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ORIGINAL ARTICLE

Comparison of Perceptual Reasoning Skills and Mental Health Problems between Deaf and Normal-Hearing Adolescents in a Semi-inclusive setting in Ibadan, Nigeria

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Keywords

Adolescents; Deaf; Mental Health problems; Reasoning skills; Semi-inclusion; SDQ; Nigeria

ABSTRACT

Background: Adolescents with hearing loss are often faced with poor cognitive and executive functions, and increased prevalence of mental health problems. The study compared the perceptual reasoning skills (PRI) and mental health problems of deaf adolescents with those of their age- and sex- matched hearing counterparts.

Methods: It was a comparative cross-sectional study of a total population (102) of deaf adolescents, who were matched for age and sex with 102 normal hearing adolescents. The PRI of the participants was assessed using the Wechsler Intelligence Scale for Children-Fourth Edition (WISC-IV). Mental health problems were assessed with the parents' and teachers' versions of the Strengths and Difficulties Questionnaire (SDQ). Descriptive statistics, chi square test and correlation co-efficient were done. Significant level was set at p-value < 5%.

Results: The PRI scores ranged from 41-106 across both groups; 58.8 % of the deaf and 41.2% of the hearing adolescents scored 69 and below on the WISC and this difference was statistically significant (p = 0.033). The PRI scores had no significant relationship with the audiometric scores of the deaf participants (r = -0.177; p = 0.076). The PRI scores in the deaf participants were inversely related to hyperactivity assessed by the teacher (r = -0.354), emotional difficulty assessed by both teachers (r = -0.221) and parents (r = -0.280) and peer problems assessed by the teachers (r = -0.329).

Conclusion: Deaf participants in this study showed significantly lower level of nonverbal IQ and higher level of behavioural difficulties compared with their hearing counterparts.

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INTRODUCTION

The World Health Organization (WHO) estimates that there are 36 million children worldwide living with hearing loss, a disability known to have profound consequences on educational attainment.[3] About 80% of these children live in low-and-middle income countries of the world. A meta-analysis of studies on childhood hearing impairment between 2000 and 2018 in sub-Saharan Africa found a pooled prevalence of 10%. [1] One study among a representative sample of 359 school children in an inner city area of Lagos

found a prevalence of 13.9%. [2] According to the WHO, unaddressed hearing impairment poses an annual global cost of US$ 750 billion. This includes health sector costs, costs of educational support, loss of productivity, and societal costs. [3]

Individuals with hearing loss are often faced with many challenges including poor cognitive and executive functions, and increased prevalence of mental health problems. One of the explanations for these difficulties is delayed language development. Hearing loss in children may delay the development of language which can in turn, affect cognitive development, both of which have a significant influence on school achievement. In developing countries, children with hearing loss and deafness rarely receive any schooling. [3] Language development may hinder progress in school and also negatively affect social skills development.[4, 5, 6] The direction of the relationship between hearing, language development and cognitive functions have been a source of debate in recent years, hence, one research approach that attempts to address this question is the comparison of typically developing children with children who have hearing loss or other developmental disorders.

There have been significant efforts, mainly from the developed countries, to understand the extent of these problems and define the underlying factors responsible for the poor school performance associated with hearing loss.[7, 8] On the contrary, there are scanty reports from Low and Middle-Income Countries (LMIC). However, some of the associated factors that have been reported to contribute to academic achievement in children with hearing loss include the age of diagnosis and severity of hearing loss, the availability and effectiveness of hearing aid technology, [8] age at intervention [9] and presence of comorbidity like mental health problems.

In the past, the belief that individuals who are deaf have lower intelligence than their hearing counterparts was almost absolute. [10, 11] This has been challenged by researchers in the field. The earliest record of administration of intelligence tests to deaf children was by Pintner and Patterson in 1915. They found that on the verbal intelligence quotient (IQ) Binet scale that they used, the deaf as a group were scoring in the mentally retarded range. [12] They soon realised that a language factor was playing a major role in their measure of verbal IQ. To be able to measure intelligence independent of the language factor, they developed the Pintner non-language Test. [13] However, this test still showed that deaf individuals scored lower compared with normal hearing children.[13] Further assessment showed that the intelligence of deaf and normal hearing children was approximately equal when language was not a factor.[11] Recent studies have further shown that deaf individuals either have lower [15 – 19] or the same level of intelligence [10] as their hearing counterparts.

More studies have been done to establish the validity of most common measures of

intelligence among deaf individuals. For example, the results of a study by Krouse and Braden [21] suggested that the WISC-IV scores were as reliable in terms of internal consistency for deaf and hard of hearing children as they were for their normal-hearing peers. Perceptual Reasoning Index is described as equivalent to the Performance IQ subscale on the third Edition of the Wechsler Intelligence Scale for Children (WISC-III). It measures non-verbal (perceptual) and fluid reasoning, spatial processing, visual-motor integration, and the ability to learn new information. It assesses the ability to examine a problem, use visual-motor and visual-spatial skills, organize thoughts, develop and test solutions.

The mental health of children with hearing loss is of potential concern as their social-emotional development may be negatively impacted by difficulties in communication. [22] There have been reports of higher prevalence of mental health problems among children with hearing loss. These include depression, oppositional defiant disorder, conduct disorder, attention deficit hyperactivity disorder. [22, 23] The presence of mental health problems in them can further worsen the poor performance on educational attainment and intelligence test, distinct from the direct impact of the disability from the hearing loss. Children and adolescents living in resource-constrained settings of the world face significant challenges including access to appropriate education. These challenges are worse with children and adolescents with disabilities. Children suffering from hearing loss often have increased rates of school failure and school drop-out and greater need for education assistance. They are also at risk of being placed in the lowest - achieving classes and increased risk of not qualifying for higher education. [24, 25]

Thus far, most of the information available on hearing loss, for example, cognitive functions and mental health problems among deaf adolescents, are from developed countries. There is an obvious gap between children and adolescents with hearing loss living in developing countries. Therefore, the current study aimed at investigating the non-verbal intelligence quotients of deaf adolescents and compared with those of their age- and sex- matched normal hearing counterparts. It also investigated the relationship between IQ scores and behavioural difficulties as reported by both teachers and parents of the deaf and hearing participants. It was expected that the findings from the study will stimulate stakeholders and policymakers to provide appropriate services for adolescents with hearing loss in Nigeria.

METHODOLOGY

The semi-inclusive setting

The participants were adolescents attending a secondary school in Ibadan, Oyo State, South-West Nigeria in a 'semi-inclusive setting. This setting is such that the school consisted of two distinct segments: the first segment which is closer to the main entrance and bigger, is the mainstream school consisting of about 800 students

while the second is a school for the deaf consisting of about 150 students. The mainstream school has a playground that is distinct from the school for the deaf but shares other facilities like the library and cafeteria with the deaf students and also have the same administrative officers. Both the school for the deaf and the mainstream school are day schools under one umbrella name being overseen by the State Ministry of Education. The students in the two arms have lessons for about 8 hours/day and sit for the same terminal examinations, however, the students in the mainstream arm are being taught in English, which is the language of instructions in Nigerian schools, while those in the deaf arm are being taught in both Sign language and English language. There is some sharing of space and interaction, however, they have different classrooms where they receive their lessons.

Teachers in the school for the deaf, who mostly have had about three years of special education training, reported that they utilise the same teaching packages as is used by the mainstream school even though there is an approved curriculum for deaf schools in Nigeria.[26] The teachers adapt these packages for their use in teaching the deaf students. The teachers also indicated that they did not have teaching aids such as charts, pictures, videos and graphs. There were no other professionals like psychologists, speech therapists working in the school. However, it is worthy of note that this setting is one of the very few in the country that provides a semblance of inclusion to students with deafness. The majority of other facilities for individuals with deafness and other disabilities are run as stand-alone facilities with no interaction with mainstream facilities. There are several stigmas associated with stand-alone facilities such as negative attitude from the society and poor allocation of resources in relation to mainstream schools, in which the arrangement in the study school appears to have reduced.

The American Sign Language is the approved language for deaf schools in Nigeria.[26] However, children with hearing loss and their families often develop means of communication early in life, which involve mainly gestural resources, and this is carried on until the deaf child is enrolled in schools where they are then introduced to the 'structured and regulated' sign language.[26] The Nigerian deaf community has a means of communication known as the Nigerian Sign Language (NSL), that is indigenous and cultural to them, especially at the community and family levels. [27, 28] The NSL has developed over the years and it has been described as a dialectal variation of the American Sign Language.[28] The NSL is still poorly documented and has limited research attention.[27]

Participants

The study was a comparative cross-sectional study of deaf students and their normal hearing counterparts attending a secondary school in Ibadan, Nigeria. Students who did not provide consent for the study and who were older than 16 years

were excluded because the upper age limit for the WISC-IV is 16 years. All the participants that met the inclusion criteria in the deaf unit were included in the study. Participants comprised of a total population of eligible deaf adolescents (102) matched in age and sex with an equal number (102) of hearing adolescents, making a total of 204 students that participated in the study.

Measure

Data was collected with the Wechsler Intelligence Scale for Children – Fourth Edition (WISC-IV) and the Strengths and Difficulties Questionnaire (SDQ).

Wechsler Intelligence Scale for Children – Fourth Edition (WISC -IV) [29]

The non-verbal (Perceptual Reasoning Index) component of the Wechsler Intelligence Scale for Children (WISC)-IV was used in this study. The Wechsler Intelligence Scale for Children (WISC) is an intelligence test for children between the ages of 6 and 16. [29] It has four main components that are referred to as indexes. It generates a full IQ score from four index scores. These are the Verbal Comprehension Index, the Perceptual Reasoning Index, the Working Memory Index and the Processing Speed Index. Within each of these four domains are a variety of sub-tests that add up to form the index score. The Perceptual Reasoning Index is described as equivalent to the Performance (non-verbal) IQ scores on the third Edition of the Wechsler Intelligence Scale for Children (WISC-III). [29] The results of a study by Krouse and Braden [21] suggest that the WISC-IV scores are as reliable in terms of internal consistency for deaf and hard of hearing children as they are for their normal-hearing peers. The WISC has been used among Nigerian children. [30-32]

The Perceptual Reasoning Index

This measures non-verbal (perceptual) and fluid reasoning, spatial processing, visual-motor integration, and the ability to learn new information. It assesses the ability to examine a problem, use visual-motor and visual-spatial skills, organize thoughts, develop and test solutions. It consists of Block Design (BD), Matrix Reasoning (MR), Picture Concepts (PC) and Picture Completion (PCP) sub-tests. BD involves putting together red-and-white blocks in a pattern to match to a displayed model. Speed is stressed, and some of the more difficult puzzles award bonuses for speed. MR asks participants to pick out of five images one fitting a shown array of pictures with one missing square. PC involves looking at two (or three) rows of pictured objects and indicate (by pointing) the single picture from each row that shares a characteristic in common with the single picture(s) from the other row(s). In PCP, pictures of common items are presented and participants are expected to name or indicate the missing part by saying the name of the part or by pointing to it.

Scoring of the WISC-IV

Raw scores were derived by summing the number of correct items within each subtest. These raw scores are converted into scaled scores which are comparative within

the child's own age group. The scaled scores for each Index are then converted into IQ scores which can be categorize into extremely low (69 and below), borderline (70 - 79), low average (80 - 89), average (90 - 109), high average (110 - 119), superior (120 -129) and very superior (130 and above) directly comparable across age groups. These categorization and scoring can also be applied to each of the indexes.

The Strengths and Difficulties Questionnaire (SDQ) was used to measure mental health problems among the participants. The SDQ was completed by parents or teachers for children ages 4–16 years and there was a self-report version for young people aged 11 years and older. The SDQ has been validated in Nigeria. [33]

Assessment of Degree of Hearing Loss

The degree of hearing loss was established by trained examiners under the supervision of one of the authors (AA) in a dedicated, sound-isolating room using the Pure Tone Audiometry (PTA). This involved the use of a diagnostic audiometer called Interacoustics^{R} AD226 and stimuli were presented through supra-aural headphones (TDH-39). Bone and air conduction methods were used and readings in decibels (dB) were taken at different frequencies of 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz and 4000 Hz. A five-frequency average was used to determine the severity of hearing loss. According to the World Health organisation, hearing impairment is classified into no impairment (26dB or less), slight (26 – 40dB), moderate (41 – 60dB), severe (61 – 80dB) and profound (80dB and above) impairments. [34]

Assessment of Intelligence Quotient

The IQ of the participants was assessed using the Perceptual Reasoning Index (PRI) domain of the WISC-IV. This is because the remaining part of the full scale requires the client to give verbal responses to the questions and this was not possible with the deaf participants. The PRI consists of block designs, matrix reasoning, picture concept and picture completion as sub-tests. The participants were assessed individually in a quiet room. The general instructions of the sub-tests were written out boldly for the participants with deafness while other specific instructions were given in sign language.

Data collection and analysis

Data collection was carried out between February and July, 2012. IQ assessment was done by the principal investigator who had received training in the administration of the WISC. The SDQ were administered by two research assistants with a first degree, the assistant did not require any training to administer the SDQ. The data was cleaned and entered into Statistical Package for the Social Sciences (SPSS) version 20 and summarised using descriptive statistics such as means, standard deviation, range, proportions and percentages. Pearson's moment correlation co-efficient was used to find relationships between PRI scores and the SDQ difficulty domain scores for both the deaf and normal hearing groups and to

find relationships between PRI scores and audiometric scores of the hearing impaired adolescents. Chi-square test was used to determine the association between audiometric levels and behavioural problems in the deaf adolescents. All analyses were performed with SPSS version 20.0 and level of significance was set at p less than 5%.

Ethical considerations

The study was approved by the University of Ibadan/University College Hospital Ethical Review Committee (UI/EC/11/0217) and parents/caregivers of the participants provided written consents. Parents and teachers of the participants completed the SDQ for each of the participants. The study was carried out in strict adherence to the Helsinki Declaration principles especially the respect for individual, right to self-determination and informed consent. These were ensured by obtaining individual verbal informed consent from parents of children after a thorough explanation of the study. Assent was also obtained from the children. Confidentiality was maintained all through data collection and analysis. The respondents' identification was protected as only codes were used as identifier.

RESULTS

Table 1 shows the sociodemographic and clinical characteristics of the participants. A total of 204 adolescents, comprising of 102 deaf and 102 age-and sex- matched normal hearing, participated in the study. Their ages ranged from 13-16 years with a mean age (±SD) of 15.0 (± 0.97) years for both groups and there were 55 (46.1%) females and 47 (53.9%) males in each group. Based on the five-frequency average calculation, 91 (89.2%) had profound hearing loss (≥81dB on PTA) and the remaining 11 (10.8%) adolescents had severe hearing loss (61-80dB on PTA). A significantly higher proportion of the mothers in the hearing impaired group 27 (26.5%) had no formal education ($x^2 = 21.72$; $p = 0.0002$). The age of onset of hearing impairment for 39 (38.2%) of the adolescents in the deaf group was between 0 to 5 years while 28 (27.5%) of them could not state when the impairment started. Thirty- four (33.3%) claimed the impairment was congenital ("born with it"). The use of hearing aid was low with 99 (97.1%) reporting no use.

The PRI scores ranged from 41 - 106 across both groups. More than half (58.8%) of the study group and 41.2% of the normal hearing group obtained a non-verbal IQ score of < 69, classified as extremely low (Table 2). Twenty-eight (27.5%) of adolescents in the deaf groups and 36 (35.5%) in the normal hearing group had IQ scores in the borderline range (70-79), the percentage of the deaf participants whose score were in the average category (110-119) was 6 (5.9%), as opposed to 16 (15.7%) of the normal hearing participants. This difference in IQ levels between the two groups was statistically significant ($p < 0.033$). In both groups, the range of the highest scores obtained was 91-110 which is classified as average (Table 2).

Table 1: Sociodemographic and clinical characteristics of the participants

Variables	Deaf (n=102) n (%)	Normal Hearing (n=102) n (%)	x^2 value	p-value
Age (years)				
13	9 (8.8)	9 (8.8)		
14	20 (19.6)	20 (19.6)	0.000	1.000
15	32 (31.4)	32 (31.4)		
16	41 (40.2)	41 (40.2)		
Sex				
Male	47 (46.1)	47 (46.1)	0.000	1.000
Female	55 (53.9)	55 (53.9)		
Family type				
Monogamy	66 (64.7)	82 (80.4)	6.301	0.012*
Polygamy	36 (35.3)	20 (19.6)		
Father's level of education				
No formal education	12 (11.8)	5 (4.9)		
Primary	20 (19.6)	20 (19.6)	4.216	0.239
Secondary	43 (42.2)	41 (40.2)		
Tertiary	27 (26.5)	36 (35.3)		
Mother's level of education				
No formal education	27 (26.5)	8 (7.8)		
Primary	25 (24.5)	47 (46.1)	21.72	0.0002*
Secondary	32 (31.4)	33 (32.4)		
Tertiary	18 (17.6)	14 (12.7)		
Age of onset of impairment (years)				
0-5	39 (38.2)	NA		
6-10	26 (25.5)			
>10	9 (8.8)			
Don't know	28 (27.5)			
Cause of hearing impairment				
Born with it	34 (33.3)	NA		
Trauma	20 (19.6)			
Measles	24 (23.5)			
Fever	16 (15.7)			
Don't know	8 (7.8)			
Use of hearing aid				
Yes	3 (2.9)	NA		
No	99 (97.1)			

Statistically significant** ***Mean age (SD) = 15.0 (±0.97) years
NA-Not applicable

Using Pearson's moment correlation test, the WISC-IV PRI scores of intelligence had no statistically significant relationship (r = -0.177; p = 0.076) with the audiometric scores (in decibels) of the deaf participants. The relationship is shown in the form of a scatter diagram (Figure 1). Table 3 shows the raw scores, the scaled scores and the means of the scores on the subtests of the PRI.

The raw score is the score that was obtained directly from the adolescents and then converted to the scaled scores using the WISC-IV manual. The sum of the scaled scores of all the subsets generated the total subscale equivalent of the nonverbal IQ score.

Table 2: Perceptual Reasoning Index scores of the participants in both groups

PRI Score	Deaf Group (n=102) n (%)	Normal Hearing Group (n=102) n (%)	Total (n=204) n (%)	Test Statistics
Extremely low	60 (58.8)	42 (41.2)	102 (50.0)	$x^2 = 8.722$
Borderline	28 (27.5)	36 (35.3)	64 (31.4)	df = 3
Low average	8 (7.8)	8 (7.8)	16 (7.8)	**p < 0.033***
Average	6 (5.9)	16 (15.7)	22 (10.8)	

PRI - Perceptual Reasoning Index ****Statistically significant***

A comparison of the mean of the nonverbal IQ scores of the two groups showed that the hearing group performed significantly better on all the subscales (p < 0.0001 in all the subscales). The mean value for the nonverbal IQ (PRI) scores was 62.11±11.42 for the deaf group, and 76.42±12.01 for the hearing group.

In the deaf group (Table 4), the nonverbal intelligence scores as assessed by WISC-IV PRI were inversely and significantly related to hyperactivity assessed by the teacher (r = -0.354, p = 0.0001)), emotional difficulty assessed by both teachers (r = -0.221, p = 0.027) and parents (r = -0.280, p = 0.005) and peer problems assessed by the teachers (r = -0.329, p = 0.0001) The WISC-IV PRI was also seen to be inversely and significantly related to total behavioural difficulties as assessed by both teachers (r = -0.419, p = 0.0001) and parents (r = -0.428, p = 0.0001).

The findings differ in the normal hearing group where WISC-IV PRI scores were significantly associated with peer problems assessed by the teacher (r = 0.199; p = 0.048) and pro-social assessed by teachers (r = 0.397; p = 0.030). (Table 4)

DISCUSSION

The study assessed the non-verbal intelligence of deaf adolescents attending a secondary school in Ibadan and compared with their age- and sex-matched normal hearing adolescents attending same school, using the perceptual reasoning index of the WISC-IV. The results of this study showed that the deaf adolescents performed significantly lower on the test of intelligence. Mean PRI otherwise known as non-verbal IQ found in the deaf participants in this study is similar to findings from previous studies. For example, a study carried out in North Carolina reported that the mean PRI for the deaf and hard of hearing sample (93.21 ± 15.98) was lower than the normative sample mean (100 ± 15) (p <0.001). [21] A recent meta-analysis concluded that children with hearing loss have lower full-scale and performance IQ scores than children with normal hearing.[19] Similarly, a study that used the WISC-R block design subtest to assess the non-verbal IQ of 6-16 year olds in the United States found that bilateral

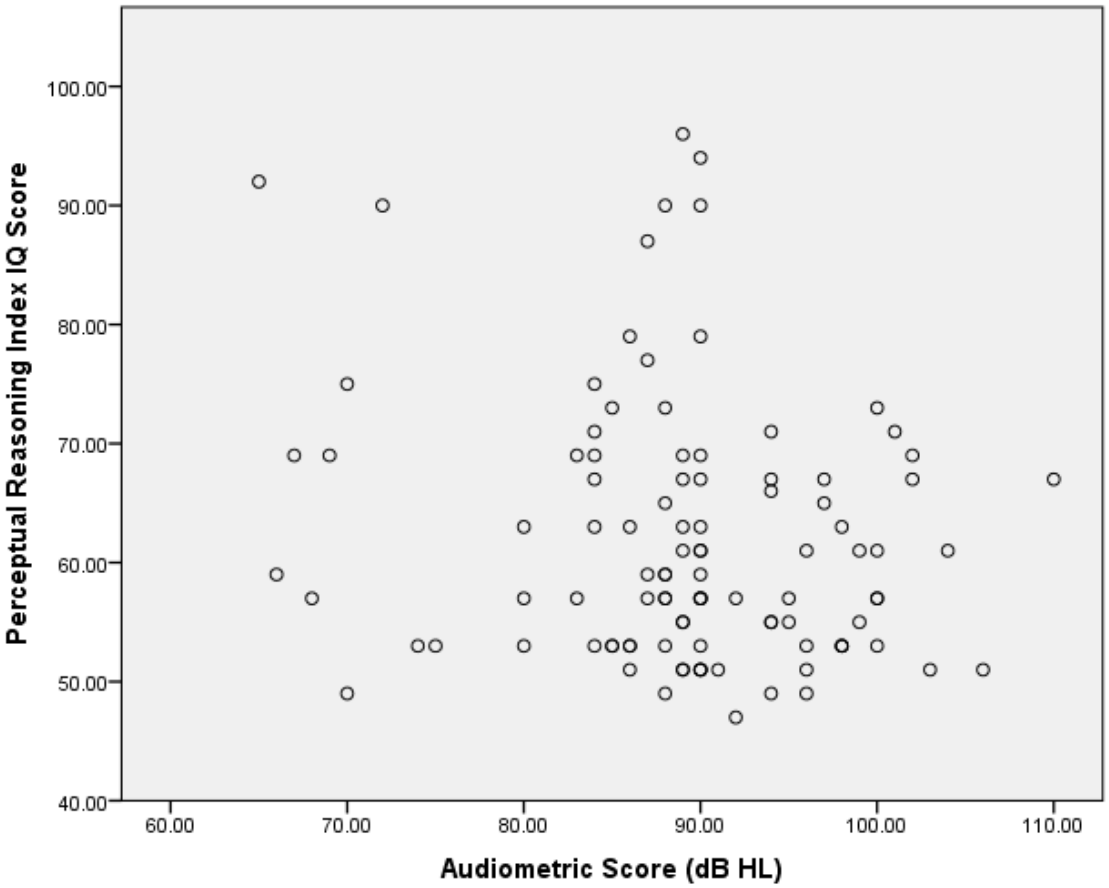

Figure 1: Relationship between non-verbal IQ (PRI) and audiometric scores (Decibels) of the deaf adolescents

Table 3: Comparison of non-verbal IQ (PRI) subsets between deaf and hearing groups

Variable	Deaf Group Mean ± SD	Hearing Group Mean ± SD	Mean Difference	t- test	p value
Raw scores					
Block design	16.37 ± 8.09	24.58 ± 9.95	-8.21	-6.396	**< 0.0001***
Picture concept	10.16 ± 4.58	13.92 ± 3.64	-3.76	-6.415	**< 0.0001***
Matrix reasoning	10.34 ± 4.73	14.45 ± 4.81	-4.11	-6.086	**< 0.0001***
Picture completion	13.27 ± 3.24	16.11 ± 2.78	-2.84	-6.718	**< 0.0001***
Scaled scores					
Block design	3.03 ± 1.76	4.80 ± 2.03	-1.77	-6.572	**< 0.0001***
Picture concept	2.69 ± 2.64	4.81 ± 3.03	-2.12	-5.262	**< 0.0001***
Matrix reasoning	2.53 ± 2.04	4.25 ± 2.41	-1.72	-5.435	**< 0.0001***
Picture completion	3.27 ± 1.19	4.73 ± 1.39	-1.46	-8.058	**< 0.0001***
Total scaled	11.52 ± 5.62	18.55 ± 5.81	-7.03	-8.783	**< 0.0001***
Nonverbal IQ (PRI)	62.11 ± 11.42	76.42 ± 12.01	-14.31	-8.721	**< 0.0001***

****Statistically significant***

Table 4: Relationship between non-verbal IQ scores (PRI) and each of SDQ domain difficulty scores based on teachers' and parents' assessments in both groups

	Deaf group		Normal hearing	
	r	p	R	p
PRI Vs Hyperactivity				
Teacher assessment	-0.354	**0.0001***	-0.127	0.227
Parent assessment	-0.077	0.044	-0.179	0.075
PRI Vs Emotional difficulty				
Teacher assessment	-0.221	**0.027***	-0.073	0.474
Parent assessment	-0.280	**0.005***	-0.100	0.321
PRI Vs Conduct problems				
Teacher assessment	-0.139	0.168	-0.020	0.841
Parent assessment	-0.140	0.164	-0.037	0.715
PRI Vs Peer problems				
Teacher assessment	-0.329	**0.0001***	0.199	**0.048***
Parent assessment	-0.177	0.079	0.028	0.784
PRI Vs Total difficulty				
Teacher assessment	-0.419	**0.0001***	0.038	0.708
Parent assessment	-0.428	**0.0001***	0.035	0.729
PRI Vs Pro-social				
Teacher assessment	0.421	**0.020***	0.397	**0.030***
Parent assessment	0.124	0.326	0.019	0.852

Statistically significant

hearing loss was independently associated with 5.77 times increased odds of low non-verbal intelligence compared to normal hearing children.[16] Another study in Lagos, Nigeria, compared the cognitive functions of hearing impaired school children, aged 6-20 years on the Ravens progressive matrices, with a hearing group in a mainstream school. The author found no significant difference in the cognitive functions of the two groups.[35] The difference in findings between the Lagos study and our study might be due to the wide age range of the participants in the other study.

A study from South Africa assessed the visual working memory functioning of 24 deaf and 15 matched hearing children, the results indicated that the hearing children scored significantly higher than the deaf children on virtually all components of visuospatial short-term and working memory. [15] The low intelligence found in the deaf adolescents have been linked with poor language development and may not be unconnected with the difficulty with which they have to learn what their non-hearing impaired counterparts may learn much more easily. Our study found a significant correlation between total difficulty score, the hyperactivity, and peer problems scales of the SDQ in the deaf participants, with more of the deaf participants having scores in the abnormal range on the SDQ. Previous studies have reported associations between

the intelligence and behavioural problems in children with hearing loss. However, these reports have remained inconclusive about the direction of this relationship; while some found that deaf children and adolescents have more behavioural problems than their hearing peers, [19, 35-38] some reported no significant differences between the groups. [39]

Our finding of increased behavioural problems in the deaf participants is similar to the one in a German study that examined 214 deaf and hard of hearing (D/HH) children and compared with normative data, D/HH children had significant problem scores on all five subscales of the Behavior Rating Inventory of Executive Function-Preschool version (BRIEF-P), as well as significant correlations on the subscales of the SDQ. [36] The non-verbal IQ scores of the adolescents in the deaf group were observed to be significantly and inversely related to their scores on the hyperactivity scale. This means that the intelligence of the adolescents with hearing impairment reduces as the burden of their hyperactivity symptoms increase. [40, 41]

Hyperactivity, one of the domains of behavioural difficulty as a symptom has been strongly linked with poor academic performance and poor performance on tests of intelligence. [42] Rates of hyperactivity and impulsive behaviour and measures of intelligence appear to have an inverse association. In a study that compared the scores on WISC for children with attention deficit hyperactivity disorder (ADHD) and children without ADHD, it was concluded that the children without ADHD performed better on the WISC than children with ADHD. [43] Manassis, Tannock, Young and John [44] also studied a sample of 21 ADHD children from two outpatient clinics in Ontario, Canada, and reported that the ADHD children showed significant impairment in their working memory and academic functioning compared to normal children. A similar study also reported that ADHD children did worse on the Wechsler intelligence scale for children-revised (WISC-R) and were more likely to have learning disabilities and repeat grades. [45] In contrast, the ratings of conduct problems and intelligence showed no statistical significant association in the current study. The 'semi-inclusive' setting where the current deaf adolescents were being educated contributed to the no significant relationship between conduct problems and nonverbal IQ. Evidence shows that students with disabilities who attend their local neighbourhood school with their siblings and neighbourhood peers achieve superior educational outcomes to those who attend separate special schools. [46]

Limitations: The study group were deaf adolescents attending a semi-inclusive secondary school. As confirmed by the audiological assessment, the students in the study had, at least, severe deafness (61-80dB). Hence the findings in the study might not be generalizable to those with mild to moderate deafness. Secondly, there were no self-report from the deaf adolescents; children and adolescents are

more likely to report internalising symptoms rather than externalising symptoms. Parents are better at reporting externalising symptoms. As a result of this, some of the internalising problems of the participants might have been missed. Thirdly, our study did not measure the impact of the 'semi inclusive' setting on the psychological functions of the deaf adolescent by comparing with, a deaf group who are in an exclusive special setting. The deaf adolescents in our study had opportunity of interacting with hearing peers in the mainstream school, this might have influenced their psychological functioning.

Conclusion: In this study, nonverbal intelligence as measured by the perceptual reasoning skills, was significantly lower in adolescents with deafness when compared with their hearing counterparts. It is important to note that the adolescents with deafness in this study had very minimal educational support; it is possible that some of the challenges reflected in the PRI assessment might be alleviated with the appropriate resources and support including hearing aids, use of visual aids, charts, pictures and regular in-service training of teachers. However, the fact that the deaf adolescents were being taught in a 'semi-inclusive' setting might have positive influence on their overall performance, the current study did not set out to measure this. Therefore, future research should explore the impact of semi inclusion on the cognitive functions of deaf adolescents and the implications for policy. Furthermore, hyperactivity and other behavioural difficulties needs prompt diagnosis and treatment to further enhance the overall outcome of deaf individuals. These findings further underscore the need for a comprehensive school mental health system to ensure early diagnosis and appropriate treatment of students including those with deafness. It is also recommended that appropriate learning tools such as visual aids, hearing aids and curricula should be made available to the deaf students to aid their learning.

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