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Annegret Dahlmann-Noor, MD, PhD, Vijay Tailor, MSc, Yassir Abou-Rayyah, MD, PhD, Gillian Adams, MD, FRCS, John Brookes, MD, FRCOphth, Sir Peng T. Khaw, MD, PhD, Catey Bunce, DSc PhD, Maria Papadopoulos, MD, FRCOphth

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Functional vision and quality of life in children with microphthalmia/anophthalmia/coloboma—a cross-sectional study

Annegret Dahlmann-Noor, MD, PhD,[a,b] Vijay Tailor, MSc,[a] Yassir Abou-Rayyah, MD, PhD,[c] Gillian Adams, MD, FRCS,[b] John Brookes, MD, FRCOphth,[a,d] Sir Peng T. Khaw, MD, PhD,[a,d] Catey Bunce DSc PhD,[a,e,f] and Maria Papadopoulos, MD, FRCOphth,[a,d]

Author affiliations: [a]National Institute for Health Research Biomedical Research Centre at Moorfields Eye Hospital and UCL Institute of Ophthalmology, London, United Kingdom; [b]Pediatric Service, Moorfields Eye Hospital, London, United Kingdom; [c]Adnexal Service, Moorfields Eye Hospital, London, United Kingdom; [d]Glaucoma Service, Moorfields Eye Hospital, London, United Kingdom; [e]London School of Hygiene & Tropical Medicine, Keppel Street, London, United Kingdom; [f]Primary Care & Public Health Sciences, King's College London, United Kingdom

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Correspondence: Annegret Dahlmann-Noor, NIHR Biomedical Research Centre at Moorfields Eye Hospital and UCL Institute of Ophthalmology,162 City Road, London EC1V 2PD, United Kingdom (email: annegret.dahlmann-noor@moorfields.nhs.uk).

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Abstract

Purpose

To determine the child's and parental perception of functional visual ability (FVA), vision-related and health-related quality of life (VR-QoL, HR-QoL) in children with microphthalmia/anophthalmia/coloboma (MAC).

Methods

Between June 25, 2014, and June 3, 2015, we carried out a cross-sectional observational study at Moorfields Eye Hospital, London, UK, enrolling 45 children 2-16 years of age with MAC attending our clinics, and their parents. To assess FVA, VR-QoL, and HR-QoL we asked participants to complete three validated tools, the Cardiff Visual Ability Questionnaire for Children (CVAQC), the Impact of Vision Impairment for Children (IVI-C) instrument, and the PedsQL V 4.0. The main outcome measures were the FVA, VR-QoL, and HR-QoL scores, reported by children and parents.

Results

In children with MAC, FVA is moderately reduced, with a median CVAQC score of −1.4 (IQR, −2.4 to 0.4; range, −3.0 [higher FVA] to +2.8 [lower FVA]). VR-QoL and HR-QoL are greatly reduced, with an IVI-C median score of 63 (IQR, 52-66; normal VR-QoL, 96), a median self-reported PedsQL score of 77 (IQR, 71-90; normal HR-QoL, 100) and parental score of 79 (IQR, 61-93), and a family impact score of 81 (67-93). Psychosocial well-being scores are lower than physical well-being scores. Parents and children have a different perception of the impact of the condition on the child's HR-QoL.

Conclusions

MAC has a significant impact on a child's FVA and QoL, similar to that described by children

with acute lymphoblastic leukaemia and chronic systemic conditions. Children and families may benefit from psychosocial support.

The microphthalmia/anophthalmia/coloboma (MAC) spectrum of congenital eye malformations is rare, with an estimated prevalence of anophthalmia at 0.6-4.2, microphthalmia at 2-17, and coloboma at 2-14 per 100,000 live births.[1,2] In most children the condition is bilateral, and in around one-third of children it is part of a syndrome associated with extraocular abnormalities, such as brain, craniofacial, cardiac, renal, and urogenital defects.[1-3] The extent of the malformation determines the visual acuity in children with MAC. Vision is often poor, and children with bilateral MAC often have severe sight impairment and require developmental support.[4] It is estimated that MAC is responsible for approximately 15% to 20% of severe visual impairment and blindness in children worldwide.[5] The published literature on the clinical management of MAC is scant.

The growth of the orbital cavity and the development of the maxilla can be significantly affected in the absence of a normal-sized globe. Therefore, in infants, orbital conjunctival conformers of progressively increasing size are applied to expand the orbital tissues; fitting and exchanging expanders may require multiple anesthetics. Cases of marked orbital asymmetry may require orbital reconstruction surgery to reduce cosmetic disfigurement. Despite the burden of MAC and its management on children and their families, no study has explored functional visual ability (FVA), vision-related and health-related quality of life (VR-QoL, HR-QoL) in this population. Two studies of adults with MAC reported low HR-QoL, increased anxiety and psychosocial impact from feelings of shame, shyness, sadness, and fear.[6,7] Validated tools to measure FVA, VR-QoL, and HR-QoL in children include the Cardiff Visual Ability Questionnaire for Children (CVAQC) for FVA,[8] Impact of Vision Impairment for Children (IVI-C) instrument for VR-QoL,[9] and PedsQL V 4.0 for HR-QoL.[10,11] The present study aimed to describe the impact of MAC on FVA, VR-QoL, and HR-QoL from a child's perspective.

Parental views on the impact of MAC on their child's and family's HR-QoL are also assessed.

Subjects and Methods

This study was approved by the National Research Ethics Committee South Central – Oxford A (14/SC/1052) and adhered to the tenets of the Declaration of Helsinki. Between June 25, 2014, and June 3, 2015, children 2-16 years of age attending Moorfields Eye Hospital were prospectively enrolled. Exclusion criteria were inability to communicate in English and surgical intervention within 1 month (before or after) of completing questionnaires. We screened the medical records of all children attending clinics in advance to identify those who met inclusion criteria. We consecutively approached these children and families. For those who did not wish to take part, we noted the reasons given. We provided parents and children age-appropriate information material and addressed any questions. Parents gave written consent, and children could sign an assent form.

Data Collected

We recorded age at study participation, sex and ethnic background, ocular and systemic diagnoses, laterality and best-corrected visual acuity with both eyes open in logMAR on the day of study participation. Where best-corrected visual acuity was counting fingers, we assigned a value of 2.1 logMAR; hand movements, 2.4 logMAR; light perception, 2.7 logMAR; and no light perception or ocular prosthesis/artificial eye, 3 logMAR.[12] We also recorded details of previous and current treatment, such as number of previous surgical interventions and number of general anesthetics.

To assess FVA, children who were at least 5 years of age completed the CVAQC.[8] The CVAQC was developed with focus groups of children with and without visual impairment and validated in children with visual impairment to assess difficulties in performing daily activities.

Designed to be completed by the child, it consists of 25 questions with answers selected on a four-point scale covering education, near and distance vision, getting around, social interaction, leisure, and sports. Using a Rasch conversion calculator provided, we transformed the raw scores into logarithmic scores. The resulting scores range from −3.0 (higher FVA) to +2.8 (lower FVA).

To evaluate VR-QoL, a subgroup of children aged ≥8 years of age enrolled after August 1, 2014, when required agreements and permissions were granted, completed the IVI-C tool.[9] The IVI-C was validated in visually impaired and normally sighted children. It consists of 24 questions with 5 possible answers plus an additional option of "no, for other reasons," covering areas of school, mobility, social interaction, and emotion. We scored the IVI-C responses using the relevant scoring sheet, which allocates values of 0-4, and did not allocate a score when the response "no, for other reasons" was selected. The resulting raw scores range from 0 to 96, with the highest score indicating normal VR-QoL. No Rasch conversion table is available for this tool as yet.

For HR-QoL, we used age-specific versions of the PedsQL Inventory (www.pedsql.org), which allows children >5 years of age to express their views on different aspects of their physical and emotional state and their social and school life.[10,11] Furthermore, parents completed two questionnaires, one regarding their child ("parental report") and one about the impact on the condition on the family ("family report"). The parental report was specific to the age of the child and consisted of 21-23 questions covering children aged 2-4, 5-7, 8-12, and 13-18 years. The family report contained 36 questions. Children from the age of 5 self-administered the questionnaire (PedsQL administration guidelines), and answers were given on a Likert scale of 0-4. We calculated the PedsQL scores following the scoring instructions. If items were left blank, we adjusted the denominator, using the number of completed items instead of the number

of total items. It is recommended to remove questionnaires from the analysis if 50% or more of the items have been left blank; this did not occur in our sample. Scores range from 0 to 100, with 100 indicating normal HR-QoL.

All questionnaires were completed on the same day, during a regular clinic appointment. When children needed help, they were assisted by a member of the research team or play leaders, but not by family members.

Statistics

We aimed for an overall sample size of 50, the smallest sample size required for Bland Altman limits-of-agreement analysis. Where data were missing for individual items in the PedsQL and IVI-C, we adjusted the denominator accordingly. For the CVAQC, the Rasch analysis–based calculator takes into account missing data. Where data were missing, datasets were excluded from the relevant analyses. We applied descriptive statistics throughout, reporting means and standard deviations for normally distributed data or median and interquartile range (IQR) for data non-normally distributed. We assessed relationships between age at participation, age at diagnosis, best-corrected visual acuity in the better-seeing eye, sum of surgical interventions, sum of general anesthetics and CVAQC, IVI-C, and Peds QL scores using Spearman rank correlation, and relationships with uni/bilaterality using the Mann-Whitney test. Agreement between parent and child PedsQL scores was assessed using Bland-Altman techniques. Statistical significance was set at the 5% level and all tests conducted were two-tailed. We did not adjust for multiple comparison testing in our exploratory investigations of associations but would urge readers to review these as hypothesis generating rather than confirmatory.[13]

Results

We approached 62 families of children with MAC who met the inclusion criteria. Sixteen

declined to take part because of perceived lack of time. We enrolled 46 children and removed one dataset, because the child did not have MAC, resulting in the analysis of 45 datasets.
The proportion of missing data was low. No data were missing for age, sex, diagnoses, laterality, and best-corrected visual acuity. Ethnicity was unknown in 13.3%. Questionnaire response rates were high (eTable 1).

The median IQR age of participants was 6.4 years (3.7-9.9 years; Table 1). Of the 45 participants, 27 (60%) were female; 33 (73%), white; 2 (4%) Asian or Asian British; 1 (2%), black or black British; 1 (2%) mixed; 2 (4%), other; 6 (13%), of unknown ethnicity.

Microphthalmia was isolated in 23 children (51%) and was associated with coloboma in 10 (22%) and with cataract in 9 (20%). Two children developed glaucoma, one following lensectomy. Three children (7%) had anophthalmia. The condition was bilateral in 20 cases (44%). Table 1 summarizes clinical and participant characteristics.

Eighteen 5- to 16-year-olds completed the CVAQC. The median of the Rasch-transformed scores indicated moderate impairment of FVA (Table 2). There was no evidence of an association between CVAQC score and age or any other clinical factors, such as best-corrected visual acuity or bilaterality of the condition (Table 2, Figure 1).

Eleven children and young people 8-16 years of age completed the IVI-C tool. The median score indicated markedly reduced VR-QoL (Table 2). There was no evidence of an association between IVI-C and age or any other clinical factors (Table 2, Figure 1).

The PedsQL self-report was completed by 24 children, with a resulting median score significantly lower than that of healthy children (Table 2). There was evidence of an association between self-report scores and the total number of surgical socket interventions (Spearman's ρ correlation coefficient, −0.43; $P = 0.04$; n = 23; see eTable 2) but no evidence of an association

with age (Figure 1) or clinical factors (eTable 2). Self-reported scores for psychosocial well-being were lower than those for physical well-being (Table 2); the mean difference was −7 (95% CI, −14 to −0.4).

The median PedsQL parental report score about the child was also reduced. There was an association between parental report scores and number of previous operations (Spearman's ρ, −0.45; $P = 0.002$; n = 43) and anesthetics (Spearman's ρ, −0.34; $P = 0.02$; n = 43; see eTable 2).

The PedsQL family report (n = 45) median score was also reduced and with the same associations as the parental report, namely previous operations (Spearman's ρ, −0.416; $P = 0.005$; n = 44) and anesthetics (Spearman's ρ, −0.35; $P = 0.02$; n = 44; see eTable 2).

Overall PedsQL parent report scores were higher than self-report scores (Table 2), with a mean difference of −4 (95% CI, −9 to 1; Figure 1). The mean difference between parental and self-scores on the PedsQL physical subscale was −4 (95% CI, −11 to 2; on the psychosocial subscale, −4 (95% CI, −10 to 2).

Discussion

This is the first report of FVA, VR-QoL, and HR-QoL in children with MAC. Previous studies reported increased anxiety and feelings of shame, shyness, sadness, and fear in adults with MAC, but these studies included also nondevelopmental MAC, such as post-traumatic or post-infectious forms of anophthalmia.[6,7] The reduction in HR-QoL in children with MAC we report here is similar to levels reported by children with acute lymphoblastic leukemia and chronic diseases.[14,15] In addition, VR-QoL is profoundly reduced, whereas FVA is moderately reduced. A greater number of surgical interventions is associated with worse HR-QoL scores reported by both children and parents. No other associations were found; however, our sample size may have limited our ability to find associations had they existed. In contrast to previous findings,[16,17] we

found that parents reported MAC to have less of an impact on their child's HR-QoL than young children themselves. Parents may be underestimating the impact of facial disfigurement and placing more emphasis on visual impairment in a group where most cases were unilateral.

A strength of our study is that children completed the questionnaires by themselves or were supported by play specialists eliminating parental perceptions influencing the children's answers.

Our study has some limitations. MAC conditions are rare, and although we enrolled participants over 1 year, only 62 families could be approached, a quarter of which declined to participate. Selection bias may arise from families stopping attending clinics as their child ages. We have no data to estimate this proportion of these families but consider the overwhelming majority of parents eager to provide the best healthcare for their child. However, our teenage group included only 3 young participants. Selection bias may also have arisen from limiting enrollment to a single site and to English-speaking families. Lack of a control group of normal-sighted children may be considered a limitation; however, the questionnaires we used were specifically developed for the age range of children we included. In addition, CVAQC was developed for children with visual impairment, leading to an expected ceiling effect if used in normal-sighted children. For both IVI-C and PedsQL, a normative database of healthy children is available.

Furthermore, the use of number of surgical procedures as a proxy of painful treatment episodes may be less valid than using validated pain scales, but has been used in similar studies before.[15] Similarly, the number of general anesthetics (including examinations under anesthesia, because these are often arranged on the understanding that should findings indicate a need for additional surgery, this will be carried out under the same anesthetic) as a proxy for episodes of

emotional upset and anxiety is not as valid as using a validated scale measuring anxiety, but it has been used previously.[18]

Although logMAR visual acuity is a well-established measure of visual function, it is not always possible to use logMAR methods in children with visual impairment, and hand movements or counting fingers at a specified testing distance are occasionally used. Complete blindness, no perception of light, or artificial eye/ocular prosthesis can also not be expressed in logMAR. In order to allow a quantitative analysis, we followed a published approach of using logMAR values of 2.1 to 3 in these cases.[12] This conversion was required in 8 cases (17.8%; 7 cases of NPL and 1 of PL) and may have led to an underestimation of logMAR acuity.

Within the limits of the study design, that is selection bias that may have led to inclusion of a higher proportion of more treatment-adherent families and the limitation of enrolling participants at a single site in a highly developed country, our findings can be generalized to other children with MAC who receive care in similar settings.

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Legends

FIG 1. Box plots of median and interquartile range (IQR) for Cardiff Visual Ability Questionnaire for Children (A), Impact of Vision Impairment for Children (B) and PedsQL self-report scores (C) of children with MAC. The Bland Altman plot (D) shows agreement between parental and child self-report PedsQL total scores.

Table 1. Age at study participation and at diagnosis and clinical characteristics.

Table 2. Scores for functional visual ability (FVA), vision- and health-related quality of life (VR-QoL, HR-QoL) reported by children according to age and parents. Possible CVAQC scores (FVA) range from -3.00 (higher FVA) to +2.80 (lower FVA). IVI-C scores range from 0 to 96 (severe reduction to normal VR-QoL). PedsQL scores range from 0 to 100 (severe reduction to normal HR-QoL). Children reported markedly reduced FVA and VR-QoL. All HR-QoL scores were significantly reduced as reported by both children and parents (self-report, parental report, family report) and psychosocial more than physical scores.

eTable 1. Response rates. Parents were asked to complete two questionnaires, and children from the age of 5 years were asked to complete two or three questionnaires.

eTable 2. Statistical significance and strengths of associations.

Table 1. Age at study participation and at diagnosis and clinical characteristics

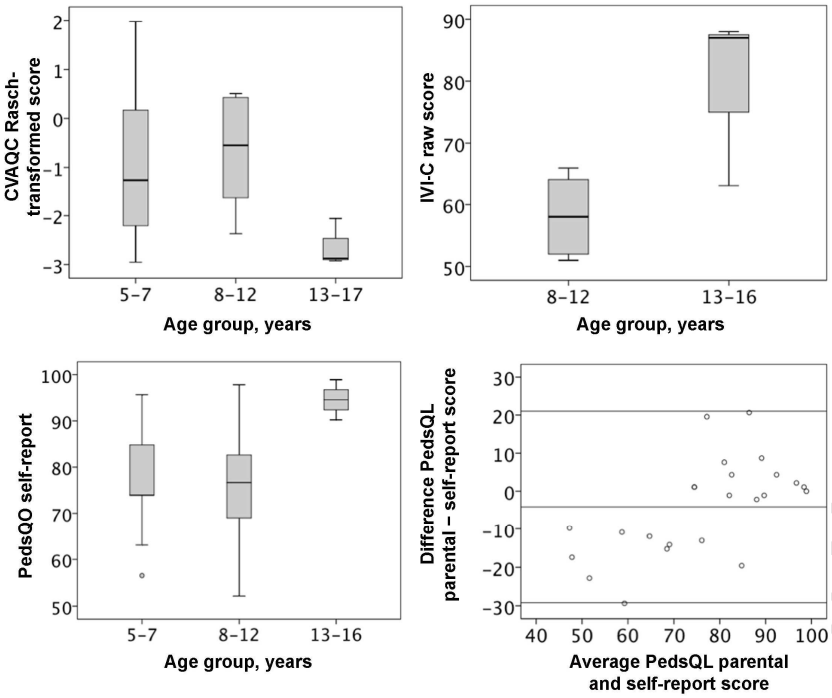
	2-4 years (n = 18)	5-7 years (n = 10)	8-12 years (n = 14)	13-16 years (n = 3)	All age groups (n = 45)
Age at study participation,	3.40 (2.87-4.13)	6.41 (5.68-6.58)	9.98 (9.21-10.44)	13.97 (13.7-13.97)	6.41 (3.68-9.89)
BCVA	0.12 (0.06-0.55)	0.16 (0.09-3)	0.06 (0-2.78)	0.02 (−0.2 to 0.02)	0.1 (0.01-0.75)
Surgical interventions, n	1 (0-2)	2.5 (1-6)	1 (1-4)	0 (0-2)	1 (0-3)
General anesthetics, n	1 (0-1)	2 (1-5)	2 (1-4)	2 (1-3)	1 (1-3)

BCVA, best-corrected visual acuity. All values show the median (interquartile range).

Table 2. Scores for functional visual ability (FVA), vision- and health-related quality of life (VR-QoL, HR-QoL) reported by children according to age and parents

	CVAQC, median (IQR) (n = 18)	IVI-C, median (IQR) (n = 11)	PedsQL, median (IQR)		
			Self-report (n = 24)	Parental report (n = 44)	Family report (n = 45)
All age groups					
Total score	−1.4 (−2.4 to 0.4)	63 (52-66)	77 (71-90)	79 (61 to 93)	81 (67-93)
Physical health			88 (73-100)	91 (69-100)	92 (73-100)
Psychosocial health			76 (69-86)	75 (57-90)	79 (65-91)
Age 2-4 years					
Total score				79 (65-94)	79 (69-93)
Physical health				91 (78-100)	83 (69-83)
Psychosocial health				72 (59-91)	80 (67-92)
Age 5-7 years					
Total score	−1.3 (−2.4 to −0.4)		74 (68-87)	81 (43-94)	87 (59-93)
Physical health			88 (56-97)	92 (44-98)	94 (61-100)
Psychosocial health			73 (68-85)	81 (55-93)	84 (59-92)
Age 8-12 years					
Total score	−0.6 (−1.7 to 0.4)	58 (52-64.5)	77 (68-83)	70 (56-86)	74 (65-86)
Physical health			84 (73-97)	81 (67-98)	94 (83-100)
Psychosocial health			74 (62-82)	70 (45-85)	69 (62-84)
Age 13-16 years					
Total score	−2.9 (−3.0 to −2.1)	87	95	95	99 (87-100)
Physical health			100	100	100
Psychosocial health			92	92	98

[a]Possible CVAQC scores (FVA) range from −3.0 (higher FVA) to +2.8 (lower FVA). IVI-C scores range from 0 to 96 (severe reduction to normal VR-QoL). PedsQL scores range from 0 to 100 (severe reduction to normal HR-QoL). Children reported markedly reduced FVA and VR-QoL. All HR-QoL scores were significantly reduced as reported by both children and parents (self-, parental, family report), psychosocial more so than physical scores.



eTable 1. Response rates

	Parents (n = 45)	Children 5-7 years (n = 10)	Children 8-12 years (n = 14)	Teenagers 13-16 years (n = 3)	All children 5-16 years
CVAQC, n (%)		7/10 (70)	8/14 (57.1)	3/3 (100)	18/27 (66.7)
IVI-C, n (%)			8/14 (57.1)	3/3 (100)	11/14 (78.6)
PedsQL self report, n (%)		9/10 (90)	12/14 (85.7)	3/3 (100)	24/27 (88.9)
PedsQL parent report, n (%)	44/45 (97.8)				
PedsQL Family report, n (%)	45/45 (100)				

eTable 2. Statistical significance and strengths of associations[a]

		CVAQC Rasch transformed score	IVI-C raw score	Peds QL		
				Self-report	Parent report	Family report
Age, years	Spearman's ρ	−0.082	0.498	0.384	0.059	0.099
	P value	0.748	0.119	0.064	0.705	0.518
	n	18	11	24	44	45
Age at diagnosis	Spearman's ρ	—	—	—	−0.078	−0.128
	P value	—	—	—	0.614	0.403
	n	18	11	24	44	45
BCVA better or both eyes	Spearman's ρ	0.371	−0.159	−0.287	−0.271	−0.245
	P value	0.129	0.64	0.174	0.076	0.104
	N	18	11	24	44	45
Sum interventions	Spearman's ρ	0.337	−0.334	−0.434	−0.451	−0.416
R+L excl EUAs	*P* value	0.185	0.345	0.038	0.002	0.005
	N	17	10	23	43	44
No. GA incl EUAs	Spearman's ρ	0.048	−0.315	−0.305	−0.343	−0.356
	P value	0.855	0.376	0.158	0.024	0.018
	N	17	10	23	43	44
Mann-Whitney uni/bilaterality	Significance	0.051	0.359	0.156	0.095	0.058
	Unilateral:bilateral	10:8	5:6	12:12	25:19	25:20

BCVA, best-corrected visual acuity; *GA*, general anesthesia; *EUA*, examination under anesthesia.

[a]A *P* value of <0.05 was considered statistically significant.