Original Article

Visual function of children with visual and other disabilities in Oman: A case series

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Background: We assessed the visual functioning of the children with special needs in Oman between 2009 and 2012. We present the methods of assessing different visual functions, outcomes, and interventions carried out to improve their functioning. **Methods:** Optometrists assessed visual functions of children of "Day care centres" in Oman. Experts further assessed them and provided low vision care. Ocular movements, refractive corrections, near, distance, contrast color, motion, field of vision, and cognitive visual function test results were noted. Feedback to caregivers was given to improve visual functioning of these children. **Results:** We grouped 321 participants, (196 [61.1%] boys, age range of 3–18 years) into 61; Down syndrome (DS), 72 with intellectual disabilities (IDs), 67; hearing impaired and 121 with other conditions. Refractive error and lag of accommodation were 26 (42.6%) and 14 (22.6%) among children with DS. Contrast sensitivity was impaired in 8 (12.7%) among hearing impaired children. Defective distant and near vision was in 162 (70%) and 104 (42%) of our cohort. Children with ID were most difficult to assess. Children in a group of other disabilities had a higher proportion of impaired visual functioning. They were given low vision aids (telescopes [22], filters [7], and magnifiers [3]) in large numbers compared to those in other groups. **Conclusions:** Visual functioning of children with other disabilities show great variation and difficult to group. The care, therefore, should be at individual level. All visual functions cannot be assessed at one time.

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Addressing vision disability in children is a priority within the "childhood blindness" - Disease control strategy of the "VISION 2020" initiative to eliminate the avoidable blindness.[1] In countries with rapidly evolving economies, nutritional, and infection-related visual disabilities have declined markedly in the last three decades, but those related to prematurity, birth defects, and syndromes are still high.[2,3] Hence, epidemiological information about these issues will be vital for formulating public health policies to tackle childhood blindness in the coming years. Since the community-based prevalence studies for the childhood blindness are neither feasible nor cost-effective, evidence from high-risk groups, i.e., students in the schools for the blind and cohorts of infants and children with other disabilities is an alternative.[4,5] Children with impaired but useful vision in the schools for the blind are often neglected and taught as totally blind. Comprehensive periodic assessments of children are therefore recommended.[6] Risk of problems in visual functioning of children with other disabilities was found twenty times higher compared to children who do not have a disability.[7] Unfortunately, reports on vision in children with special needs often cover refractive errors (REs) only and other visual functions have not been studied in many surveys targeting such children with special needs.[8-10] Even standard protocols need to be evaluated for systematic and comprehensive assessment of visual functioning of children with different combinations of disorders causing communication and cognitive problems.[11]

Sultanate of Oman adopted the low vision care as a part of the "VISION 2020 OMAN" in 2001.[12] In this study, well-trained optometrists assessed the visual functioning of children with special needs attending 32 Al Wafa Centers (day care facilities for children 6–16 years) of the Ministry of Social Development and one School for the Blind of the Ministry of Education. Children with impaired visual functioning were given vision devices free of cost by Al Noor Association for the Blind and trained to use these devices. In addition, pediatric ophthalmologists and neonatologists referred children with impaired vision to the Low Vision Clinic of the Ministry of Health. This paper reviews the data on the visual functioning of children with isolated vision disabilities and/or with other sensory disabilities.

Methods

The Ethical and Research Committee of Al Noor Association for the Blind approved this study. As case records were reviewed without disclosing the identity of the participants, we did not obtain written consent of parents. This case series type of descriptive study was conducted between 2009 and 2011.

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Field investigators were optometrists and ophthalmologists trained in vision assessment and working for the School Health Department. Demographic data included age, gender, region, and type of school. Other health information of the children was gathered from the school health records. This included hearing, ocular disorders, and REs.

The Hirschberg's test was used to evaluate fixation. Findings in cover-uncover test, ocular movements in nine cardinal positions of gaze, saccades, and nystagmus were recorded.[13] If reflection of light corneal reflex was not center while the child was looking straight at far distance, it was considered as strabismus present. If it was turned inward, strabismus was of ecotype esotropia, and if it was deviated outward, strabismus was of exo type exotropia. If the deviation of eye was in vertical direction, the strabismus was of hyper or hypo type hypotropia. If eyes were moving rapidly involuntarily, nystagmus was present. While tracking an object, the movements of eyes of the child were observed. To test for saccades, the examiner sat in front of the child at 1 m distance and held two toys of >10 cm in size. The child was asked to see from one toy to another and his/her eye movements were observed. To grade the saccades, we used Northeastern State University College of Optometry scoring criteria. We noted the ability to complete round trips in following two objects, ability of the child to accurately and consistently fixate objects and presence of head and body movements during saccade testing. We referred age and sex of the child and minimum score for testing saccadic eye movements to define normal and defective saccades.[13]

The anterior segment of the eyeball was examined with a flashlight to detect abnormalities of eyelid, conjunctiva, cornea and lens and pupillary reaction to the light was recorded.

Homatropine 2% was used for cycloplegic refraction using a direct retinoscope (Heine, Germany). Children who needed new spectacles were assessed for their visual functions on the subsequent visit scheduled after 1 week. Myopia was defined as mild (0.75D–<2D), moderate (2–5D), and severe (>5D). Hypermetropia was graded for spectacle prescription if it was more than +0.75D without esotropia. The value of astigmatism of <2D was transposed into spherical equivalent.

While prescribing RE corrections (distance and near), we considered child's age, systemic condition, and accommodation values. Myopia of >1.00D, hyperopia of >1.00D, and astigmatism of >+1.00D were registered and corrected if relevant within the child's visual and cognitive sphere. Lag of accommodation was measured with the modified estimation method. Lag of accommodation of +0.25–+0.50 D was considered normal. Weak accommodation was supported with appropriate near vision correction to allow age appropriate near vision tasks.

Visual acuity for near was recorded with the help of LEA Symbols Near Vision test Card (Good-Lite, USA). The card was held at the standard 40 cm distance from the eyes. If the child preferred to keep the card at other than the 40 cm distance, the distance used was noted for calculation of visual acuity values. If a child was unable to respond to the LEA Symbols Card, responses to LEA Gratings Paddles were recorded in a preferential looking situation at distances from 50 to 100 cm.

To assess for distance visual acuity, we used LEA Symbols chart for distance on a light box. The chart was held at 3 m distance from the child. If the child could not recognize any symbol in the top line of the chart, the test was repeated at 1.5 m distance and even closer. Log value (0.02) of each optotype of a line was considered while determining distance visual acuity of each eye.

Low contrast visual acuity was assessed with the LEA Symbols Low Contrast test with Symbols of 10M size. This test was performed only for children who responded to the distance vision using full contrast LEA Symbols chart. For children who responded to LEA Gratings, the Hiding Heidi Low Contrast Face test was used for assessment of communication distances. If there was more than three line difference in distant vision reading between 100% and 2.5% contrast chart, we considered the contrast test as defective.

Color vision was measured using Panel 16 Color Vision Test. The child was first shown the pilot colored disc and then explained how to match with the other one disc that has nearly matching color. The test was repeated to complete all 16 disc color identification. On completion of the task the disc was reversed, and numbers on the back of color discs were recorded. The confusion between color shades was revealed by an altered sequence of the numbers even after repeating the test. If there was a consistent jump of more than two serial numbers, we considered color vision of the child as defective.

Motion perception was observed using the figure-in-motion PEPI test on the computer screen. To attract child's attention, red and white moving strips were shown in the center of the screen. Then the figure-in-motion PEPI target was displayed. Children's eye movements were observed during the test: Quick saccades to the corners of the screen where the figure appears and slow following movements diagonally across the screen, after which they were asked to name the moving object (any animal with four legs was recorded as a correct description) and to show the directions of movement. For children with communication problems, eye movements following the moving target were used as the correct answer. The test was repeated for those children who were either totally inattentive or failed to follow the moving target although they fixated the central target. Inability to track the moving dog on computer screen in any one of four directions was labeled as defective motion perception.

Early visual processing functions (in occipital cortex) were tested using three tests: (1) Mailbox test (Good-Lite) was used to evaluate the visual recognition of direction of lines and objects for eye-hand coordination. Children were given a card to pass it through the "Mailbox's" slit held in vertical, horizontal, and oblique orientations. The movements of the wrist and fingers of the child were observed. (2) Rectangles test (Good-Lite) was used to evaluate child's ability to perceive differences in size and to use that information for eye-hand-coordination. Test consists of two sets of rectangles of five different sizes. One set of the rectangles was placed in front of the child and he/she was asked to place a rectangle from the other set on a rectangle of similar size on the table or, if unable to use hand movements, was asked to point to the similar rectangle with gaze. (3) Heidi Expressions Test was used to test children's ability to perceive and match pictures with different facial expressions at different contrast levels. For details of visual functions testing, we referred to the relevant chapters of book for low vision testing and the detailed instructions of the tests.[14] If the child was unable to correctly perform any of the above-mentioned tests, we considered that child's higher visual functions were defective.

Information was collected using a standardized data collection form. We used EpiData (Data Management and basic Statistical Analysis System, Odense, Denmark) to enter the data.[15] The univariate data analysis using parametric method was carried out using software called Statistical Package for Social Science (SPSS 23, IBM, New York, USA). Frequency and percentage proportions of different parameters were calculated.

All children benefiting from spectacles were given spectacles and vision devices free of cost. Children with problems in visual functions had periodic assessments by pediatric ophthalmologists. Teachers and parents were advised to adjust the environment of the child to meet each child's needs. Exercises and play situations for cognitive functions were suggested. The outcomes of this study were discussed with the institutions in charge of the care and education of children, and timely follow-up was recommended. Children were referred to the Low Vision Unit of the Eye Health Care Program, Ministry of Health in Muscat by the school or the day care centers for further evaluation.

Results

The cohort was of 321 children that were referred from 32 centers for disabled children. The age range of children was 3–8 years and the mean age 8.7 years (standard deviation 4.39 years). There were 196 boys (61.1%) and 125 girls (38.9%). Based on the principal clinical diagnosis by the child's pediatrician, the participants were grouped into (1) children with Down syndrome (DS) – 61 (19%), (2) children with intellectual disability (ID) but without DS – 72 (22.4%), (3) children with impaired hearing – 67 (20.9%), and (4) children with other conditions (other) – 121 (37.7%). The Group 4 included 8 children with aphakia, 31 with retinal conditions, 13 with microcephaly and cerebral palsy, 11 autistic children, 16 spastic children, 28 children with delayed general development, and 9 children with a syndrome affecting eyes.

Ocular movements and related functions are reported in Table 1. Strabismus was in higher proportion (26 out of 121) in children with ocular morbidities (group: "Other") resulting in strabismic amblyopia in 1 eye in 121 children. Although ocular movements were affected in 12 children with low vision disabilities in this cohort, there was no specific pattern by the groups.

Twenty-five (41%) children with DS were using spectacles; in two cases, the spectacles were changed as the lenses had significant scratch marks. One child was prescribed spectacles for the first time. Twenty children were myopic (15 of them with 5D–9D myopia; 5 with moderate myopia [2D–5D] and 6 were hyperopic [1D–2D]). All 15 students with severe myopia were given 1D–3D weaker correction for distance. Accommodation lag was in nearly one-fourth of DS children. Visual functioning in different groups is displayed in Table 2. In nine children with DS, values of distance vision were lower than values of near vision with full correction. Low accuracy of measurements of the field of vision using the arc perimeter was found especially among children with low intelligence quotient (IQ).

A large number 69% (77/111) of children in low vision group due to other causes, had problems in their visual functions. Spectacles were the most often prescribed low vision device (LVD) in the group of children with "other causes;" seven children were tested for and then provided filter lenses. Nearly, one-fourth of children in this group with a single disability affecting eyes (other group), were prescribed telescopes to explore distant objects. LVDs prescribed for children are reported in Table 3. They were magnifiers, telescopes, focused table lamps and filters.

Discussion

This is a large series of visual functions and low vision care of the children with special needs. The largest group of vision-impaired infants and children with the need of early intervention and special assessments and support is to be found among children with other more visible disorders among the children with special needs. Although each child is an individual for providing low vision care, an attempt was made in this study to categorize the outcomes based on other morbidities the child had. Our study has clearly demonstrated the need for and the value of assessing comprehensive visual functions of the children with special needs. However, it was evident that it may not be possible to assess all visual functions in all children. The provision of low vision care improved the visual functions of many (58/321) children. We used Lea Vision Test System. It has shown high validity for detecting RE and visual pathology.[16]

Therefore, findings of our study are likely to be accurate and less affected by measurement bias.

Forty-three percent of children with DS had RE. REs (26), especially high myopia (>5D in 15 children), were the single most common finding in children with DS (51). Adio reported that 76.2% of 42 DS children had RE higher than 5D in Nigeria.[17] In contrast, Mohd-Ali *et al*. in Malaysia reported that only 30% of 73 children with DS had RE higher than 5D.[18] Strabismus and nystagmus among children with DS in our study were lower than that reported by Karlica *et al*. and Ljubic *et al*.[19,20]

Table 1: Problems in ocular motor functions of children with other disabilities

	DS (61)	Percentage	ID (72)	Percentage	IH (67)	Percentage	Other (121)	Percentage
Strabismus	6	9.8	7	9.7	6	9.0	26	21.5
Nystagmus	3	4.9	2	2.8	0	0	7	5.8
Accommodation lag	14	22.6	0	0	0	0	1	0.8
Saccades	8	13.1	0	0	3	4.5	6	5.0
Pursuit movement	10	16.4	0	0	3	4.5	3	2.5
Scanning	4	6.6	0	0	2	3.0	4	3.3

DS: Down syndrome, ID: Intellectual disability, IH: Impaired hearing

Table 2: Problems in visual functions of children with other disabilities

Visual function	DS			ID			HI			Other		
Form sense test?	Children assessed	Abnormal	Percentage	Children assessed	Defective	Percentage	Children assessed	Defective	Percentage	Children assessed	Defective	Percentage
Near VA	51	24	47.1	71	9	12.7	63	15	23.8	103	56	54.4
Distance VA	53	35	66.0	61	21	34.4	63	29	46.0	102	77	75.5
Color vision	37	2	5.4	64	4	6.3	49	2	4.1	67	18	26.9
Contrast sensitivity	54	17	31.5	66	9	13.6	63	8	12.7	91	35	38.5
Field of vision	45	0	0	58	1	1.7	47	0	0	72	12	16.7
Motion perception	41	2	4.9	47	0	0	58	1	1.7	55	8	14.5
Spectacles/refraction	60	26	43.3	72	1	1.4	67	42	62.7	110	5	4.5
Early processing												
Hiedi facial expression	20	1	5.0	1	0	0	34	0	0	58	4	6.9
Rectangle test	20	19	95.0	1	0	0	33	14	42.4	111	54	48.6
Facial expressions	20	14	70.0	1	0	0	33	12	36.4	57	12	21.1

VA: Visual acuity, DS: Down syndrome, ID: Intellectual disability, IH: Impaired hearing

Lower proportion of hyperopia and already using spectacles in a large number of children with DS perhaps could explain less cases of strabismus in our study. Accommodative insufficiency is often found in children with DS.[21-23] In this study, we found 23% of children with DS having accommodation lag. Undercorrection of myopia and provision of the addition of near vision correction were, therefore, important for these children. With increasing age, many children with DS show changes in accommodation power. Therefore, it is important that their visual functioning is periodically checked.[24,25]

The children with low IQ but without DS were difficult to assess as their attention span is short and test is often time-consuming. Interpreting the assessment outcomes and intervention, therefore, were not attempted in this study. It requires further observations and testing.

The importance of assessing visual functions in children with hearing impairment is stressed in the literature.[8,26] Children with hearing impairment studying at special school were not included in present series. Only children with hearing impairment and multiple disabilities who did not attend the school were assessed. The outcomes of such school students were described in our earlier publication.[26] It is worth to note that we did not find a significant deficiency in visual functioning in children with hearing impairment in the present study. Contrast sensitivity which is usually affected in Ushers syndrome was noted in 13% of children with hearing impairment only in our study.[27] Normal interpretation of facial expressions was not present in more than one-third of children with hearing impairment. In 15% (5/34) children, poor contrast was responsible for the inability to interpret the facial expressions. Correction of REs (42/67) and providing more illumination to 10/67 children with hearing impairment compensated poor contrast sensitivity.

The group with "other causes" of visual disabilities mainly included pathologies like retinitis pigmentosa, autism, developmental delay, cerebral palsy, and spastic children. Poor distance and near vision were present in more than half of children in this group. However, many of them did not accept refractive corrections. The underlying cause of nonacceptance should be explored. Use of telescope, filter, and magnification were useful for some children of this group.

The visual functioning of children with other disabilities show great variation and thus are difficult to group. The care, therefore, should be individualized. All visual functions cannot be assessed at one time. Information from teachers, parents, and caregivers at day care institution is important for assessing visual functions. While performing an assessment, clues could be noticed for suggestions that might be helpful in early intervention and education.

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Table 3: Special vision care advised for children with impaired visual functioning

	Children with DS (assessed 59)		Mentally challenged children without DS (assessed 67)		Children with hearing impairment (assessed 66)		Other children with disabilities (assessed 106)	
	LVD given	Percentage	LVD given	Percentage	LVD given	Percentage	LVD given	Percentage
Correction of RE	3	5.1	10	15	3	4.5	11	10.4
Magnification	0	0	0	0	0	0	3	2.8
Telescope	0	0	0	0	0	0	22	23.9
Filters	0	0	1	1.5	0	0	7	6.6

LVD: Low vision device, DS: Down syndrome, RE: Refractive error

Conflicts of interest

There are no conflicts of interest.

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