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Comparative study of prevalence of refractive errors in autistic and non-autistic children in Abuja

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Abstract

Autism is a neuro-developmental disorder in children which is mainly characterised by poor communication skills including visual challenges. This study was aimed to comparing the prevalence of refractive errors in 24 (50%) autistic and 24 (50%) non-autistic children that were attending two special schools and two normal schools in Abuja metropolis. Each group of 24 subjects consisted of 12 (25%) males and 12 (25%) females with a mean age of 8.9 ± 2.6 years and 7.9 ± 2.2 years respectively. The 48 subjects were subjected to same examination procedure from 9.00 am-2.00 pm daily in designated schools. The visual acuity charts for distance (3 meters) and near (40 cm) consisted of Goodlite LEA symbol charts model #250150 (far) and Goodlite LEA symbol acuity charts model #250800 (near), respectively. These are paediatric acuity charts which consisted of various symbols that are replicated in the response key-pads held by the subjects. The retinoscopic findings served as a guide to determine the refractive status for each subject using a trial frame with trial lens set. The results revealed that the prevalence of refractive error in the study population was 41(85%). Myopic-astigmatism was the most common type of refractive error in both autistic and non – autistic subjects, with 12 (50%) and 9 (37.5%) respectively, while hyperopia was the least common with 01 (4.2%) in each group. The data were analysed using the Fisher's exact test of independence for the first research hypothesis which showed that there was no significant difference in the prevalence of refractive errors in autistic and non-autistic subjects (p=0.828). There was also no significant difference in the types of refractive errors by gender in autistic and non-autistic subjects (p = 0.068). The need for early diagnosis and management of refractive errors in autistic children is, therefore, advised to optimise visual function.

Keywords: Autistic children, Non-autistic children, Refractive errors

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Introduction

Autism is a state of mental disorder that develops in early childhood and is characterised by learning difficulties, inability to relate to other people and the outside world, and repetitive body movements" (Maira *et al.*, 2004; Shaw *et al.*, 2021). Similarly, the term "autistic psychopathy" was used to describe the behaviour of some children who displayed difficulties in making new friends; engaged in one-sided conversation and were engrossed in personal activities with repetitive behaviour (Fuentes *et al.*, 2014; Pratt *et al.*, 2017). American Psychiatric Association provided the first diagnostic criteria for autism in the third edition of the Diagnostic and Statistical Manual for Mental Disorders (DSM-3), published in 1980 (Gizadzinski *et al.*, 2013). This led to the description of autism as a wide range of neuro-developmental disabilities characterised by deficit in social interaction; challenges with communication; limited interests in social interaction and repetitive behaviour (Coulter *et al.*, 2009).

The early signs of autism were usually noticed at about 12-18 months of age where children show significant deficits in communication and social interaction such as delayed speech; poor eye contact; resistance to cuddling and failure to readily respond to their names when called upon. Autism may also be accompanied by some visual challenges like poor visual acuity (distance or near); squinting of the eyes; frequent or involuntary rubbing of the eyes; and tilting of the head while gazing at objects. Some of these symptoms are often associated with ocular abnormalities such as refractive errors, amblyopia, etc. (Onaolapo and Onaolapo, 2017; Meera *et al.*, 2017; Bajo *et al.*, 2018 ; Bakare *et al.,* 2019 ; Hyman *et al.*, 2020; Maenner *et al.*, 2023).

World Health Organization (WHO) in 2012, estimated the global prevalence of autism in Sub-Sahara Africa,

India and the Caribbean Islands to be 1:160 persons; while the prevalence of autism in other parts of the World was approximately put at 1:588 children. Similarly, about half of the children diagnosed with autism within this period had intellectual disabilities with an intelligent quotient (IQ) of less than 70 (Bajo *et al.*, 2014; Onaolapo and Onaolapo, 2017; Raina *et al.,* 2017). The first prevalence of autism in Nigeria was recorded in 1978, following a study that involved five other Sub–Saharan African countries, namely Ghana, Kenya, Zimbabwe, Zambia and South Africa with a prevalence of 1:145 children with intellectual disabilities (Zablotsky *et al.*, 2017; Bakare *et al.*, 2019).

Refractive errors are common natural visual development that occur due to failure of healthy eyes to focus clear images of objects at both distance (6 meters) and near (40 cm). Under normal circumstance, light rays from objects at any given distance, incident upon the cornea will be refracted and brought to a point focus on the retina. This consists of photo-receptor cells which will convert the light energy into electrical impulse before being transmitted through the optic nerve to the visual cortex.

These are interpreted as appropriate visual images that we perceive. However, in situation where incident light rays are not brought to a point focus on the retina indicate presence of refractive error e.g. myopia, hyperopia, astigmatism, or a combination of these. Consequently, where refractive errors remain uncorrected for a long period of time from early childhood, it may lead to the photo-receptor cells becoming less sensitive to light perception a condition known as amblyopia (Alrasheed *et al.,* 2016; Kannan *et al.*, 2016; Prabha *et al.*, 2016; Pratt *et al.,* 2017).

Materials and Methods

This was a cross sectional analytical study which was designed to compare the refractive status of autistic and non-autistic children in order to determine their level of vision at distance (6 meters) and at near (40 cm) respectively.

Study Population

A total population of 48 autistic and non-autistic children, aged between 5 – 12 years, were selected from a population of 92. The 48 subjects consisted of 24 autistics (50%) and 24 non-autistics (50%) children with a gender distribution of 12 males and 12 females for each group

Sampling Method

Purposive sampling technique method was adopted. This is a non-probability sampling method that relies on the decision of the researcher to select the qualities of subjects that suits the purpose of its study. This sampling technique ensured that proper selection of 24 autistic subjects from two special schools in Abuja was achieved. All the autistic subjects were earlier diagnosed with autism prior to their enrolment in their schools (; Hellerstein *et al.* 2014; Etikan, Musa and Alkassim, 2016). Similarly, the non-autistic subjects were recruited from normal primary schools. The non – autistic subjects were defined as children without developmental delays including normal intellectual capacity. (Kannan *et al.*, 2016; Kaur *et al.*, 2016).

Research Materials

These included: Examination room with table and chair; Visual acuity charts i.e. Goodlite LEA symbols distance acuity chart (model #250150); Goodlite LEA symbol near acuity chart (model #250800); Goodlite response key pad (model #251700); Goodlite flash pad (model #251800); Goodlite LEA 3-D puzzle chart (model #251600); Occluder; Pen-light; Keeler streak retinoscope; Keeler monocular direct ophthalmoscope; Trial lens set and frame; Pen, paper and ethical clearance certificate.

Inclusion Criteria

Autistic and non – autistic children aged between 5 – 12 years.
Autistic and non - autistic children with parental consent.
Autistic and non - autistic children who agreed to be part of the study.

Exclusion Criteria

Autistic and non – autistic children below the age of 5 years and above the age of 12 years.
Autistic and non – autistic children without parental consent.
Autistic and non - autistic children who refused to be part of the study.

Ethical approval

Ethical approval was obtained from the Health Research Ethics Committee (HREC) of the Federal Capital Territory (FCT) with protocol number FHREC/ 2018/ 01/ 117. A written Informed consent was also obtained from each child's parents through the school authorities prior to their enrolment into the study.

Research procedure
The 48 participants were daily subjected to the same examination procedure from 9 am – 2 pm, at the designated examination rooms within their school premises. Simple positive reinforcement techniques such as praises and clapping of hands were used as strategies to sustain the childrens' attention span all through the eye examination period.

The Case History
Relevant information about the health status of each autistic subject were obtained from their parents and the school authorities while the non – autistic subjects were able to provide useful information about their eye-health individually.

External eye examination
A penlight was used to inspect pupillary responses and to assess the general health status of the eyelids, conjunctiva and cornea. No significant abnormality was detected in all the 48 subjects.

Visual acuity measurement
The Goodlite LEA symbol chart is a paediatric chart which is designed to assess the level of vision of young children from the age of 2.5 years and above. It features paediatric symbols that were proportionally spaced in various sizes. This test was performed at a test distance of 3 meters (or 10 feet) from the subject. It also has a response key-pad and flash cards that have the same symbols as the distance chart. Before visual acuity measurement was taken, each child was asked to identify the 4 symbols on the Goodlite response key-pad (model #251700) which was held at 40 cm either by naming them or by matching the symbols with the flash pad. The name given to each symbol on the response key-pad was unique to each child and was used to assess their visual acuity. Children who could not readily match the symbols were trained with the Goodlite LEA 3-D puzzle card (model #251600) by asking each child to place the puzzle shapes correctly into the tray before progressing to match the symbols. The LEA 3-D puzzle pad is a test that is designed to enable each child to develop eye-hand coordination and learn how to match and name the puzzle shapes on the visual acuity chart.

The unaided distance (3 meters) visual acuity was determined with the Goodlite LEA symbol acuity chart (Model #250150); while the Goodlite LEA near (40 cm) acuity chart (model #250800) was used to determine the level of vision at near. The data were recorded in their individual case notes.

Ophthalmoscopy
A hand-held monocular direct ophthalmoscope (Keeler) was used to examine the fundus (internal structures) of each eye. The findings were within normal limits.

Retinoscopy
A non-cycloplegic retinoscopy was conducted on all the subjects using a hand-held streak retinoscope (Keeler). This was to ascertain their objective refractive status. These data were also recorded in their individual case notes.

Subjective refraction
This was performed with a trial lens set and frame. The net result obtained from retinoscopy was used as a guide. The refractive errors of all the autistic and non – autistic subjects were determined and duly documented in their case notes.

Data analysis
The IBM Statistical Package for the Social Sciences (SPSS) for Windows Version 24.0 was used for the analysis of data.
The Fisher exact test of independent statistical test was used to compare the two nominal variables in order to determine if the proportion of one variable differs from the other. It is an alternate test to the Chi – square test and it is used in experiments with small number of participants (i.e. less than 1,000).
The Confidence level and statistical significance values were set at 95% with $p<0.05$, respectively.

Limitation of Study
The reluctance (or lack of interest) displayed by some parents of autistic children resulted in the small sample size for the study population. The outbreak of Covid-19 pandemic during the period of this study prevented the researcher from visiting other cities within the Federation for the purpose of increased sample-size.

Results
Table 1 showed the age and gender distribution of the total population of 24 (50%) autistic and 24 (50%) non-autistic subjects used for the study. The autistic subjects had the highest population of 9 (18.7%) in age range11-12 years while the non-autistics had 8 (16.6%), in age range 7-8 years. The male autistics had the highest population of 5 (10.4%) in age range 11-12 years while the female autistic subjects had the highest population of 4 (8.3%) in both age range 5-6 and 11-12 years.
The male non-autistics had the highest population of 4 (8.3%) in both age range 7-8 and 9-10 years while the females had the highest of 5(10.4%) in age range 5-6 Years. The least population in both male autistics was

1(2.1%) in age range 9-10 while that of the female is also 1 (2.15) but in age range and female 7-8 Years. In male non-autistic the least population was 2 (4.2%) in age range 5-6 and 11-12 years while that of the female non-autistics was 1(2.1%) in age range 11-12 years.

Table 1: Age and gender distribution of the total population

	AUTISTIC SUBJECTS			NON – AUTISTIC SUBJECTS		
	MALE	FEMALE	TOTAL (%)	MALE	FEMALE	TOTAL (%)
5 – 6	2 (4.2%)	4 (8.3%)	6 (12.5%)	2 (4.2%)	5 (10.4%)	7 (14.6%)
7 – 8	4 (8.3%)	1 (2.1%)	5 (10.4%)	4 (8.3%)	4 (8.3%)	8 (16.6%)
9 – 10	1 (2.1%)	3 (6.3%)	4 (8.4%)	4 (8.3%)	2 (4.2%)	6 (12.5%)
11 – 12	5 (10.4%)	4 (8.3%)	9 (18.7%)	2 (4.2%)	1 (2.1%)	3 (6.3%)
TOTAL (%)	12 (25%)	12 (25%)	24 (50%)	12 (25%)	12 (25%)	24 (50%)

Table 2 showed the age distribution of refractive errors in Autistic subjects. The result revealed that the age range 11-12 years had the highest number of subjects with refractive errors of 9 (37.5%), while the age range number of subjects with refractive errors of 4 (16.7%). Myopic astigmatism was the most common refractive error with 12 (50%), followed by Hyperopic astigmatism 5 (20.8%), Myopia 4 (16.7%), Mixed astigmatism 2 (8.4%) and the least Hyperopia 1(4.2%)

Table 2: Age distribution of refractive errors in autistic subjects

Age Range (Years)	Myopia (M %)	Hyperopia (H %)	Myopic Astigmatism (MA %)	Hyperopic Astigmatism (HA %)	Mixed Astigmatism (MxA %)	Total (%)
5 – 6	1 (4.2%)	0	3 (12.5%)	1 (4.2%)	1 (4.2%)	6 (25%)
7 – 8	1 (4.2%)	0	4 (16.7%)	0	0	5 (20.8%)
9 – 10	0	0	3 (12.5%)	1 (4.2%)	0	4 (16.7%)
11 – 12	2 (8.3%)	1 (4.2%)	2 (8.3%)	3 (12.5%)	1 (4.2%)	9 (37.5%)
TOTAL (%)	4 (16.7%)	1 (4.2%)	12 (50%)	5 (20.8%)	2 (8.4%)	24 (100%)

In Table 3, the age distribution of refractive errors in non - Autistic subjects showed that the age range of 11-12 years had the highest number of refractive errors of 9 (37.5%), followed by age range 5-6 years with 6 (25%), 7-8 with 5 (20.8%), and the least was age range 9-10 with4 (16.7%). The most common refractive error was

Myopic astigmatism with 9 (37.5%), followed by Hyperopic astigmatism with 6(25.1%), Mixed astigmatism 5 (20.8%), Myopia 3 (12.5%) and the least was Hyperopia 1 (4.2%).

Table 3: Age distribution of Refractive Errors in Non - Autistic Subjects

Age Range (Years)	Myopia (M %)	Hyperopia (H %)	Myopic Astigmatism (MA %)	Hyperopic Astigmatism (HA %)	Mixed Astigmatism (MxA %)	Total (%)
5 – 6	1 (4.2%)	0	3 (12.5%)	1 (4.2%)	1 (4.2%)	6 (25%)
7 – 8	2 (8.3%)	0	0	1 (4.2%)	2 (8.3%)	5 (20.8%)
9 – 10	0	0	3 (12.5%)	0	1 (4.2%)	4 (16.7%)
11 – 12	0	1 (4.2%)	3 (12.5%)	4 (16.7%)	1 (4.2%)	9 (37.5%)
TOTAL (%)	3 (12.5%)	1 (4.2%)	9 (37.5%)	6 (25.1%)	5 (20.8%)	24 (100%)

Test of Hypothesis

The Fischer exact test of independence was used to analyze the distribution of refractive errors between autistic and non – autistic subjects in order to determine their level of significance. Table 4 represents the outcome of this statistical analysis (Fisher's exact test statistic = 2.207; *p*– value = 0.828; statistical significance level = 0.05).

Table 4: Fisher's Exact Test of Research Hypothesis 1

Total number of participants (N)	Fisher's exact test statistic	Exact significance (*p* – value)	Significance level (alpha)
48	2.207	0.828	0.05

Table 5 represents the outcome of gender distribution of refractive errors amongst autistic and non – autistic subjects using the Fisher's exact test of independence (Fisher's exact test statistic = 7.850; *p*– value = 0.068; statistical significance level = 0.05).

Table 5: Fisher's Exact Test of Research Hypothesis 2

Total number of participants (N)	Fisher's exact test statistic	Exact significance (*P* – value)	Significance level (alpha)
48	7.850	0.068	0.05

Discussion

Table 1 showed the total sample population of 48 (100%) subjects that were aged between 5-12 years. The mean age of the 24 autistic subjects was 8.9± 2.6 while that of the 24 non-autistic subjects was 7.9±2.2 years. The mean age of the autistic subjects in this study was lower than 12.9±3.3 years as was reported by Ezeh *et al.* (2018), among children who attended special schools in Cross River State, Nigeria. This was also comparable to the mean age of 9±3 years as was recorded among 36 autistic children from Nepal, by Bhandari *et al.* (2013). The table further indicated that for the autistic subjects, the age group of 11-12 years had the highest number of subjects of 9 (18.7%) i.e. 5 (10.4%) males and 4 (8.3%)

females. On the other hand, the age group of 9-10 years had the least number of subjects of 4 (8.3%): i.e. 1 (2.1%) male and 3 (6.3%) females. For the non-autistic subjects, the age group of 7-8 years produced the highest number of 8 (16.6%) subjects. This consisted of 4 (8.3%) males and 4 (8.3%) females. On the other hand, the age group of 11-12 years had the least number of 3 (6.3%) subjects: i.e. 2 (4.2%) males and 1(2.1%) females respectively. The older age of most of the autistic subjects in this study may have resulted from late enrolment into the schools due to their peculiar mental status as was reported by Kaur *et al.* (2016) and Darge *et al.* (2017).

Table 2 indicated that the age range of 11-12 years had the highest number of refractive errors of 9 (37.5%) subjects. This consisted of 2 (8.3%) myopia; 1 (4.2%) hyperopia; 2 (8.3%) myopic-astigmatism; 3(12.5%) hyperopic-astigmatism and 1 (4.2%) mixed-astigmatism. On the other hand, the age range of 9-10 years had the least refractive error of 4 (16.7%) subjects.
This consisted of 3 (12.5%) myopic- astigmatism and 1 (4.2%) of hyperopic astigmatism. For this age range, there was no myopia and hyperopia.

The high prevalence of myopic-astigmatism that was found among autistic subjects in this study may present some level of concern due to the fact that such children may be unable to naturally appreciate the world around them. This may further tend to restrict their inherent learning potentials. For example, in a study by Nallasamy *et al.* (2011), it was found that refractive errors in 22 (17%) out of a population of 76 children eventually led to some developing visual impairment such as amblyopia.

Table 3 showed that the age range of 11-12 Years had the highest number of refractive errors of 9 (37.5%) subjects: i.e. 1 (4.2%) hyperopia; 3 (12.5%) myopic-astigmatism; 4(16.7%) hyperopic-astigmatism; and 1(4.2%) mixed astigmatism. There was no myopia in this age group. On the other hand, the age group of 9-10 years produced the least refractive errors of 4 (16.7%) subjects. These were: 3 (12.5%) myopic-astigmatism and 1 (4.2%) mixed-astigmatism. There was no myopia, hyperopia and hyperopic-astigmatism in this age group.

In same vein, the visual acuity assessment in these children may be quite challenging due to their poor mental status, which may have made it difficult for such refractive errors to remain undiagnosed. In agreement with this, Wang *et al.* (2018), recorded a higher risk of amblyopia among autistic children as compared to the normal population; while Kabatas *et al.* (2015) and Thankappan *et al.* (2017), attributed amblyopia in autistic children to challenges faced during eye examination of these children and failure to observe poor vision by their parents. This may have significantly affected the physical, social and overall well-being of these children and their quality of life. This is why there is need for practitioners to develop some innovative strategies to ensure that appropriate spectacle corrections are given to autistic children, (Alranili *et al.*, 2017; Hodgon, 2019).

The most common refractive error in this study between male and female autistic and non-autistic subjects was myopic-astigmatism with a prevalence of 12 (50%) autistic and 9 (37.5%) non-autistic subjects. This was similar to the study of Alrasheed *et al.* (2016), where they found no significant difference in the prevalence of myopia and hyperopia in both male and female autistic and non-autistic subjects. Similarly, Kannan *et al.* (2016), also found no significant difference in the gender distribution of refractive errors among urban and rural school children aged between 6-4 years.

Consequently, based on the small sample size of the autistic and non-autistic subjects in this study and the presence of nominal variables like refractive error and gender, the Fisher's exact test of independence was adopted to determine the level of significance of the research hypotheses. This was conducted using the IBM SPSS statistics for windows, version 24 software. According to Mcdonald (2014), the Fisher's exact test is an alternative test to the Chi-square test which is used to determine whether or not the distributions of two nominal variables are the same for a sample size of less than 1000 participants. This test makes use of contingency tables (Tables 1-3) that displays a cross tabulation of the proportions of the different types of refractive errors.

The value of Fisher's exact test for this study statistically was 2.207; p-value =0.828. This exceeded our significance criteria of 0.05.
This suggested that there was no significant difference in the types of refractive errors that were found in autistic and non-autistic subjects. Thus the Null hypothesis was accepted while the Alternate hypothesis was rejected. Similarly, the application of Fisher's exact test statistic (7.850) in Tables 2 and 3 yielded a p- value of 0.068 (p> 0.05) which indicates that there is no significant difference in the gender distribution of refractive errors between autistic and non-autistic

subjects. Thus the Alternate hypothesis was rejected in favour of the Null hypothesis.

Conclusion

The similarities between the types of refractive errors found in autistic and non – autistic participants in this study emphasizes the need to pay close attention to the visual health needs of autistic children. This is to prevent situation where autistic children may be more prone to development of amblyopia from uncorrected refractive errors than their non– autistic peers. Thus, there is need for early detection as well as measures of prevention to avoid progression of ocular defects in autism.

Recommendation

Eye care practitioners should strive to improve on the level of care for autistic children by modifying examination techniques/protocols to satisfy their visual needs.

Large high-tech ophthalmic equipment should be replaced with simple,
Hand-held, non-contact, alternatives to enhance the outcome of eye examination in autistic children.

There should be proper education of parents or care-givers and teachers on the importance of regular eye examination of autistic children.

There should also be provision of vision screening protocols in schools and special centres to ensure early detection and management of ocular disorders.

Emphasis should be placed on co-management among eye-care practitioners in caring for the visual needs of autistic children.

The Federal Government should embark on formulation of special health programmes at the National and State levels that would promote early diagnosis and treatment of visual disorders in autistic children.

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