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Ocular morbidity among children (aged 6-18 yr) of the tribal area of Melghat, India: A community-based study

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***Background & objectives*: Most of the ocular morbidities among school children are preventable or treatable. Melghat, a difficult to access, hilly, forest, tribal area with poorly developed infrastructure in the Amravati district of Maharashtra. Scarcity of ophthalmologists and low health-seeking behaviour of tribal people contributes to the high burden of ocular morbidity. Given the lack of published studies on the ocular morbidity among children in Melghat, outreach programmes are essential to diagnose and treat visual impairments promptly. The objective was to determine the prevalence of ocular morbidity among children in the tribal area of Melghat.**

***Methods*: A community-based observational study was carried out in the Chikhaldara and Dharni blocks of Melghat. Children from 15 tribal villages were screened for eye disorders by trained paramedics. Most of the children were examined by an ophthalmologist. We used Chi-square test for categorical variables.**

***Results*: A total of 4357 children aged between 6 and 18 yr were examined. Of these 2336 (53.6%) were females and 2021 (46.4%) were males. Out of 4357 children, 507 (11.63%) had an ocular morbidity. The prevalence of ocular morbidity and refractive error increased in the age group of 8-10 yr ($P<0.05$ and <0.001, respectively). Refractive error was the most common ocular morbidity (n=339; 7.8%), followed by vitamin A deficiency (VAD) (n=120; 2.8%).**

***Interpretation & conclusions*: The prevalence of refractive error and VAD in this study was significantly higher than the rest of India and the world. For the prevention of childhood blindness, immediate intervention programme, including eye screening by trained paramedics, treatment by an ophthalmologist and prophylaxis, is crucial.**

Key words Melghat - ocular morbidity - refractive error - tribal - vitamin A deficiency

Childhood blindness is an important problem due to the blindness burden in terms of blind-person years[1]. The definition of childhood blindness is 'presenting visual acuity (VA) of lower than 3/60 in the healthier eye of a child, 16 yr and younger'[2]. Globally, around 1.4 million and 0.8 per 1000 children are suffering from blindness[3] and visual impairment,[4] respectively. Globally, the most important causes of avoidable

childhood blindness are corneal scarring, followed by cataract and ROP[5] . Uncorrected refractive error is reportedly the cause of visual impairment globally in 13 million children aged 5-15 yr, as per World Health Organization (WHO)[6]. Based on WHO criteria for childhood blindness[7], out of 1.5 million blind children worldwide, one million are in Asia, 0.3 million in Africa and 0.2 million in rest of the world[8]. Out of the total global burden of visual impairment in 2010, the preventable causes were as high as 80 per cent[9].

Globally, vitamin A deficiency (VAD) is a significant contributor to the burden of diseases[10]. In low- and middle- income countries (LMICs), 7-31 per cent of childhood blindness and visual impairment is reportedly avoidable, 10-58 per cent is treatable and 3-28 per cent is preventable[11]. At a rural eye hospital in Central Ethiopia between August and October 2012, the most common ocular morbidities among under 15 yr children included conjunctivitis (35%), refractive error (11.4%), ocular trauma (11.8%), and trachoma (7.6%). The various ophthalmic presentations of VAD in South Asia include Bitot's spots, night blindness and later on, keratomalacia, leading to xerophthalmia which was the major contributor of preventable childhood blindness[4]. In Asia, cataract is a more common cause of treatable childhood blindness due to decline in VAD. Myopia is the most common economically treatable cause of visual impairment, followed by amblyopia and other uncorrected refractive errors[12].

A systematic review of 30 community-based studies in India revealed that the prevalence of visual impairment was 2.05 to 13.6 per thousand and that of childhood blindness was 0.6 to 1.06 per thousand, respectively[13]. In north India, preventable and/or treatable conditions contributed to 50 per cent of the blind school children[14]. In Jawadhi hills, southern India, out of 260 tribal children less than 15 yr, ocular morbidity was seen in 10.8 per cent of cases. VAD was the most common disease (4.6%), followed by refractive error (2.7%)[1,15].

The causes of childhood blindness and severe visual impairment and prevalence data are required for planning preventive, curative, special education and low vision services and for evaluation. Preliminary literature search did not show any study on visual impairment and ophthalmic diseases in tribal children of Melghat and Korku tribes of India. Due to a scarcity of ophthalmologists and the low health-seeking behaviour of tribals in Melghat[16], most of the individuals with eye diseases, including blindness typically did not receive timely medical treatment due to which many of them were becoming permanently blind. For the prevention of childhood blindness, early identification of eye disorders and treatment is important. The early identification in this age group will improve the vision of school going children, their scholastic performance and productivity.

On this premise, the primary objective of this study was to evaluate the prevalence of various ophthalmic disorders (particularly preventable or treatable diseases) of Melghat tribal children, such that the preventable blindness can be identified and treated early.

Material & Methods

The present study was an observational study of 6-18 yr age group children carried out in 15 villages of Melghat from July to September 2019 after receiving approval of an independent Institutioanl Review Board, MAHAN IRB, Mahan Trust, Dharni, Melghat, Amaravati, Maharashtra.

Study population: Melghat is a mountainous, hard to reach, highly penurious forest tribal region in the Amravati district of Maharashtra and comprises two blocks, *i.e*. Chikhaldara and Dharni. The population is 3,00,000, spreads over 4000 square km. Poor tribals constitute 84 per cent of the total population and 50 per cent of them are semi-illiterate or illiterate[4,17-19]. The scarcity of ophthalmologists and low health-seeking behaviour of tribals[19] leads to the high burden of visual impairment.

Sample size estimation: The sample size was calculated using the formula, $n = z^2 \times P \times (1-P)/d^2$. Where 'n' is the sample size, P is expected prevalence, z is the 95 per cent confidence level (z=1.96) and 'd' is the margin of error (corresponding to effect size)[20]. To make the data more robust, we assumed 'd' to be 1.2 per cent = 0.012, P = 20.55 per cent (the collective prevalence of 7 Indian studies: Prevalence of ophthalmic disorders in students of India)[21-27]. Hence, $n = 1.96 \times 1.96 \times 0.205 \times (1-0.205)/(0.012)^2 = 4348$. A minimum of 4348 children were needed to conduct the study. Considering an average of 275 children per village, a sample of 15-16 villages was sufficient. However, given issues such as refusal by the child for examination, refusal from parents and local community leaders and other operational difficulties faced by non-medical supervisors, 4357 children were randomly

selected from 15 out of 300 villages in Melghat. This also captured the diversity across villages in terms of health and village-level infrastructure and included both tribal and non-tribal communities.

Inclusion and exclusion criteria: Children of 6-18 yr age group, present in the randomly chosen tribal villages, were included in this study after obtaining parents' or teachers' permission. Children with a learning disability who could not cooperate during the examination and whose parents or teachers refused permission were excluded.

Evaluation methodology: For field supervision local tribal individuals who had successfully completed education upto 10th standard were preferred. These supervisors were trained by our ophthalmic surgeon in the study hospital, schools and villages, and was an ongoing process throughout the study. Training methods were lectures, group discussions, demonstrations, flipcharts, *etc*. These supervisors were certified by an ophthalmologist after theory and practical examination. Ophthalmologists regularly cross-checked cases identified by the supervisors. The supervisors were extensively trained for communication skills with illiterate/semiliterate (able to read and write on an elementary level, it usually encompasses grades 1-7 of schooling) community, assessment of visual acuity, identification of chalazion, hordeolum, microophthalmia, macroophthalmia, entropion, ectropion, ptosis, proptosis, pterygium, bitot's spots, conjunctivitis, corneal opacity, iridocyclitis, cataract, dacryocystitis, squint, *etc*. Night blindness, bitot's spot and corneal opacity were the criteria used for defining VAD. Trained supervisors could diagnose congenital cataract, chalazion and strabismus.

Screening and consent: During the village screening, the study team visited all the houses in the selected villages to assess all school going children present during the screening. The children were identified by door-to-door screening of all houses and schools. Before the examination, permission and informed consent were taken from parents/teachers. Consent was always sought from the parents while examining a child at his/her home. In the case of illiterate parents, verbal consent was obtained from parents, and his/her thumb impression was obtained on the consent form followed by the school teacher's signature on the educated nearby relatives or villager same, or the village *Gram Sabha* who could read the Hindi consent form and gave the permission. During the examination of the children in schools, the teachers, tribal development department, father or close relatives who were educated, present in the school and could read the Hindi form, gave the permission.

All children whose permission was given by parents/elderly or school teachers were selected and a date for screening was fixed. The field supervisors examined children in schools and villages in clean, quiet and well lit rooms. They set up eye examination centres in each school/village that was visited and examined only those children who were available at the time of screening. The field supervisors screened and examined the children by torch light examination (anterior segmental pathologies) and Snellen visual acuity chart (near and distant) at 6 m in both eyes separately. They did an inspection and palpation of eyeball and eyelids, and applied pressure over the nasolacrimal passage. Supervisors did not conduct fundus examination.

Children who were found to have vision less than 6/6 and/or any anterior segmental pathology were brought to the base hospital (Mahatma Gandhi Tribal Hospital, Karmgram) for further assessment by the ophthalmologist. Slit lamp examination and autorefractometer-based refraction were performed. An expert, well-experienced ophthalmologist examined them under dilated pupil in case of suspected posterior segmental pathology or if they do not accept subjective refractive correction. Eye surgeons regularly cross-checked cases identified by supervisors. Suspected cases of nystagmus, trauma, iridocyclitis and other pathologies were confirmed by the eye surgeon. The qualified ophthalmologist examined all children (n=372) brought to the hospital. The ophthalmologist also visited all 15 villages and examined 50 per cent (n=68) of all children with ocular morbidity who did not come to the hospital. In the process, 35 per cent (n=1348) of normal children in the villages and schools were also examined as a quality control of the data. The diagnosis by the field supervisors was correct in 87 per cent of cases, as per the cross-examination by the ophthalmologist. Most of the pterygium cases were confirmed by the ophthalmologist. There were a few cases of pseudo pterygium which were, however, confirmed by the ophthalmologist and excluded from the list of participants with pterygium. Free treatment was provided in the trust hospital, either spectacles, drugs or surgery to the children diagnosed with an eye disorder during or as a result of the study. If the surgeries were not possible in the study hospital, then

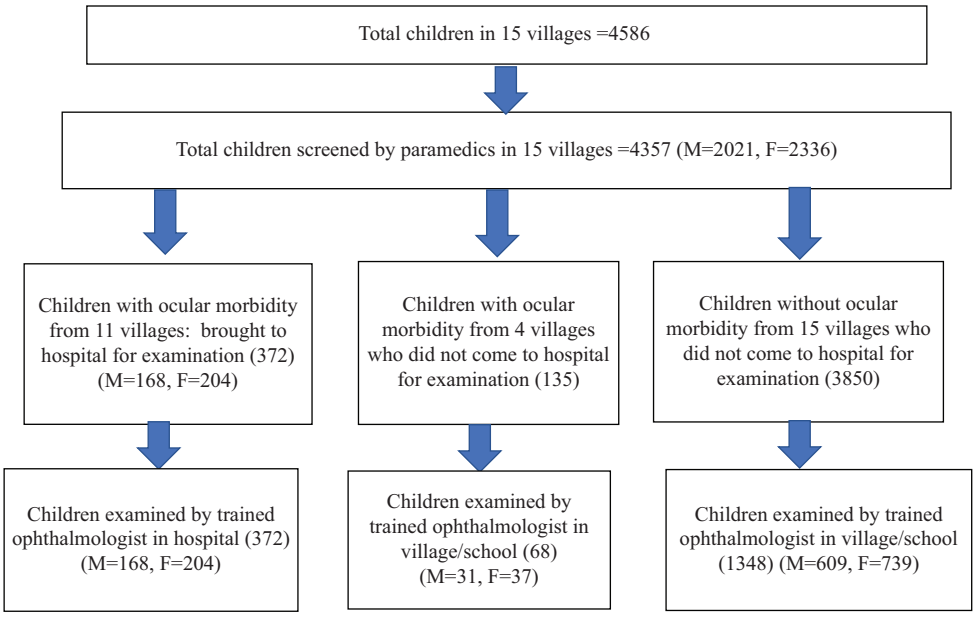

Fig. 1. Flow diagram of recruitment of study subjects. M, males; F, females.

participants were referred to higher centres in cities and was extended help for the referral.

Statistical analysis: Statistical analysis was performed using R-commander version is R 3.6.2. Chi-square test was used for categorical data analysis. For calculation of *P* value Fisher's exact test was used after Chi-square test wherever applicable.

Results

Figure 1 reveals a flow diagram of the recruitment of the research subjects. A total of 4357 children of 6-18 yr age range from 15 villages with a mean age of 13.5 yr were screened. Out of the 15 villages screened, children from 11 villages were brought to the base hospital (Mahatma Gandhi Tribal Hospital) for eye examination by the ophthalmologist. Children from four villages did not turn up for the examination even after repeated counselling and constant efforts. However, the ophthalmologist visited those particular villages and schools and examined the children.

Table I reveals that there were a total of 2021 (46.4%) males and 2336 (53.6%) females. Maximum and minimum ocular morbidities were seen in 14-16 yr (33.26%) and 6-7 yr (5.65%) age brackets, respectively.

Table II reveals that the overall prevalence of ophthalmic disorders was 11.64 per cent (n=507) in 6-18 yr age bracket. The most common ophthalmic disorder was refractive error, with the prevalence of 7.78 per cent (n=339), followed by VAD: 2.75 per cent (n=120). The types of refractive errors seen in this study were myopia, astigmatism and hypermetropia. The frequency of various stages of VAD was, however, not recorded. The findings of this study revealed five children were suffering from partial blindness. About 95.84 per cent of childhood ophthalmic morbidities in this study were found to be preventable or treatable.

Table I. Gender and age distribution

Age groups (yr)	Male (%)	Female (%)	Total (%)
6-7	116 (5.74)	130 (5.57)	246 (5.65)
8-10	259 (12.82)	244 (10.45)	503 (11.54)
11-13	551 (27.26)	527 (22.56)	1078 (27.04)
14-16	615 (30.43)	834 (35.7)	1449 (33.26)
17-18	480 (23.75)	601 (25.73)	1081 (24.81)
Total	2021	2336	4357

Table III shows the overall prevalence of ophthalmic disorders in children between 6-18 yr age group. It was slightly lower in males (11.3%) than in females (11.9%) (P=0.5587). The prevalence of refractive error was lower in males (6.38%) than in females (8.99%) and the difference was significant (χ^2=10.26, P<0.05). VAD was less prevalent in females (2.01%) than males (3.61%) with a significant difference (χ^2=10.36, P<0.05).

Table II. Prevalence of eye disorders

Type	Number of children (n=4357); n (%)
Total ocular morbidity	507 (11.64)
Uncorrected refractive error	339 (7.78)
Vitamin A deficiency	120 (2.75)
Strabismus	18 (0.41)
Pterygium	14 (0.32)
Chalazion	9 (0.21)
Corneal opacity	8 (0.18)
Ptosis	7 (0.16)
Hordeolum	5 (0.11)
Coloboma of iris	3 (0.07)
Nystagmus	2 (0.04)
Congenital cataract	2 (0.04)
Amblyopia	1 (0.02)
Traumatic iridodialysis	1 (0.02)
Congenital nevus	1 (0.02)

The refractive error prevalence was maximum in the 17-18 yr (10.55%) age bracket and was lowest in the age group 6-7 yr (1.22%), the difference was significant (χ^2=28.02, P<0.001) between these groups (Table IV). Reverse trend was seen with VAD, the VAD prevalence was maximum in the 8-10 yr age bracket (4.97%) and was minimum in the 17-18 yr age bracket (0.93%), the difference being significant (χ^2=35.86, P<0.001). Furthermore, the VAD prevalence in the 11-13 yr age range was 4.36 per cent, which was also high. The prevalence of ophthalmic disorders was significantly higher in the 8-10 yr and 11-13 yr age brackets.

Discussion

The present study provides an understanding of the details of various ophthalmic morbidities among tribal children in Melghat, Maharashtra. The findings of this study suggest that ophthalmic disorders are highly prevalent among the tribal children. Most of the morbidities (95.84%) were either preventable or treatable, for example, VAD or refractive errors, respectively. As per our knowledge this is the first study of the Melghat tribal belt of Maharashtra documenting the ophthalmic disorder prevalence among children.

In this study, prevalence of ophthalmic disorders was 11.64 per cent, which is similar to the findings of earlier studies[21,28]. A low prevalence (2.66%) of ocular morbidities was seen in another study in south India[29]. Different prevalence was seen in different areas because of the disparities in the geographical locations, socioeconomic status, availability of ophthalmic services and the difference in criteria of age group considered for the study. In our study, ocular morbidity (with and without visual impairment) was the highest in the 11-13 yr age range (13.45%).

The findings of the refractive error prevalence (7.78%) in the present study were comparable to the prevalence of 8.1 per cent of students of Kathmandu, Nepal[10]. This was comparatively higher than that found in similar studies[29,30]. Higher refractive error prevalence was noted in several studies[22,26].

VAD is a matter of concern and a chief reason for childhood blindness in India as well as globally. An estimated 2,50,000 to 5,00,000 children with vitamin A deficiency, become blind each year, and 50 per cent of the children die within 12 months of losing their sight[24]. VAD is known to be associated with significant illness and deaths from common childhood infections and is the leading preventable cause of childhood blindness globally. VAD is an important cause of maternal deaths and other poor outcomes of pregnancy and lactation. It also reduces the immunity. Children with mild/subclinical VAD are also prone to respiratory and diarrhoeal infections, reduced growth rates, sluggish bone development and increased mortality from serious diseases.

Figure 2 shows that prevalence of VAD induced ocular morbidity in the present study is 2.75 per cent, which is of moderate public health problem as per the WHO[25]. This is much higher than the prevalence in India (<1%)[13] and the world (in the age group of 5-19 yr <0.1%)[26]. In the adolescent tribal population of India, VAD prevalence was bitot's spots (2%) and conjunctival xerosis (4.9%). The National Vitamin A Prophylaxis Programme (NVAPP) is unable to reach difficult-to-approach tribal areas, inadequate medical services, parents without knowledge about vitamin A prophylaxis, poverty, poor nutrition especially less intake of leafy vegetables in diet and unemployment, leading to emigration for long time[27]. In the present study, VAD was significantly higher in boys as compared to girls. A similar trend was noted in the case of severe malnutrition (0-5 yr age), which was less common in females as compared to males as per the previous study by MAHAN Trust[18]. This reflects the need of in depth studies to measure the VAD prevalence across all age groups of children

Table III. Comparison of various morbidities between gender

Disease	Male (%)	Female (%)	χ^2	*P*
Overall ophthalmic disorders	229 (11.33)	278 (11.9)	0.3419	0.56
Uncorrected refractive error	129 (6.38)	210 (8.99)	10.26	<0.05
Vitamin A deficiency	73 (3.61)	47 (2.01)	10.36	<0.05
Strabismus	7 (0.35)	11 (0.47)	0.41	0.52
Pterygium	9 (0.45)	5 (0.21)	1.81	0.18
Chalazion	4 (0.2)	5 (0.21)	NS	NS
Corneal opacity	4 (0.2)	4 (0.17)	NS	NS
Ptosis	5 (0.25)	2 (0.09)	NS	NS

P value computed using Fisher's exact test. NS, non significant

Table IV. Comparison of various morbidities across age groups

Morbidity	Group 1 (%)	Group 2 (%)	Group 3 (%)	Group 4 (%)	Group 5 (%)	χ^2	*P*
Overall ocular morbidity	13 (5.28)	60 (11.93)	145 (13.45)	150 (10.35)	139 (12.86)	17.04	<0.05
Uncorrected refractive error	3 (1.22)	32 (6.36)	83 (7.7)	107 (7.38)	114 (10.55)	28.02	<0.001
Vitamin A deficiency	8 (3.25)	25 (4.97)	47 (4.36)	30 (2.07)	10 (0.93)	35.86	<0.001
Strabismus	1 (0.41)	4 (0.8)	4 (0.37)	6 (0.41)	3 (0.28)	NS	NS
Pterygium	1 (0.41)	2 (0.4)	5 (0.46)	1 (0.07)	5 (0.46)	NS	NS
Chalazion	-	-	2 (0.19)	3 (0.2)	4 (0.37)	NS	NS
Corneal opacity	-	1 (0.2)	2 (0.19)	2 (0.14)	3 (0.28)	NS	NS
Ptosis	-	-	1 (0.09)	2 (0.14)	4 (0.37)	NS	NS

P value computed using Fisher's exact test. Group 1=6-7 yr; Group 2=8-10 yr; Group 3=11-13 yr; Group 4=14-16 yr; Group 5=17-18 yr. NS, non significant

in Melghat. This will help to plan additional proper strategies to reduce VAD, prevent blindness, other infections and deaths. High prevalence of VAD warrants urgent holistic interventions in the form of behaviour change communication of nutrition, regular vitamin A supplementation and nutrition garden for the production of vitamin A-rich food.

Figure 2 shows that the non-corrected refractive error prevalence is higher in Melghat (7.78%) in contrast to the world figures (0.97%) and India (0.63%)[28,29]. The possible underlying causes of this high burden of uncorrected refractive error in Melghat include less eye health-seeking behaviour, social causes (superstitions, less awareness related to eye health, high prevalence of illiteracy and misperceptions related to spectacles use), poor socioeconomic status (>80% of tribals are below the poverty line, loss of wages to attend hospital, cost of correction, replacement costs), grossly inadequate healthcare facilities for the eye (scarcity of ophthalmologists and spectacle shops) and hereditary (unpublished data). In Melghat, there

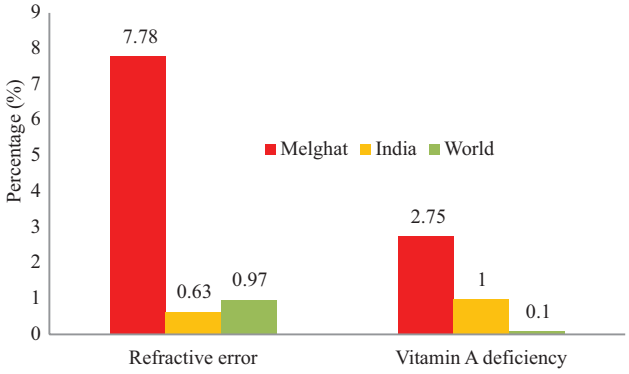

Fig. 2. Comparison of prevalence of refractive error[28] and vitamin A deficiency[31,32] between World, India and Melghat.

was also a lack of coordination between parents and school authorities for the referral of children with eye diseases. All these factors contribute to an increase in ocular morbidity and blindness in tribal Melghat. The evolution of several folklores about the diagnosis and treatment of ophthalmic disorders (*e.g.*, strabismus as a God's gift) impacts the diagnosis and treatment of ocular diseases by ophthalmologists[29].

The prevalence of strabismus was 0.41 per cent in the present study similar to that previously reported (0.43%) in school going children in Dhulikhel, Nepal[28]. However contrary to this high prevalence was reported by Mahesh *et al* 2019 (7.10%) in tribal students, Jawadhi Hills, south India[15]. Corneal opacities were seen in 0.18 per cent of cases in this study. The possible underlying causes of corneal opacities are environmental (physical and chemical injuries), social (unawareness, delay in treatment and traditional medicine uses), economic (cost of treatment) and medical (VAD).

The ocular morbidities started manifesting right after the age of 6-7 yr in our study population. The possible underlying causes of childhood blindness in this study may include social (consanguinity, beliefs and taboos), economic (poverty and cost of treatment) and medical (incomplete immunization, very high prevalence of malnutrition: 80%)[18]. Childhood blindness is a public health issue and should be addressed by routine examinations. Eye check-up should be an integral part of routine school screening, as it is easy and cost-effective. Furthermore, preventable blindness can be avoided by early intervention. Most of the ophthalmic diseases are curable and require initial recognition by way of ophthalmic examination along with appropriate management. Children should be screened at the onset of preschool for refractive errors by a trained professionals. It would be useful in reducing amblyopia, as children generally have a higher incidence of refractive errors. As per Vision 2020, the important diseases to be tackled urgently to decrease childhood blindness in India are refractive error, VAD, cataract-related amblyopia and corneal diseases[30].

Due to scarcity of ophthalmologists and low health-seeking behaviour of tribals in Melghat, most of the individuals with eye diseases, including blindness do not get timely medical treatment and many of them become permanently blind (unpublished data). For prevention of childhood blindness, early identification of eye disorders and treatment is important. This study reflects the need for regular eye screening of school going children, especially in difficult to access, tribal areas. The early detection in this age group will improve the vision of school going children, their scholastic performance, living standard and productivity. This study will help policy-makers, other voluntary organizations and institutes to administer comparable research in other similar tribal settings in India and policy-makers to develop sustainable public health strategies. Government should initiate outreach programmes to improve eye health indicators, in the difficult to reach tribal areas of India. It is necessary to screen and diagnose ocular morbidities in the community and in schools by trained grass root health workers and teachers. Training of school teachers for regular eye screening of children will play a pivotal role. It will assist for prompt diagnosis and management of various types of ophthalmic disorders, for example, refractive errors, common ocular infections; VAD, *etc*. Proper prevention and promotion strategies, for example, hygiene and diet modification, *etc*., can prevent childhood blindness.

This study was not without some limitations. Although it was undertaken to assess the prevalence of ophthalmic morbidities in tribal areas of Melghat, but the socioeconomic and demographical data of the screened children were not collected. Hence, the correlation between the findings and the sociodemographic profile of the children could not be done. Although the data regarding the availability of TV (18.72%) and mobile phones (29.54%) in households of villages of Melghat are available, the screen time of the children could not be assessed.

Overall, the findings of this study show a significantly high, prevalence of refractive error and VAD among the children in the tribal area of Melghat, which requires immediate intervention with treatment and prophylaxis. In this study, 95.84 per cent of childhood ophthalmic morbidities were preventable or treatable. In tribal areas, early eye screening and diagnosis in the community and schools by trained frontline workers can prevent childhood blindness, enhance scholastic performance and overall quality of life.

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***Conflicts of Interest*:** None.

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