

Prevalence and Possible Attributes of Decreased Visual Acuity among Primary Schoolchildren in Kufa City, Al-Najaf Governorate

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Abstract

Background: Visual impairment in children is a severe worldwide public problem. It can be detrimental to child's ability to learn. In Iraq, the size of this problem among primary school children is not well defined. **Objectives:** to determine the prevalence of visual impairment among primary school children in Kufa city, Al Najaf Governorate and to identify some factors associated with decreased visual acuity in the sample. **Subjects and Methods:** A cross sectional study was performed during the period of 1st of March to the 15th of April, 2017; the studied sample was 630 primary school children aged 6 to 15 years of both genders from fourteen governmental schools, both students and schools were randomly selected. Data were collected by using questionnaire designed especially for this study. Measurement of each pupil's vision was done by using standard Snellen E chart. Those with visual acuity(VA<6/6) was regarded as visually impaired. The Statistical Package for Social Science, SPSS, (version 20) program was used for data entry and analysis. **Results:** From the total participants, there were 533(84.6%) students with normal VA(VA=6/6), 97(15.4%) students with decreased VA(VA<6/6). It was found that majority 81/97 (84.5%) of children with decreased VA were under the age of 10 years with a high significant statistical difference ($X^2=28.028$, $P = 0.0001$). Statistical analysis showed a significant association of decreased vision with female gender ($X^2=4.429$, $P = 0.0353$), rural residency ($X^2=6.446$, $P = 0.01$), low socioeconomic status ($X^2=7.128$, $P = 0.028$), and positive family history of wearing spectacles($X^2=7.414$, $P = 0.006$), the highest rate of decreased visual acuity was shown in the students of second grade(24.7%), however, the grade was not statistically significant ($X^2=7.128$, $P = 0.265$). The overall prevalence of low vision ($VA \leq 6/18$) in the studied sample was 5.4% (34/630), statistically, there is a significant correlation between poor vision and female gender ($P = 0.031$), however, there is no significant association of poor vision with residency ($P = 0.373$), socioeconomic status ($P = 0.431$), and family history of using spectacles ($P = 0.146$). **Conclusions:** The prevalence of decreased visual acuity among primary school children in Kufa city was 15.4%, reduced vision is significantly higher in younger age group(≤ 10 years old), female gender, rural residency, lower socioeconomic status, and in those of positive family history of wearing spectacles. Female gender is significantly associated with low vision.

Keywords: Low visual acuity, poor vision, prevalence, primary school students, visual impairment

INTRODUCTION

Visual acuity (VA) is defined as the sharpness or clarity of vision, which is the measure of the ability of eye to see and distinguish fine details.^[1] Visual disabilities in children is a severe worldwide public problem that includes health, social, psychological, and economic dimensions,^[2] it can affect school performance, future employment opportunities, and subsequently affecting the quality of life of the individual, the family, and the community.^[2-4] Data from the WHO revealed that about 285 million people are visually impaired worldwide,

one child in each 5 min and an individual becomes blind in each minute. Globally, more than 12 million children in the age group of 5–15 years are visually impaired due to uncorrected refractive errors,^[4] uncorrected refractive errors are the second

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major cause of treatable blindness,^[5-7] being one of the five priorities of the global initiative “VISION 2020” for the elimination of avoidable visual impairment.^[8-10]

The prevalence of visual problems is not distributed uniformly throughout the world. About 90% of visually impaired people are living in developing countries.^[11] The prevalence rates of visual impairment in children worldwide are variable from low as 2.72% in South Africa to high as 25.1% in India.^[12,13] The prevalence of refractive errors reported by the study of primary schoolchildren in Saudi Arabia equal to 13.7%,^[14] a research conducted in Iran demonstrated that the prevalence rate of refractive errors is 3.8% of participants.^[15] In Iraq, one available published study demonstrated that the prevalence rate of refractive errors among primary schoolchildren in urban of Erbil city (North of Iraq) is equal to 19.6%.^[16] Knowledge about the prevalence and causes of visual impairment would be of great help in planning public health strategies and development of appropriate policies on human resources and infrastructure.^[17] Such information may also help in the development of screening programs that aimed at preservation of visual health.^[18] The present study aims to obtain information about the prevalence of visual impairment among primary schoolchildren in Kufa city and to identify some factors associated with decreased VA in the sample.

MATERIALS AND METHODS

Study design

This was a cross-sectional study of VA covering 630 primary schoolchildren in Kufa city.

Setting

the study was carried out at 14 primary schools of both sexes in Kufa city during March 1 to April 15, 2017.

Subjects and sampling

The studied sample was children between the ages of 6–15 years of 14 schools about 9% of 154 governmental schools existing in Kufa city.

Target population comprised 49,691 primary schoolchildren in Kufa city according to education directorate in Al-Najaf governorate in 2017, 14 primary schools were randomly selected using random digit table. A required sample size of pupils (750) was randomly selected from 14 primary schools. The list of the children from the respective schools was used as a sampling frame; the random selection of pupils from each grade was done using systematic random sampling method. Forty-five pupils were selected from each school using the school records. From these records, nine pupils from the first three grades and six from the last three grades were chosen and if the selected name was absent or refused to participate, the next name in the list was taken.

The sample size was done on the basis of the following equation:

$$n = N / 1 + N (e)^2 [15]$$

Where

n = sample size, N = population size, e = level of precision, $n = 49691 / 1 + 49691 (0.05)^2$, $n = 396.9$ i.e., 400.

Regarding nonresponse rate, 10% (75 pupils) of the proposed sample (750 pupils) were nonresponders, leaving behind 675 participants. In addition to the 45 pupils that were included in the pilot study were excluded, so the final number was 630 pupils.

Data collection

Information was obtained by the investigator through interviewing the pupils, their teachers, and from the pupil's school records using questionnaire designed, especially for this study and validated by a panel of 5 experts in the field. Information was obtained by the investigators through interviewing the pupils, their teachers, and from the pupil's school records. Then, the investigators examined each pupil's vision using standard Snellen E chart.

The study questionnaire includes the demographic data that are used to assess personal and family factors that include children's general characteristics such as age, gender, residency, grade, history of chronic diseases, a family history of using spectacles among parents or siblings, and socioeconomic status scale (SESS). SESS is defined in terms of standard sociological paradigm consisting of three components: Occupation, education, and income.^[19] The final score of SESS ranges from (0–100), in which a score of <50 represents a low socioeconomic class; a score of 50–69 represents a medium socioeconomic class; and a score of 70 or more represents a high socioeconomic class.

Measurement of visual acuity

VA was measured in a properly illuminated room using Snellen E chart at a distance of 6 m. The investigators explained to the pupil that they will point on the letters on the different lines on the chart, and the direction of each optotype simply as up, down, to the door, and to the window. If the pupil wears spectacles, he or she was examined with and without it. Both the eyes of student were examined alternatively when he or she can no longer distinguish at least half of the letters on a line that is considered the smallest line that they can see. The degree of decreased VA of the worst eye was recorded. If the pupil cannot read the largest letters of the chart, the investigator asks him/her to walk toward the chart; the distance at which he/she began to read the large letters is recorded as the top number. If the pupil cannot see the largest letters at any distance, the investigator holds her fingers in front of his/her eyes and records his/her vision as the farthest distance at which he/she can count her fingers. If the pupil is unable to count fingers, the investigator waves a hand in front of his/her eyes to find out if he/she can perceive the movement. If he/she perceives it, this was recorded as H. M. (Hand Movements). If the pupil is unable to detect hand movement, shine a test light into his/her eyes and ask if he or she perceives it. This was recorded as “L. P.” (Light Perceived) or “N. L. P.” (No Light Perceived).

Definitions

The definitions used in the current study follow those given in

the International statistical classification of diseases, injuries and causes of death, 10th revision (ICD-10): H54 (9) where:

Visual impairment is defined as low vision as well as blindness, low vision means VA of $<6/18$, but $\geq 3/60$, or a corresponding visual field loss to $<20^\circ$ in the better eye with best possible correction (categories 1 and 2), blindness means VA of $<3/60$ or a corresponding visual field loss to $<10^\circ$ in the better eye with best possible correction (categories 3, 4, and 5).^[20] In this study, no correction was used because it was difficult to obtain it, and for this, low vision was considered as VA of 6/18 or less.

Pilot study

A pilot study on 45 pupils was conducted to check children's understanding of instrumental items, to determine the instrument reliability and to obtain a preliminary estimate of the time required for the filling questionnaire form and examination. It revealed that the time required for taking the required data and eye the examination is enough as planned by the investigator, that is, during the classes' time, with no further adjustment on the questionnaire.

Official approval and ethical issues

The researcher took approval from Al-Najaf Education Directorate involved in the study before the collection of data. Written consents from the parents and verbal consents were required from all participating students.

Statistical analysis

Statistical Package for the Social Science, SPSS, (version 20, IBM, Chicago, Illinois) program was used for data entry and analysis. The results were represented through basic descriptive statistics, which include: frequency tables, percentages, means and standard deviations. Chi-square test for dependence was used whenever applicable. $P \leq 0.05$ was considered statistically significant.

RESULTS

The studied sample comprised 630 primary school pupils, of which 428 (67.9%) were male and 202 (32.1%) were female. The age of participants ranges from 6 to 15 years (mean, 8.4 ± 3.6). According to their residency, half of them live in urban areas and another half in rural areas. Classification of pupils according to their socioeconomic status revealed that

318 (50.5%) were from low, 265 (42%) were from middle, and 47 (7.5%) were from high socioeconomic class. From the total participants, 533 (84.6%) students with normal (VA = 6/6), 97 (15.4%) students with decreased (VA $<6/6$) [Table 1].

Table 2 showed the distribution of the studied students according to the sociodemographic characteristics. Regarding the age, it was found that majority 81/97 (84.5%) of children with decreased VA were under and equal to the age of 10 years with a highly significant statistical difference ($\chi^2 = 28.028$, $P = 0.0001$). It was found that higher percentage of students with decreased VA were male (58.8%); however, females were more likely to have decreased vision than male because of 40/162 female students had decreased VA in comparison to 57/371 male students, statistical analysis showed a significant relationship ($\chi^2 = 4.429$, $P = 0.0353$).

It was found that most of the students with decreased VA live in rural areas (60, 61.2%) with a significances statistical association ($P = 0.01$). Of all the pupils examined in grades 1–6, the higher rate of decreased VA was shown in the second grade (24.7%); however, grade was not statistically significant ($P = 0.265$). Among students with decreased VA, 61 (62.9%) of low, 30 (30.1%) of middle, 6 (6.1%) of high socioeconomic status, statistical analysis showed a significant association ($P = 0.028$). The majority of students with decreased VA had a positive family history of eye disease 56 (57.7%), a highly significant statistical difference was found between family history of using spectacles and VA ($P = 0.006$).

The overall prevalence of low vision (VA $\leq 6/18$) among the studied sample was 5.4% (34/630), low vision was higher among females 15 (58.8%) than males 40 (41.2%), statistically, there is a significant difference ($P = 0.031$), in students with low vision, rural residency was higher 19 (55.9%) than urban residency 15 (44.1%) although there was no significant association ($P = 0.373$). There was no significant association between socioeconomic status and family history of using spectacles with low vision ($P = 0.431$, 0.146), respectively [Table 3].

Eleven pupils (11.3%) of those whose found to have decreased VA wore eyeglasses, while 86 (88.7%) did not wear eyeglasses. Squint was found in 14 pupils (2.2%) of the sample.

DISCUSSION

Reduced VA can negatively impact the child's ability to learn and sometimes it can be very difficult to distinguish this from mental problem. Poor academic performance, lack of motivation in schooling, and dropping out of school can be prevented when the cause is related to poor vision.^[21]

Any student with vision worse than 6/9 Snellen acuity was considered to have visual impairment. This is because lack of correction method, however, there are many screening criteria among which are the Danish Assistance to the National Program for Control of Blindness (DANPCB) vision screening program which uses the VA Snellen 6/9 E chart.^[22]

Table 1: Distribution of visual acuity of 630 primary schoolchildren examined in Kufa city

VA category	n (%)
6/6	533 (84.6)
6/9	20 (3.2)
6/12	43 (6.8)
6/18	18 (2.9)
6/24	6 (0.95)
6/36	6 (0.95)
6/60	4 (0.6)
Total	630 (100)

VA: Visual acuity

Table 2: Distribution of studied sample according to the sociodemographic characteristics

Variables	Decreased VA, n (%)	Normal VA, n (%)	Total, n (%)	χ^2 (P)
Age (years)				
6	12 (12.4)	108 (20.3)	120 (19)	28.028 (0.0001)
7	24 (24.7)	108 (20.3)	132 (20.9)	
8	19 (19.6)	105 (19.7)	124 (19.7)	
9	10 (10.3)	75 (14.1)	85 (13.5)	
10	16 (16.5)	64 (12.0)	80 (12.7)	
11	10 (10.3)	71 (13.2)	81 (12.9)	
10-15	6 (6.2)	2 (0.4)	8 (1.3)	
Gender				
Male	57 (58.8)	371 (69.6)	428 (67.9)	4.429 (0.0353)
Female	40 (41.2)	162 (30.4)	202 (32.1)	
Residency				
Urban	37 (38.1)	278 (52.2)	315 (50.0)	6.446 (0.0111)
Rural	60 (61.2)	255 (47.8)	315 (50.0)	
Grade				
1 st	12 (12.4)	114 (21.4)	126 (20.0)	6.44 (0.2657)
2 nd	24 (24.7)	102 (19.1)	126 (20.0)	
3 rd	18 (18.6)	108 (20.3)	126 (20.0)	
4 th	14 (14.4)	70 (13.1)	84 (13.3)	
5 th	12 (12.4)	72 (13.5)	84 (13.3)	
6 th	17 (17.5)	67 (12.6)	84 (13.3)	
SES				
Low	61 (62.9)	257 (48.2)	318 (50.5)	7.128 (0.0283)
Middle	30 (30.1)	235 (44.1)	265 (42.0)	
High	6 (6.1)	41 (7.7)	47 (7.5)	
Family history of using spectacles				
Yes	56 (57.7)	228 (42.3)	284 (45.1)	7.414 (0.006)
No	41 (42.3)	305 (57.2)	346 (54.9)	
Total	97 (15.4)	533 (84.6)	630 (100)	

SES: Socioeconomic state, VA: Visual acuity

Table 3: Distribution of students with decreased visual acuity according to their sociodemographic characteristics

Variables	VA		Total	χ^2 (P)
	6/9-6/12, n (%)	≤6/18, n (%)		
Gender				
Male	42 (66.7)	15 (44.1)	57 (58.8)	4.634 (0.031)
Female	21 (33.3)	19 (55.9)	40 (41.2)	
Residency				
Urban	22 (34.9)	15 (44.1)	37 (38.1)	0.972 (0.373)
Rural	41 (65.1)	19 (55.9)	60 (61.9)	
SES				
Low	42 (66.7)	19 (55.9)	61 (62.9)	1.684 (0.431)
Middle	19 (30.2)	11 (32.4)	30 (30.9)	
High	2 (3.1)	4 (11.7)	6 (6.2)	
Family history of using spectacles				
Yes	33 (52.4)	23 (67.6)	56 (57.7)	2.109 (0.146)
No	30 (47.6)	11 (32.4)	41 (42.3)	
Total	97 (15.4)	533 (84.6)	630 (100)	

SES: Socioeconomic state, VA: Visual acuity

DANPCB screening criteria are more suitable for schoolchildren because VA of 6/18 or worse is already grossly subnormal for schoolchildren.^[22]

In the present study, the prevalence rate of decreased VA and poor vision was 15.4% and 5.4%, respectively, among the examined 630 primary schoolchildren. The prevalence of visual impairment was higher than that reported by studies conducted in Saudi Arabia, 13.7%;^[14] Iran, 3.8%;^[15] Malaysia, 7.7%;^[23] Nepal, 8.6%;^[24] South Africa, 2.7%;^[13] and lower than those reported by other studies conducted in North of Iraq, 19.6%;^[16] Qassim Province, Saudi Arabia, 18.6%;^[25] and Qatar, 19.7%.^[26] This variation in prevalence could be attributed to differences in sampling methods, operational definitions, size of screened populations, and the geographical areas.

Although many studies showed that the prevalence of visual impairment increases with increased age.^[23,27-30] These findings are in contrast to that of the present study, where 84.5% of the pupils are under and equal to 10 year old. These differences could be due to the age distribution of the studied sample, where majority 460/630 (73.2%) are below 11 years old. According to grade distribution of the students, it was found

that the highest rate of VA reduction (24.7%) was among the second-grade students, although there are no significant differences; a previous Vietnamese study in 2014 reported that rate of myopia was increased in higher grades,^[31] whereas our findings could also be explained by sample distribution of the grade where 60% of studied students in 1st–3rd grade and 40% in 4th–6th grade.

The present study found that the prevalence of decreased VA and poor vision are significantly higher among female students than males, this finding agrees with other studies^[14,26,32,33] and disagrees with a study conducted in Ethiopia that showed no significant sex differences.^[34] Higher prevalence rates of decreased vision among females may be due to women's eyes have a shallower anterior chamber depth, and shorter axial length than those of men, hence a higher probability of being hyperopic.^[35]

In this study, the prevalence rate of reduced VA was higher among rural children. This is similar to findings of a study conducted in Saudi Arabia by Al Wadaani *et al.* in 2013,^[14] while it contradicts to that reported by others.^[12,23,24] The current finding may be due to neglect, poverty, lack of access to medical services, and low educational background in rural areas.

Few population-based studies have investigated the role of socioeconomic factors in the development of visual impairment.^[36] It was found that the prevalence of visual impairment is significantly higher in low socioeconomic status than those of middle and high status. This finding was compatible with that of a study done in Ethiopia,^[34] which showed that family incomes of most children with reduced vision are low. Our finding may be due to the inability of the parents to get balanced diet to their children which may contribute to decreased VA,^[37] also children of lower socioeconomic status could be spend longer time of studying their lessons in badly illuminated, crowded rooms, in addition to that, poverty could be lead to ignorance of child's health.

There is certain genetic factors influence the development of refractive errors, and the relation between refractive errors in parents and their siblings rather than would be expected by chance,^[38,39] myopic parents are much more likely than nonmyopic parents to have myopic children.^[40]

Pervious researches^[41–43] showed a significant association between refractive errors and positive family history. All these researches agree with the results that found in this study of a significant statistical association between reduced vision and positive family history of spectacle wearing.

Higher percentage (88.7%) of visually impaired pupils did not wear glasses in contrast to (11.3%) who wore glasses. In an Egyptian study,^[44] 42.3% of the examined pupils wore glasses and 57.7% did not wear glasses. The higher rate of not wearing spectacle among visually disabled children might be due to poor knowledge about the importance of wearing glasses and its effects on the progression of vision deterioration. One of

the limitations of the current study is lacking of corrective glasses, hence we cannot differentiate the type of refractive errors in the students, also it is a cross-sectional study, and so casual relationships cannot be inferred.

CONCLUSION

The prevalence of decreased VA among primary schoolchildren in Kufa city was 15.4%, whereas decreased VA is significantly higher in younger age group (≤ 10 years), female gender, rural residency, lower socioeconomic status, and those of positive family history of wearing spectacles. Female gender is significantly associated with low vision.

It is necessary to provide effective health education and trained staff in the school environment to do a quick and simple test for newly enrolled primary schoolchildren and to provide education of the parents and teachers about the importance of wearing spectacles of visually impaired students to prevent further deterioration of their vision. It is important to quantify the disadvantages of attending school with decreased VA. Early diagnosis and proper management through public health measures can improve the ocular health status of schoolchildren. The current results need more attention by Ministry of Health for strengthening and effectively implementing school health services, also for regular screening of students' VA for the early detection of visual impairment, its causes, and treatment together with a governmental support for providing low-cost spectacles.

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Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Cline D, Hofstetter HW, Griffin JR. Dictionary of Visual Science. 4th ed. Boston: Elsevier Science & Technology Books, Butterworth-Heinemann; 1997.
2. Gilbert C, Foster A. Childhood blindness in the context of VISION 2020 – The right to sight. Bull World Health Organ 2001;79:227-32.
3. Gordoia A, Cutler H, Pezzullo L, Gordon K, Cruess A, Winyard S, *et al.* An estimation of the worldwide economic and health burden of visual impairment. Glob Public Health 2012;7:465-81.
4. Resnikoff S, Pascolini D, Etya'ale D, Kocur I, Pararajasegaram R, Pokharel GP, *et al.* Global data on visual impairment in the year 2002. Bull World Health Organ 2004;82:844-51.
5. Dandona R, Dandona L. Refractive error blindness. Bull World Health Organ 2001;79:237-43.
6. Dandona R, Dandona L, Srinivas M, Sahare P, Narsaiah S, Muñoz SR, *et al.* Refractive error in children in a rural population in India. Invest Ophthalmol Vis Sci 2002;43:615-22.
7. Fan DS, Lam DS, Lam RF, Lau JT, Chong KS, Cheung EY, *et al.*

- Prevalence, incidence, and progression of myopia of school children in Hong Kong. *Invest Ophthalmol Vis Sci* 2004;45:1071-5.
8. Berhane Y, Worku A, Bejiga A. Federal Ministry of Health of Ethiopia with Support from and in Collaboration with a Consortium of NGOs (The Carter Center, CBM, ITI, ORBIS Intl. Ethiopia and LfW), Ophthalmological Society of Ethiopia, and the Ethiopian Public Health Association, "National Survey on Blindness, Low Vision and Trachoma in Ethiopia," Addis Ababa, Ethiopia; 2006. p. 6.
9. Oye JE, Kuper H, Dineen B, Befidi-Mengue R, Foster A. Prevalence and causes of blindness and visual impairment in Muyuka: A rural health district in South West Province, Cameroon. *Br J Ophthalmol* 2006;90:538-42.
10. Patrick-Ferife G, Ashaye AO, Qureshi BM. Blindness and low vision in adults in Ozo, a rural community in delta state, Nigeria. *Niger J Med* 2005;14:390-5.
11. World Health Organization. Visual Impairment and Blindness Fact Sheet, 2013. [online] Available from: <http://www.who.int/mediacentre/factsheets/fs282/en/>. [Last accessed on 2017 Feb 19].
12. Padhye AS, Khandekar R, Dharmadhikari S, Dole K, Gogate P, Deshpande M, *et al.* Prevalence of uncorrected refractive error and other eye problems among urban and rural school children. *Middle East Afr J Ophthalmol* 2009;16:69-74.
13. Naidoo KS, Raghunandan A, Mashige KP, Govender P, Holden BA, Pokharel GP, *et al.* Refractive error and visual impairment in African children in South Africa. *Invest Ophthalmol Vis Sci* 2003;44:3764-70.
14. Al Wadaani FA, Amin TT, Ali A, Khan AR. Prevalence and pattern of refractive errors among primary school children in al Hassa, Saudi Arabia. *Glob J Health Sci* 2012;5:125-34.
15. Fotouhi A, Hashemi H, Khabazkhoob M, Mohammad K. The prevalence of refractive errors among schoolchildren in Dezful, Iran. *Br J Ophthalmol* 2007;91:287-92.
16. Ahmad MA, Al-Khayat ZA, Shakir NF. Prevalence of refractive errors and other ocular disorders among students of the primary schools in urban of the Erbil city. *Polytechnic J* 2017;7:1-10.
17. Raju P, Ramesh SV, Arvind H, George R, Baskaran M, Paul PG, *et al.* Prevalence of refractive errors in a rural South Indian population. *Invest Ophthalmol Vis Sci* 2004;45:4268-72.
18. Thylefors B, Négrel AD, Pararajasegaram R. Epidemiologic aspects of global blindness prevention. *Curr Opin Ophthalmol* 1992;3:824-34.
19. Zhan L. Quality of life: Conceptual and measurement issues. *J Adv Nurs* 1992;17:795-800.
20. The Oslo Invitational Workshop, Toward a Reduction in the Global Impact of Low Vision, The International Society for Low Vision Research and Rehabilitation, The International Society for Low Vision Research and Rehabilitation, New York, USA; 2005.
21. Schneider J, Leeder SR, Gopinath B, Wang JJ, Mitchell P. Frequency, course, and impact of correctable visual impairment (uncorrected refractive error). *Surv Ophthalmol* 2010;55:539-60.
22. DANIDA Support Unit (DANPCB) Vision Screening in Schoolchildren – A Training Module; 1992. p. 5.
23. Hashim SE, Tan HK, Wan-Hazabbah WH, Ibrahim M. Prevalence of refractive error in Malay primary school children in suburban area of Kota Bharu, Kelantan, Malaysia. *Ann Acad Med Singapore* 2008;37:940-6.
24. Pokharel A, Pokharel PK, Das H, Adhikari S. The patterns of refractive errors among the school children of rural and urban settings in Nepal. *Nepal J Ophthalmol* 2010;2:114-20.
25. Aldebasi YA. Prevalence of correctable visual impairment in primary school children in Qassim Province, Saudi Arabia. *J Optom* 2014;7:168-76.
26. Al-Nuaimi AA, Salama RE, Eljack IE. Study of refractive errors among school children Doha. *World Fam Med J* 2010;8:41-8.
27. Lin LL, Shih YF, Hsiao CK, Chen CJ. Prevalence of myopia in Taiwanese schoolchildren: 1983 to 2000. *Ann Acad Med Singapore* 2004;33:27-33.
28. Rose K, Smith W, Morgan I, Mitchell P. The increasing prevalence of myopia: Implications for Australia. *Clin Exp Ophthalmol* 2001;29:116-20.
29. Saw SM, Tong L, Chua WH, Chia KS, Koh D, Tan DT, *et al.* Incidence and progression of myopia in Singaporean school children. *Invest Ophthalmol Vis Sci* 2005;46:51-7.
30. Hendricks TJ, de Brabander J, Vankan-Hendricks MH, van der Horst FG, Hendrikse F, Knottnerus JA, *et al.* Prevalence of habitual refractive errors and anisometropia among Dutch schoolchildren and hospital employees. *Acta Ophthalmol* 2009;87:538-43.
31. Paudel P, Ramson P, Naduvilath T, Wilson D, Phuong HT, Ho SM, *et al.* Prevalence of vision impairment and refractive error in school children in Ba Ria - Vung Tau province, Vietnam. *Clin Exp Ophthalmol* 2014;42:217-26.
32. Al Rowaily MA, Alanizi BM. Prevalence of uncorrected refractive errors among adolescents at King Abdul-Aziz Medical City, Riyadh, Saudi Arabia. *J Clin Exp Ophthalmol* 2010;1:114.
33. Prema N. Prevalence of refractive errors in school children. *Indian J Sci Technol* 2011;4:160-1.
34. Darge HF, Shibri G, Mulugeta A, Dagnachew YM. The prevalence of visual acuity impairment among school children at Arada subcity primary schools in Addis Ababa, Ethiopia. *J Ophthalmol* 2017;2017:9326108.
35. Wong TY. Variation in ocular biometry in an adult Chinese population in Singapore: The Tanjong Pagar Survey. *Invest Ophthalmol Vis Sci* 2001;42:73-80.
36. Dandona R, Dandona L. Socioeconomic status and blindness. *Br J Ophthalmol* 2001;85:1484-8.
37. Murthy GV, Gupta S, Ellwein LB, Munoz SR, Bachani D, Dada VK, *et al.* A population-based eye survey of older adults in a rural district of Rajasthan: I. Central vision impairment, blindness, and cataract surgery. *Ophthalmology* 2001;108:679-85.
38. Wojciechowski R. Nature and nurture: The complex genetics of myopia and refractive error. *Clin Genet* 2011;79:301-20.
39. Klein AP, Suktitipat B, Duggal P, Lee KE, Klein R, Bailey-Wilson JE, *et al.* Heritability analysis of spherical equivalent, axial length, corneal curvature, and anterior chamber depth in the Beaver Dam eye study. *Arch Ophthalmol* 2009;127:649-55.
40. 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;43:3633-40.
41. Pavithra MB, Maheshwaran R, Rani Sujatha MA. A study on the prevalence of refractive errors among school children of 7–15 years age group in the field practice areas of a medical college in Bangalore. *Int J Med Sci Public Health* 2013;2:641-5.
42. Kumar KS, Akoijam BS. Prevalence of refractive error among school-going children of Imphal, Manipur. *Int J Med Sci Public Health* 2016;5:1364-8.
43. Sun Y, Cao H, Yan ZG. Prevalence of refractive errors in middle school students in Lanzhou city. *Int J Ophthalmol* 2008;1:180-2.
44. El-Bayoumy BM, Saad A, Choudhury AH. Prevalence of refractive error and low vision among schoolchildren in Cairo. *East Mediterr Health J* 2007;13:575-9.