ORIGINAL RESEARCH

Ophthalmic manifestations of children with Down syndrome in Port Harcourt, Nigeria

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Aim: The aim of this study was to provide a profile of oculo-visual anomalies in children with Down syndrome (DS) in Port Harcourt, Nigeria.

Methods: This comparative study assessed the visual functions of 120 children (42 DS and 78 developmentally normal children). The visual functions evaluated and the techniques used were: visual acuity (Snellen illiterate chart and Lea picture charts), refraction (static retinoscopy with cyclopegia), ocular alignment (cover test), near point of convergence (pen and rule), and external examinations and fundoscopy.

Results: A total of 42 children with DS (22 males, 20 females, mean age 11.43 ± 6.041 years) and control group of 78 normal children (36 females, 42 males) with mean age 6.63 ± 1.98 years were examined. Of the 42 DS children, visual acuity was less than 6/18 in eight and one of the DS and control groups, respectively. Visual acuity could not be checked conventionally in eleven participants from the DS group due to poor response. The main findings were: DS compared to control group showed refractive errors of 76.2% (half of which was from myopia) vs 14.1% (only 10% due to myopia). There was a statistically significant difference in total refractive errors between the Down syndrome group and the control group ($P = 0.001$, $\chi^2 = 18.29$). Strabismus was 9.5% (75% esotropia) vs 0%, and there was a statistically significant difference ($P = 0.001$, $\chi^2 = 5.01$), nystagmus was 4.8% v 0%, conjunctivitis 19.05% vs 8.97%, and keratitis 7.14% vs 0%, which was statistically significant ($P = 0.05$, $\chi^2 = 2.90$).

Conclusion: Refractive errors were prevalent in a sample of children with DS in Port Harcourt, Nigeria, whereas the prevalence of ocular diseases was low when compared to age-matched control participants. This study highlights the need for ophthalmic care in children with DS. Routine eye care such as the use of spectacles when necessary is recommended for people with DS at all ages to improve their educational and social needs as well as overall quality of life.

Keywords: Down syndrome, refractive errors, strabismus, ocular diseases

Introduction

Down syndrome (DS), first comprehensively described in 1866 by a British physician named Langdon Down,[1] is a genetic condition in which a person has 47 chromosomes instead of 46, with an extra copy of chromosome 21. This extra genetic material disrupts the normal developmental processes, leading to characteristic intellectual, medical, and physical abnormalities in persons with DS.[2,3] DS (trisomy 21) is associated with characteristic features that include physical (short stature, small heads, flat nasal bridges, oblique palpebral fissures, prominent epicanthal folds, medical conditions such as cardiac defects, skeletal abnormalities, and obesity,[3–6] oculo-visual anomalies including refractive and binocular-vision disorders, and anterior and posterior segment disorders.[7]

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DS is associated with various medical conditions[8,9] and constitutes a major socioeconomic problem to our societies. Advanced maternal age is the main documented risk factor for trisomy 21,[12] though it is speculated that paternal age may play a role in DS births.[13–15] DS is found in all races, nationalities, and socioeconomic strata.[13,15] The incidence of DS is about one per 650–1000 live births worldwide. Specifically, the incidence of DS is one in 865 live births in Nigeria,[10] and between 1.2 and 1.8 in every 1000 live births in South Africa.[11]

Although the incidence of ocular anomalies in children with DS varies in different studies,[16–34] studies have shown that children with DS are more at risk for several ocular disorders than typical children.[7–19] The prevalence of refractive errors (myopia, hyperopia, and astigmatism) ranged between 3% and 62.3%,[16,19,20–27,30] strabismus 5% and 57%,[16,19,21,26,29,35,36] and the prevalence of esotropia was higher than exotropia in all the studies.[16,19,21,26,29,35,36] Others include reduced amplitude of accommodation (26%–91.8%),[19,27,28] conjunctivitis (5.6%–6.7%),[20,34] eyelid abnormalities (1%–6.7%),[25,26,29,30,33,34] blepharitis (especially high, at 30%–47%),[18,27,31] Brushfield spots (36%–81%),[18,31] glaucoma (0.8%–6.7%),[16,29,34] and retinal disorders (1.7%–40%).[27,29,31,34]

Invariably, eye-care practitioners play an important role in improving the quality of lives of persons with DS by attending to their visual needs. However, DS in Africa remains poorly understood,[11] and eye care for persons with DS is still inadequate.[19] Although several studies have been conducted on persons with DS in various racial groups,[16–34] available studies that have assessed ocular features of persons with DS are few in the African populations.[19–20] Moreover, studies on African populations lacked comparison groups with the general population. Using comparison groups is important in identifying unique ocular anomalies in children with DS. Consequently, we studied the ophthalmic status of children with DS compared with an age- (chronological), socioeconomic, and sex-matched control group of normal children from the general school-age population. The aim of the study was to characterize oculo-visual anomalies in our sample of African children with DS that will help to identify high-risk ocular conditions in persons with DS.

Materials and methods

Ethics clearance was obtained from the University of Port Harcourt Teaching Hospital (UPTH) biomedical research ethics committee. Informed consent was obtained from the parents or guardian who accompanied the children. For the control group, group consent was obtained from school authorities. For both the DS and the control groups, the nature and purpose of the study was explained to the participants/parents and the group representative. The study participants in this comparative study comprised persons with DS attending the UPTH eye clinic and were mainly those who were attending special schools for people with intellectual disability, who had been brought by their parents or guardians from their homes in the Port Harcourt metropolis. Other DS cases were children attending "well baby clinics," who were brought by their mothers to the eye clinic. The "well baby clinic" is a unit of the pediatric and community medicine departments at the UPTH where routine immunizations and health talks are given.

As it was impossible to conduct a cytogenetic chromosomal assay, all participants were diagnosed as having DS based only on their physical and clinical features; therefore, we do not know the type of DS each participant had. The control group was comprised of children attending the UPTH "well baby clinics" and from a mainstream primary school in the Port Harcourt metropolis. The study was conducted between April and August 2011.

The following tests were performed on each DS participant: visual acuity (both unaided and with pinhole) before and after refraction, tested using the Snellen illiterate E chart, and Lea picture charts or Lea paddles (preferential looking) test depending on their abilities, interpupillary distance using an interpupillary distance (IPD) rule. Ocular alignment was evaluated using the prism cover test, and the near point of convergence (NPC) was assessed using a fixation target (tip of a pen) brought in towards the child's eye from 40 cm, with the distance where one eye begins to deviate measured from the respondent's lateral canthus with a tape measure. Detailed external eye examination as well as dilated fundus examination was performed using direct and binocular indirect ophthalmoscopy. The Keeler SL-16 slit-lamp (Keeler Ltd, Windsor, UK) biomicroscope was also used where possible. The refractive status was evaluated using the streak retinoscope (Welch Allyn 3.5V Elite Streak Retinoscope; Model 18245, Welch Allyn Inc, Skaneateles Falls, NY) in cycloplegia. For cycloplegic refraction, a drop of 1% cycloplentolate was instilled at about 5-minute intervals into the conjunctival fornix of the participants three times. To minimize systemic absorption and a possibility of raised intraocular pressure, which may occur in patients with DS, the puncta was occluded accordingly. Retinoscopy was then carried out upon dilatation on cooperative children. Objective retinoscopy data for the right eye were used for the analysis. All external, anterior, and posterior segment examinations

were performed by an ophthalmologist, while other tests were performed by an optometrist. Due to inattention and a lack of cooperation, it was impossible to perform all the tests on all the DS participants. Refractive errors were defined as myopia ≥ -0.50 D, hyperopia as $\geq +1.00$ D, and astigmatism as ≥ -0.75 cyl.[16,34]

The data were analyzed using Epi Info version 6.04d (Centers for Disease Control & Prevention, GA). Frequency was presented in percentages; means and standard deviation were calculated for descriptive and comparative purposes. For comparison between the means of the two groups, all data were subjected to Fisher's exact test. The level of significance considered to support our hypothesis was taken as $P < 0.05$.

Results

A total of 42 children with DS (22 males, 20 females) aged between 6 months and 28 years (mean age of 11.43 ± 6.041 years) were examined. The control group was 78 children (36 females, 42 males, age range 3–13 years, mean age 6.63 ± 1.98 years). Findings were as follows: visual acuity was less than 6/18 in eight and one of the DS and control groups, respectively. Visual acuity could not be checked conventionally in eleven subjects in the DS group due to poor response/poor understanding of the test, but eight of the participants may be amblyopic. The mean palpebral fissure height in the DS group was 8.6 ± 1.083 mm in the Right Eye (RE) and 8.3 ± 1.519 mm in the Left Eye (LE). The palpebral fissure height for the RE in the control group was 10.064 ± 0.958 mm and 10.115 ± 0.911 mm. There was a statistically significant difference between the DS and control groups ($P = 0.00$ for Both Eyes, $\chi^2 = 7.65$ for the RE and $\chi^2 = 8.24$ for the LE). For the DS group, the mean IPD for near was 57.5 ± 2.57 mm and 59.5 ± 2.51 mm for distance, and the mean NPC was 16.714 ± 2.298 mm. For the control group, the mean IPD was 56.74 ± 2.58 mm and 58.74 ± 2.58 mm for near and distance, respectively, while the NPC was 16.68 mm ± 3.014. These were not statistically significant. Using the right eye as sentinel for the DS group, the total prevalence of refractive error was 76.2% (n = 32) whereas in the control group, using the RE as sentinel, 14.1% (n = 11) of the control participants had refractive errors. There was a statistically significant difference in refractive errors between the DS and control groups ($P = 0.001$, $\chi^2 = 18.29$). Refraction improved vision in 13 cases (40.6%) of the DS group (eleven of which were myopic), which was measurable up to three lines better than before on average ($P = 0.001$, $\chi^2 = 18.29$). Eight subjects (25% of the 32) could not respond appropriately to the tests, but five cases (15.6% of the 32) were believed to have improved. Vision

did not improve in the remaining eleven cases (34.4% of the 32), possibly due to amblyopia. Refraction improved visual acuity in seven cases (63.6%), only two of which were myopic. Four cases (36.4% of the eleven) did not improve, due to coexisting cupped discs in three cases (27.3%) and pale atrophic discs in one case (9.1%). Allergy was noted in the form of conjunctivitis more in the control (less than 10%) than in the DS group, though this was not statistically significant. Other details are indicated in Tables 2–4.

Nystagmus was significantly more prevalent in the DS group (4.8%) than in the control (0%). Strabismus was present in 9.5% (n = 4) of the DS group, the most prevalent being esotropia (three cases). This was statistically significant ($P = 0.01$, $\chi^2 = 5.01$). No participant in the control group had strabismus (Table 1). Table 2 shows the details of anterior segment disorders noted in both groups, with the presence of keratitis being statistically significant in the DS group compared with the controls ($P = 0.05$, $\chi^2 = 2.90$). The most common ocular features observed among the control group were cupped discs in 18 cases (23.1%), seven cases of vernal conjunctivitis (8.97%), and six cases of optic atrophy (7.67%), none of which were statistically significant. A summary of other anomalies is shown in Table 4.

Discussion

We compared the ocular findings in persons with DS with an age-matched control group. Our study showed the prevalence of refractive errors, strabismus, and nystagmus was higher in the DS group than the control group. There was a statistically significant difference in myopia and myopic astigmatism when comparing the DS group and the control ($P = 0.001$, $\chi^2 = 20.53$; $P = 0.001$, $\chi^2 = 5.86$ for the RE; $P = 0.001$, $\chi^2 = 15.93$; and $P = 0.001$, $\chi^2 = 5.74$ for the LE). None of the participants in the control group had strabismus. The frequency of nystagmus (4.8%) was significantly higher in the DS than in the control group ($P = 0.001$, $\chi^2 = 6.30$) (Table 1).

Table 1 Frequency of refractive errors, strabismus and nystagmus in Down syndrome (DS) and control groups

Defect	DS group n (%)	Control group n (%)	χ^2	P-value
Visual acuity (<6/18)	8 (36.3)	1 (1.3)	9.99	0.00*,F
Myopia	16 (38.1)	1 (1.3)	18.96	0.00*,C
Hyperopia	4 (9.5)	4 (5.2)	0.29	0.457F
Astigmatism	12 (28.6)	5 (6.5)	6.48	0.01*,C
Total refractive errors	32 (76.2)	11 (14.1)	18.29	0.00*,C
Emmetropia	10 (23.8)	68 (87.2)	10.89	0.00*,C
Strabismus	4 (9.5)	0 (0.0)	5.01	0.01*,F
Nystagmus	2 (4.8)	0 (0.0)	6.30	0.01*,F

Notes: *Significant ($P < 0.05$); [F]P-value derived from Fisher's exact test; [C]P-value derived from Pearson's chi-square.

Table 2 Anterior segment disorders in Down syndrome (DS) and control groups

Disorder	DS group n (%)	Control group n (%)	χ^2	P-value
Allergy	1 (2.38)	7 (8.97)	0.99	0.269[F]
Blepharitis	1 (2.38)	2 (2.56)	0.30	1.000[F]
Chalazion	1 (2.38)	0 (0.0)	0.09	0.355[F]
Conjunctivitis	8 (19.05)	7 (8.97)	1.22	0.270[C]
Hypochromia iridis	1 (2.38)	0 (0.0)	0.09	0.355[F]
Keratitis	3 (7.14)	0 (0.0)	2.90	0.05[*,F]
Buphthalmos	1 (2.38)	0 (0.0)	0.09	0.355[F]
Nasolacrimal duct obstruction	1 (2.38)	0 (0.0)	0.09	0.355[F]
Total	17 (40.48)	16 (20.50)		
No abnormality detected	25 (59.52)	62 (79.48)	5.46	0.02[*C]
Total	42 (100.0)	78 (99.98)		

Notes: *Significant ($P < 0.05$); [F]P-value derived from Fisher's exact test; [C]P-value derived from Pearson's chi-square.

A spectrum of ocular anomalies is prevalent in DS and has been described extensively in the literature across different racial groups.[16–34] Previous studies[7–19] have established that refractive errors and strabismus are more prevalent among children and young adults with DS when compared with controls, as reported in other studies.[17,23,24,38,39] For refractive errors, our finding of 38.1% prevalence of myopia (Table 1) is comparable to findings from other studies[17,23,24,38,39] and lower than findings by other authors,[17,24,39] although higher than findings reported by others.[19,27,35,40] In children with DS, heart defects have been reported to be associated with myopia, although the mechanism is not clear.[22,27,41] Our finding on hyperopia (9.5%) is comparable to other studies with a reported range of between 12%[26] and 15%,[22] but lower than reports by other authors.[19,29,30,40] Our finding of 28.6% prevalence of astigmatism is similar to the findings in other studies,[19,20,22,25,26,29,38,42] although lower than findings reported by other authors.[17,24,40] The high incidence of refractive errors among children with DS is believed to be caused by failure of emmetropisation.[39,34] Visual acuity was improved to a statistically significant degree in the DS group after refraction

Table 3 Fundus abnormalities in Down syndrome (DS) and control groups

Disorder	DS group n (%)	Normal group n (%)	χ^2	P-value
Cupped disc	4 (9.52)	18 (23.1)	1.69	0.193[F]
Optic atrophy	2 (4.76)	6 (7.67)	0.05	0.714[F]
Persistent hyaloid artery	0 (0.0)	1 (1.28)	0.10	1.000[F]

Notes: [F]P-value derived from Fisher's exact test; [C]P-value derived from Pearson's chi-square.

Table 4 Frequency of other anomalies in Down syndrome (DS) and control groups

	DS group n (%)	Control group n (%)	χ^2	P-value
Alopecia	1 (2.38)	0 (0.0)	0.09	0.355[F]
Macroglossia	1 (2.38)	0 (0.0)	0.09	0.355[F]
Mongoloid	0 (0.0)	4 (5.12)	0.84	0.299[F]
Flat nose	3 (7.14)	0 (0.0)	2.90	0.05[*,F]
Hypertelorism	0 (0.0)	1 (1.28)	0.10	1.00[F]
Autism	3 (7.14)	0 (0.0)	2.90	0.05[*,F]
Cerebral palsy	3 (7.14)	0 (0.0)	2.90	0.05[*,F]

Notes: *Significant ($P < 0.05$); [F]P-value derived from Fisher's exact test.

($P = 0.001$, $\chi^2 = 27.86$). The prevalence of strabismus in the DS group in our study (9.5%) was higher than findings reported by Paudel et al,[35] but lower than in other studies: 18.2%,[19] 27%,[30] 21.8%,[31] 26.7%,[33] and 23%.[40] As in the current study, esotropia has been reported to be more prevalent than exotropia in DS populations.[16,19,25,29,37] Bromham[41] et al reported that nystagmus was a feature of DS in his series. However, only 4.8% (two cases) of our DS group had nystagmus. Ocular diseases were not prevalent in our DS sample. The 19.05% prevalence of conjunctivitis was similar to the 16% prevalence of blepharoconjunctivitis reported by Kim et al,[16] though there was no statistically significant difference when compared with the control group (Table 2). Early cataract formation, which may reflect the faster aging process in many persons with DS,[15] was not prevalent in our sample. Cupping of the discs and optic atrophy, however, were less prevalent in the DS group than in the control group (Table 3).

This study is significant in that it enhanced an understanding of ocular features in African children with DS and will help to guide diagnosis, treatment, and health-policy planning for persons with DS. Advocacy for DS children to be offered special education programs is necessary, as they have associated learning difficulties from their mental handicap.

Limitations

A limitation of this study that may affect the applicability of the study findings was the poor response and inattention from some of the DS participants. The use of visual evoked responses could have been beneficial in further categorizing some findings, but the facility was not available at our unit at the time the study was conducted.

Conclusion

Refractive errors were prevalent in a sample of children with DS in Port Harcourt, Nigeria, whereas the prevalence of ocular diseases as well as uncorrectable visual loss was low.

An understanding of the prevalence and distribution of ocular abnormalities in DS populations will improve awareness of these disorders and their medical sequelae, which will enhance detection and management of these disorders. This will subsequently improve the developmental capabilities and the quality of life of children with DS.

Recommendations

Family physicians, authorities of special schools for children with DS, and eye-care workers need to be aware of the specific eye problems of persons with DS so that referral for appropriate ophthalmologic care can be initiated promptly. Furthermore, evaluation, treatment, and periodic review of ocular and refractive findings in children with DS are needed. Specifically, we suggest that persons with DS should be monitored for vision and eye disease at the following periods of life: (1) at birth, (2) at 2–3 years of age, (3) at the beginning and end of school, (4) at 45 years of age and every 5 years thereafter, and (5) in the case of vision anomalies such as refractive errors, poor accommodation, or strabismus, the frequency of examination should be increased and determined individually by the ophthalmologist. Photo screening may help save time and expense and encourage parents to comply more with the annual checks necessary for their DS children.[43] The recommendations outlined above will impact positively on the educational and social needs of persons with DS.

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Disclosure

The authors report no conflicts of interest in this work.

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