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Iodine Deficiency and Intellectual Ability of School Children Living in a Severely Goitre Endemic Area in Nigeria.

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ABSTRACT

Two hundred and seventy-eight pupils were assessed using this modality of IQ assessment, made up of one hundred and thirty-five pupils from Nimbo consisting of ninety-six males and thirty-nine females and one hundred and forty-four pupils (eighty-one males and sixty-three females) from Ezzillo. For every age, pupils from Ezzillo the control population achieved higher scores. Male mean scores were generally higher than the female mean scores in both

populations of Nimbo and Ezzillo. The total population mean DAPQ score for the two communities investigated; Nimbo and Ezzillo were 82.14 ± 20.23 Vs. 88.94 ± 21.19, respectively. The difference between these scores was statistically significant, P< 0.05. On stratification according to specific ages, statistically significant difference were noted for the matched DAPQ mean scores of those aged 10, 12 and 14 years. Further stratification according to gender and age showed that the matched DAPQ mean scores for males was significant only for those aged 12 years (75.81 ± 15.15 Vs. 86.4 ± 12.45, P<0.05); and for the female sub-populations significant differences were observed in those aged 12 and 14 years (65.33 ±5.51 Vs 79.61 ± 10.57; P<0.05); (59.17 ± 7.70 Vs 71.8 ± 7.36; P< 0.05), respectively. It is noteworthy that the mean DAPQ score for those aged 12 years amongst the female sub-population of Nimbo, the study area, was below 75% of the mean DAPQ for rural females aged 12 years; 65.33 VS. 65.66, respectively. Two hundred and thirty-three pupils were assessed for their intellectual ability using the SPM. Ninety-five of the subjects were from Nimbo consisting of fifty-seven males and thirty-eight females, while from Ezzillo one hundred and thirty-eight pupils participated made up of seventy-seven males and sixty-one females. The SPM mean scores generally improved with increasing age. The scores achieved by males were generally higher than that of females of the same age particularly in the goitre hyperendemic area of Nimbo. The total population mean scores for the two rural communities under investigation - Nimbo and Ezzillo were 13.78± 6.84 vs 12. 79±5.30, with no statistically significant difference P>0.05.
Keywords: goitre, iodine, Intellectual, Population, IQ , assessment

INTRODUCTION

The relationship of endemic goitre with overt cretinism and the attendant poor intellectual ability had long been observed [1] [2] [3]. The association of endemic goitre with subtle intellectual impairment without overt cretinism is currently been investigated [4]. [5], had observed in 1848 that in addition to the small number of cretins in the village of Chiselborough in Somerset, the majority of the population were slow of speech and dull. [6] had remarked in 1921 that the prevention of goitre meant vastly more than the correction of cervical deformities. They noted that, it meant in addition the prevention of those forms of physical and mental degeneration such as cretinism, mutisim and iodiocy which were dependent on thyroid insufficiency. [7], demonstrated in 1959 the correlation between goitre, mental retardation, and deaf-mutism with low serum thyroid hormone levels in non-cretinoid subjects in a severe endemic goitre area in lndia. More recent studies in India [8] and [9] also have demonstrated impaired intellectual ability in children living in iodine deficient environments.

The subject of iodine deficiency induced neuropsychological and neuromotor disabilities, has therefore been subject of several studies. Although these studies had certain shortcomings often in

methodology and study design almost all were consistent with results suggesting an excess of subjects who measure below normal standards on IQ, neuromotor ability or both in populations with endemic goitre and clinical criticism [10] Ma Thai [11] from his extensive IDD surveys in China reported an incidence of 17.5% of mental retardation in iodine deprived communities as compared to 6% in iodine sufficient area. He further estimated from his results the number of subcretins i.e. those whose neuropsychological and/or neuromotor development were/was impaired but less severely than in the cretin. He found 5.7:1 sub-cretins for every cretin in the population.

A number of psychological test have been administered to children in iodine deficient areas. [12], in 1969 studied school children living in iodine deficient area of Ecuador using the Goodenough Draw a Person Test to measure their natural intelligence. He noted significantly higher scores amongst female students who had been given iodized oil earlier. The higher scores achieved by females who had iodine were more statistically significant than the scores achieved by males who also had iodine. [13], in 1972 using the Standford Binet Intelligence test on the same population of school children administered the test to 125 pupils. Results indicated that all the score were below the North American standards. However, he observed that the scores of pupils whose mothers had received iodized oil prior to their conception were significantly higher than those whose mothers did not receive iodine prior to their conception or in the control village [13]. In the Andean, iodine deprived region of Ecuador, [14] in 1972 assessed the scores on modified Stanford-Binet test amongst children in the communities after iodization programme. Interestingly, scores of children whose mothers had iodine prior to conception were better than those whose mothers had iodine after the 16th week of gestation. In addition, he noted that only 9.5% had scores below 70 in contrast to the untreated group amongst whom 50% scored below 70. However, all the scores were generally below the accepted standard as earlier noted by Trowbridge et al [14].

Further assessments were made some years later by Fierro-Benitez et al on the same population. Using various tests of intellectual function such as, Goodenough, Wechsler scale, Terman-Merill ,they concentrated on 128 children aged 8-15 years whose mothers had iodized oil prior to second trimester of pregnancy. They reported that there was no significant statistical difference between the study and control subjects marched for age and sex from a neighbouring community that was iodine deficient whose mothers were not given iodine. Both the study and control groups were impaired in school performance in reading, writing and mathematics; the control subjects however were more

afflicted. They observed that the study subjects performed distinctly better in school year achieved for age, school drop-out rate, failure rate, years repeated and school marks as judged by the class teachers' notes on the pupils performance record books [14].

Although evidence suggesting a widespread and pervasive subtle intellectual impairment resulting from severe and moderate iodine deficiency are now being advanced from various studies in the past few decades; proving unequivocally the existence of a significant learning and adaptation disability due specifically to iodine deficiency has not been convincingly achieved [15]. Often communities that have iodine deficiency are also inflicted with malnutrition and reduced environmental stimulation both of which may adversely affect learning ability. Connolly and Pharoah [16] had observed that excluding extremes of biological dysfunction, that it is the number rather than the nature of risk factors that best predicts the outcome. They postulated that most outcomes are a result of the complex and subtle interactions, noting that "biological systems have a means of righting themselves and adapting to demands made on them". The greater relevance of 'transactional effect' instead of 'main effect' in the outcome of iodine deficiency in human popuplations is therefore being considered.

It has been observed that populations at risk of IDD often are rural and remote. They concurrently run the risk of protein-energy malnutrition (PEM), iron deficiency, short term food deprivation, parasitic infection and environmental stimulation deprivation [17]. Several workers have demonstrated the association of poor intellectual performance with PEM [18] [19] [20] [21], iron deficiency with and without anaemia [22][23] and parasitic infections which is often confounded with undernutrition and iron deficiency [24] [25] [26][27]. The negative impact of poor environmental stimulation on intellectual performance has been demonstrated [28][29], [30] The significant positive effect of gonadal hormones on intelligence has also been shown [31].

Efforts to elicit the sole effect of iodine deficiency on intellectual ability has led to the application of meta analysis (a recent method of research results integration) to results of the various research findings, from 8 countries using various psychological tests and involving 2676 subjects. The age range was 2-30 years. A d-value (Cohen's d-value is the standardized difference in means between two groups on the same variable: it is an indicator of the size or strength of an effect) of 0.90 was derived which suggested a lowering of the average IQ by 13.5 points in areas of iodine deficiency [32] Iodine is probably one of the nutritional factors that influence intelligence. Nutrition itself constitutes only an aspect of nurture. As such, the result of the meta-analysis suggesting that iodine deficiency causes 13.5

points loss in IQ, will need some further studies. This research is aimed at Assessing the intellectual ability of school children living in a severely goitre endemic area in Nigeria. A comparism with a less endemic area will be made.

MATERIALS AND METHODS

The research was undertaken at Central Primary School, Nimbo, in Uzo-Uwani Local Government Area of Enugu State. Nimbo constitutes of four villages or quarters; namely Opanda, Owerri, Ukpabi, and Nimbo. The town was noted some thirty-two years ago to have a goitre prevalence of 38.5% □□3.29% in a general population survey excluding children under twelve years [33]. Low iodine in drinking water (0.58 □0.6 ug/L) was also documented [34].

LOCATION OF CONTROL AREA:

Ezzillo town became the Headquarters of Ishielu LGA of Ebonyi State about six years ago following creation of new LGAs. It is made up of five villages. A previous survey had documented a total goitre prevalence rate of 0.2% □ 0.10% of the general population at Ezzamgbo, an adjacent town and long-standing headquarters of Ishielu LGA

STUDY DESIGN

This is a controlled community based study.Prior to the main study, a preliminary study was carried out to re-establish the prevailing goitre prevalence rates of the previously assessed areas in Enugu State using the palpation method and the WHO grading system [35]. The initial results suggested an increasing trend. The previously known non-endemic areas [33] were noted to have developed high goitre prevalence rates. Further widespread assessment involving cohorts of 50 pupils per school from a minimum of two primary schools (each from a different autonomous community) in each local government area in Enugu State was done. This was with the view to locating areas that have no goitre endemicity within the same socio-cultural environment as Nimbo town.

Study Population

Pupils of the Central Primary School Nimbo, Uzo-Uwani LGA, from primary one to six aged between 6-18 years were studied. Control pupils of similar age and sex from Ezzillo Community Primary School in Ishielu LGA were enlisted.

Sampling Procedure

Following the clearance of the Ethical Committee of the University of Nigeria Teaching Hospital, Enugu, consultations were held with the Ministry of Education, Enugu, Uzo-Uwani and Ishielu Local Government officials, Health workers, and the Parents/Teachers Association of the study and Control Primary Schools. The aim, procedure and relevance of the study was fully explained to the relevant officials at each administrative level and their

permission obtained. At the school, prior to the commencement of the study, all the pupils were assembled for a health-talk on goitre and other iodine deficiency disorders and the need for supplementation with iodine in their daily diet. The details of the study were explained to them. Pupils had to satisfy the following criteria to qualify for inclusion in the study.

- Must have been born in the locality or must have been resident in the locality up to five years consecutively.
- Must be in the age range from six to eighteen years.

The exclusion criteria were:

- Consumption of cough mixture in the proceeding six weeks before the study.
- Use of iodine for treatment of external wounds six weeks prior to study.
- Presence of febrile illness on the day of the study (As per collection of samples for laboratory tests).

SAMPLING TECHNIQUE

Sample Size Determination

To determine the minimum statistically acceptable sample size the formula

$$n = \frac{(1.96)^2 \times P(100-P)}{e^2}$$

where P = Prevalence rate of 38.8%

e = Sampling error of 5%

was employed.

Sampling

The cluster sampling method was used in which the schools were the clusters. Hence a simple random sampling technique was used to select the Central Primary School out of the four primary schools in Nimbo. Consequently all the pupils present on the days of the study were examined for goitre.

Study Sample Size

The population of pupils at Central Primary School, Nimbo is four hundred and forty-eight. In all, three hundred and ninety-six pupils were examined for goitre: consisting of two hundred and forty-six males (246 males and 150 females) representing 88.4% of the entire study population. Intellectual assessment was performed in one hundred and thirty-five pupils selected by systematic random sampling of every third pupil, representing 34.1% of the study sample size. Venous blood was collected from ninety eight pupils (representing 24.74%) who gave their informed consent for thyroid hormone profile.

Control Sample Size

The school population at Community Primary School Ezzillo is three hundred and seventeen. Of these two hundred and seventy-five pupils were examined for goitre (146 males and 129 females)

representing 86.75% of the entire control sample size. Intellectual assessment was performed on one hundred and forty-four pupils selected by systematic random sampling of every second pupil, representing 52.36% of the control sample size. Venous blood was collected from fifty-six pupils representing 20.36% of the control sample size for thyroid hormone profile.

Clinical Assessment

Each pupil was examined for the presence of goitre using the palpation/inspection method. They were requested to drink a mouth full of water while inspecting the anterior aspect of the neck. This was followed with palpation in both the normal and extended positions of the neck. The grading was done according to the WHO classification [35]. After the examination of the neck, the height and weight of each subject (without footwear's) were measured using a calibrated wall in metres and the HANA bathroom weighing balance (in kilogrammes). The body mass indices (BMI) were subsequently calculated using the formula

$$\frac{\text{(Body Mass in kg)}}{\text{(Height in Metres)}^{2.}}$$ [36]

Some clinical signs of hypothyroidism were assessed. The intellectual ability was assessed using the culture free and Nigerian standardized methods of Raven's Standardized Progressive Matrices (SPM) [37] and Draw A Person Test (DAPT) [38] (appendices ii and iii). The pupils were called into a classroom in groups of 20 each; while 10 were engaged with the SPM test individually (each with a separate booklet) the other 10 were requested to draw a human being the best way they could on the reverse side of the individualized answer sheets. As each pupil completed one test, he/she was moved to the other test modality. There was no time limit. Venous blood (2mls) was collected from the cubital vein into a plain bottle and carried in a cold chain box to the Mission Hospital at Adani where the serum was separated by centrifugation and stored in deep freezer. The samples were subsequently transported in a cold chain box to the University of Nigeria Teaching Hospital Enugu for analysis.

LABORATORY TECHNIQUE

The thyroid hormore profiles (TSH, T4 and T3) were analysed on each research at the UNTH radio-immuno-assay research laboratory using a scintillation counter (SD 12, Oakfield Health Care Products, Birmingham, England). All the assays were done with reagents supplied from the North-East Thames Region Immuno-Assay Unit (NETRIA) London at the radio-immuno-assay laboratory of the University of Nigeria Teaching Hospital (UNTH) Enugu. The serum concentration of TSH were determined by the sandwich method of immuno-radiometric assay (IRMA). The assay sensitivity was 0.04 mU/L. The serum concentration of T4 and T3 were

determined by the double antibody radioimmuno-assay (DA-RIA). The assay sensitivities were 3.103 nmol/L and 0.2051 nmoL/L respectively.

STATISTICAL ANALYSIS

Results were expressed as percentages and mean ISD. Mean values for the two populations with different goitre prevalences were compared. Calculations were made with student t test. The difference was considered significant where probability P 0.05.

Results and discussion

This study has attempted to assess the current goitre prevalence, the thyroid Hormone profiles and the intellectual (cognitive) ability of school children in two rural communities in Nigeria with different prevalence of goitre. The IQ distribution in the populations investigated using the draw-a-person quotient (DAPQ) as a measure of IQ is shown in figure 2. An obvious shift of the curve of the study population (Nimbo) to the left is observed. Though the modal score for both populations are in the score range of 71-80 DAPQ mean score, with 20% and 21.09% of the study and control population respectively being within that score range. Only 67.4% of the study population compared to 80.95% of the control population scored over 71. Furthermore, 14.07% and 6.8% of the study and control populations respectively scored 60 or less. The difference in the DAPQ mean score which is statistically significant (82.14 20.23 vs 88.94 21.19 P< 0.05) for study and control populations respectively, clearly indicates the subtle impairment of the IQ which appears to affect many members of the study population. On stratification according to age the study population had a consistently lower score than the control population. The difference in the scores of the 10, 12 and 14 year olds were statistically significant (Table 2a) . Similar pattern was noted on further stratification according to gender and age. The 12 year olds consistently had a significant difference in the scores. It is important to note that amongst the female sub-population, the 12 year olds in the study group scored less than the standard 75% of DAPQ score for village females of that age (65.33 Vs 65.66 respectively). Scores below 75% of the average score for any age is suggestive of mental backwardness [38] as shown in tables 2b and 2c. The significance of this finding in the 12 years old females in goitre hyperedemic area will need to be further evaluated with a larger population. It is noteworthy that the scores achieved by both the study and control pupils were less than that of the average scores for each age of the rural children in Nigeria as studied by Ebigbo [38]. It is also interesting to note that this difference is more evident in the study population of Nimbo; especially amongst the females than in the males sub population (tables 2b and 2c). The lower scores achieved by pupils in the rural populations under this investigation may be due to iodine deficiency. The study population of Nimbo with a higher goitre prevalence achieved

lower scores. The Draw A Person Test using the draw a person quotient (DAPQ) appears to be a good discriminating test for the survey, fig 3, 4, and 5.

The SPM mean scores from both communities under this investigation as in the study of Ojule [39] ere generally below the average score range according to Bakare's [40] standardization of Progressive Matrices in Nigeria. This suggests a general impairment of IQ in these populations which could probably be due to iodine deficiency. The observation that the mean SPM scores from the present study were generally lower than the scores obtained by Ojule [(13.78 ± 6.83 vs 12.79 ± 5.30, P>0.05) compared to (13.88 ± 4.39 Vs 16.14 ± .7.28 P>0.05)] seems to reflect the higher severity of iodine deficiency disorders at Nimbo and Ezzillo respectively than at Saki and Moniya respectively studied by Ojule. The goitre prevalence rates were 68.93% vs 24.01% compared to 15.2% vs 8.6% respectively. It is also observed that while the age range for this study is 6 - 18 years, Ojule's work had studied only those aged 10 - 14 years.

However scores obtained by pupils of the age range 11-14yrs in this study were 14.61+- 6.54 vs 13.93 +- 6.45 (P>0.05) for Nimbo and Ezzillo respectively and compares better with the figures obtained by Ojule whose subjects were aged 10 - 14 years only [39].

The apparent higher SPM mean score of the study population at Nimbo though not statistically significant may have been due to age factor. On specific age stratification of the SPM mean scores (table 3 a ,b and c) higher mean scores were observed for the ages 8 years, 10 years and 14 years old amongst the control population. It is higher in the study population of Nimbo only in pupils aged 12 years and 15 years and above. The difference in the older age group (15 yrs and above) appeared large though not statistically significant (21.86 ± 8.80 vs 15.71 ± 6.86 P>0.05). The effect of this group appears to give the erroneous impression that the whole study population achieved higher scores than the control population.

Stratifying the results according to gender and age also suggests an apparently higher mean score for the male gender of the study population. But again this appears to be due to the high scores of the older age groups 14 and 15 years and above. (Tables 3b). Figures 7, 8 and 9 graphically shows this relationship.

Furthermore, figure 6 shows a skewed curve for the study population and a normal bell shaped curve for the control population. The earlier phases of the study population curve manifests a left shift with a SPM mean score modal in the range of 5-9 compared to the mean score modal in the range of 10-14 achieved by the pupils of the control population. A higher percentage of the control population

(46.09%) achieved scores within the range of 10-14 whereas only 31.11% of the study population achieved scores in the ower modal score range of 5-9. A higher percentage of the study population achieved scores greater than 9 and less than 5; 34.44% and 3.33% compared to 26.95% and 0.71% noted amongst the pupils of the control population. The obvious shift of the curve therefore suggests the presence of a greater percentage of pupils with a comparatively lower IQ ability amongst the study population, (i.e Nimbo). In addition the lower peak score range may suggest a widespread lowering of IQ score in the community.

The skewing of the study population curve at the right side probably suggest inclusion of a non-homogenous group. The SPM score appear to improve with age [36] [39]. The study population has a higher mean age suggesting a preponderance of pupils in the older age bracket. This could possibly explain the skewing of the curve and it's shift to the right beyond the score range 15-19. However this may need further investigation with a larger population.

In both the study and control populations males consistently had higher scores than their female counterparts for each age strata in the two modalities of intellectual ability tests. Probable factors influencing this observation may include the effect of sex hormones on IQ [31] and a cultural gender effect and stimulation as males are 'valued' more in the rural areas traditionally and greater expectations and responsibilites are placed on them. The possibility of a greater impairment of the intellectual ability in the females as with the female gender's higher prevalence of goiter [41] [36] is also entertained. [12] and [43] had both demonstrated differential female responsiveness to iodine supplementation in terms of IQ improvement in Ecuador and Bolivia respectively. In general as observed from the results, with increasing age of the pupils, there is tendency towards improving scores in the SPM and depreciating scores in DAPQ. However this tendency is less obvious in the SPM mean scores for the ages 10years and 12years as demonstrated by the figures 7, 8 and 9 showing a flattening of the graph. For the same age range in the DAPQ modality scores, there is a discernible widening of the graphs lines. The statistically significant difference noted in the DAPQ mean scores of the 12 years olds in both gender and the scoring of the female study sub-population of that age below 75% of it's expected score is noteworthy (tables 10a and 10c). Furthermore, it is observed that the difference in the scores achieved by the 15 years olds were not statistically significant. This suggests a probable peak effect on IQ at the age range of 10-12yrs. Beyond that age the effect

on IQ appears minimized or compensated. In both IQ test modalities, the differences observed in the study and control populations seem to be eliminated with increase in age. The results of the control population especially with SPM, were surpassed by the study population by the age of 15 years and above. A similar catch-up phenomena on manual dexterity and reaction time with increasing age starting from 9-12 years had earlier been noted by Bleichrodt et al in Spain [44]. While reviewing the subclinical effects of iodine deficiency and the transactional model theory of outcomes, Connolly and Pharoah [45] had observed that outcomes depend on both the biological constraints, its severity as well as the child's experience and the changing environments. They noted that iodine deficiency presents a challenge to the child's development but does not determine its final response except in extreme cases because "biological systems have a way of righting themselves via a continued and progressive interplay between the organism and the environment".

However in discussing IQ consistency [46] had observed that experts seem to agree that decertification' (i.e re-diagnosing as normal some that had earlier been diagnosed as mentally retarded) seems to increase, in the 'teens'. They pointed out that besides possible earlier erroneous diagnosis that both age and the attendant further environmental exposure and experience probably play some role in the apparent improvement of IQ over years leading to decertification.

Catch-up

This catch-up phenonema suggests that as neuronal growth is slowed down [47], [48] processing of information/formation of concepts which culminates into experience and inherently intelligence and adaptation are also slowed down. Though there may exist a possible leveling up of the intellectual ability, the time interval for this in a goitre endemic community is prolonged more than in the non-endemic community. This time factor is essential on considering the critical period concept of normal human development (which coincides with the childhood development {2-10 years}) held by many psychologists. On the basis of this concept Wober [49] had suggested that "educational measures if they are to have any effect should take place earlier than later"; and [50] discussed the possibility of bringing the school entering age forwards. Also [41]had pointed out that the fact of intellectual development being most rapid during this period compels the fostering of cognitive skills in children at the pre-school and primary school levels. Generally psychologist believe that failure to

capitalize on this period may lead to difficulties in learning at a later stage. Such concern is more so for an iodine deficient environment where both neuropsychological and neuromotor factors combine to impair the learning capacity of the pupils. In such populations, impaired attention span, perceptual ability and memory as well as vocabulary and verbal fluidity have been documented,[51] [52] [53]. In countries such as Nigeria where the official language of instructions in schools (English) is different from the native language the problem resulting from impaired vocabulary is even more emphasized. The defective fine motor activity/reaction time observed in such populations adversely affect grip strength and finger dexterity [51] [52] [53]. In the school system where lessons are copied such factors lead to longer periods for copying which will limit the number of lessons taught per day [54]. It also results to poor writing/eligibility impairing subsequent reading of such copied lessons .Also the associated impaired co-ordination and balance often lead to injuries and absenteeism in class/school [54]. In addition studies have also demonstrated some impaired hearing at most frequencies amongst children living in goitre endemic environments though not up to the extent of deafness [55]. The impaired auditory function in addition to impaired attention span often limits the capacity of pupils to follow the lessons taught in class .

The inherent lethargy and poor enterprise prevalent in such populations impair dedicated work output completion of homework and taking of extra-mural lessons [56] [57], [54].

The apparently lower IQ of children in iodine deficient communities during the period a child is supposed to have established his pattern of intellectual development may erroneously result to guiding of the child to professions /trades that are intellectually less demanding. Invariably such professionals may earn less, and will remain economically disadvantaged [58].

In view of the identical Body Mass Index (BMI) in both communities, malnutrition is unlikely to have influenced the comparative relevance of the IQ scores of both communities,[59]. Malnutrition appears to affect IQ mainly when it is severe and prolonged [58].

The social setting and exposure of both rural communities appear to be very identical except for the fact that while a tarred trunk C road traverses through Nimbo, a trunk Broad crosses Ezzillo. The residents of both communities are basically farmers and merchants of farm produce. However, social exposure

and stimulation are but one aspect of the environment and the environment accounts for only a portion of the variability in intelligence. A number of teachers in the two schools investigated are involved in continuing education and sandwich courses for updating of their knowledge. The T4 values obtained exclude the consideration of cerebral hypothyroidism as a possible explanation of the widespread low IQ obtained in this investigation.[60]. The absence of cretins in the schools maybe due to social bias. Cretins do not progress in school normally nor benefit from formal education as normal children do. And so they are therefore probably discouraged from attending the village primary school.

FREQUENCY OF DAPQ SCORE RANGES AND CORRESPONDING % OF SAMPLE POPULATION

Table 1

Score Ranges		≤50	51-60	61-70	71-80	81-90	91-100	101-110	111-120	121-130	≥131
STUDY	Male	4	7	18	18	21	11	9	3	5	-
	Female	1	7	7	9	1	8	3	1	1	1
	Total & %	5 (3.70%)	14 (10.37%)	25 (18.52%)	27 (20%)	22 (16.30%)	19 (14.07%)	12 (8.89%)	4 (2.96%)	6 (4.44%)	1 (0.74%)
CONTROL	Male	4	-	8	14	14	15	13	9	6	1
	Female	1	5	10	17	10	7	5	5	2	1
	Total & %	5 (3.40%)	5 (3.40%)	18 (12.24%)	31 (21.09%)	24 (16.33%)	22 (14.97%)	18 (12.24%)	14 (9.52%)	8 (5.44%)	2 (1.36%)

MEAN DAPQ SCORES OF TOTAL SAMPLE POPULAATION BY AGE

Table 2a

	STUDY		CONTROL		
Age (Yrs)	**Score**	**Freq**	**Score**	**Freq**	**Critical Values (0.05)**
8	94.29 ± 12.17	17	99.71 ± 21.37	17	0.908870116
10	81.96 ± 9.78	25	89.51 ± 20.20	37	1.960900727
12	73.84 ± 14.72	25	82.08 ± 11.81	26	2.198695473
14	61.3 ± 6.75	10	72.71 ± 7.41	7	3.241412655
≥15	61.57 ± 13.26	7	67.0 ± 15.60	9	0.751545064
All ages	82.14 ± 20.23	135	88.94 ± 21.19	144	2.742098148

MEAN DAPQ SCORES OF MALE GENDER BY AGE

Table 2b

	STUDY				CONTROL		
Age (Yrs)	**Score**	**Freq**	**Average Score by Village boys**	**75% of Ave. Score by village boys**	**Score**	**Freq**	**Critical Values (0.05)**
8	95.0 ± 11.95	12	100.2	75.15	101 ± 19.55	11	0.87842586
10	84.71 ± 12.24	17	95.40	71.55	91.33 ± 21.05	24	1.268958205

	STUDY				CONTROL		
12	75.81 ± 15.15	21	87.14	65.36	86.4 ± 12.45	10	2.060384794
14	64.5 ± 3.87	4	78.50	58.88	93.0 ± 35.55	2	1.130301314
≥15	62.83 ± 19.31	6			75.0 ± 9.54	3	1.529286355
All ages	82.49 ± 19.31	96			92.44 ± 26.93	81	2.777042437

MEAN DAPQ SCORES OF FEMALES GENDER BY AGE

Table 2c

	STUDY				CONTROL		
Age (Yrs)	**Score**	**Freq**	**Average Score by Village Girls**	**75% of Ave. Score by village Girls**	**Score**	**Freq**	**Critical Values 0.05**
8	92.6 ± 13.94	5	100.60	75.45	97.33 ± 26.19	6	0.382453516
10	76.13 ± 7.72	8	94.15	70.61	86.15 ± 18.86	13	1.699706317
12	65.33 ± 5.51	3	87.55	65.66	79.63 ≥10.57	10	3.456755593
14	59.17 ± 7.70	6	72.72	54.54	71.8 ± 7.36	5	2.774417106
≥15	54.0 ± 0.00	1			63.0 ± 17.18	6	1.283098384
All ages	81.28 ± 22.56	39			84.43 ± 20.83	63	0.705487122

NB: Average Score and 75% Average Score by Village boys and girls are according Ebigbo and Izuora[172].

REQUENCY OF SPM SCORE RANGES AND CORRESPONDING % OF SAMPLE POPULATION

Table3

Ranges		0 - 4	5 - 9	10 - 14	15 - 19	20 - 24	25 - 29
Y	Male	3	13	16	8	9	1
	Female	0	15	7	14	1	1
	Total & %	3 (3.33%)	28 (31.11%)	23 (25.56%)	22 (24.44%)	10 (11.11%)	2 (2.22%
TROL	Male	1	21	37	16	4	1
	Female	0	16	28	11	1	3
	Total & %	1 (0.709%)	37 (26.34%)	65 (46.09%)	27 (19.15%)	5 (3.55%)	4 (2.85%)

MEAN SPM SCORES OF TOTAL SAMPLE POPULATION BY AGE

Table 3a

	STUDY		CONTROL		
Age (Yrs)	**Score**	**Freq**	**Score**	**Freq**	**Critical Values (0.05)**
8	10.5 □ 5.07	8	11.18 □ 3.00	17	0.351364766
10	12.67 □ 4.77	18	12.81 □ 4.66	36	0.104930485
12	13.29 □ 6.76	21	13.08 □ 6.01	25	0.344916687
14	16.85 □ 5.89	13	18.53 □ 9.05	6	0.699238799
□15	21.86 □ 8.80	7	15.71 □ 6.86	6	1.414405274
All ages	13.78 □ 6.83	95	12.79 □ 5.30	138	1.187873998

MEAN SPM SCORE OF MALE GENDER BY AGE

Table 3b

	STUDY		CONTROL		
Age (Yrs)	**Score**	**Freq**	**Score**	**Freq**	**Critical Values (0.05)**
8	11.33 □ 5.72	6	11.36 □ 3.64	11	0.011751658
10	13.27 □ 5.37	11	12.87 □ 3.25	23	0.229492304
12	13.8 □ 7.43	15	14.10 □ 8.53	10	0.090658368
14	21.0 □ 5.20	3	18.0 □ 11.31	2	0.351123595
□15	24.2 □ 9.60	5	-	-	-
All ages	14.47 □ 7.94	57	12.47 □ 5.12	77	1.66293225

MEAN SPM SCORE OF FEMALE GENDER BY AGE

Table 3c

	STUDY		CONTROL		
Age (Yrs)	**Score**	**Freq**	**Score**	**Freq**	**Critical Values (0.05)**
8	8.0 □ 0	2	10.83 □ 1.47	6	4.71495
10	11.71 □ 31.82	7	12.69 □ 6.15	13	0.43772944
12	12.0 □ 4.10	6	12.40 □ 3.31	15	0.212855452
14	15.6 □ 5.72	10	18.8 □ 8.64	4	0.14581171
□5	16.0 □ 0	2	15.71 □ 6.86	6	0.103549841
All ages	12.47 □ 4.72	38	13.15 □ 5.88	61	0.63363069

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