Original Article

Environmental Factors that Determine Visual Skill Development of Under-fives in a Developing Country

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Abstract

Introduction: During the early years of life, children get most of their information by relying on their visual observation. Knowledge of visual skill development and environmental risk factors influencing it provides useful guide for early identification of children who may develop some form of visual impairment. **Aim:** The aim of this study is to describe the visual developmental pattern and determine the environmental risk factors associated with delay in the visual skill area of under-five children. **Subjects and Methods:** This was a cross-sectional study of 415 preschoolers aged 6–59 months. Visual function and visual comprehension were assessed using the Schedule of Growing Skills II tool (GL Assessment Ltd., London). Delay in the visual skill was defined as a developmental quotient in visual skill area below threshold point of 85%. Data were analyzed using descriptive statistics and logistic regression analysis with adjusted odds ratio (AOR) and 95% confidence interval (CI) (95% CI). Alpha value was set at $P < 0.05$. **Results:** Mean age of the children studied was 32.6 ± 15.9 months. The prevalence of delay in visual skill area was 17.1%. The odds of delay in visual skill were higher among children of first birth order (AOR 1.83; 95% CI 1.05–3.30), those who lived in large households (AOR 2.34; 95% CI 1.32–3.14), children whose mothers had secondary level education and below (AOR 2.21; 95% CI 1.31–3.83), and those whose fathers earned ≤$100 per month (AOR 1.75; 95% CI 1.01–3.03). **Conclusion:** Identification and management of environmental factors negatively affecting visual skill development will help improve on the visual skill area and invariably child development.

Keywords: *Developing country, development, environmental factors, under-fives, visual skill*

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Introduction

During the early years of life, children get more information rapidly by relying on their vision than any other sense.[1] The negative impact of poor vision goes far beyond the immediate impairment. Deficits in visual acuity, visual efficiency, and visual information processing can lead to difficulties in reading and writing, poor school performance, poor cognitive, social and behavioral development, and ultimately reduced the quality of life and reduced earning opportunities.[2-6] Early detection and identification of risk factors, on the other hand, reduce the burden of the disease, improve the general developmental outcome, and provide useful guide for detection of children at the risk of visual impairment. Regular vision screening in early childhood, for instance, has been found to reduce the risk of persistent amblyopia at 7 years of age by more than 50%.[7] This study aimed to expand the knowledge about visual skill development in under-fives by describing the developmental pattern and determining the environmental factors associated with delay in the skill area.

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Subjects and Methods

Study area and participants

The study was a cross-sectional study, conducted in institutions where apparently well under-fives are seen. These are selected preschool units (crèches, day cares, playgroups, and nurseries) and immunization centers in Zaria metropolis, Kaduna state, Nigeria. Data were collected between the months of November 2013 and May 2014. Zaria metropolis is a semi-urban region located within the Guinea Savannah belt of Nigeria, about 70 km North of Kaduna, the capital city of Kaduna state, North Western Nigeria.

Sampling method

Multistage sampling method was used to select the preschools and immunization centers while systematic sampling method was used to recruit the participants. Two local government areas (LGA) make up the Zaria metropolis: Zaria and Sabon gari LGAs. In stage I, two wards were selected from each LGA. In stage II, four immunization centers were selected from the wards by simple random sampling (one immunization center per ward). The list of schools for each ward was also obtained from the Primary School Management Board, and the schools were sampled proportioned to the number of schools per ward. A total of ten preschools were selected. Stage III involved the selection of children. In the schools, eligible pupils were selected by systematic sampling using the class register. The participants in the immunization centers were also selected by systematic sampling, repeating this during each visit until the sample size was achieved.

The minimal sample size for the study was determined using the formula:

$n = z^2pq/d^2$

Where n = the desired sample size; z = standard normal deviate corresponding to 95% confidence interval (CI) =1.96; p = prevalence of delay in visual skill (assumed to be 50% since no previous published study in Nigeria was found); $q = 1 - p$ (the proportion of children without delay in visual skill); d = degree of accuracy desired (0.05).

For this study, $z = 1.96$, $p = 0.50$, $q = 1 - 0.50 = 0.50$, $d = 0.05$.

$n = (1.96)^2 \times 0.50 \times 0.50/(0.05)^2 = 384$ children.

Allowance of 10% was made for nonresponse.

$n = 38.4 + 384 = 422$ children.

Selection criteria

Children aged 6–59 months found in the selected preschools and immunization centers and whose parents/guardians consented were included in this study. Children with previously diagnosed or obvious visual impairment were excluded from the study.

Ethical consideration

Approval of the Scientific and Health Research Ethics Committee of the Ahmadu Bello University Teaching Hospital Zaria and the Primary School Management Board were obtained. Written consent was obtained from the parents/caregivers of the participating children.

Data collection

The sociodemographic data were obtained from parents or guardians of the children using researcher administered prestructured questionnaire. Chronological age (CA) was ascertained using either record from school, birth certificate, or the immunization card. Households of six members and less were classified as small household size while those with more than six members were classified as large households. Father's monthly income was as reported by the father or the mother, where the information is known to her. The rate of exchange used was 199 naira= $1. The visual skill was assessed with the Schedule of Growing Skills II (SGS II) tool.[8]

Visual skill developmental assessment

The SGS II tool[8] was used to assess each child. The tool assesses the visual skill area along with 9 other skill areas (passive postural, active postural, locomotor, manipulative, hearing and language, speech and language, interactive social, self-care social, and cognitive skill).

The visual skill set contains two subsets: visual function and visual comprehension. The visual function assesses the child's ability to turn toward diffuse light, fixate, track objects through 90° and 180°, convergence on approaching object, and ability to finger point accurately at small objects. The visual comprehension tests for object permanence and scanning, discrimination of objects to identify objects by shape and outline, discrimination of details to identify actions, matching of objects by colors, and perception of patterns. The Snellen linear chart at 6 m was used to assess vision formally.

The developmental age (DA) in the visual skill area was obtained from the "Profile form" of the tool. The developmental quotient (DQ) in visual skill was obtained using the formula:

DQ (%) = DA/CA × 100

The DQ was then classified into:[9] Normal (DQ ≥85%) and delay (DQ ≤84%). Delay was recategorized into mild-moderate delay (DQ 71%–84%) and severe delay (DQ ≤70%). Children who required further visual evaluation were referred to the ophthalmologist.

Statistical analysis

Data were checked for completeness, coded, and analyzed using SPSS version 20.0.0. (Armonk, NY: IBM Corp) Descriptive analysis was used to calculate the frequencies and percentages of the respondents by sociodemographic characteristics. Binary logistic regression analysis was performed; the crude odds ratio was estimated to assess the association between each independent variable (e.g., household size, child's birth order, and mother's educational level,), and the dependent variable (developmental delay) and to select significant variables for multivariate logistic regression analysis. Variables which showed an association with dependent variable in the binary logistic regression analyses at alpha <0.05 were entered into multivariate logistic regression model. Adjusted odds ratios (AOR) with corresponding 95% CIs (95% CI) were used to analyze and interpret study results.

Results

From a total of 422 children selected, 415 completed the assessment (98.3% response rate) and were included in the analysis.

Sociodemographic characteristics

Table 1 show the age range was 6–59 months and mean age of 32.6 ± 15.9 months. The male to female ratio was 1.2:1. Two hundred and twenty-seven (54.7%) mothers had tertiary level of education, while 34 (8.2%) had no formal education. One hundred and thirty (31.3%) fathers had monthly income of 20,000 naira (approximately $100) or less. One hundred and five (25.3%) came from household size of more than six members.

Mean developmental quotient (± standard deviation) of visual skill

Table 2 shows that the mean DQ was highest among infants, with male infant mean DQ of 111 ± 12.7 and female infant mean DQ of 107 ± 11.8 compared to the other age groups. There was a significant gender difference in mean DQ among preschoolers aged 48–59 months. Overall mean DQ for visual skill was 100 ± 17.5%.

Prevalence of delay in visual skill

Table 3 shows that overall prevalence of delay in visual skill is 17.1%, with 11.6% having mild-moderate delay, and 5.5% being severely delayed.

Environmental risk factors associated with visual skill

Table 4 shows that children of the first birth order were nearly two times more likely to have delay in visual skill area compared to other birth orders (AOR 1.83; 95% CI 1.05–3.30). The table also shows that children in large household size had more than twice the likelihood of delay in visual skill (AOR 2.34; 95% CI 1.32–2.14) compared to their counterparts from small households. Mother's educational level and the father's income

Table 1: Sociodemographic characteristics of study population (*n*=415)

Characteristics	Frequency (%)
Age (months)	
6-11	63 (15.2)
12-23	50 (12.1)
24-35	94 (22.7)
36-47	110 (26.5)
48-59	98 (23.6)
Sex	
Male	227 (55.0)
Female	188 (45.0)
Mother's educational level	
No formal education	34 (8.2)
Primary	28 (6.7)
Secondary	126 (30.4)
Tertiary	227 (54.7)
Childbirth order	
First	96 (23.1)
Others	319 (76.9)
Household size	
≤6	310 (74.6)
>6	105 (25.3)
Father's income	
≤$100/month	130 (31.3)
>$100/month	285 (68.7)

Table 2: Means±standard deviation of visual skill developmental quotient by age and sex

Age group (months)	Mean DQ±SD		*t*	*P*
	Male	Female		
6-11	111±12.7	107±11.8	2.021	0.053
12-23	94±14.8	95±19.0	−0.110	0.914
24-35	102±23.2	94±21.5	1.931	0.060
36-47	102±17.7	101±17.3	0.486	0.629
48-59	99±11.7	94±12.5	2.833	0.007*

*P<0.05 for paired *t*-test. DQ=Developmental quotient; SD=Standard deviation

Table 3: Prevalence of delay in visual skill

DQ	Frequency (*n*)			Percentage
	Male	Female	Total	
Normal (DQ ≥85%)	184	160	344	82.9
Mild-moderate delay (DQ 71%-84%)	26	22	48	11.6
Severe delay (DQ ≤70%)	17	6	23	5.5
Total	227	188	415	100.0

DQ=Developmental quotient

Table 4: Environmental risk factors associated with developmental delay in visual skill

Factor (*N*)	Frequency of delay, *n* (%)	COR (95% CI)	AOR (95% CI)
Childbirth order			
First (96)	25 (26.0)	2.09 (1.20-3.63)*	1.83 (1.05-3.30)*
Others (319)	46 (14.4)	1	1
Household size			
≤6 (310)	44 (14.2)	1	1
>6 (105)	27 (25.7)	2.09 (1.22-3.60)*	2.34 (1.32-3.14)*
Mother's education			
Secondary and below (188)	43 (22.9)	2.11 (1.25-3.55)*	2.21 (1.31-3.83)*
Tertiary (227)	28 (12.3)	1	1
Father's income			
≤$100/month (130)	29 (22.3)	1.66 (0.981-2.81)*	1.75 (1.01-3.03)*
>$100/month (285)	41 (14.4)	1	1
Number of siblings			
No siblings (76)	14 (18.4)	1.73 (0.586-2.13)	-
Has siblings (339)	57 (16.8)	1	

*$P<0.05$. *N*=Total number of children within the variable; *n*=Number of children with delay. COR=Crude odds ratio; AOR=Adjusted odds ratio; CI=Confidence interval

also had significant association with delay in the visual domain.

Discussion

The high mean DQ observed in this study during infancy and a lower mean DQ by age 48–59 months corroborates with reports from other studies.[10,11] This finding suggests that maturation of the visual skill is not uniform across the stages of development. As an infant explores and searches for information in the environment, his visual processing ability is stimulated. However, as search skill diminishes with age, the visual processing stimulation diminishes as the child grows older and by age six this stimulation would have stabilized.[12] Our study also showed significant gender difference in visual skill DQ by age 48–59 months in favor of boys. The previous studies have also shown sex difference in several facets of vision in favor of boys[13,14] while some others reported difference in favor of girls.[15,16] The finding in this study can be a reflection of the effect of gender stereotypic behavior of children within this age group having influence on their visual skill development. It has been shown that as children grow older, they regulate and enact behavior that is socially linked to gender.[17,18] Boys compared to girls tend to be more engaged in activities that stimulate visual skill development such as mental rotation, map reading, targeting, embedded figures, sporting activities, video games, and play with large mobile toys such as trucks.[18-21]

It was observed in this study that the prevalence rate of delayed visual skill was quite high. This prevalence was higher than prevalence rate of 10.5% and 4.4% obtained in other studies.[22,23] The high prevalence rate obtained in our study may be because our assessment focused on different aspects of the child's visual system such as visual efficiency, visual information processing, and spatial skills. Previous studies[22,23] focused on assessing single aspect of visual functional system either visual acuity or only visual perception. A high prevalence rate as observed in this study underpins the need for early assessment of every area of the visual system, other than visual acuity alone, especially as the preschool and early school years place relatively great demand on the child's visual skills.

Our study set out to determine environmental risk factors associated with delay in the visual skill development of children. We observed that children who were "first born" and those who were members of large households had increased odds of delay in the visual skill area. This finding supports the fact that certain familial environmental factors influence visual skill development and probably child development as a whole.[11] Children of higher birth order, compared to first-born children, have the benefit of more experienced parents, exposure to stimulating toys, books, and other such materials and also benefit of added stimulation from older siblings.[24] With added siblings, however, large family size can sometimes have negative effect on child developmental outcomes, as observed in this study. However, it has also been shown that the irrespective of household size; within family influences have greater impact on child development.[25]

In this study, we found that delay in visual skill development was about two times more likely for children whose mothers had secondary school level of education and below (i.e., primary school and no formal education). This is in keeping with the previous studies[26-28] that

have consistently shown the negative effect of low maternal education on visual skill development and child development as a whole. Highly educated mothers are more likely to invest in their children through stimulating materials such as toys, books, computers, special lessons, cognitive stimulating games[28] not only because they know the benefit of such exposure to the child's development but also because they have the financial resources to do so. This present study also showed that children whose fathers had low income had nearly twice the odds of delay in visual skill compared to children whose fathers had better income. A father's income reflects the family financial resources to a considerable extent, in addition to being an important resource for children in terms of provision of materials and activities needed for their development.[29] Just like low maternal education, thin financial resources limit the availability of materials that can stimulate visual skill development as preference for what is extremely essential is often made over what may be considered luxury or even waste.

Findings from this study provide information on visual skill development of under-fives, demonstrating that even apparently well children may exhibit delay in their visual system. The practical implication is to reinforce that the assessment of visual behavior during the first 5 years of life will allow us to verify how the child uses his vision to build his sensorimotor world as vision integrates other systems and senses. The knowledge of the environmental factors influencing this visual system during the early years justifies the need to assess their effect on the child's visual development at regular intervals.

There has been no study before this which had the primary aim of establishing visual skill developmental pattern of under-fives in Nigeria. Studies found were only for targeted ocular conditions. Meanwhile, studies such as this present one aims at early identification of visual developmental deviations which are not cosmetically obvious and are likely to be missed without assessment. The visual skill set in the SGS II tool is formulated with the consideration of DA and distinguishing developmental characteristics. It therefore cuts across geographic boundaries. Despite these strengths, this study is not without its limitations. First, the cross-sectional design of the study limits conclusions to be drawn about the causality. Second, a study across other developing countries would have given a wider perspective of the developmental pattern of the visual skill and the interplay with other environmental factors peculiar to the locality.

Conclusion

Our findings show that delay in visual skill is quite common and that there is a significant gender difference in visual skill development for children aged between 48 and 59 months. Environmental factors such as first birth order, large family size, low father's income, and low maternal educational level were associated with delay in the visual skill area. Early identification of such delay and the environmental risk factors responsible will definitely have an impact on the improvement of visual skills, especially during the vulnerable first 5 years of life. We propose further research to compare the visual behavior with their school performance.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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