberg E, et al. Visual activity and its association with nearsightedness stabilisation. *Ophthalmic Physiol Opt.* 2014; 34(3):353-61. doi:10.1111/opo.12111 PMID:24345071
30. Chen CJ, Cohen B, Diamond E. Genetic and environmental effects on the development of nearsightedness in Chinese twin studies. *Ophthalmol Pediatr Genet* 1985; 6: 113-119
31. Prasad, Madhumita, Sachin Daigavane, and Vishal Kalode. "Visual Outcome after Cataract Surgery in Rural Hospital of Wardha District: A Prospective Study." *JOURNAL OF CLINICAL AND DIAGNOSTIC RESEARCH* 14, no. 2 (February 2020). <https://doi.org/10.7860/JCDR/2020/42643.13528>.
32. Thool A, Walavalkar R. Visual Dysfunction as the First Presentation of Oligodendroglioma - A Case Report. *JOURNAL OF EVOLUTION OF MEDICAL AND DENTAL SCIENCES-JEMDS.* 2021 Jan 11;10(2):114-7.

33. Choudhari SG, Gaidhane AM, Desai P, Srivastava T, Mishra V, Zahiruddin SQ. Applying visual mapping techniques to promote learning in community-based medical education activities. *BMC MEDICAL EDUCATION*. 2021 Apr 13;21(1).
34. Abbafati, Cristiana, Kaja M. Abbas, Mohammad Abbasi, Mitra Abbasifard, Mohsen Abbasi-Kangevari, Hedayat Abbastabar, Foad Abd-Allah, et al. "Five Insights from the Global Burden of Disease Study 2019." *LANCET* 396, no. 10258 (October 17, 2020): 1135–59.
35. Abbafati, Cristiana, Kaja M. Abbas, Mohammad Abbasi, Mitra Abbasifard, Mohsen Abbasi-Kangevari, Hedayat Abbastabar, Foad Abd-Allah, et al. "Global Burden of 369 Diseases and Injuries in 204 Countries and Territories, 1990-2019: A Systematic Analysis for the Global Burden of Disease Study 2019." *LANCET* 396, no. 10258 (October 17, 2020): 1204–22.

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