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Original Article

Ultraviolet-related ocular problems in children living on the coast of Southwest Sumba, Indonesia

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Abstract

Background A previous study has shown a high proportion of visual impairment and blindness in the adults of Southwest Sumba, Indonesia due to ultraviolet-radiation (UVR)-related ocular problems, such as cataract and pterygium. Currently, there is no data regarding the effect of ultraviolet (UV) exposure on children and its future implications.

Objective To seek the predisposing factors of UVR ocular problems in the children of Southwest Sumba.

Methods A population-based cross-sectional study was conducted in Perokonda Village, Southwest Sumba in May 2017. A total of 337 children <16 years old were examined for ocular problems by ophthalmologists. Subjects with ocular problems were then treated accordingly.

Results Visual acuity was normal in 98.2% of subjects. Visual impairment and blindness were found in 1.2% and 0.3% of subjects, respectively. Ocular problems were found in 38%, consisting of conjunctival pigment deposits (60.2%), pinguecula (15.6%), and pterygium (13.3%). The UVR ocular problems constituted 33.8% of all ocular problems, comprising conjunctival pigment deposits (22.8%), pinguecula (6%), and pterygium (5%).

Conclusion The proportion of UVR ocular problems in the children of Perokonda village is 34.5%, the most common of which being conjunctival pigment deposits. Such deposits may be early signs of UVR ocular problems. This study serves as a platform to highlight the possible relationship between pigment deposits and future UVR ocular problems, which warrants further study. **[Paediatr Indones. 2018;58:128-32; doi: http://dx.doi.org/10.14238/pi58.3.2018.128-32]**.

Keywords: *ocular problems; ultraviolet; pigment deposit; children*

Blindness and visual impairment are major health concerns around the globe. Approximately 285 million people are visually impaired, with 39 million suffering from blindness, most of whom live in low-income settings.[1] *The World Health Organization* (WHO) has established *VISION 2020*: Right to Sight as an initiative to eliminate blindness and visual impairment, especially in underdeveloped areas, by bringing eye care to remote areas and ensuring the availability of eye care to all.[2]

Indonesia is a developing country located along equatorial lines with constant exposure to the sun, hence harboring an increased risk of ocular problems caused by excessive ultraviolet (UV) exposure.[3] Uneven distribution of health care facilities and personnel combined with unnoticed ocular problems amplify the magnitude of this problem.

Perokonda Village in Southwest Sumba District is a remote coastal village with excessive sun exposure where most community members work as fishermen with low socioeconomic status and low educational

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levels. Moreover, the people of Perokonda village spend the majority of their time outside, partly owing to the lack of facilities for indoor activities. Accumulation of UV exposure in early stages of life may contribute to the increased risk of developing eye diseases such as pterygium, cataract, and pinguecula. A 2016 survey to determine the distribution of ocular problems in adults in Southwest Sumba found that cataract and pterygium were prevalent (12.8% and 10.7%, respectively), possibly owing to the constant exposure to UV without protection.[4]

Although the prevalence of blindness and visual impairment in UV-exposed individuals has been reported in adults, it has not been studied in children. This study aimed to determine the predisposing factors to UV-related (UVR) ocular problems in children with constant UV exposure.

Methods

This population-based, cross-sectional study was conducted in Perokonda Village in May 2017. The children were examined by a team of four ophthalmologists and two general practitioners from the Universitas Indonesia Medical School, Jakarta. Prior notices regarding the event were given to local residents through the chiefs of the village and banners. Examination was conducted in the local elementary school, which was converted into a clinic. The ophthalmologists diagnosed eye problems by history taking and ophthalmologic examinations. Prior to the examination, parents were given information regarding the study and asked for consent. All children aged less than 16 years in Perokonda Village who came and followed the examination process until completion were included in the study. Each subject and the parents were informed consent prior to the examination.

Visual acuity was measured using a *Plusoptix® S12C* mobile autorefractor (Plusoptix Inc., Atlanta, Georgia). In accordance with WHO standards, we classified visual acuity as blindness (<3/60), severe visual impairment (<6/60), moderate visual impairment (<6/18), or mild/absent visual impairment (≥6/18). Children who could not read or show directions were examined using a fix and follow test. An anterior segment examination was performed using *KOWA SL-15* portable slit lamp (Kowa Company Ltd., Nagoya), and a posterior segment examination using *Welch Allyin* standard ophthalmoscope (Welch Allyn, Skaneateles Falls, New York). Data were analyzed using *SPPS version 20*. We used a 95% confidence interval (CI) and a significance level of $P<0.05$.

After diagnoses were made, subjects were treated accordingly. Refraction errors were corrected using corrective lenses, given one month following the examination. Eye infections were treated with antibiotics. One subject with blindness due to corneal staphyloma was referred to Dr. Cipto Mangunkusumo Hospital, Jakarta for evisceration surgery. The study protocol has been approved by the Medical Research Ethics Committee of the Universitas Indonesia Medical School.

Results

A total of 337 subjects between six months and 16 years of age were included in the study. There were 166 (49.3%) males and 171 (50.7%) females. Subjects' educational level ranged from preschool to senior high school; most were in primary school (62%). Most of the parents were fishermen (67.7%) and farmers

Table 1. Demographic characteristics of study subjects

Characteristics	n (%)
Gender	
Male	166 (49.3)
Female	171 (50.7)
Level of education	
No education	40 (11.8)
Preschool	9 (2.7)
Kindergartern	33 (9.8)
Primary school	209 (62.0)
Junior high school	37 (11.0)
Senior high school	9 (2.7)
Parent's occupation	
Fisherman	228 (67.7)
Farmer	53 (15.7)
Teacher	26 (7.7)
Employee	16 (4.7)
Others	14 (4.2)
Parent with prescription glasses	
None	300 (89.0)
Father	14 (4.1)
Mother	15 (4.5)
Both	8 (2.4)

(15.7%). The demographic characteristics of our subjects are shown in **Table 1**.

Table 2 shows the subjects' visual acuity. There were 331 children (98.2%) with normal visual acuity in both eyes. Six children had impaired visual acuity. Moderate visual impairment was caused by refractive error and papillary atrophy due to traumatic optic neuropathy. All cases of severe visual impairment were caused by refractive errors. One child had unilateral blindness due to corneal staphyloma (**Table 3**).

Ocular problems were found in 128 children (38%). The most common problems were conjunctival pigment deposits (60.2%), pinguecula (15.6%), and pterygium (13.3%), followed by others such as conjunctivitis, microcornea, scleral pigment deposits, and limbal pigment deposits (**Table 3**). Two subjects were diagnosed with pinguecula and conjunctival pigment deposits, nine with pinguecula and pterygium, and two with pterygium and conjunctival pigment deposits.

Table 4 shows that the prevalence of UVR ocular problems in Perokonda village was 34.5%. The most common UVR ocular disease was conjunctival pigment deposit (22.8%), followed by pinguecula (6%) and pterygium (5%). Most of the pterygiums, pinguecula, and pigmented deposits were located in the interpalpebral fissure.

Table 2. Visual acuity of children in Perokonda Village

Classification	OD, n(%)	OS, n(%)	ODS, n(%)	Overall, n(%)
Normal vision	0	0	331 (98.2)	331 (98.2)
Moderate visual impairment	2 (0.6)	1 (0.3)	0	3 (0.9)
Severe visual impairment	0	1 (0.3)	1 (0.3)	2 (0.6)
bLINDNESS	0	1 (0.3)	0	1 (0.3)

OD=right eye; OS=left eye; ODS=both eyes

Table 3. Proportion of ocular problems in the children of Perokonda Village

Diagnosis	OD, n(%)	OS, n(%)	ODS, n(%)	Subjects, n(%)
Moderate visual impairment	2 (1.6)	1 (0.8)	-	3 (2.4)
Traumatic optic neuropathy	1 (0.8)	-	-	1 (0.8)
Myopia + astigmatism*	1 (0.8)	1 (0.8)	-	2 (1.6)
Severe visual impairment	-	1 (0.8)	1 (0.8)	2 (1.6)
Congenital retinal dystrophy	-	-	1 (0.8)	1 (0.8)
Hyperopia$^{\Delta}$	-	1 (0.8)	-	1 (0.8)
Blindness				
Corneal staphyloma	-	1 (0.8)	-	1 (0.8)
Conjunctivitis	1 (0.8)	1 (0.8)	3 (2.4)	5 (3.9)
Conjunctival pigment deposit	11 (8.6)	10 (7.8)	56 (43.8)	77 (60.2)
Limbal pigmentation	0	0	1 (0.8)	1 (0.8)
Scleral pigmentation	1 (0.8)	0	0	1 (0.8)
Pinguecula	5 (3.9)	3 (2.3)	12 (9.4)	20 (15.6)
Pterygium	1 (0.8)	2 (1.6)	14 (10.9)	17 (13.3)
Microcornea	0	0	1 (0.8)	1 (0.8)
Total	21 (16.4)	19 (18.4)	88 (68.8)	128 (100)

*two subjects had anisometropia, $^{\Delta}$subject had esotropia alternans in both eyes

Table 4. Proportion of UVR ocular problems in children of Perokonda Village, 2017

Diagnosis	OD, n(%)	OS, n(%)	ODS, n(%)	Subjects, n(%)
Conjunctival pigment deposit	11 (3.3)	10 (3)	56 (16.5)	77 (22.8)
Limbal pigmentation	0	0	1 (0.3)	1. (0.3)
Scleral pigmentation	1 (0.3)	0	0	1 (0.3)
Pinguecula	5 (1.5)	3 (0.9)	12 (3.6)	20 (6)
Pterygium	1 (0.3)	2 (0.6)	14 (4.2)	17 (5.1)
Total	18 (5.4)	15 (4.5)	83 (24.6)	116 (34.5)

Discussion

The province of East Nusa Tenggara, where Perokonda Village is situated, has the second highest prevalence of blindness in Indonesia. The magnitude of the problem is enhanced due to its challenging geographical terrain, lack of health- and eye care services, poverty, and low education. Children in Perokonda Village spend most of their time doing outdoor activities. The high prevalence of normal visual acuity in these children (98.2%) may be attributable to the lack of near-vision activity, such as watching television and playing computer games. However, unprotected outdoor activities also carry the risk of UVR ocular diseases.

UV exposure has been associated with the occurrence of eyelid malignancies (such as basal cell carcinoma and squamous cell carcinoma), photokeratitis, climatic droplet keratopathy, pterygium, and cortical cataract.[5] However, evidence of the association between UV exposure and development of pinguecula, nuclear and posterior subscapular cataract, ocular surface squamous neoplasia, and ocular melanoma is not fully established.

On the molecular level, UV creates active free radicals, which attacks various macromolecules.[6] The abundance of free radicals will lead to oxidative DNA damage. Double-stranded DNA (dsDNA) damage is affected by different expressions of dsDNA break repair genes such as XRCC2, XRCC3, RAD50, and RAD51.[7] Moreover, one of the most common genetic markers of human neoplastic growth p53 is highly expressed the UVR population. The p53 gene, which functions as a cell cycle regulator and has a role in DNA repair and synthesis, cell differentiation, and apoptosis, is mutated in UVR population.[7]

The high prevalence of pterygium and pinguecula in Perokonda Village suggests the significant involvement of UV radiation in the development of those diseases. Pterygium is a type of benign uncontrolled growth of the conjunctiva that lays over the sclera, which impairs the visual acuity and triggers an inflammatory process. Pterygium mostly affects people with higher exposure to sunlight and other factors such as sand and wind.[8] Pinguecula is a UV radiation exposure-related fibro-fatty degenerative change in the bulbar conjunctiva within the palpebral aperture. A study in Sumatra, Indonesia reported a high prevalence of pterygium due to the abundance of sun exposure during outdoor activities.[9] Therefore, UV, sand, and wind may contribute to the progression of pterygium and pinguecula in Perokonda village.

A previous study reported that the prevalence of pterygium in Perokonda Village adults is 10.7%.[4] In contrast, we found a prevalence of 5% in children from the same village. These findings suggest that there may be an increasing trend in the proportion of UVR eye diseases from time to time. Furthermore, accelerating degenerative process due to persistent UVR radiation could lead to early cataract formation. In Perokonda village adults, the prevalence of cataract is 12.8%, dominated by those aged >40 years (12.1%). Among those with cataract, fisherman was the most common occupation (6.4%), while only 0.3% were students.[4] Based on those results, we suggested that the high prevalence of pterygium and cataract in adults might be initiated by high UV radiation from the early stages of life.

Yellowish brown pigment deposits in the conjunctiva (60.2%) are common in children of Perokonda Village. Such pigment deposits are different from pterygium, pinguecula, nevus, or other melanoma characteristics. There are no feeding veins or signs of inflammation around the deposits, which are usually found in the pterygium and pinguecula. The yellowish brown pigment tends to appear like several droplets in certain areas of the ocular surface. Moreover, the yellowish brown pigmentation, pinguecula, and pterygium are located in the nasal and temporal area of the eyes, which might show that the areas with high UV exposure tend to develop pigments more easily than areas protected by the eyelids. A study on pterygium and UV-treated conjunctival cells using immunochemistry and the Northern blot procedure found a significantly higher expression of elastin compared to normal cells, due to elastodysplasia and elastodystrophy processes.[10] Elastin is a major component of connective tissue in large arteries, lung, skin, and ligaments, and provides elasticity in those tissues.[10] Due to the high proportion of yellowish pigment deposits in the population of Perokonda Village, we hypothesize that these deposits are one of the most apparent early sign of UVR eye diseases.

Prevention of UVR ocular diseases are achieved by simple behavioral changes, such as wearing appropriate clothing, hats, and UV-blocking spectacles or sunglasses.[3] The most effective method to limit

UVR problems is by avoidance of exposure. Wearing clothing made of thick synthetic materials, hats with wide brims, contact lenses, and sunglasses are effective methods of avoidance.[3] To obtain in-depth knowledge about the yellowish pigment, microscopic samples are needed.

These findings highlight the effect of UV exposure to ocular health from the early stages of life, and stress the importance of UV protection and public awareness in ocular health. In children of Perobatang Village, UV exposure has led to conjunctival pigment deposit, pinguecula, and pterygium, which may contribute to the risk of visual impairment and blindness. Further study to explain this phenomenon is required.

The main limitation of this study was the design of the study was a cross-sectional study hence there is no correlation that can be elucidated. To draw a more conclusive relationship between sun exposure and UVR eye problems in such areas, a prospective cohort study is needed. Despite the limitations, this study is the first to explore the possible outcome of UV exposure from early stages of life.

In conclusion, 38% of children in Perokonda Village suffer from ocular problems, consisting of conjunctival pigment deposit (60.2%), pinguecula (15.6%), and pterygium (13.3%). The proportion of UVR ocular problems in the children of Perokonda village is 34.5%, mostly comprised of conjunctival pigment deposit (22.8%), pingecuela (6%) and pterygium (5%). The yellowish pigment deposit is thought to be an early sign of UVR ocular problems.

Conflict of Interest

None declared.

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