

Review Article

Epidemiology of visual impairment: focus on Delta State, Nigeria

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ABSTRACT

The eyes being the most delicate organs as well as the window of the body to the world make it dysfunction a public health problem. The aim of this study is to review the epidemiology of visual impairment in relation to anaemia, antioxidant vitamins and nutritional status in order to identify and proffer appropriate solution to various factors associated with visual impairment. A systematic review and evaluation of published literatures globally, in sub Saharan Africa and in Nigeria was done through web search and Mendeley reference library. Findings showed that visual impairment increases with increase in age. Gender, race, geographical location, literacy level, income and culture are social demographic factors that influence visual impairment. Refractive error, cataract, glaucoma and age-related macula degeneration (ARMD) are the most common causes of visual impairment worldwide. Over 80% of visual impairment are preventable. Hence, early detection and prompt treatment especially at the primary health care level is the most effective ways to prevent visual impairment.

Keywords: Visual impairment, Anaemia, Antioxidant vitamins, Nutritional status, Refractive error, Oxidative stress, Primary school age children

INTRODUCTION

WHO estimates that in 2010 there were 285 million people visually impaired, of which 39 million were blind.¹ The burden of visual impairment have increased exponentially over the years. Globally, it is estimated that at least 2.2 billion people have a vision impairment or blindness, of whom at least 1 billion have a vision impairment that could have been prevented or has yet to be addressed. This 1 billion people includes those with moderate or severe distance vision impairment or blindness due to uncorrected refractive error (123.7 million), cataract (65.2 million), glaucoma (6.9 million), corneal opacities (4.2 million), diabetic retinopathy (3 million), and trachoma (2 million), as well as near vision impairment caused by unaddressed presbyopia (826 million).² 80% of all causes of visual impairment are

preventable or curable. One individual becomes blind in each minute and a child in each 5 minutes, and almost one in 1000 children are blind, which is less than a tenth of the prevalence in adults. The burden of visual impairment is not distributed uniformly throughout the world. The prevalence of distance vision impairment in low- and middle-income regions is estimated to be four times higher than in high-income regions.² With regards to near vision, rates of uncorrected near vision impairment are estimated to be greater than 80% in western, eastern and central sub-Saharan Africa, while comparative rates in high-income regions of North America, Australia, Western Europe, and of Asia-Pacific are reported to be lower than 10%. About 90% of visually impaired people are living in developing countries.² The poorest regions of Africa and Asia are where three quarters of the world's blind children live.³ Out of the 1.4

million blind children globally, about 300,000 live in Africa. The prevalence of blindness in children in a country is related to the nutritional, health, and socioeconomic status of that country.³

Sub-Saharan Africa has an estimated 5-6 million blind and 16-18 million persons with low vision. Around 60% of them live in twenty African countries including Botswana, Eritrea, Ethiopia, Gambia, Ghana, Kenya, Lesotho, Liberia, Malawi, Mauritius, Namibia, Nigeria, Seychelles, Sierra Leone, South Africa, Swaziland, Uganda, the United Republic of Tanzania, Zambia, and Zimbabwe.⁴ It is estimated that globally 153 million people over 5 years of age are visually impaired as a result of uncorrected refractive errors, of which 8 million are blind.

For school age children, the inability to read standardized print, to see the chalkboard, overhead projection, or the computer, or to discriminate colour can have a significant impact on their educational development. The principal causes of visual impairment and blindness in the world include uncorrected refractive error, un-operated cataract, glaucoma, age related macular degeneration, diabetic retinopathy (secondary to oxidative stress and anaemia), trachoma and corneal opacities (secondary to malnutrition and Vitamin deficiencies.⁵ The most common cause of childhood SVI/BL in industrialised countries such as the UK and USA is neurological or cerebral disorder affecting the visual system, due to ischaemic, developmental or unknown insults.⁶ Most of the causes of visual impairment and blindness are either preventable or treatable.

Anaemia being a major cause of retinal vessels abnormality which results in visual impairment is one of the most common public health problems worldwide. About one-third (32.9%) of the world's population was anaemic in 2010 and anaemia was responsible for 68.3 million years lived with disability.⁷ Anaemia is defined as a state in which there are an insufficient number of red blood cells to cater for the body's physiologic demands.⁷ Anaemia occurs when the level of healthy red blood cells (RBCs) or haemoglobin (an iron-binding, oxygen-carrying protein within RBCs) is too low. Anaemia is classified as a severe public health problem (defined as a prevalence of anaemia >40%) in most parts of the African continent. In children, anaemia is associated with impaired cognitive development and possibly with motor development as well.⁸ Anaemia is associated with weakness, fatigue, reduced productivity, and inhibited immune function. In the eye, anaemia can lead to transient retinal haemorrhages. These were first described by Ulrich in 1883 in association with gastrointestinal haemorrhage.⁹ Anaemia is suggested as another long term complication of Diabetes Mellitus (DM).¹⁰ The prevalence of anaemia in DM patients is reported as 14-48%. High glycosylated haemoglobin, diabetic neuropathy, low serum albumin, younger age and also low haematocrit were reported as risk factors for the

development of more severe form of Diabetic Retinopathy (high risk proliferative DR) and visual loss.⁵ A variety of pathologic changes occurring due to and associated with anaemia are implicated in the clinical features of anaemic retinopathy. Anaemia causes retinal hypoxia, which leads to infarction of the nerve fiber layer and clinically manifests as cotton wool spots.¹¹ Retinal hypoxia also leads to vascular dilatation; increased transmural pressure owing to hypoproteinaemia; and microtraumas to the vessel walls, which cause retinal oedema and haemorrhages.¹¹

Malnutrition in children is the consequence of factors that are often related to poor food quality, insufficient food intake, and severe and repeated infectious diseases, or frequently some combination of the three.¹² Antioxidant vitamins such as vitamin A is necessary for the normal production of red blood cells, while others such as vitamins C and E protect mature red blood cells from premature destruction by free radical oxidation.

Vitamins C and E function is to act as a coordinated and balanced system to protect tissues and body fluids from damage by Reactive Oxygen Species, Reactive Nitrogen Species, Reactive Carbo Species (ROS/RNS/RCS) whether produced physiologically or as a response to inflammation, infection or disease. Vitamin E (protects against lipid peroxidation) and vitamin C (scavenges some ROS/RNS/RCS directly and probably recycles vitamin E). Vitamin A and vitamin C may also prevent anaemia by improving intestinal absorption of iron, or by facilitating its mobilization from body stores.¹³ Vitamins A and C can be considered preventive antioxidants in that deficiencies are associated with the breakdown of anatomic barriers. α -Tocopherol, ascorbate and carotenes obtained from the diet are the main radical quenching antioxidants for preventing the propagation and chain elongation of radicals. Studies showed that vitamin C and E intake are associated with protection from cataracts.^{14,15}

A systematic review and evaluation of published literatures globally, in sub Saharan Africa and in Nigeria was done through web search and Mendeley reference library. The published literatures were searched using the following key words: blindness, childhood blindness, visual impairment, prevalence, refractive error. All articles were reviewed, and the references of the articles were also searched for relevant articles, which were also reviewed.

Despite the absence of data in on childhood blindness in most countries of the world, effort was made to judiciously compare available data with that of adults in different regions of the world. There is social, economic, geographic and ethnic diversity in most of these countries which will greatly affect the prevalence and causes of blindness and visual impairment.

EPIDEMIOLOGY OF VISUAL IMPAIRMENT GLOBALLY

The global prevalence of blindness in children as estimated for the 17 WHO sub regions is shown in Table 1.¹⁶ The prevalence of blindness for three age groups: children less than 15 years; adults from 15 to 49 years; and adults aged 50 years and older. Although childhood blindness remains a significant problem (there are an estimated 1.4 million blind children below the age of 15 years), its magnitude is relatively small when compared to the extent of blindness in older adults: more than 82% of all blind people are 50 years and older.¹⁶ The eight sub regions concerned (Afr-D, Afr-E, Emr-B, Emr-D, Sear-B, Sear-D, Wpr-B1 and Wpr-B2) are home to 70% of the world's population and contribute 85% of the total number of blind people. In 1990 there were an estimated 148 million people who were visually impaired, of whom 38 million were blind, in 2002 the estimated number of visually impaired people was 161 million, of whom 37 million were blind. In the developed countries the number of blind people was estimated to be 3.5 million in 1990 and 3.8 million in 2002, an increase of 8.5%. During the same period the size of the population aged 50 years and older in these countries had increased by 16%. The change in the number of people with low vision is more significant: there were an estimated 18 million people with low vision in 2002, compared to 10 million in 1990.¹⁶

In developing countries, excluding China and India, 18.8 million people were blind in 1990 compared to 19.4 million in 2002, an increase of 3%. In China and India the estimated numbers of blind people in 1990 were 6.7 and 8.9 million, respectively; in 2002 there were an estimated 6.9 million blind people in China and 6.7 million in India.¹⁶

A Blindness defined as in the ICD-10:H54 tables refers to visual acuity in the better eye with best possible correction (WHO, 1993)

Global Comparison of Causes of Visual Impairment

The leading cause of blindness in all ages globally was cataract, followed by glaucoma and age-related macular degeneration.¹⁶ The largest proportion of blindness is necessarily related to ageing.¹⁶ Uncorrected refractive errors are still responsible for up to 42% of the cases of visual impairment worldwide.¹ The most common causes of visual impairment in children worldwide was uncorrected refractive error followed by amblyopia, corneal diseases and retinal disorders as shown in Table 2 and Figure 1.¹⁷ The prevalence of myopia, hyperopia, and astigmatism in children and adults according to WHO regions¹⁸ are shown in Tables 3. The table showed that myopia, astigmatism and hyperopia were the most common refractive errors in children and adults in the mentioned order. Children and adults in South-East Asia had the highest prevalence and myopia as compared to

other WHO regions, while the lowest prevalence of myopia was seen in Eastern Mediterranean Region children and adults. The highest prevalence of hyperopia in adults was seen in the Americas and that of children was seen in Eastern Mediterranean Region. Africans and Eastern Mediterranean Region had the lowest prevalence of hyperopia for children and adults respectively. The highest prevalence of astigmatism in adults was seen in the Africans and that of children was seen in South-East Asia. Africans had the lowest prevalence of astigmatism for both children and adults.¹⁸

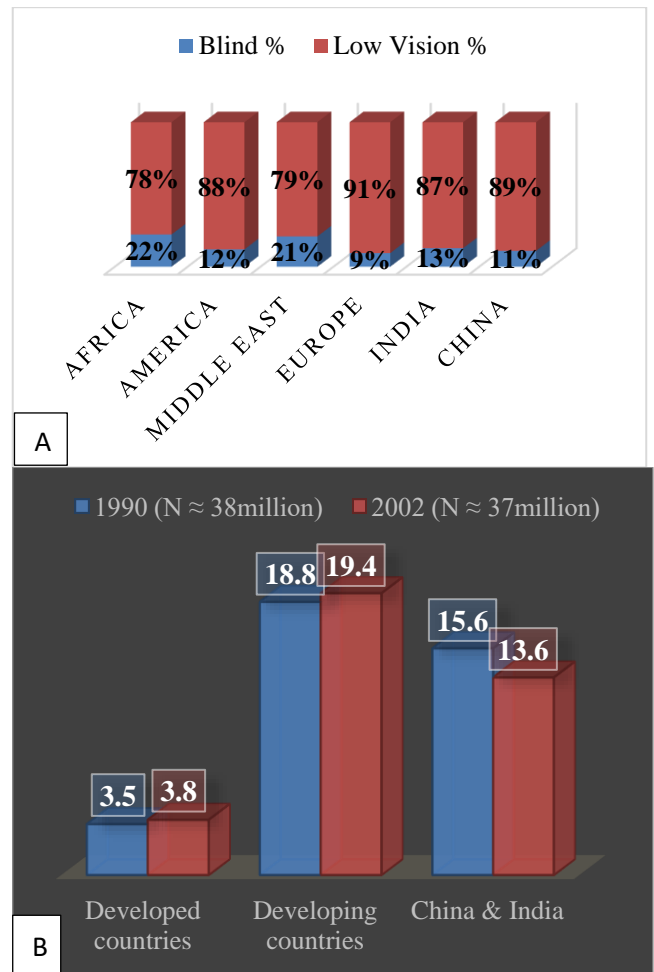


Figure 1: Global outlook of prevalence of visual impairment (Adapted from WHO).¹⁷ (A): Blindness and low vision compared; (B): Regional contributions to global blindness statistics.

EPIDEMIOLOGY OF VISUAL IMPAIRMENT IN SUB SAHARAN AFRICA

Sub-Saharan Africa has an estimated 5-6 million blind and 16-18 million persons with low vision of which around 60% of them live in western African countries including Nigeria.⁴ Eye disease in sub-Saharan Africa is now estimated to affect 18-25% of the population.²³ Figure 2A shows the percentage of Population affected by eye diseases in Sub Saharan Africa.²³ The prevalence of blindness ranged from 0.5 to 1.1 per 1000 children with

the highest prevalence reported in an area in Malawi, once known for vitamin A deficiency. In general, the prevalence of blindness is related to the general level of nutritional care of infants and young children. It is estimated that countries with higher under 5 mortality rates have higher prevalence of childhood blindness as shown in Figure 2B.²⁴

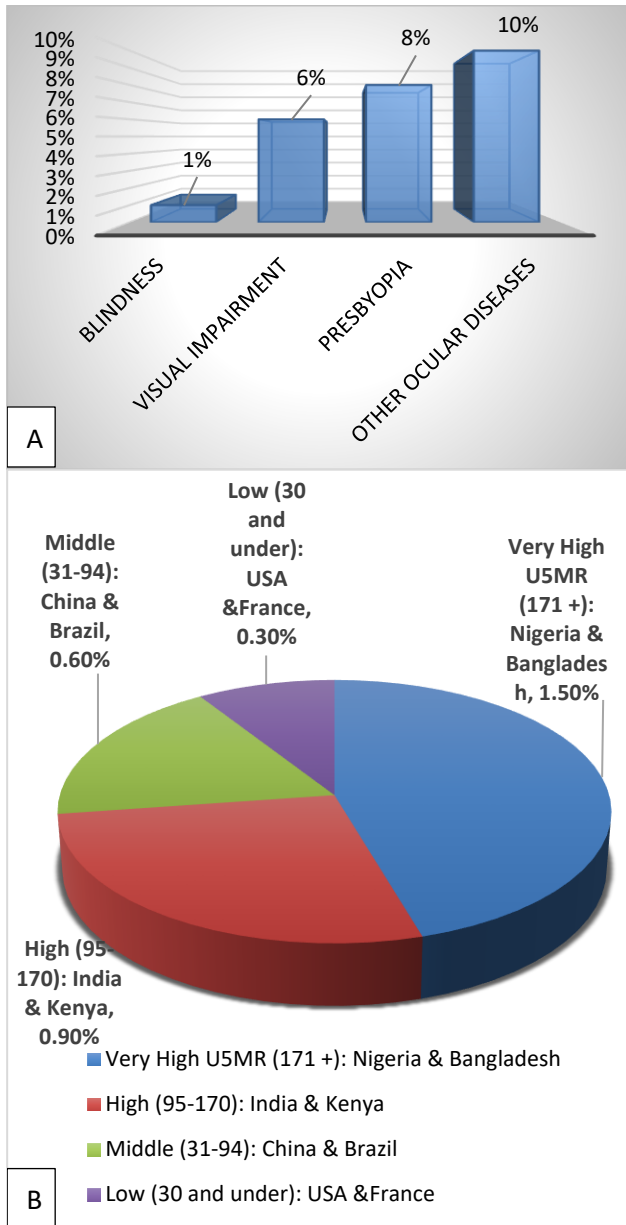


Figure (2A): Percentage of population affected by eye diseases in sub-Saharan Africa; (2B): Prevalence of childhood blindness in different countries.

Many of the causes of severe visual impairment and blindness (SVI/BL) in children are preventable or treatable, and therefore the control of blindness in children is a high priority in the WHO and the International Agency for the Prevention of Blindness (IAPB) VISION2020 initiative, the Right to Sight. Table 4 shows Africa and Sub-Saharan African countries

prevalence of visual impairment in children respectively. Refractive error is a major cause of visual impairment in Sub-Saharan Africa. Figure 3A shows comparison of refractive error vs. visual impairment in sub-Saharan Africa alongside Nigerian zonal evaluation.

EPIDEMIOLOGY OF VISUAL IMPAIRMENT IN NIGERIA

Studies in Nigeria have indicated that refractive errors, conjunctivitis, corneal scarring and injuries were some of the most common eye conditions affecting Nigerian children.²⁸ Allergic conjunctivitis and ocular trauma were the most common causes of eye diseases as well as the leading cause of absenteeism from school in children in south western Nigeria.²⁹ Table 5 shows prevalence and causes of visual impairment by states, and Fig. 3b shows the comparison of visual impairment between children and adults by geopolitical zones in Nigeria.^{19,25,30,31}

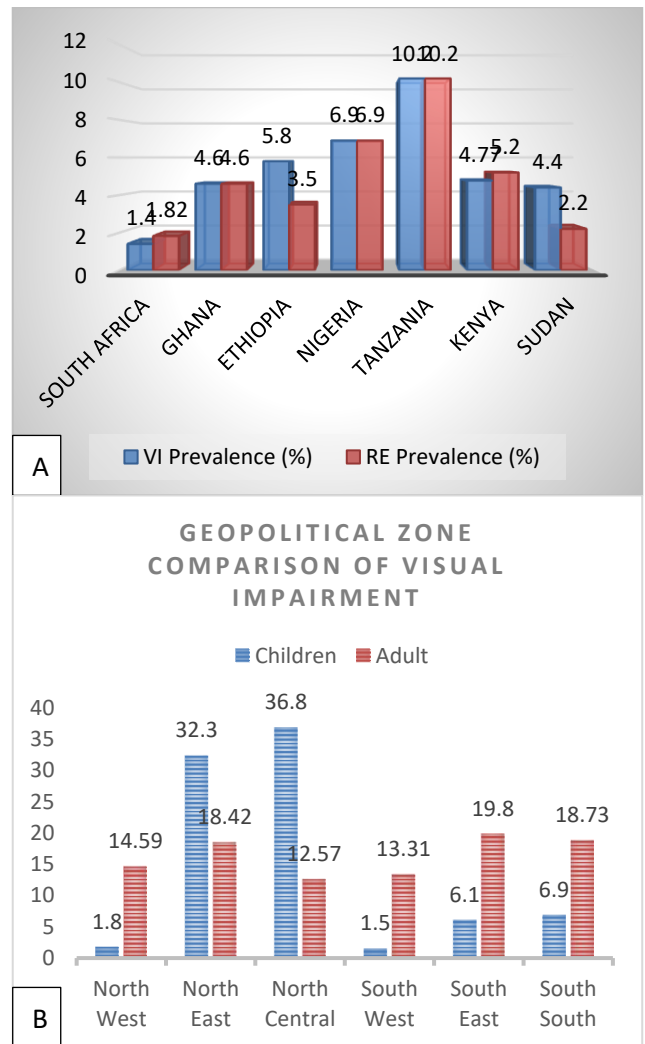


Figure (3A): Comparison of refractive error vs visual impairment in sub-Saharan Africa; (3B): Geopolitical zone (GPZ) comparison of visual impairment between children and adult in Nigeria.

Table 1: Age-specific prevalence of blindness and global estimate of visual impairment by WHO subregion, 2002.

Subregion	Studies	Prev. all age Blindness	Prev. all age low vision	<15 (years)	15-49 (years)	≥50 (years)
Africa region						
Afr-D	Surveys from 13 countries (Benin, Cameroon, Cape Verde, Equatorial Guinea, Gambia, Ghana, Mali, Mauritania, Niger, Nigeria, Sierra Leone, Sudan, Togo)	0.124	0.2	9	1.0	3.0
Afr-E	Surveys from 6 countries (Central African Republic, Congo, Ethiopia, Kenya, South Africa, United Republic of Tanzania)	0.124	0.2	9	1.0	3.0
Americas region						
Amr-A	Surveys from 1 country (United States of America)	0.03	0.1	0.4	0.2	1.2
Amr-B	Surveys from 3 countries (Barbados, Brazil, Paraguay)	0.062	0.15	1.3	0.3	1.7
Amr-D	Survey from 1 country (Peru)	0.062	0.2	2.6	0.5	2.0
Eastern Mediterranean region						
Emr-B	Surveys from 4 countries (Lebanon, Oman, Saudi Arabia, Tunisia)	0.08	0.15	5.6	0.8	2.5
Emr-D	Survey from 1 country (Morocco)	0.08	0.2	7	0.97	2.9
Europe region						
Eur-A	Surveys from 7 countries (Denmark, Finland, Iceland, Ireland, Italy, Netherlands, United Kingdom)	0.03	0.1	0.5	0.2	1.3
Eur-B1	Surveys from 2 countries (Bulgaria, Turkey)	0.051	0.15	1.2	0.4	1.5
Eur-B2	Survey from 1 country (Turkmenistan)	0.051	0.15	1.3	0.3	1.1
Eur-C	No population-based surveys were identified	0.051	0.15	1.2	0.4	1.8
South-East Asia region						
Sear-B	Surveys from 4 countries (Indonesia, Malaysia, Philippines, Thailand)	0.083	0.15	6.3	1.0	2.4
Sear-D	Surveys from 4 countries (Bangladesh, India, Nepal, Pakistan)	0.08	0.2	3.4	0.6	2.0
Western Pacific region						
Wpr-A	Surveys from 1 country (Australia)	0.03	0.1	0.6	0.3	1.2
Wpr-B1	Surveys from 2 countries (China and Mongolia)	0.05	0.15	2.3	0.6	1.9
Wpr-B2	Surveys from 3 countries (Cambodia, Myanmar, Viet Nam)	0.083	0.15	5.6	0.8	1.9
Wpr-B3	Surveys from 2 countries (Tonga and Vanuatu)	0.083	0.15	2.2	0.3	1.2
World		0.57	2.0			

Afr, WHO African Region; Amr, WHO Region of the Americas; Emr, WHO Eastern Mediterranean Region; Eur, WHO European Region; Sear, WHO South-East Asia Region; Wpr, WHO Western Pacific Region. The letter with each sub-region indicates mortality stratum: A is very low child mortality and low adult mortality, B is low child mortality and low adult mortality, C is low child mortality and high adult mortality, D is high child mortality and high adult mortality, E is high child mortality and very high adult mortality; EURO B and WPRO B sub-divided further to capture epidemiological differences; this classification aims at maximising the epidemiological homogeneity of sub-regions (Murray et al. 2001).

Table 2: Global comparison of causes of visual impairment in children (adapted from WHO).^{17,19-22}

Countries	Prevalence (%)					
	RE	Amblyopia	Cornea Ds	Retinal Ds	Cataract	Strabismus
South Africa	63.6	7.3	3.7	9.9	-	-
Nigeria	58.8	5.9	11.8	0	11.8	-
Ghana	71.1	9.9	4.6	5.9	0	-
Kenya	81.08	-	5.41	-	-	2.7
Sudan	57	5.6	-	13.1	3.7	-
Egypt	90.32	-	-	-	-	2.37
Pakistan	89.3	5.0	1.8	-	-	1.8
Vietnam	92.7	2.2	-	0.4	0.7	-
China	95.6	2.8	0.1	0.2	0.1	-
Australia	4.1	80.0	-	-	-	86.4
India	80.9	6.4	1.3	5.1	0.37	-
Malaysia	87.0	2.0	0	0	0	-
Brazil	76.8	11.4	0	5.9	0	-

RE: refractive error; Ds: disease.

Table 3: Global prevalence of refractive error in children.¹⁸

Sub regions	Prevalence of refraction				
	Age (years)	Refraction	Myopia (%)	Hyperopia (%)	Astigmatism (%)
Africa region					
Ghana	26-60 (A)	Non-cycloplegic	10.8	17.5	2.5
Ghana	12-15 (C)	Cycloplegic	3.2	0.3	
Nigeria	≥ 40 (A)	Non-cycloplegic	16.2	50.7	63.0
Nigeria	6-15 (C)	Non-cycloplegic	9	52.2	38.8
Ethiopia	1-80 (A)	Non-cycloplegic	34.5	38.3	
Ethiopia	7-18 (C)	Non-cycloplegic	6.0	0.33	2.17
South Africa	3 -90 (A)	Non-cycloplegic		37.7	25.7
South Africa	5-15 (C)	Cycloplegic	4.0	2.6	9.6
Americas region					
USA	>50 (A)	Non-cycloplegic	35.1	40.2	45.6
USA	3-5 (C)	Non-cycloplegic	21	58	
Brazil	>1 (A)	Cycloplegic	25.3	33.8	59.7
Brazil	7 -15 (C)	Non-cycloplegic		13.4	
Eastern Mediterranean region					
Saudi Arabia	16-39 (A)	Non-cycloplegic	24.4	11.9	9.5
Saudi Arabia	12-13 (C)	Non-cycloplegic	53.7		
Iran	>54 (A)	Non-cycloplegic	27.2	51.6	37.5
Iran	7-15 (C)	Cycloplegic	4.35	5.04	11.27
Sudan	10-60 (A)	Non-cycloplegi	6.6	19.6	10.9
Sudan	6-15 (C)	Cycloplegic	6.8	1.9	2.5
Jordan	17- 40 (A)	Non-cycloplegic	36.3	5.67	36.8
Jordan	12- 17 (C)	Non-cycloplegic	63.5	11.2	
Pakistan	>30 (A)	Non-cycloplegic	2.5	27.1	
Pakistan	5 -16 (C)	Cycloplegic	1.89	0.76	
Europe region					
Netherlands	17-60 (A)	Non-cycloplegic	30	10	
Netherlands	11-13 (C)	Non-cycloplegic	28	8	
Norway	38 -87 (A)	Non-cycloplegic	19.4	33.7	
Norway	Mean 20.6 (C)	Cycloplegic			47
South-East Asia region					
India	>40 (A)	Non-cycloplegic	19.4	39.7	
India	7-15 (C)	Cycloplegic	4.1	0.8	6.30
South Korea	>20 (A)	Non-cycloplegic	41.8	24.2	
South Korea	8-13 (C)	Non-cycloplegic	46.5	6.2	
Singapore	40-79 (A)	Non-cycloplegic	38.7	28.4	
Singapore	15-19 (C)	Non-cycloplegic	73.9	1.5	58.7

Continued.

Sub regions	Prevalence of refraction				
	Age (years)	Refraction	Myopia (%)	Hyperopia (%)	Astigmatism (%)
Western Pacific region					
Australia	49-97 (A)	Non-cycloplegic		57	37
Australia	4-12 (C)	Non-cycloplegic	14.02	38.4	
China	≥ 40 (A)	Non-cycloplegic	38.5	19.9	
China	6-21 (C)	Cycloplegic	54.1	15.5	

(A): Adult; (C): Children.

Table 4: Prevalence of visual impairment in Africa and refractive error in sub Saharan Africa.^{20,21,25-27}

Countries	Visual impairment prevalence (%)	Countries	Refractive error prevalence (%)
South Africa	1.4	South Africa	1.82
Ghana	4.6	Ghana	4.6
Ethiopia	5.8	Ethiopia	3.5
Nigeria	6.9	Nigeria	6.9
Tanzania	10.2	Tanzania	10.2
Kenya	4.77	Kenya	5.2
Sudan	4.4	Sudan	2.2
Egypt	29.4		
Malawi	2.4		
Uganda	11.6		
Rwanda	18.9		

Table 5: Comparison of causes and prevalence of Visual Impairments among children in Nigeria.^{19,25,30,31}

States*	Anambra	Cross Rivers	Kaduna-Zaria	Osun, Ilesa East	
Causes	Refractive error	0.7	11.5	8	5.8
	Conjunctivitis		18.8	7.3	7.4
	Amblyopia	0.3	0.3	-	-
	Glaucoma	0.1	2.5	3.7	-
	Cataract	0.1	-	-	0.2
	Retina Diseases	0.2	0.2	-	-
	Cornea Diseases	0.1	0.2	-	0.3
	Others	0.1	0.7	1.5	0.9
Prevalence (%)	6.1	32.1	22.6	15.5	

*Limited to states where literature presented data for both causes and prevalence.

DISCUSSION

Most data on causes of childhood blindness come from surveys of blind schools. Corneal scar/phthisis bulbi is the leading anatomical cause of blindness and severe visual impairment in reports from West Africa (Togo, Benin, Ghana), East Africa (Zimbabwe), Southern Africa (Malawi), and followed by retinal disease. Corneal scar/phthisis bulbi as a cause of blindness and severe visual is lower in Kenya and Uganda, respectively.³² Lower rates of corneal blindness may reflect improved measles immunisation coverage rates, emphasising the relation between childhood blindness and general health care in the evolving epidemiology of childhood blindness. The bulk of childhood blindness is either preventable or treatable. Vitamin A deficiency not only may cause blindness through the development of keratomalacia, but it is a common cause of mortality in children. The association of measles or a recent history of measles with corneal ulceration has been well documented.³³

Refractive error is a significant cause of low vision (vision less than 6/18 but better than or equal to 3/60). In studies of self-presenters, refractive error (mostly presbyopia) was found to be the single most important diagnosis in South Africa, Nigeria, and Uganda.³⁴ In Nigeria refractive error was the cause of 59% of visual loss in those between 5 and 15 years of age. Retinal diseases as a whole generally account for less than 5% of blindness in surveys; age related macular degeneration (AMD) is generally considered to be uncommon in Africans. However, several reports document its existence in selected populations in Nigeria.³⁵

Women tend to be more visually impaired compare to men worldwide. A number of factors contribute to this gender imbalance, including the longer life expectancy of women compared with that of men, women suffer disadvantages in terms of access to eye health services due to multiple socio-economic and cultural factors.³⁶

Studies in Nigeria, and Kenya, reported higher prevalence of visual impairment in male.^{37,20} While other study in Saudi Arabia³⁸ reported higher prevalence of visual impairment in female than in male. Visual impairment varies with age in different countries of the world including Africa. Visual impairment is lower in most countries among children than adults.^{19,21}

Prevalence of visual impairment of 6.9% in South-South Nigeria where Delta State is located was lower than that of Tanzania, Egypt, Vietnam, China, Pakistan, Malaysia, and India, but higher than that of Sudan, Ethiopia, South Africa, Ghana, Kenya, UK, Ireland, Australia, Netherlands, and Brazil.^{18,22,25,26} However, it is noteworthy that the prevalence varies in different geopolitical zone (Figure 3). It was lowest in south west and North West regions with a prevalence of 1.5%.¹⁹ This may be as a result of the high literacy level, increasing awareness of the population to seek eye care early as well as the presence of eye care practitioners in the regions. North Central with visual impairment of 36.8%³¹ had the highest level of visual impairment in Nigeria. South East with prevalence of 6.1% was only slightly lower than that of South-South region.³⁰ The plausible interpretation is level of illiteracy and not seeking eye care services as well as variability in affordances of eye-care including but not limited to lack of eye care professionals in the regions.

CONCLUSION

Reduction of avoidable visual impairment remains an important international public health goal. Knowledge of the magnitude and causes of childhood visual impairment is important to the planning, provision, and evaluation of educational and health services for affected children.

Visual impairment has significant implications for the affected child and family in terms of education, future employment, and personal and social welfare throughout life, especially for developing children. Interesting, there is currently lack of data regarding this phenomenon of interest among children in Delta State Nigeria, hence a need for investigation.

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