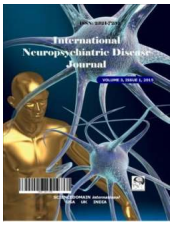

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Do Socio-demographic Characteristics Influence the Performance of Children on Raven Progressive Matrices in Enugu, Nigeria?

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Authors' contributions

This work was carried out in collaboration between all authors. Authors KKI, ACU and ONI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors ACU and ONI managed the analyses of the study. Author KKI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: Poor socioeconomic status and lower level of maternal education have been identified to contribute significantly to lower cognitive function of HIV-positive children. This study was designed to determine if there are significant associations between performance in Raven Progressive Matrices (RPM) scores and socio-demographic factors.
Materials and Methods: A cross-sectional study of 100 school-aged children seen at the Children Outpatient Clinic of the University of Nigeria Teaching Hospital. Cognitive function was assessed using the Raven Progressive Matrices. Data were analyzed with SPSS version 19.
Results: Mean RPM scores of males and females were 31.8 ± 13.4 and 33.7 ± 12.2. Fifty-six children were above average/superior while 44 performed at or below average on RPM cognitive test. Twenty-one of 23 children (91.3%) children from upper social class, 27 of 48 (56.3%) from middle social class and only 8 of 29 (27.6%) from lower social class performed above average or superior on the RPM test ($p<0.001$).

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Conclusions: Low socio-economic status and poor maternal literacy were significantly associated with below RPM scores whereas scores were not influenced by gender.

Keywords: RPM; socio-demographic; children; Nigeria.

1. INTRODUCTION

The term 'cognition' refers to the entire range of mental skills and abilities that a person possesses [1]. It includes memory, concentration, planning, recognizing, decision-making and understanding [1]. Cognitive impairment in children may begin as early as 4 months, continue into the preschool years and manifest as either global or selective delays in neurodevelopment at school age [2,3]. One of the two validated cognitive assessment tool in Nigeria is the Ravens progressive matrices test (RPM), [4] and the Draw-a-person test (DAPT) [5]. RPM test is a widely used non-verbal test of general intelligence that appraises visuo-spatial reasoning, abstract thinking, deductive reasoning and general intelligence of individuals [6]. It consists of a series of 60 matrices, in 5 sets of 12 subsets of patterns of geometric shapes. In RPM, a person is shown a matrix of patterns with one pattern missing. The task is to identify the missing pattern from the options given, following the rules governing the pattern. The test was designed to minimize the influence of culture by relying on non-verbal problems that require abstract reasoning and do not require knowledge of a particular culture [7]. However, there are sub-cultural differences in lifestyles and child rearing practices that may affect equal access to the skills and knowledge required by IQ tests [8]. Socioeconomic status and parental literacy could influence child rearing practices and performance on RPM. Poor socioeconomic status and lower level of maternal education have been identified to contribute significantly to lower cognitive function of HIV-positive children [9]. In Ghana, a study reported difference in RPM scores between urban and rural children and concluded that it was due to differences in socio-economic opportunities [10]. We hypothesize that the RPM tool may be influenced by socio-demographic factors including parental poverty and illiteracy. This is because these factors can affect child rearing and exposure, thus the abstract reasoning required in RPM test. This study therefore, sought to determine if there are significant associations between performance in RPM scores and socio-demographic factors among children in Enugu, Nigeria.

2. MATERIALS AND METHODS

This study was conducted at the University of Nigeria Teaching Hospital, (UNTH), Ituku- Ozalla in Enugu state. The hospital is located in Ituku/Ozalla, near Enugu, the capital of Enugu state**.** Most of the residents are Igbos although other ethnic groups reside in the metropolis. The inhabitants are people with different educational backgrounds and occupation.

2.1 Study Population

The study participants were children aged 6 – 12 years attending follow-up clinics at the Paediatric Outpatient clinics. These children had been treated for acute illnesses (excluding acute brain illnesses for example meningitis and encephalitis) and had no chronic medical conditions and were being routinely followed up. The ages of the children were calculated from their dates of birth by verbal reports given by the caregivers and/or the children.

2.2 Inclusion and Exclusion Criteria

Children attending children out-patient and consultant's clinics with no previous history suggesting meningitis, encephalitis, birth asphyxia, sickle cell disease and seizure disorders were included in the study. Children whose parents/caregivers declined consent were excluded.

2.3 Ethical Considerations

Ethical approval was obtained from the Health Research and Ethical Committee (HREC) of the UNTH. Written informed consent was obtained from the parent/care-giver after detailed explanation of the study to them.

2.4 Sampling Method

Study participants who satisfied the inclusion criteria were recruited until the desired sample size was achieved. A proforma consisting of socio-demographic data was completed for each participant. The children were examined to ensure their mental alertness. The Oyedeji

classification system [11] was used to determine the socioeconomic status. This classification system uses parental occupation and educational attainment for scoring. Each of these factors is graded one to five. Class one is the highest social class while class five is the lowest. Each parent is scored separately by finding the average score of the two factors. The mean score for both parents to the nearest whole number is the social class assigned to the child. The RPM cognitive test was administered individually after the neurological assessment. The RPM booklet contains a series of 60 matrices, in 5 sets of 12 each (A1-A12, B1-B12…E1-E12), a pattern of geometric shapes and an answer sheet. The purpose of the test was explained to the caregiver and the child. The task was to look for the missing piece that was required to complete a larger pattern chosen from six to eight alternatives provided in the booklet. The numbers of the alternative chosen from the booklet were entered in the answer sheet provided. Each child was allowed enough time to complete the task. Most of the children completed the task within thirty to sixty minutes. The parents/care-givers were not allowed to aid the children during the test. The investigators occasionally checked to make sure the answers were circled against the appropriate number. Where mistakes had been made, a fresh answer sheet was provided and the subject asked to start afresh. At the end of the task, the answers were marked using the provided marking scheme and the total number of correct responses determined. The raw scores were checked against a scoring matrix table in the booklet to determine its correlate on the nationally-norm percentile score. The intellectual capacity of each child was classified into the any of the following categories according to the percentile score;

Grade I: (intellectually superior) if score lies at or above the 95th percentile for age.

Grade II: (Definitely above average) if score lies at or above 75th percentile for age.

Grade III: (intellectually average): if his score lies between 25th and 75th percentiles for age.

Grade IV: (definitely below average) if his score lies at or below 25th percentile for age.

Grade V: (intellectually defective): if his score lies at or below the 5th percentile for age.

Grades I and II were grouped into above average/superior while grades III to V were grouped into average and below.

2.5 Data Analysis

The data were analyzed using the Statistical Package for Social Sciences (SPSS) version 20.0 (SPSS Inc. Chicago, Illinois, USA). Mann-Whitney U was used to test for significant association between RPM scores and gender while Kruskal Wallis was used to test for significant association between RPM scores and maternal education/socio-economic status. The intellectual capacity was dichotomized into above average and below or equal to average. Chi-square was used to test for significant association between dichotomized intellectually capacity and gender, maternal education and socio-economic status. The level of significance set at 0.05.

3. RESULTS

One hundred children aged 6 – 12 (median, 10) years were enrolled into the study. Fifty-nine (59%) were females and male: female ratio was 1: 1.4. The maternal educational attainment of 49 study participants was tertiary while 48 were from middle socio-economic class. The socio-demographic details of the study participants are shown in Table 1.

Table 1. Socio-demographic characteristics of the study participants

Characteristics	n (%)
Gender	
Male	41 (41%)
Female	59 (59%)
Maternal education	
Tertiary	49 (49%)
Secondary	32 (32%)
Primary	15 (15%)
None	4 (4%)
Socio-economic class	
Upper class	23 (23%)
Middle class	48 (48%)
Lower class	29 (29%)

The mean RPM scores of males and females were 31.8 ± 13.4 and 33.7 ± 12.2. Fifty-six children were above average/superior while 44 performed at or below average on RPM cognitive test. Mann Whitney U test showed that there was no statistically significant difference in RPM scores between the different gender (1170),

p = 0.602, with a sum of ranks of 2298.0 for males and, 2752.0 for females.

A Kruskal-Wallis H test showed that there was a statistically significant difference in RPM scores between the different maternal educational level, $\chi^2(2) = 28.873$, $p < 0.001$, with a mean rank RPM score of 22.20 for Primary, 48.88 for Secondary and 63.68 for Tertiary education. Similarly, Kruskal-Wallis H test showed that there was a statistically significant difference in RPM scores between the different socio-economic classes, $\chi^2(2) = 39.873$, $p < 0.001$, with a mean rank RPM score of 62.97 for Upper, 60.83 for Middle and 21.18 for Low social class.

Twenty-three of 41 males (56.1%) compared to 33 of 59 females (55.9%) were superior or above average in intellectual capacity (p = 1.0). Forty-one of 50 participants (87.3%) whose mother had tertiary education compared to 13 of 32 (40.6%), 2 of 15 (13.3%) and none of 4 with secondary, primary and nil formal education respectively performed superior or above average (p<0.001).

Similarly, 21 of 23 (91.3%) children from upper social class, 27 of 48 (56.3%) from middle social class and only 8 of 29 (27.6%) from lower social class performed above average or superior on the RPM test (p<0.001) as shown in Table 2.

4. DISCUSSION

Our study showed that low socioeconomic class was associated poorer cognitive functioning. Children from the low socioeconomic class were more likely to have average or below average intelligence. The finding of lower cognitive functioning among children from lower socio-economic status had been documented by other researchers [12,13]. Boyede et al. [9], studied 69 HIV-infected children and 69 HIV-negative controls in Lagos, Nigeria. The authors assessed the cognitive functions of their study participants with RPM test and reported that children from lower socioeconomic class strata were three times more likely to have lower RPM scores compared to children from upper strata. It has been speculated that children from families of low socioeconomic status are more likely to live in less stimulating and supportive home environments [14]. Stimulation provides both direct and indirect learning opportunities and serves as a motivational basis for continued learning [13]. It has also been argued that children of lower socioeconomic status lack cognitively stimulating materials and experiences, which limits their cognitive growth [15]. These materials and experiences mediate the relationship between socioeconomic status or family income and children's intellectual and academic achievement [16].

In the index study, maternal education contributed to the cognitive functioning of the children as those whose mothers had primary education were more likely to be at, or below average in intellectual capacity, while those whose mothers had tertiary education were more likely to be above average to intellectually superior range. In the study by Boyede et al. [9] children of mothers with no formal education or primary education were about three times more likely to have below average RPM scores compared to children of mothers with secondary or tertiary education. A significant association between a lower level of maternal education and below average RPM score has also been reported by Smith et al. [2] and other workers [17,18]. It is possible that better educated mothers provide more cognitively stimulating experiences for their children than their counterparts with less education, which has been shown to have a positive impact on cognitive development [15]. In addition, the effect of maternal education on a child's cognitive function may be an indirect effect of socioeconomic status [1,2,4]. These will include the ability to afford good schools, educational and learning materials for their children as well as good nutrition that enhances mental development. It has also been postulated that while genes account for between 50% and 70% of the variation in cognition at the population level, genetic influences on cognition are maximized in more advantaged socioeconomic contexts [19].

Interestingly, our study did not show any significant difference in the RPM performance between genders. The potential effect of gender on intellectual abilities remains controversial Ardila et al. [16] in a study that examined gender differences in cognitive development among children concluded that gender differences during cognitive development are minimal, appearing in only a small number of tests, and account for only a low percentage of the score variance [16]. In a study designed to determine the effect of gender, age, grade and social class on the intellectual capacity of 102 Pakistani children using Raven Coloured Progressive Matrices, Aziz et al. [20] reported no significant difference in the performance of boys and girls. Significant determinants noted in that study were

Table 2. Socio-demographic characteristics and performance on RPM cognitive test

Characteristics	Above average (%)	≤ Average (%)	p-value
Gender			
Male	23 (56.1%)	18(43.9%)	1.0
Female	33 (55.9%)	26 (44.1%)	
Maternal education			
Tertiary	41 (87.3%)	8 (12.7%)	
Secondary	13 (40.6%)	19 (59.4%)	<0.001
Primary	2 (13.3%)	13 (86.7%)	
None	0 (4%)	4 (100%)	
Socio-economic class			
Upper class	21 (91.3%)	2 (8.7%)	<0.001
Middle class	27 (56.3%)	21 (43.8%)	
Lower class	8 (27.6%)	21 (72.4%)	

socio-economic status and grade of the children. Our current finding of no significant difference in intellectual capacity of boys and girls underscores the fact that both genders are endowed equally to achieve full intellectual potentials. Emphasis should rather be on addressing stereotypes that limits girls in low income countries from achieving their full intellectual potentials.

5. CONCLUSIONS

Poor socio-economic status and low maternal literacy were associated with average and below performance on low RPM test.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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