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Computer use and onset of myopia in children: a systematic review

Gianpaolo Smaldone[1], Orazio Campagna[1], Fernanda Pacella[1], Elena Pacella[1], Giuseppe La Torre[2]

[1] Department of Sense Organs, Sapienza University of Rome, Viale del Policlinico Clinica Oculistica, 00161 Rome Italy
[2] Department of Public Health and Infectious Diseases, Sapienza University of Rome, P.le A. Moro, 5 - 00185 Rome, Italy

***Corresponding author** Ph Elena Pacella, Department of Sense Organs, Sapienza University of Rome. Viale del Policlinico Clinica Oculistica, 00161 Rome, Italy; e-mail: elena.pacella@uniroma1.it

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Abstract

Background: *The aim of this study is to systematically review the scientific literature about the relationship between computer use and onset of myopia in children.*
Methods: *The search was conducted using Medline and Scopus databases. For each database, we used the following query: "Children AND Myopia AND Computer". 15 observational studies were considered suitable: 11 cross-sectional studies, 3 cohort studies and one longitudinal study.*
Results: *There is no significant evidence in scientific literature about the association between computer use and juvenile myopia.*
Conclusions: *More comprehensive and multicenter studies would be opportune, given the importance of computer use as a risk factor in the development of juvenile myopia.*

Keywords: *myopia; computer; children.*

Introduction

Myopia is the most common eye disorder among the population, it has several etiopathogenic moments.

The clinical classification separates it in simple myopia known as phisiological or benign myopia and degenerative myopia known as pathological or high or malignant because of the presence of scleral-choroidal-retinal degenerative phenomena [1-2].

Generally, within the population there are more patients affected by physiological myopia: about 66% have less than 2D and up to the 95% have less than 6D.

More research needs to be done to determine the risk factors of myopia. [3-4]

Several studies worldwide have shown that the prevalence of myopia considerably varies from one geographic area to another and that it has increased over the past decades [5].

As increases in the prevalence of myopia have coincided with increased accessibility to technology, the impact of computer and television use has also been extensively investigated [6-7-8-9-10].

In light of this introduction, we decided to conduct a systematic review of the literature in order to evaluate the association between the use of computer and the development of juvenile myopia.

Material and Methods

Identification of Relevant Studies

The scientific literature review was based on Electronic medical databases. The search was performed on Medline and Scopus databases. For each database, we used the following query: “Children AND Myopia AND Computer”. Articles were retrieved from the medical area of PubMed and Scopus. Moreover, all potentially relevant studies found in the references of the selected articles were included. Data Extraction and Quality Assessment The selection of articles, performed according to the PRISMA statement [11], is shown in the flowchart (Figure 1). The duplicate papers coming from PubMed and Scopus consultation were removed. The inclusion criteria were as follows: (I)observational studies; (II)English language; (III)availability of full text; (IV)data concerning the association between computer use and juvenile myopia. The full texts of included publications were analyzed by two different researchers independently. Statistical analysis for the meta-analysis. Episheet meta-analysis package was used, random effects model, heterogeneity test p <0.001.

Results

Identification of Relevant Studies: a total of 227 studies was found through PubMed (67) and Scopus (160) databases. Out of these, 180 articles were excluded because there were duplicates of Medline and Scopus outcomes, whereas 32 were excluded because they did not fit the inclusion criteria. Finally, 15 observational studies were considered suitable, eleven cross sectional studies [7, 8, 12, 13, 14, 15, 16, 17, 18, 19, 20], one longitudinal study [21]and three cohort studies [22, 23, 24]. The flow-chart of the studies is described in Figure 1.

Cross-sectional studies:

Mutti et al. conducted a cross-sectional study to evaluate the risk factors involved in the onset of juvenile myopia in Ohio (USA). They considered hereditary and environmental factors focusing in particular on indoor and outdoor activities. Out of 366 enrolled patients, whose mean age was 13.7, 67 of them (18.3%) were myopic. The average of weekly hours spent at the computer in myopic subjects was 2.7 ± 4.1, while in emmetropic and hyperopic subjects was 2.2 ± 3.2 and 1.4 ± 1.8 respectively. In conclusion they found no association between computer use and myopia [13].

Lisa A. JJ et al. conducted a multicentric cross-sectional study in Ohio (USA), based on the study carried out by Mutti in 2002. The 1329 enrolled patients were divided into 2 groups: 731 myopes and 587 emmetropes. It was pointed out that in myopic patients the number of hours spent at the computer increased with age: from 0.8 hours per week at the onset of myopia to 1.9 hours per week after 5 years of follow-up. In the emmetropes group the increase of hours spent at the computer was less consistent: from 2.9 hours per week at the age of six to 3.0 hours per week at the age of 14. No evidence of computer use influence on the development of myopia was pointed out [7].

Kathryn A.Rose et al. analyzed 752 6- and 7-year-old patients of Chinese ethnicity in a cross-sectional study. 124 of these were from Australia (Australian Chinese cohort) and 628 from Singapore (Singapore Chinese cohort). As a result there were 4 myopic patients among the Australians and 183 myopic patients from Singapore. The number of hours spent at the computer is considered for the entire population enrolled, with no distinction between myopic and non-myopic patients. In particular, in the Australian Chinese cohort the value found was 4.65 h/we; while in the Singaporean Chinese cohort the result was 3.55 h/we. No evidence of computer use influence on the development of myopia was pointed out [14].

Penpimoll Yingyong et al. carried out a cross-sectional study in Thailand, analyzing 377 children aged between 6 and 12. They divided the sample into: myopic, emmetropic and hyperopic children. No significant differences concerning the hours spent at the computer were found in the three considered groups. Specifically, the myopic children spent 2.8 ± 4.0 h/w, the emmetropic ones 2.0 ± 3.3 h/w, while the hyperopic ones spent 1.3 ± 1.7 hours per week at the computer [15].

Bei Lu et al., in a 2009 cross sectional study, evaluated the association between near-work, outdoor activities and myopia over a population of 1892 Chinese children aged between 10 and 19. They found that myopic children spent about 6.2 h/week at the computer while non-myopic spent 7.6 h/week. In conclusion, they found no correlation between computer use and onset of myopia [8].

In 2006 Khader YS et al. analyzed, in a cross-sectional study, a population of 1777 children aged between 12 and 17, in Jordan. 313 of these were myopic and 1464 non-myopic. They found that the myopic ones spent 0.95 hours per day at the computer, while the non-myopic ones spent 0.69 hours per day. Furthermore, the association between computer use and development of myopia resulted also from the odds ratio value: 1,16 (CI 1,06-1,26). From the study, it emerged that myopic children spend more hours in close-up activities and in computer use than non-myopic ones; for what concerns outdoor activities, non-myopic children spend more hours than their myopic peers[16].

In the 2001 cross-sectional study by Saw S.M. et al., 128 Singaporean children aged between 3 and 7 were examined. 11 of these were myopic and 117 non-myopic. The authors evaluated the number of weekly hours spent at the computer and in close-up activities. In both groups, the number of daily hours spent at the computer was 0.2. No significant differences were found between the two groups [17].

Saw SM. et al. carried out a new cross-sectional study in 2002, involving 1005 Singaporean children aged between 7 and 9. 325 of these were myopic; more specifically there were 81 higher myopes and 244 lower myopes within this last group. As for computer use, the results of this study showed that in the first group the 10% used the computer, while in the second group the percentage was 24.4%. No data about the time spent at the computer are reported. In conclusion, children who regularly used the computer (P=0.05) and children who had at least one myopic parent (P=0.01) had an earlier onset of myopia [12].

In 2014 Sawunet S.A. et al. analyzed in a cross-sectional study, a population of 432 Ethiopian children aged between 7 and 15. 23 of these (5.47%) were myopic. The study shows a close relation between ametropia and computer use without specifying the number of hours spent at the computer. The adjusted odds ratio value is actually 4.539 (CI 1.589-12.968) [18].

Paudel P. et al., in 2014, carried out a cross-sectional study in Vietnam involving 2238 children aged between 12 and 15; 456 of these were myopic. They showed that myopic children spent 4.9 h/week at

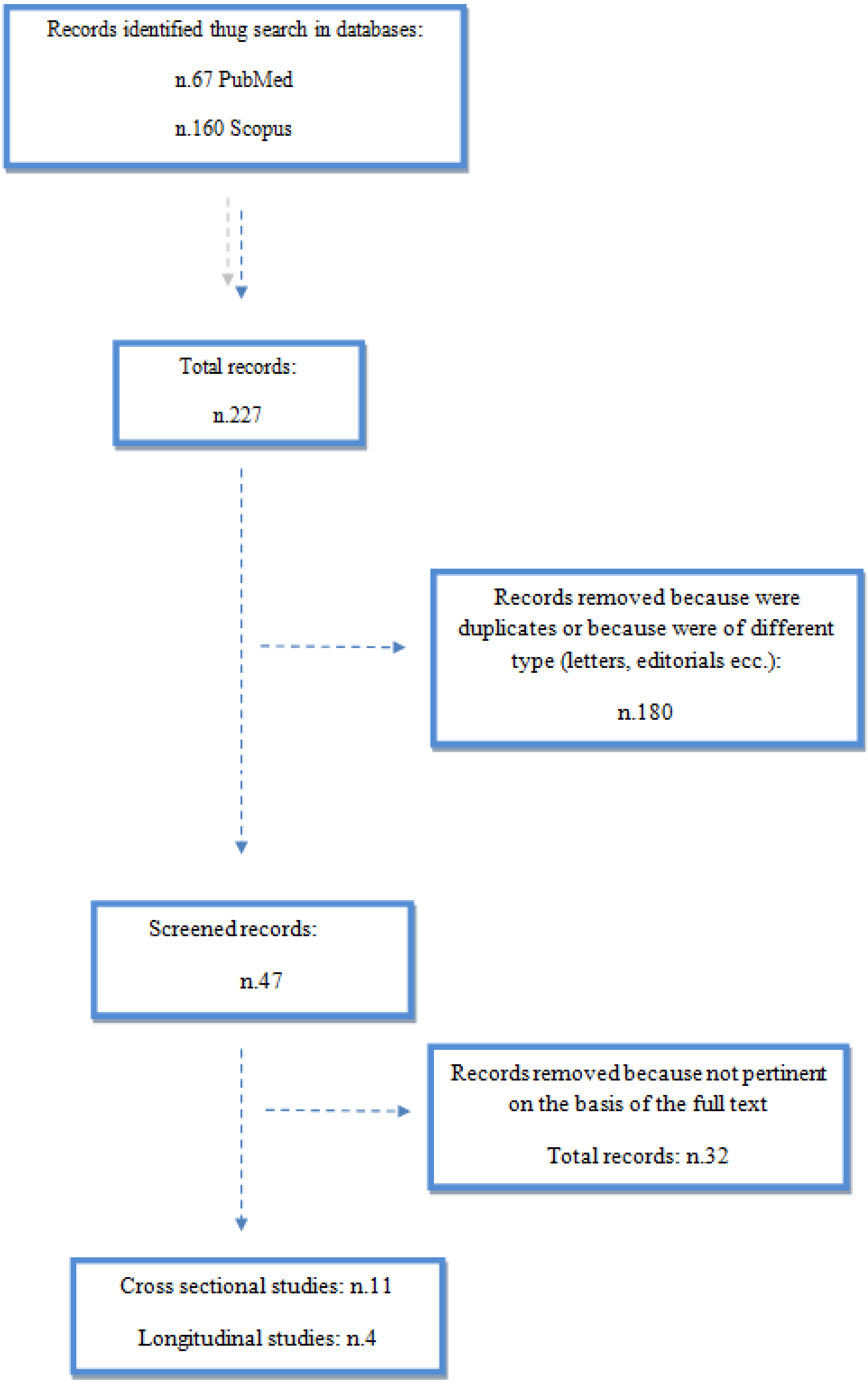

Figure 1. Flow chart of the selection of the studies of the systematic review.

the computer compared to non-myopic ones who, on the contrary, spent 4.3 h/week. The odds ratio was 1.02 (CI 1.00-1.04) [19].

Qi Sheng You et al., in 2012, conducted a cross-sectional study over a population of 15066 Chinese children aged between 7 and 18. 8588 of these were myopic (57%). No data about hours spent at the computer were reported; what can be extrapolated is just the odds ratio concerning the TV watching risk factor (or computer use), which was 0.93 (CI 0.90-0.96) [20].

Longitudinal studies

Li Deng et al. in 2010 conducted a longitudinal study in Massachusetts (USA) over a sample of 147 children aged between 6 and 18; 33 of these were myopic. Myopic children spent 6.00 h/week at the computer compared to 4.96 h/week of non-myopic. In conclusion, they found no correlation between computer use and onset of myopia [21].

Czepita et al. conducted a cohort study over a population of 5865 Polish children aged on average 11.9. The myopic ones were 730 (12.44%). 392 myopic subjects (54%) spent less than 0.8 hours per day at the computer, while 338 (46%) spent more than 0.8 hours per day. The obtained results indicate that working at a computer might be associated with the occurrence of myopia among schoolchildren [22].

Amanda N. French et al. in 2013, in Australia, conducted a cohort study over a population of 1739 children, dividing them into two cohorts: 788 younger (6 years) and 951 older (12 years). The myopic patients were 115 in the first group and 205 in the second one. The hours spent for indoor activities increased with age: in the younger cohort, 50.51 hours/week from baseline to 61.81 at follow-up; in the older cohort 60.99 hours/week from baseline to 64.41 at follow-up. At the same time, the hours spent at the computer increased: in the younger cohort 3.45 h/w from baseline to 8.38 at follow-up; in older cohort 7.86 h/w from baseline to 12.96 h/w at follow-up. The obtained results indicate that working at a computer might be associated with myopia onset among schoolchildren [23].

The cohort study, conducted in China by Lin Z. et al on 2014, examined 370 children with myopia and separated them in two groups: primary and secondary cohorts. The aim of this investigation was to examine the possible association between nearwork, outdoor activities and myopia onset in school children in Bejing. The nearwork total time was separated in many activities; as for computer use and juvenile myopia no significant associations were found in both primary cohort (ß=0,16; p=0,60) and secondary cohort (ß=0,33; p=0,18) [24].

Meta-analysis

We were able to use data from 4 cross-sectional study for the meta-analysis. The pooled analysis of these studies, considering 19513 children, showed no association between computer use and myopia (OR = 1,035; 95%CI: 0.94-1.14) (Fig. 2).

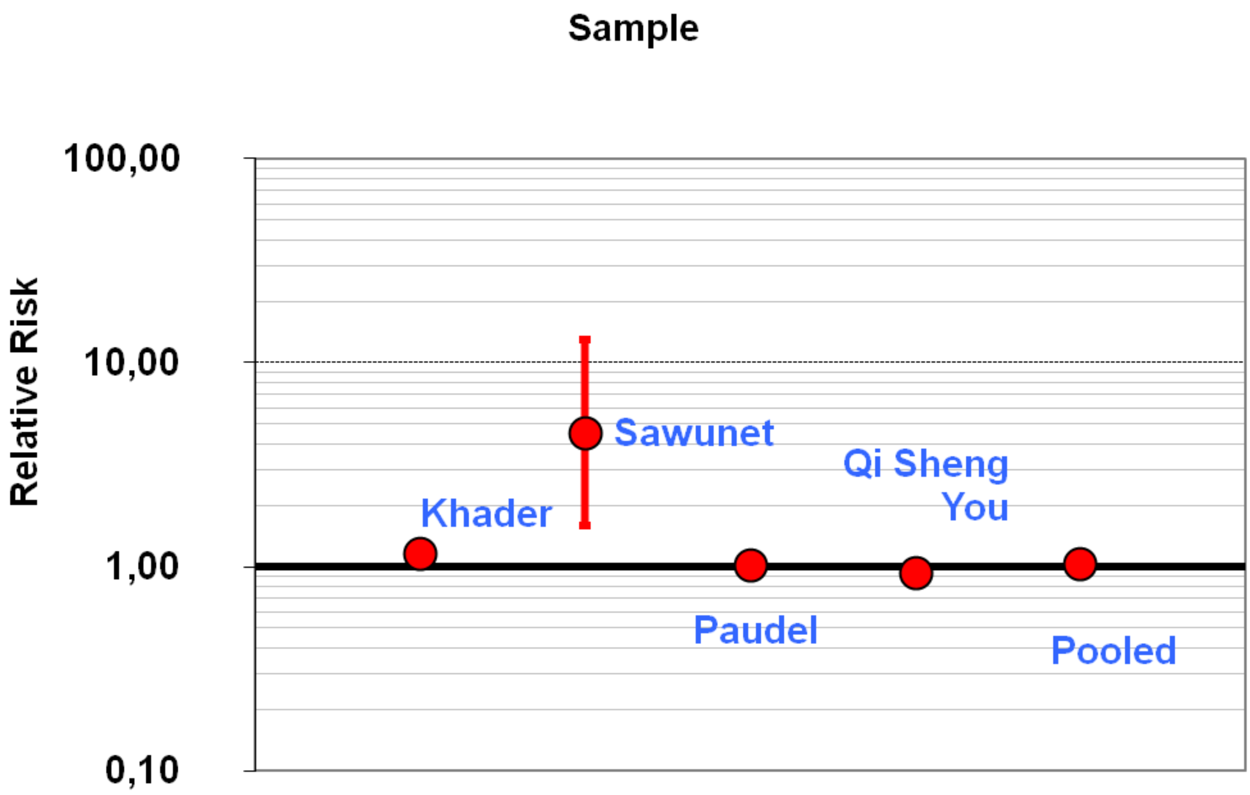

Figure 2. The pooled analysis of cross-sectional studies.

Discussion

The increased incidence and prevalence of juvenile myopia is a public health problem worldwide because there are both mild forms with low developmental trend and severe forms which may damage visual function and even lead to blindness. The most commonly observed form is the physiological myopia (PM) which is multifactorial and etiopathogenic-based. The results of these investigations support both genetic and environmental components. Physiological myopia is thought to be a multifactorial condition with both genetic and environmental factors. [3]

Twin studies and segregation analysis studies have indicated that myopia is hereditary. [25] Evidence for a genetic role includes a higher risk of developing juvenile myopia among children with myopic parents [12-26] and a high posistivecorrelation in refractive error between siblings and between parents and children[27-28]. On the environmental front, nearwork is the most commonly implicated environmental factor, both by animal studies in monkeys genetically predisposed [29-30-31-32-33] as well as by epidemiological studies [4]. Other possible risk factors include age, sex, education, occupation, intelligence, high socioeconomic status and decreased outdoor activities [34-35]. It is reported to be high (up to 80%) in the student population in Asia [5]. In a national survey of children in Taiwan, Lin et al. reported the prevalence of myopia to be over 70% [36]. Because the gene pool has not changed significantly over the decades the rapid increase in myopia prevalence rates has been attributed to increases in reading activity and other environmental factors [37].

Special attention has to be given to school age because is the age at which refractive errors begins. The prevalence of myopia is less than 2% before 7 or 8 years but increases with age and reaches 20% at 15 years. The potential risk factors for myopia were family history and nearwork during childhood, and time spent outdoors [6-38].

Potentially responsible environmental factors for the onset of PM were also widely investigated; among these the most related were: education, occupation, intelligence, high socioeconomic status, increased indoor activities and decreased outdoor activities. For socio-economic growth, social networks and digital technology, in the past two decades, has had a major impact, but also changed the lifestyle of children [7-8] The more relevant consequences in pediatric age are: less hours spent on outdoor activities and more hours spent on indoor activities [6-39]. More hours spent on indoor activities, would assume a greater accommodative effort and presumably a greater number of myopic children. From this general observation was born the need to conduct a systematic review of the international literature in order to analyze the correlation between the development of juvenile myopia and computer use.

Our research performed on Medline and Scopus databases, noted that the association between computer use and development of physiological myopia in pediatric age appears questionable for several reasons. Firstly, the main target of these studies is to evaluate the hours spent on the various daily activities, separating them in indoor and outdoor ones, and the possible presence of myopic ametropia [7-8-9-11]. All the selected studies actually show that as the hours spent in outdoor activities increase, the risk of myopia decreases and vice versa as the hours spent in indoor activities increase, the risk of myopia development in pediatric age increases[12-13-18-20-21-23-24]. Secondly, a distinction is made for the different indoor activities, based on the working distance and, thus, on the accommodative effort required [8-10]. It is indeed evident that as the accommodative effort increases, the risk of developing myopia increases too [8-10]. Therefore, computer use is considered a lesser accommodative effort factor than the recreational reading and everyday studying [12-13].

Conclusion

Recently, we argue about the evidence of the relation between the use of tablet, smartphone and myopia [40]. Considering the results on the computer use from the selected articles, it is difficult to argue whether computer use is a risk factor for the development of juvenile myopia. There are numerous studies [13,14,17,21] including those of Jones-Jordan LA , Lu B, Congdon N , [7,8,11] conclude that there is no evidence on the association of the aforesaid risk factor and myopia.

Conversely, other studies point out a correlation, although minor, between computer use and myopia [12,15,18,19,22,23]. Czepita D in his study concludes that computer use might even be a protective factor against juvenile myopia [20].

In addition, the results our data have the limit mainly show the socio-economic and cultural picture of two populations: the American/Australian and the South-East Asiatic one [7-8-12-13-14-15-17-19-20-21-23-24]. We have few data about African and European populations [18-22].

Given the important genetic, ethnic, cultural and environmental influences on the development of juvenile myopia, it would be desirable that new studies are structured, standardizing the investigation methods and taking multicentric population samples in order to analyze computer use as a risk factor in the onset of physiological myopia.

More complete and multicentric studies are opportune, given the importance of computer use as a risk factor in the development of myopia.

References

1. Duke-Elder S, Abrams D, System of ophthalmology: Ophthalmic optics and refraction. Vol . 5. St Louis, Mo. Mosby (1970).

2. Balacco CG, Moramarco A, Cruciani F, Filipec M, Bozzoni Pantaleon F, Carresi C, Pacella E. Variations of steroids hormones in a high myopia population. Ophtalmologie 1995; 9(5): 473-475.
3. Grosvenor TP. Primary care optometry: anomalies of refraction and binocular vision, 3rd ed. Boston, Butterworth-Heinemann, 1996: 76-9.
4. Ito-Ohara M et al. Clinical course of newly developed or progressive patchy chorioretinal atrophy in pathological myopia. Ophtalmologica, 1998, 212: 23-9.
5. Lin LL at al. Epidemiologic study of the prevalence and severity of myopia among school children in Taiwan in 2000. Journal of the Formosan Medical Association, 2001,100 (10): 684-91.
6. Rose KA, Morgan IG, Ip J, Kifley A, Huynh S, Smith W, Mitchell P: Ophthalmology-Outdoor activity reduces the prevalence of myopia in children. j.ophtha 2008, 115(8):1279-1285.
7. Ip JM, Saw S-M, Rose KA et al. Role of near work in myopia: findings in a sample of Australian school children. Invest Ophthalmol Vis Sci 2008; 49: 2903-2910.
8. Jones-Jordan LA, Mitchell GL, Cotter SA et al. Visual activity before and after the onset of juvenile myopia. Invest Ophthalmol Vis Sci 2011; 52: 1841-1850.
9. Lu B, Congdon N, Liu X et al. Associations between nearwork, outdoor activity, and myopia among adolescent students in rural China: the Xichang pediatric refractive error study report no.2. Arch Ophthalmol 2009; 127:769-775.
10. Mutti DO & Zadnik K. Is computer use a risk factor for myopia? J Am Optom Assoc 1996; 67:521-530.
11. Liberati, D. G. Altman, J. Tetzlaff et al. The PRISMA statement for reporting systematic reviews and metaanalyses of studies that evaluate health care interventions: explanation and elaboration. Italian Journal of Public Health 2009; 6(4): 354–391.
12. Saw SM, Chua WH, Hong CY, Wu HM, Chan WY, Chia KS, Stone RA, Tan D. Nearwork in early-onset myopia. Invest Ophthalmol Vis Sci. 2002; 43: 332-339.
13. Mutti DO, Mitchell GL, Moeschberger ML, Jones LA, Zadnik K. Parental myopia, near work, school achievement, and children's refractive error. Invest Ophthalmol Vis Sci. 2002 Dec;43(12):3633-40.
14. Kathryn A. Rose et all. Myopia, lifestyle, and schooling in students of chinese ethnicity in Singapore and Sydney. Arch Opthalmol 2008; 126(4): 527-530.
15. Yingyong P. Risk factors for refractive errors in primary school children (6-12 years old) in Nakhon Pathom Province.J Med Assoc Thai. 2010 Nov;93(11):1288-93.
16. Khader YS, Batayha WQ, Abdul-Aziz SM, Al-Shiekh-Khalil MI. Prevalence and risk indicators of myopia among schoolchildren in Amman, Jordan. East Mediterr Health J. 2006 May-Jul;12(3-4):434-9.
17. Saw SM, Chan B, Seenyen L, Yap M, Tan D, Chew SJ. Myopia in Singapore kindergarten children. Optometry. 2001 May;72(5):286-91.
18. Sewunet SA, Aredo KK, Gedefew M. Uncorrected refractive error and associated factors among primary school children in Debre Markos District, Northwest Ethiopia. BMC Ophthalmol. 2014 Jul 29;14:95.
19. Paudel P, Ramson P, Naduvilath T, Wilson D, Phuong HT, Ho SM, Giap NV. Prevalence of vision impairment and refractive error in school children in Ba Ria - Vung Tau province, Vietnam. Clin Experiment Ophthalmol. 2014 Apr;42(3):217-26.
20. You QS, Wu LJ, Duan JL, Luo YX, Liu LJ, Li X, Gao Q, Wang W, Xu L, Jonas JB, Guo XH. Factors associated with myopia in school children in China: the Beijing childhood eye study. PLoS One. 2012;7(12):e52668.
21. Deng L, Gwiazda J & Thorn F. Children’s refractions and visual activities in school year and summer. Optom Vis Sci 2010; 87: 406-413.
22. Czepita D, Mojsa A, Ustianowska M, Czepita M, Lachowicz E. Reading, writing, working on a computer or watching television, and myopia. Klin Oczna. 2010;112(10-12):293-5.
23. French AN, Morgan IG, Mitchell P, Rose KA. Patterns of myopigenic activities with age, gender and ethnicity in Sydney schoolchildren. Ophthalmic Physiol Opt. 2013 May;33(3):318-28.
24. Lin Z, Vasudevan B, Jhanji V, Mao GY, Gao TY, Wang FH, Rong SS, Ciuffreda KJ, Liang YB. Near work, outdoor activity, and their association with refractive error. Optom Vis Sci. 2014 Apr;91(4):376-82.
25. Sorsby A, Sheridan M, Leary GA. Refraction and its components in twins. MRC Report No 303. London, HMSO, 1962.
26. Gwiazda J, Thaorn F, Bauer J, Held R. Emmetropizzation and the progression of manifest refraction in children followed infanchy to puberty. Clin Vis Sci 1993; 8: 337-334.
27. Ashton GC.Segregation analysis of ocular refraction and myopia. Hum Hered. 1985; 35:232-239.
28. Guggenheim JA, Pong-Wong R, Haley CS, Gazzard G, Saw SM. Correlation in refractive errors between siblings in the Singapore Cohort Study of Risk factors for Myopia. Br J Ophthalmol. 2007; 91: 781-784.
29. Wiesel TN, Raviola E. Myopia and eye enlargement after neonatal lid fusion in monkeys. Nature, 1997, 266 (5597): 66-8.
30. Wallman J, Turkel J, Tracatman J. Extreme myopia produced by modest change in early visual experience. Science, 1978,201(4362):1249-51.
31. “La Miopia” Coordinatore S.M. Recupero. Di: Scuderi, Balacco Gabrieli, Recupero. Verduci Edit., Roma, 1993. cap 3, 63-72
32. Balacco Gabrieli C., Chietri A., Pacella E. :Light and Myopia. “LIGHT AND MYOPIA”. Myopia International Research Foundation Inc., V Intern. Conf.On Myopia,I.C.O., Singapore March 1990, 11-21.
33. Cheng ZY, Wang XP, Schmid KL, Han YF, Han XG, Tang HW, Tang X. GABAB Receptor Antagonist CGP46381 Inhibits Form-Deprivation MyopiaDevelopment in Guinea Pigs. Biomed Res Int. 2015;2015:207312.

34. Sperduto RD. Prevalence of myopia in United States. Archives of ophthalmology, 1983, 101: 405-7.
35. Wong L et al. Education, reading and familial tendency as risk factors for myopia in Honk Hong fishermen. Journal of epidemiology and community health, 1993, 47(1): 50-3.
36. Lin LL at al. Nation-wide survey of myopia among school children in Taiwan, 1986 Acta Ophthalmologica. Supplement, 1988, 185: 29-33.
37. Saw SM, Katz J, Schein OD, Chew SJ, Chan TK. Epidemiology of myopia. Epidemiol Rev. 1996;18:175-187.
38. Alam H, Irfanullah Siddiqui M, Imtiaz S, Jafri A: Prevalence of refractive error in school children of Karachi. J Pak Med Assoc 2008, 58(6):294-298.
39. Wu PC, Tsai CL, Hu CH, Yang YH. Effects of outdoor activities on myopia among rural school children in Taiwan. Ophthalmic Epidemiol 2010; 17:338-42.
40. La Torre G, Pacella E. Use of tablet, smartphone and myopia: where is the evidence? Senses Sci 2014; 1 (3):82-83.