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Dietary intake and its association with myopia in children in Goa

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ABSTRACT

Background: Myopia is a multifactorial condition. Myopia is largely influenced by hereditary and environmental variables. Vitamins D, E, and C, omega-3 fatty acids, and antioxidants have been noted as essential for preserving healthy eye function and possibly reducing the development of myopia.
Aim: This study was conducted to compare dietary consumption between myopes and emmetropes.
Materials and Methods: A cross-sectional study was conducted in the outpatient department of ophthalmology in the state of Goa, India. Children aged between 7 and 15 years were included. Children with visual acuity of less than 0.1 logMAR later underwent objective evaluation using retinoscopy and subjective refraction. The spherical equivalent (SE), and myopia were defined as SE 0.5 D in at least one eye. Children with logMAR visual acuity of 0.1 in both eyes, no glasses, or an ophthalmic history were classified as emmetropic (SE< 0.50D). A daily intake interview was taken using a 24-hour dietary recall, and a detailed interview of the subject's food consumption was taken.
Result: A total of 60 children who visited the outpatient department of ophthalmology were included in the analysis. The sample consisted of 31 emmetropes and 29 myopes The mean age of the sample was 10 ± 2.29 years. Almost half the population was male (32 children [53.33%]). The mean refractive error in myopic children was -2.02 ± 1.449 D. The mean axial length in emmetrope children was 22.84 ± 0.972 mm, and in myopic children it was 23.81 ± 0.91mm (P = 0.629). Emmetropes showed higher dietary nutritional consumption than myopes in all dietary components, but the results were not statistically significant.
Conclusion: In our study, we could not link Diet and myopia statistically. Although there is a clear indication that emmetropes demonstrated better dietary consumption compared to myopes.

1. Introduction

Myopia has caused public health and economic problems, especially in East Asian countries,[1] where the prevalence has increased by 80–90% myopia and 20% high myopia.[2] In India, the prevalence varies from urban to rural. A study conducted in New Delhi reported a prevalence of 7.4%,[3] whereas a study conducted in 1 urban and 2 rural cohorts reported a 3.2% prevalence in subjects below the age of 15.[4] The prevalence of myopia has increased from 4.44% in 1999 to 21.15% in 2019 in India, which is postulated to rise to 49% by 2050.

The etiology of myopia is complex. Many environmental and genetic factors are currently being studied to isolate the causative factors. The development and progression of myopia are likely to be influenced by a combination of these factors. Gardiner, in 1956, proposed a link between diet and myopia. In this study, it was found that stationary myopes consumed more proteins and less fat and carbohydrates compared to active myopes.[5] He was also able to curb the growth of axial length in active myopes by increasing their dietary protein intake.[6]

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A study done in 2002 on healthy Singapore Chinese schoolchildren showed a higher saturated fat and cholesterol intake may be associated with axial globe elongation.[7] A possible theory linking insulin resistance, chronic hyperinsulinemia, increased circulating insulin-like growth factor (IGF-1), decreased circulating growth hormone, and decreased retinoid receptor signaling to increases in scleral growth suggests that dietary changes may have contributed to the rise in the prevalence of myopia.[8] This theory has gained little support, with no consistent results across different subject groups.

Another study was conducted with 24 myopics between the age of 7 to 10 years and emmetropes aged 10 years. The comparison showed no evidence of undernourishment in myopes but there was a statistically significant difference in energy intake, protein, fat, vitamins B1, B2, and C, phosphorus, iron, and cholesterol.[9]

Despite many types of research being conducted to understand the effect of multiple risk factors on the development and progression of myopia, there is no research to understand diet and its association with myopia in the Indian population. The swift intergenerational increase in the frequency of myopia has been attributed in part to dietary changes in countries experiencing rapid economic transitions.[10] This trend may be partially explained by the rising prevalence of sedentary lifestyles and obesogenic diets. It is common knowledge that abdominal obesity is linked to Insulin resistance, mild inflammation, and changes in the vascular wall.[10] We aimed to determine whether variations in dietary intake are associated with measures of myopia in a cohort of healthy children.

2. Materials and Methods

The study was approved by the institutional ethics committee which adhered to the tenets of the Declaration of Helsinki. A cross-sectional study was conducted in the Outpatient department of ophthalmology in Goa, India. Children aged between 7 to 15 years were included in this study. Children with prior history of any other ocular manifestations, systemic disorder, and myopia due to secondary reasons were excluded from the study. Written consent was obtained from the guardian.

A two-step approach was followed to identify myopia. The first step included an ophthalmological examination consisting of visual acuity according to logMAR using an ETDRS chart. Children with visual acuity of less than 0.1 logMAR later underwent objective evaluation using retinoscopy and subjective refraction. The second step involved instilling two drops (three in case of dark irises), with a 5 min time interval, of cyclopentolate (1%) for complete cycloplegic refraction, and the pupil diameter at the time of the measurement will be constant ≥6 mm. Spherical equivalent (SE) was calculated as sphere + $\frac{1}{2}$ cylinder, and myopia was defined as SE ≤−0.5 D in at least one eye. Children with logMAR visual acuity ≤0.1 in both eyes, no glasses, or ophthalmic history were classified as emmetropic (SE< 0.50D). A daily intake interview was taken using 24-hour dietary recall and a detailed interview of the subject's food consumption was taken. This daily interview compresses of meals of the subject from breakfast till the end of the day. It includes ingredients used in a meal and their amount. From this, we could calculate the energy, carbohydrate, protein, fat, calcium, and vitamin A per day of the subject using Indian food composition tables developed by the National Institute of Nutrition.[11] The following formula was used to calculate the nutritional level from the 24-hour dietary recall questionnaire.

Energy = Amount in KJ x Original amount eaten (grams)/4.18 x 100

Carbohydrates, proteins, Fats, Calcium, and Vitamin A were calculated using the below formula

= Amount of nutrition x Original amount eaten (grams)/100

All data were then stored in an Excel sheet and SPSS version 14 was used to perform statistical analysis. An Independent T-test was performed to compare values between groups and a Chi-square test was performed to understand the association between parameters.

3. Results

A total of 60 children who visited the outpatient department of ophthalmology were included in the analysis. The sample consisted of 31 emmetrope and 29 myopes The mean age of the sample was 10 ± 2.29 years. Almost half the population was males (32 children [53.33%]). The mean refractive error in myopic children was -2.02 ± 1.449 D. The mean axial length in emmetrope children was 22.84 ± 0.972 mm and in myopic children was 23.81 ± 0.91mm (P=0.629).

Table 1 describes the mean daily intakes of the various nutrients, segregated by type refractive errors. There was no statistically significant difference seen between myopes and emmetropes. (Figure 1)

Emmetropes showed higher dietary nutritional consumption than compared myopes in all dietary components but the results were not statistically significant.

4. Discussion

Due to its capacity for modification, diet is a significant environmental element that has been researched concerning numerous ocular illnesses, such as age-related macular degeneration and cataracts.[12–15] Dietary intake is a complex and highly changeable environmental exposure, and as a result, the method employed to gather dietary data affects the quality of that data.

There have been varied reports recorded over the period. Several studies have suggested that diet may be an important

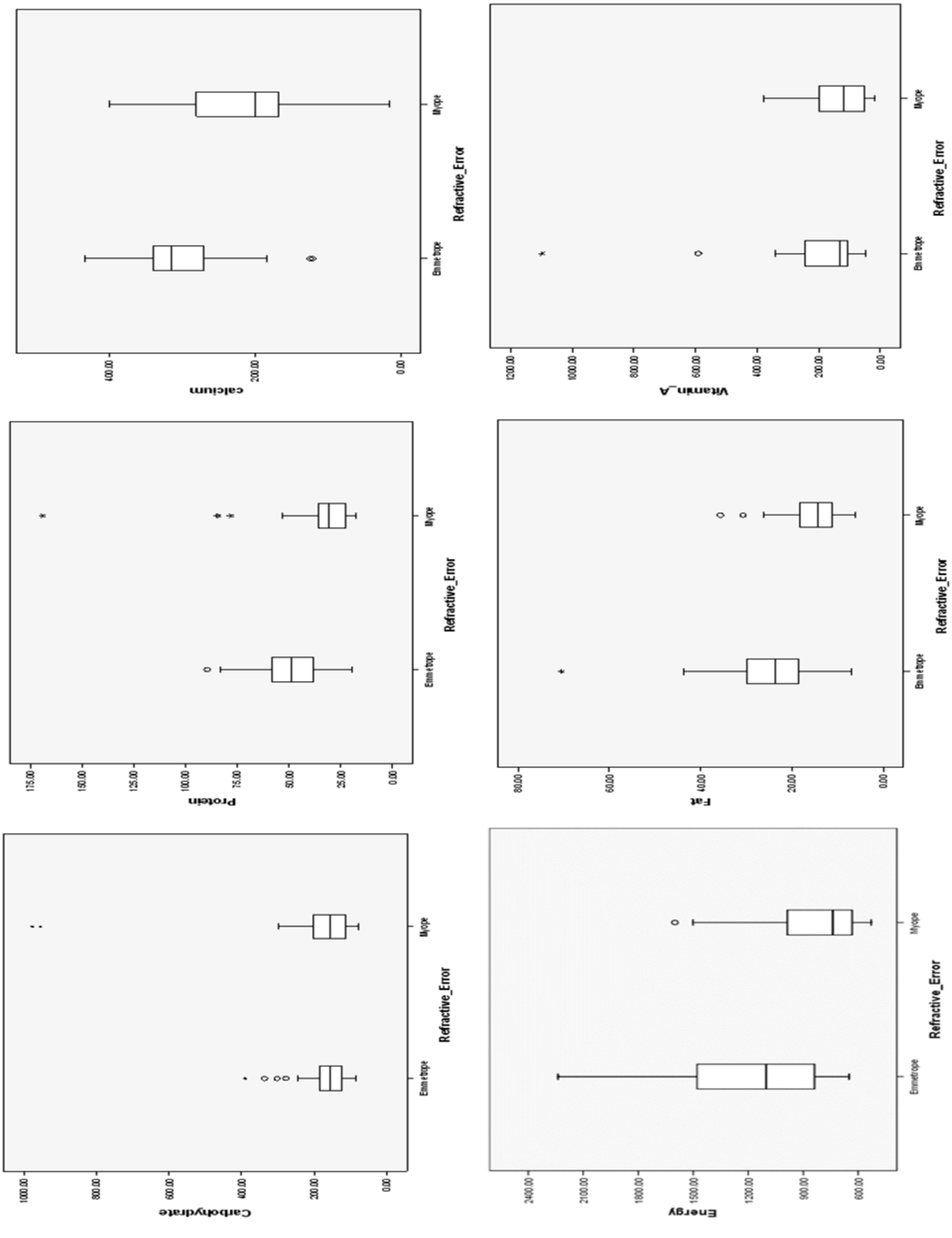

Figure 1: Demonstrates the mean daily intakes of the various nutrient’s comparison between myopes and emmetropes

Table 1: The table demonstrates the mean daily intake of various nutrients, segregated by type refractive error and gender. There were slightly high nutritional component levels seen inemmetropes compared to myopes across both genders

S. No.	Parameter	Myopes		Emmetropes		p-value
		Males	Females	Males	Females	
1	n (%)	16 (55.17%)	13(44.82%)	16(51.61%)	15(43.38%)	
2	Age (Years)	9.892± 2.199	9.9 ± 2.17	10.107 ± 2.528	10.071± 2.522	
3	Spherical equivalent (D)	1.96 ± 1.403	2.01 ± 1.47 D	0.25±00	0.12± 0.12	
4	Axial Length (mm)	23.804 ± 0.926	23.823±0.922	22.815± 0.928	22.834±0.962	0.807
5	BMI	14.68 ± 2.088	14.772±2.171	14.421±3.046	14.755±2.949	0.022
6	Energy (Kcal)	852.677±285.193	841.801±286.705	1205.044±419.855	1139.946±397.754	0.049
7	Carbohydrate (g)	215.277±218.286	212.132±219.127	176.982±72.558	165.176±63.660	0.078
8	Protein (g)	40.239±31.230	39.820±31.428	50.330±17.912	48.066±17.263	0.318
9	Fat (g)	16.109±7.401	16.004±7.466	25.822±12.452	25.008±12.607	0.077
10	Calcium (mg)	215.234±87.841	217.325±88.419	308.826±74.759	300.804±78.130	0.439
11	Vitamin A (mg)	138.599±104.318	138.714±104.536	197.232± 204.017	208.609± 220.620	0.15

environmental factor in the development of myopia. One of the most consistent findings is that a high intake of carbohydrates, particularly refined carbohydrates, may increase the risk of myopia.[16–19] A study published in the American Journal of Clinical Nutrition in 2013 found that children who consumed a diet high in refined carbohydrates had a higher risk of developing myopia than those who consumed a diet high in protein and fat.[16] In contrast, a study conducted in Singapore found no significant association between carbohydrate intake and myopia.[20] In our study, we recorded an increase in carbohydrate consumption in myopes compared to emmetropes. But this difference was not statistically significant. According to the initial 2002 hypothesis, consuming refined carbohydrates could contribute to juvenile-onset myopia. This was because the interaction between hyperinsulinism and hormones that control eye growth could lengthen the axial eyeball.[8] The effect of carbohydrates cannot be studied independently without considering the effect of the near-work hypothesis for juvenile-onset myopia.

Collagen, elastin, and crystallins are a few of the proteins that make up the eye and help with the structure and optical qualities of the eye. Particularly, a large proportion of proteins are found in the eye's lens. Refractive errors and abnormal eye growth have been linked to low protein consumption during early development.[21] In a study published by Gardiner, he reported that active or progressive myopes had lower protein intake compared to stationary myopes, emmetropes, and hyperopes.[5,6] On the contrary, a study conducted by Edwards et al., demonstrated that there was no deficiency of protein seen across the refractive error group.[9] Similar results were seen in our study, there was a higher protein intake in emmetropes compared to myopes, but the difference was not statistically significant.

In a study conducted on animal models, the therapeutic effect of dietary supplements of omega-3 polyunsaturated fatty acids (ω-3 PUFAs) on myopia progression was studied. There was a decrease in the choroidal blood perfusion (ChBP) reduction-scleral hypoxia cascade caused by near work, a risk factor for myopia.[22] Dietary unsaturated fats are said to have protective behavior against the progression of induced myopia in animal models. In human studies, there have been no significant differences between refractive error groups.[9] Similar results were seen in our study, emmetropes had fatter intake compared to myopes. The type of dietary fat may also play a role in myopia's development. Omega-3 fatty acids, found in fatty fish and some plant sources, have anti-inflammatory properties and may protect against myopia progression. Fish was a major component of the children's diet in Goa.

Various animal studies have associated vitamin A with eye elongation. Dysregulation of dopamine, a neurotransmitter, and retinoic acid, which are both regulated by vitamin A, can cause an increase in eye elongation.[23–25] In a study conducted on human adults, there was no association between vitamin A and myopia. Furthermore, they suggested a possible link associating optimal vitamin A intake with axial length elongation.[25] In our study, we noted that vitamin A consumption was higher in emmetropes compared to myopes.

This study did not involve an invasive procedure to measure nutritional levels in children, making it easier to adapt in practice. With no cost involved in testing, it makes it economical to get a basic understanding of a child's diet. Serum measurements of any nutrition components that were not available from our data. The sample size is small, convenient, and associated with a small geographical area. The data was solely obtained from the 24-hour dietary recall, which provided a retrospective assumption of an individual's dietary intake. This data can be affected by recall bias.

5. Conclusion

In our study, we could not link Diet and myopia statistically. Although there is a clear indication that emmetropes demonstrated better dietary consumption compared to myopes suggesting that there may exist a role of diet in myopia progression. More research needs to be done with an increased sample size.

6. Source of Funding

None.

7. Conflict of Interest

None.

8. Acknowledgement

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References

1. Vitale S, Cotch MF, Sperduto RD. Prevalence of visual impairment in the United States. *JAMA*. 2006;295(18):2158–63.
2. Liang YB, Wong TY, Sun LP, Tao QS, Wang JJ, Yang X, et al. Refractive errors in a rural Chinese adult population the Handan eye study. *Ophthalmology*. 2009;116(11):2119–27.
3. Murthy GV, Gupta SK, Ellwein LB, Muñoz SR, Pokharel GP, Sanga L, et al. Refractive error in children in an urban population in New Delhi. *Invest Ophthalmol Vis Sci*. 2002;43(3):623–31.
4. Dandona R, Dandona L, Srinivas M, Giridhar P, Mccarty CA, Rao GN. Population-based assessment of refractive error in India: the Andhra Pradesh eye disease study. *Clin Exp Ophthalmol*. 2002;30(2):84–93.
5. Gardiner PA. The diet of growing myopes. *Trans Ophthalmol Soc U K*. 1956;76:171–80.
6. Gardiner PA. Protein and myopia. *Proc Nutr Soc*. 1960;19(1):96–100.
7. Lim LS, Gazzard G, Low YL, Choo R, Tan DT, Tong L, et al. Dietary factors, myopia, and axial dimensions in children. *Ophthalmology*. 2010;117(5):993–997.
8. Cordain L, Eaton SB, Miller JB, Lindeberg S, Jensen C. An evolutionary analysis of the aetiology and pathogenesis of juvenile-onset myopia. *Acta Ophthalmol Scand*. 2002;80(2):125–35.
9. Edwards MH. Do variations in normal nutrition play a role in the development of myopia? *Optom Vis Sci*. 1996;73(10):638–43.
10. Galvis V, López-Jaramillo P, Tello A, Castellanos-Castellanos YA, Camacho PA, Cohen DD, et al. Is myopia another clinical manifestation of insulin resistance? . *Med Hypotheses*. 2016;90:32–40.
11. Longvah T, Ananthan R, Bhaskarachary K, Venkaiah K. Indian Food Composition Tables. Telangana: National Institute of Nutrition; 2017. Available from: https://rb.gy/mg2kur.
12. Chiu CJ, Hubbard LD, Armstrong J, Rogers G, Jacques PF, Chylack LT, et al. Dietary glycemic index and carbohydrate in relation to early age-related macular degeneration. *Am J Clin Nutr*. 2006;83(4):880–6.
13. Chiu CJ, Milton RC, Klein R, Gensler G, Taylor A. Dietary carbohydrate and the progression of age-related macular degeneration: a prospective study from the Age-Related Eye Disease Study. *Am J Clin Nutr*. 2007;86(4):1210–8.
14. Chiu CJ, Taylor A. Nutritional antioxidants and age-related cataract and maculopathy. *Exp Eye Res*. 2007;84(2):229–45.
15. Maurya RP, Gupta S, Gautam S. Effect of diet on eye diseases and visual impairement. *Indian J Clin Exp Ophthalmol*. 2023;9(3):282–6.
16. Zeng Y, Ke X, Wu J. Association between dietary patterns and the risk of myopia in Chinese children: a case-control study. *Am J Clin Nutr*. 2013;98(3):1012–7.
17. Sasaki E, Momose H, Hiradate Y, Furuhata K, Takai M, Asanuma H, et al. Modeling for influenza vaccines and adjuvants profile for safety prediction system using gene expression profiling and statistical tools. *PLoS One*. 2018;13(2):e0191896.
18. Gao Z, Meng N, Muecke J, Chan WO, Piseth H, Kong A, et al. Refractive error in school children in an urban and rural setting in Cambodia. *Ophthalmic Epidemiol*. 2012;19(1):16–22.
19. Liang CL, Yen E, Su JY, Liu C, Chang TY, Park N, et al. Impact of family history of high myopia on level and onset of myopia. *Invest Ophthalmol Vis Sci*. 2004;45(10):3446–52.
20. Li M, Tan CS, Foo LL, Sugianto R, Toh JY, Sun CH, et al. Dietary intake and associations with myopia in Singapore children. *Ophthalmic Physiol Opt*. 2022;42(2):319–26.
21. Graw J. Genetics of crystallins: cataract and beyond. *Exp Eye Res*. 2009;88(2):173–89.
22. Pan M, Zhao F, Xie B, Wu H, Zhang S, Ye C, et al. Dietary ω-3 polyunsaturated fatty acids are protective for myopia. *Proc Natl Acad Sci U S A*. 2021;118(43):e2104689118.
23. Witkovsky P. Dopamine and retinal function. *Doc Ophthalmol*. 2004;108(1):17–40.
24. Bitzer M, Feldkaemper M, Schaeffel F. Visually induced changes in components of the retinoic acid system in fundal layers of the chick. *Exp Eye Res*. 2000;70(1):97–106.
25. Ng FJ, Mackey DA, O'Sullivan TA, Oddy WH, Yazar S. Is Dietary Vitamin A Associated with Myopia from Adolescence to Young Adulthood? *Transl Vis Sci Technol*. 2020;9(6):29.

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