

# Ocular disorders among schoolchildren in Khartoum State, Sudan

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## الاضطرابات العينية لدى أطفال المدارس في ولاية الخرطوم، السودان

عادل الرشود، شاه عظمت، مسعود شارق، عمار خميس، خليل لاکو، زاهد جادون، نعمت الله سيال، عبد العزيز الرشود، العاص أحمد كامل

الخلاصة: أجرى الباحثون تحريماً شمل 1418 من المدارس الابتدائية في الخرطوم، السودان، في الفترة من 2005 - 2007، من أجل تقدير المشكلات العينية بين الأطفال ممن هم في عمر 6-15 عاماً. وتحووا 119 671 طفلاً (56.7% منهم ذكور) بحثاً عن اختلالات واضحة في الانكسار أو اعتلال في العين الأخرى. ووجد الباحثون مشكلات عينية لدى 20 321 طفلاً (3.03%)، أما المواقع التي كان فيها أعلى معدلات الأمراض العينية فكانت كاراري 26.2%، عمبادا (21.0%)، وجبل أوليه 15.7%. وكان المعدل الإجمالي لأخطاء الانكسار 2.19%، أما الحسّر فكان لدى 10 064 طفلاً (1.50%) في حين شوهد مد البصر لدى 4661 (0.70%). ومن المشكلات العينية الأخرى التهاب الملتحمة والقرنية المنقول جنسياً، وعوز الفيتامين "أ"، والتهاب الملتحمة الجرثومي، والحول والكثافة القرنية. ولم يتم تشخيص أكثر من 288 (0.04%) طفلاً بالترخوما النشطة؛ وكان 86.5% منهم من موقع عمبادا في المناطق النائية من الولاية، حيث مرافق النقل سيئة والفقر منتشر على نطاق واسع. وعلى وجه الإجمال فإن 99% من أمراض العين التي تعرف الباحثون عليها كانت إما قابلة للمعالجة أو يمكن الوقاية منها. وللإقلال من هذه الأمراض وبلوغ مرمى "الرؤية 2020" تمس الحاجة إلى برامج الصحة المدرسية العالية الفعالية والكفاءة.

**ABSTRACT** From December 2005 to June 2007, a total screening of all 1418 government primary schools in Khartoum State, Sudan, was performed to estimate ocular problems among children aged 6–15 years. We screened 671 119 children (56.7% males) for significant refractive error and other eye ailments. Ocular problems were found in 20 321 (3.03%) children. The 3 localities with highest ocular pathology were Karary (26.2%), Ummbada (21.0%) and Jabal Awlia (15.7%). The overall prevalence of refractive error was 2.19%. Myopia was found in 10 064 (1.50%) children while 4661 (0.70%) were hyperopic. Other ocular problems included vernal keratoconjunctivitis, vitamin A deficiency, microbial conjunctivitis, strabismus and corneal opacity. Only 288 (0.04%) children were diagnosed with active trachoma: 86.5% of these were from Ummbada locality, on the periphery of the State, where transportation facilities are poor and poverty is widespread. Overall, 99% of the eye ailments identified are either treatable or preventable. To reduce these and to achieve the goals of Vision 2020, an effective and efficient school health programme is needed.

## Troubles oculaires chez des écoliers dans l'État de Khartoum (Soudan)

**RÉSUMÉ** De décembre 2005 à juin 2007, un dépistage exhaustif dans l'ensemble des 1418 écoles primaires publiques de l'État de Khartoum (Soudan) a été mené afin d'évaluer les troubles oculaires des enfants âgés de 6 à 15 ans. Nous avons soumis 671 119 enfants (56,7 % de sexe masculin) à un dépistage des vices de réfraction et autres pathologies apparentées. Des troubles oculaires ont été dépistés chez 20 321 enfants (3,03 %). Les trois localités où ce type de pathologies étaient les plus fréquentes étaient Karary (26,2 %), Ummbada (21,0 %) et Jabal Awlia (15,7 %). La prévalence globale des vices de réfraction s'élevait à 2,19 %. Une myopie a été diagnostiquée chez 10 064 enfants (1,50 %) et une hypermétropie chez 4661 élèves (0,70 %). La kératoconjonctivite vernale, la carence en vitamine A, la conjonctivite microbienne, le strabisme et l'opacité cornéenne comptaient parmi les autres troubles oculaires. Seuls 288 enfants (0,04 %) ont reçu le diagnostic de trachome actif : 86,5 % d'entre eux étaient originaires de la localité d'Ummbada, à la périphérie de l'État, où les transports sont médiocres et la pauvreté généralisée. Globalement, 99 % des maladies oculaires identifiées étaient soit traitables, soit évitables. Afin de réduire leur prévalence et de réaliser les objectifs de Vision 2020, il est nécessaire d'avoir un programme de santé scolaire qui soit efficace et bien organisé.

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## Introduction

Blindness and visual impairment remain a major problem in the world today. There are an estimated 37 million people worldwide who suffer from blindness and 161 million who suffer from visual disability; around 80% of these are avoidable [1]. Cataract, which can be easily operated upon and cured, is responsible for more than half of the blindness in the world. Glaucoma, diabetic retinopathy, trachoma, uncorrected refractive error and childhood blindness make up the rest [1]. According to the World Health Organization (WHO), the number of blind children in the world is approximately 1.4 million, and three-quarters of these live in the poorest regions of Africa and Asia [2].

The available data suggest that there is wide regional variation in the major causes of blindness in children. In wealthy parts of the world lesions of the central nervous system predominate, while in poorer countries corneal scarring as a result of acquired diseases are the most important causes [3].

Children are given priority in the Vision 2020 initiative and WHO plans for fighting blindness [4]. In developed countries, screening for eye diseases in preschool and school-aged children is done routinely [5,6]. Vision screening to detect eye problems in school-aged children dates back at least a century [7], but as yet no such services are available in Sudan.

Sudan is one of the largest countries in Africa, but has poor socioeconomic status. Blindness remains a major public health problem, with around half a million people blind, mostly due to cataract, glaucoma, onchocerciasis and childhood blindness. The prevalence of blindness in Sudan is estimated to be 1.5% [8,9].

Currently there are no data available on pattern of eye problems in children in Sudan and owing to the absence of effective school health services the situation has become more serious. Causes

of avoidable blindness among children need early detection and intervention.

This study focuses on assessing the burden of ocular disorders in schoolchildren in order to plan effectively for prevention and/or managing avoidable blindness among Sudanese children. We estimated the prevalence of ocular problems in schoolchildren aged 6–15 years, in Khartoum State, Sudan.

## Methods

This study was conducted in all 1418 governmental basic schools in Khartoum State, Sudan. It started in December 2005 and was completed by the end of June 2007. This was a total coverage survey for these types of schools. In 2008, the population was estimated at 7.15 million, around 24% of the total population of Sudan [10]. Basic schools are present in all areas of the State.

A total of 671 119 schoolchildren aged 6–15 years were included in the survey.

### Study procedure

The teams visited all governmental basic schools in Khartoum State according to a planned schedule. All children were screened. Multiple visits were paid to each site to ensure coverage of any absentees.

Visual acuity (V/A) of each eye was assessed using Snellen's E chart at a distance of 6 m. The targeted age group (aged 6–15 years) allowed using the E-chart with ease. External ocular examination was done with torch and hand-held magnifier, while the fundus was examined with direct ophthalmoscope. Refraction was done to obtain maximum vision amongst children with visual acuity  $\leq 6/12$  and showing improvement with pin-hole.

Treatment was provided for common ocular conditions such as conjunctivitis, vernal catarrh etc. Children with V/A  $\leq 6/12$  were refracted and provided with corrective spectacles when needed. Children with xerophthalmia

were provided with vitamin A capsules and health education regarding vitamin A deficiency disorders. Children needing surgical intervention were referred to tertiary eye care facilities in Makkah Eye Complex, Khartoum.

The check-list for the survey covering the data collected for each pupil was piloted on patients attending the paediatric ophthalmology clinics in the out-patient department of Makkah Eye Complex in Khartoum. This was carried out to ensure the feasibility and practicality of collecting such information, as well as to train the team members in form-filling, coding and data entry.

### Field methodology

Although the initial plan was to recruit and train school teachers to perform the initial screening and visual acuity testing, this plan could not be continued due to lack of interest among the teachers. Seven field teams were formed for the purpose of screening. Each team consisted of 2 optometrists and 2 ophthalmic assistants provided from well-established, busy paediatric ophthalmology out-patient clinics at Makkah Eye Complex. A community ophthalmologist supervised the overall activities of the screening. Multiple visits were paid to each site to ensure coverage of any absentees. The survey was done in 2 rounds. First, the ophthalmic assistants screened the children by checking V/A and looking for any ocular disorders. In the second round the optometrists and the ophthalmic assistants refracted all with V/A  $\leq 6/12$ . In both rounds, the V/A of each eye was assessed separately. External ocular examination was done with the help of a magnifying loupe ( $\times 1.25$ ) and a pin-light to distinguish red eye, discharging eyes, and white spot in the eye (corneal scar) as well as crossed-eyes. The fundus was examined with a direct ophthalmoscope. Refraction was done to obtain maximum vision. Spherical equivalents were calculated for each refractive finding. Myopia was defined as  $-0.50$  based on the spherical equivalent

readings, and hyperopia was defined as  $+1.50$  based on the same.

Detailed ocular examination including fundoscopy with direct ophthalmoscope was performed on all children with best corrected V/A  $< 6/18$ . History of poor vision at night or in dim light, loss of conjunctival and corneal lustre together with white spot (scar) in the cornea were considered hallmarks of vitamin A deficiency. Cataract was diagnosed by assessing the red reflex using distant direct ophthalmoscopy.

Forms (check-lists) were completed only for those with either an eye ailment or binocular vision  $\leq 6/12$ . Figure 1 demonstrates the steps taken during the field and hospital work. Each examination took 5–10 minutes.

### Data management and analysis

Completed data forms were reviewed in the field for accuracy and missing values. Data were double entered in the computer using *SPSS for Windows*, version 13.0. Verification and data cleaning were conducted at Makkah Eye Complex. Frequency and distribution tables were constructed as descriptive statistics. Results were cross-tabulated to examine the relationships between variables.

Statistical analysis was performed using the chi-squared test for association and Fisher's exact test, as appropriate. *P*-values  $< 0.05$  were considered statistically significant in all statistical analyses.

### Ethical approval

The study was approved by the ethical committees of Makkah Eye Complex, Khartoum State Ministry of Health and Khartoum State Ministry of Education. Informed consent for examination and cycloplegic refraction was obtained from parents via the teachers. Ophthalmic medicine, including vitamin A capsules and free glasses were provided to all children detected as having any eye problem or refractive error.

## Results

A total of 671 119 schoolchildren (56.7% males) aged 6–15 years from 1418 governmental schools were

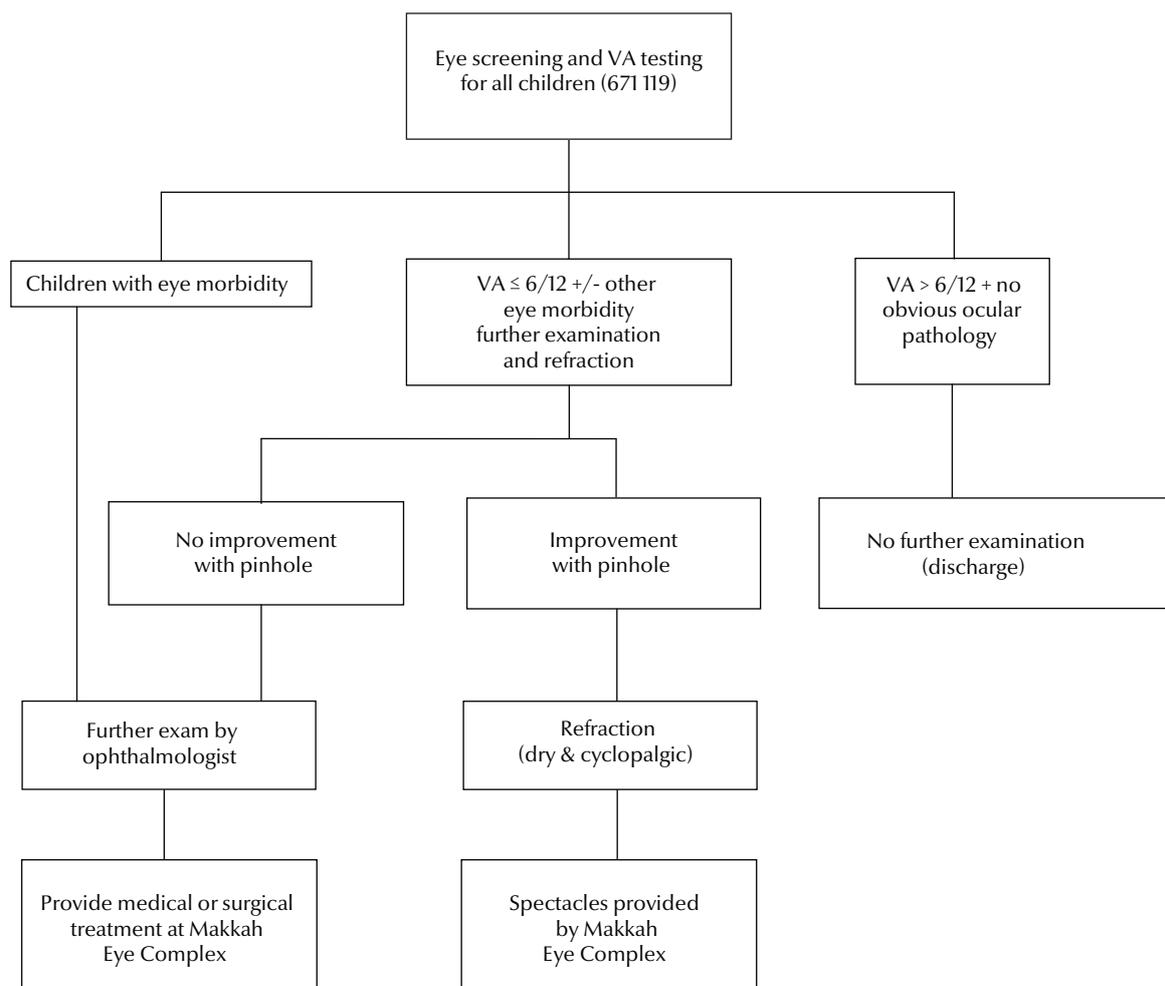


Figure 1 Scheme of the steps taken during the field and hospital work: VA = visual acuity

**Table 1 Distribution of eye problems among schoolchildren aged 6-15 years in Khartoum State, Sudan, December 2005-June 2007**

Eye problem	No.	%
Refractive error only	10 987	1.63
Other eye ailments only	5 596	0.83
Refractive error + other eye ailments	3 738	0.56
No problem	650 798	96.97
Total	671 119	100.00

screened. Initial screening indicated 30 693 pupils suspected of having some ocular ailment. Further evaluation of this group by senior staff excluded 10 372 children from the initial suspects. This left 20 321 (3.03%) children who had some ocular problem: 10 125 (49.8%) of those were aged  $\leq 10$  years; 11 543 (56.8%) were boys.

The overall prevalence of refractive error (RE) was 2.19% (Table 1). This makes RE the most common cause for ocular morbidity among the schoolchildren (72.5%; 14 725 of 20 321): 8233 (55.9%) of these were boys (Table 2). We found 10 064 children had myopia and 4661 were hyperopic, giving a prevalence of 1.50% and 0.70% for

myopia and hyperopia respectively. Of the 14 725 children with RE, 7028 (47.7%) were aged  $\leq 10$  years (Table 2). Hyperopia, but not myopia, was more associated with female sex (Table 2). Among females, there was no association between age and type of RE. Myopia was associated with older age amongst male children in our study.

Karary locality had the highest number of children with RE (5096; 34.6%) while Sharq el Nil has the lowest number (527; 3.6%) (Table 3).

Some ocular disorders showed a significant association with sex (Table 2): hyperopia, strabismus, trachoma and chalazia were more prevalent among

girls ( $P = 0.001$ ), and myopia, vernal keratoconjunctivitis and corneal opacities were more common among boys ( $P = 0.001$ ). With the exception of cataract and nystagmus, all other ocular morbidities were statistically significantly associated with sex.

Cataract was found coexisting with other eye ailments and was dealt with separately in the data analysis. Visually disturbing cataract of any grading and any type (congenital, developmental or traumatic) was diagnosed in 261 (0.04%) children, 145 (55.6%) boys and 116 (44.4%) girls (Table 2). Of these, 137 (52.5%) were aged  $> 10$  years. Almost 29% (75 out of 261) of these cases came from Karary locality (Table 3).

Of the other ocular problems diagnosed, with or without RE, the most commonly occurring were vernal keratoconjunctivitis (spring catarrh) 3429 (0.51%) followed by vitamin A deficiency 2397 (0.36%) (Table 2). The prevalence of trachoma, chalazion, ptosis and nystagmus were all below 0.05% (Table 2). Of the 288 pupils who were diagnosed as having active

**Table 2 Prevalence of ocular problems in schoolchildren ( $n = 671 119$ ) in Khartoum State, Sudan and association with age and sex**

Ocular problem	Prevalence		Age (years)				P-value	Sex				
			$\leq 10$		$> 10$			Male		Female		P-value
	No.	%	No.	%	No.	%	No.	%	No.	%		
Refractive error	14 725	2.19	7 028	47.7	7 697	52.3	0.001	8 233	55.9	6 492	44.1	0.001
Hyperopia	4 661	0.70	1 881	40.4	2 780	59.6	0.001	1 989	42.7	2 672	57.4	0.001
Myopia	10 064	1.50	5 147	51.1	4 917	48.9	0.001	6 244	62.0	3 820	38.0	0.001
Vernal keratoconjunctivitis	3 429	0.51	1 801	52.5	1 628	47.5	0.001	2 065	60.2	1 364	39.8	0.001
Vitamin A deficiency	2 397	0.36	1 214	0.6	970	40.5	0.002	1 427	59.5	970	40.5	0.002
Microbial (non-allergic) conjunctivitis	1 501	0.22	852	56.8	649	43.2	0.001	904	60.2	597	39.8	0.003
Strabismus <sup>a</sup>	1 466	0.22	750	51.2	716	48.8	0.151	706	48.2	760	51.8	0.001
Other corneal opacities	1 319	0.20	727	55.1	592	44.9	0.001	826	62.6	493	37.4	0.001
Trachoma	288	0.04	216	75.0	72	25.0	0.001	126	43.8	162	56.2	0.001
Cataract	261	0.04	124	47.5	137	52.5	0.515	145	55.6	116	44.4	0.365
Chalazion (lid lump)	199	0.03	72	36.2	127	63.8	0.001	89	44.7	110	55.3	0.001
Ptosis	128	0.02	76	59.4	52	40.6	0.019	62	48.4	66	51.6	0.034
Nystagmus	61	0.01	30	49.2	31	50.8	0.511	28	45.9	33	54.1	0.056

$P < 0.05$  was considered significant:  $\chi^2$  distribution test.

<sup>a</sup>Fortunately, 82.0% (1202) of these were not amblyopiogenic (i.e. alternating strabismus).

Table 3 Distribution of ocular problems in schoolchildren (n = 671 119) in Khartoum State, Sudan according to locality

Ocular problem	Bahry		Jabal Awlia		Karary		Khartoum		Omdurman		Sharq el Nil		Ummbada		P-value
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Refractive error	2119	14.4	2198	14.9	5096	34.6	1896	12.9	12810	8.7	527	3.6	1608	10.9	0.001
Hyperopia	651	14.0	488	10.5	1764	12.4	577	12.4	324	7.0	273	5.9	584	12.5	0.001
Myopia	1468	14.6	1710	17.0	3332	33.1	1319	13.1	957	9.5	254	2.5	1024	10.2	0.001
Vernal keratoconjunctivitis	413	12.0	1145	33.4	174	5.1	429	12.5	248	7.2	25	0.7	995	29.0	0.001
Vitamin A deficiency	137	5.7	193	8.1	1169	48.6	32	1.3	76	3.2	175	7.3	618	25.8	0.001
Microbial (non-allergic) conjunctivitis	112	7.5	136	9.1	249	16.6	85	5.7	290	19.3	74	4.9	555	37.0	0.001
Strabismus	95	6.5	135	9.2	608	41.5	196	13.4	152	10.4	129	8.8	151	10.3	0.001
Other corneal opacities	118	8.9	174	12.3	147	11.1	60	4.5	77	5.8	309	23.4	434	32.9	0.001
Trachoma	3	1.0	10	3.5	1	1.0	0	0.0	1	1.0	24	8.3	249	86.5	NA
Cataract	25	9.6	34	13.0	75	28.7	24	9.2	15	5.7	42	16.1	46	17.6	0.001
Chalazion (lid lump)	13	6.5	46	23.1	21	10.6	11	5.5	23	11.6	7	3.5	78	39.2	0.001
Ptosis	9	7.0	9	7.0	39	30.5	6	4.7	15	11.7	14	10.9	36	28.1	0.001
Nystagmus	9	14.9	4	6.6	12	19.7	8	13.1	4	6.6	13	21.3	11	18.0	0.008

P-value < 0.05 was considered significant:  $\chi^2$  distribution test.  
NA = not available.

trachoma, 249 (86.5%) were from Ummbada locality (Table 3).

Cataract, strabismus, ptosis and vitamin A deficiency were more prevalent in Karary than in other localities ( $P = 0.001$  for each) (Table 3). Trachoma, other corneal opacities (post-traumatic or post-infective), chalazia and microbial conjunctivitis significantly predominated in Ummbada locality. One third of the children with vernal keratoconjunctivitis (1145 out of 3429) were from Jabal Awlia locality.

## Discussion

The prevalence of ocular morbidity detected amongst the schoolchildren in our study was 3.03%. This is lower than the prevalence in studies from Tibet (18.36%) [11], Nepal (11%) [12] and Ethiopia (62.6%) [13]. Males outnumbered females in having eye diseases: 56.3% of boys and 43.7% of girls had some ocular pathology. This is contradictory to the findings from some studies in Nigeria [14] and Pakistan [15].

Distribution of eye diseases varied from region to region. Most of the eye problems were reported amongst children from Karary and Ummbada. Most probably, the reason for this is that these 2 localities are situated in the periphery of Khartoum State and are far from the centre of Khartoum, away from contacts and eye care services. Transportation facilities are poor and poverty is widespread. It is important to note here that these locations are preferred places for many "temporary settlers" who are migrating from different areas of Sudan to Khartoum State. These regions are heavily populated and schools are very crowded (perhaps 100 or more in a class). These conditions facilitate contamination and infection between children. On the other hand, on the whole, Khartoum and Sharq el Nil localities had the lowest proportion of ocular morbidity among schoolchildren (with the exception of strabismus, nystagmus and cataract). These 2 localities are considered to be the richest areas in Khartoum State. Inhabitants are mostly high-ranking government employees and people of high socioeconomic status.

The prevalence of RE amongst the children was 2.19%. It is worth mentioning that the initial screening in a few cases was performed by trained teachers and ophthalmic technicians. It is likely

this resulted in missing some children with RE, leading to an underestimation of the prevalence of this problem. More important, as cycloplegic refraction was only done on those children with obvious ocular morbidity, there is a high possibility that some pupils with RE, especially low hyperopes, were missed. The prevalence is lower than what was found in studies in Nepal (2.9%) [16], Malaysia (17.1%) [17], China (22.3%) [18] but more than in studies from South Africa (1.4%) [19] and Tanzania (1%) [20], though in Tanzania, the age group studied was slightly different from that in the current study, focusing on pupils aged 7–19 years.

Hyperopia in our study was quite low, even with a definition of +1.50 D or more. This is most probably because cycloplegic refraction was not done on everyone. Both myopia and hyperopia were more prevalent in pupils aged > 10 years. This is very important because amblyopia is considered by most authorities to be untreatable above this age [21], while it is manageable in those < 10 years with proper occlusion and refractive therapy. When the prevalence of RE ( $VA \leq 6/12$ ) is 2%–5%, WHO recommends active intervention, and considers this as a moderate priority [22]. The 2.19% prevalence for RE in this study is most likely an underestimation of the total burden of this problem in Sudanese children. There are children who do not go to school, and it is likely that some of those will have some visual impairment due to RE. Additionally, a small number of enrolled children were absent from school at the time of screening even though this was partially overcome by arranging more than one visit to each site.

Vernal keratoconjunctivitis was the second most common cause of ocular pathology (0.51%). This was close to what was found in schoolchildren in a study in southern Ethiopia (0.7%) [13] but much lower than in a study in South-Western Nigeria (7.4%) [23]. Most of the vernal keratoconjunctivitis

cases are of the limbal form, well known in African people. This form is more severe, hence more associated with complications such as corneal vascularization and ectatic corneal changes like keratoconus [24].

Just under 0.4% of our sample had some ocular manifestation of vitamin A deficiency. It is clear that with the criteria followed in the diagnosis of this problem, a number of cases were missed and under-diagnosis of this morbidity was likely.

Microbial conjunctivitis and other corneal opacities were diagnosed in 0.22% and 0.20% of our sample respectively. Almost two-thirds of the corneal scars were found in boys. Similar findings have been reported in studies from Ethiopia and Nigeria [13,14,23].

Strabismus was the fifth most common cause of ocular morbidity in our sample of Sudanese schoolchildren. Overall prevalence was 0.22%. This is much lower than Oman (0.9%) [25] and the Islamic Republic of Iran (1.2%) [26].

Surprisingly, trachoma was not a major cause of ocular morbidity in our sample of schoolchildren from Khartoum State. Only 288 (0.04%) pupils were diagnosed with active trachoma. This is in contrast to reports from some regions of southern Sudan, where trachoma was found to be endemic and there was an unusually high prevalence of active trachoma and trachomatous trichiasis in children [27]. Early stages of the disease (F1 and F2) can be asymptomatic and may be overlooked in quick ocular examination. This leads to the suspicion that trachoma might be under-diagnosed in our study. An interesting finding is that 86.5% of the diagnosed cases of trachoma were found in Ummbada locality. This area is poor and has harsh environmental conditions. A modest prevalence of trachoma has also been found in studies in Tanzania [20], Ethiopia [13] and Nigeria [28,29].

A small proportion of children in our study (0.04%) had visually disturbing cataract. This is lower than in children from South Africa (0.6%) [19] and Tanzania (0.22%) [20]. Zeidan Z et al. studied the prevalence and causes of visual impairment and blindness in children under 16 years among internally displaced people in Khartoum State [30]. They found that the commonest anatomical sites of visual loss in the 40 blind and/or severely visually impaired children were corneal scarring (mostly related to vitamin A deficiency disorders) and lens opacity (cataract).

The strength of this study comes from the large number of children examined. This is also a maiden study on childhood ocular morbidity in Sudan, and it provides baseline data for strategies of planning and implementation of the Vision 2020 initiative.

One of the weaknesses of this study is that data was collected by optometrists and ophthalmic technicians and that possibly limited the ability to detect posterior segment disorders and hence miss some of the morbidity.

## Conclusion

This study shows that 99% of the eye ailments we identified in the schoolchildren we studied are either treatable or preventable. This is a very high proportion of avoidable and/or treatable eye disease compared with other countries.

In the absence of an efficient school screening programme, the prevalence of eye diseases in schoolchildren may rise. Refractive error, vitamin A deficiency, corneal opacities and ocular alignment problems are on the high priority list of the WHO Vision 2020 Programme. They are also the commonest causes of ocular morbidities in Sudanese children.

Our findings also indicate that if a trachoma campaign is to be started, Ummbada locality should have priority since more than 85% of the trachoma cases identified were in that locality.

To achieve the goals of Vision 2020 in Sudan, there is a need to start an effective and efficient school health programme. This will enable eye-health workers to prevent and/or treat 99% of eye diseases in school-going children.

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