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Original research article

Comparative analysis of baseline and cranial measurements in idiopathic mentally retarded and normal children in South Tamil Nadu

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Abstract

Background: Mental retardation, an incomplete development of mental capacities, and associated behavioral abnormalities caused by a variety of genetic as well as environmental reasons where non-syndromic or idiopathic cases account for 30–50%. Owing to the different applications, anthropometry has turned out to be an excellent tool in the medical field. In the present study baseline, facial and cephalometric measurements are used to assess mental retardation.

Methods: In the present study parameters such as body height, body weight, occipito-frontal diameter, anterio-posterior dimension, biparietal diameter, cranial height, facial height, bi-zygomatic distance, nasal length, nasal breadth, inner canthal distance, outer canthal distance, inter-pupillary distance are measured to identify the variation in mentally retarded children. Cranial capacity, Cephalic index, Cephalic length-height index, Transverse cranio-facial index, and facial and nasal indices were also calculated**.** All the data obtained are statistically analyzed using SPSS version 22.0.

Results: A significant change in the height was noted in males in the study groups I and III ($p<0.05$). Significant changes were noted in the Cephalic Index, Cephalic Length Height Index, Cranial Capacity, and Nasal Index in some of the study subjects when compared to the normal subjects. The cephalic index of the study subjects was found to be significantly lesser than that of normal children.

Conclusion: The present study has clearly explicated the association between mental ability and cephalometric indices, in idiopathic mentally retarded children.

Keywords: Cephalometric indices, cranial capacity, nasal index, anthropometry.

Introduction

Mental retardation is stated as the incomplete development of mental capacities and associated behavioral abnormalities. It is regarded as the "sub-average intellectual functioning which originates during the developmental period and is associated with impairment in adaptive behaviour". The Mentally Retarded children will have very low IQs due to developmental period insufficiency and also it is coherent with adjustment behavioral problems [1]. Mental healthcare professionals in the United States have classified Mental Disorders as Mild, Moderate, Severe and Profound based on the functioning level of a person [2]. It can be either associated with other syndromes such as Down Syndrome, Hydrocephalus, Cerebral Palsy, Lead Poisoning, Fanconi Anemia, Phenylketonuria, Muscular Dystrophy, Homocystinuria, Tuberous Sclerosis, Basal Cell Nervous Syndrome or it can also occur as an isolated finding such as problems during pregnancy, during child birth and illness or any injury. Among mentally retarded individuals, non-syndromic or idiopathic cases account for 30–50% of cases as described in the Gale Encyclopedia of Medicine. About 5% of idiopathic cases are inherited from a person's parents and other causes such as prenatal illness, childhood illness, and environmental factors, etc. [3]. Idiopathic mental retardation is often missed by clinicians as it's not associated with any other syndromes. Diagnosis mainly includes family history a close physical examination and careful developmental assessment of the child. Anthropometry study can be used widely and also it plays a vital role in the application of human measurement. Being the most portable, universally applicable, less expensive, and noninvasive technique for assessing the size, proportions, and composition of the human body

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anthropometry has more practical applications principally in areas of genetic research and work place ergonomics in the modern era [4]. Anthropometry is a tool to assess mental retardation through a series of measurements like facial – head parameters and their relation to other body measurements. Cephalometry is a specialized area of anthropometry, which deals with the quantitative study of the head. Higher incidence of malocclusion in mentally retarded children compared with control children [5], malocclusion in children affected with Down syndrome [6] increase in the head circumference due to an abnormal pattern of Brain development in autism [7] etc. could be effectively studied by Cephalometry. In the light of above the present study used parameters such as body height, body weight, occipitofrontal diameter, anterior-posterior dimension, biparietal diameter, cranial height, facial height, bi-zygomatic distance, nasal length, nasal breadth, inner canthal distance, outer canthal distance, inter-pupillary distance to identify the variation in mentally retarded children.

Methods

Study population

One hundred and seventy-three children with pure idiopathic mental retardation in between 4 and 9 years were selected from the various institutions for mentally retarded children *viz* Santhi Nilayam, at Nagercoil, Anugraha at Nithravilla and other small institutions in and around south Tamil Nadu.

Control group

The control group consists of 200 school-going children who did not exhibit any mental deficiency and were selected by the respective teachers on the basis of average intelligence in studies and behavior, indicating normal mental development.

Group I: 4 & 5 years
Group II: 6 & 7 years
Group III: 8 & 9 years

Anthropometry

Apart from general parameters like height and weight, Cephalometric parameters were also measured [8].

Height

The subject was asked to stand bare foot on the floor with heels, buttocks, back, and head touching the upright wall. The feet were placed parallel to each other, the head held straight, the shoulders held comfortably and arms hung to the maximum with palms touching the thighs. The height was measured using an anthropometer and was recorded to the nearest of a millimeter.

Weight

The subject was asked to stand barefoot in the center of the platform of a standardized weighing machine exerting equal pressure on both feet without any movement. The weight was recorded as one-tenth of a kilogram.

Cephalometry

All the measurements were taken with the subject sitting in a chair, in a relaxed condition & the head in the anatomical position.

Head Circumference (Occipito frontal Circumference OFC)

Using flexible centimeter taps the circumference was noted at the level of external occipital protuberance and glabella, the midpoint of the portion of the frontal bone above the nasal root between the supraorbital ridges.

Anteroposterior Dimension (APD)

The maximum length of the cranial diameter from the glabella to the external occipital protuberance was measured using a spreading caliper.

Biparietal Dimension (BPD)

Using a spreading caliper, the greatest horizontal and transverse diameter above the supra mastoid region on the head was measured.

Cranial Height

The distance between the vertex superiorly and the superior border of the auditory opening inferiorly was measured by spreading the caliper.

Facial Height

The distance between the glabella and the symphysis menti was measured using a sliding caliper.

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Bi-zygomatic Breadth
The distance between the midpoints of two zygomatic arches was measured using a spreading caliper.

Nasal Length
The distance from nasion to tip of the nose was measured by using sliding caliper.

Nasal Breadth
The distance between the alae of the nose is measured using a spreading caliper.

Inner canthal distance (ICD)
Distance between the medial angles of the eyes was measured with a sliding caliper.

Outer Canthal Distance (OCD)
Distance between the lateral angles of the eyes was measured using a sliding caliper.

Inter-Pupillary Distance (IPD)
Distance between the two pupils was calculated by Pryor's (9) formula:

I P D = OCD – ICD/2 + ICD

Calculation of the Indices

1. Cranial Capacity

Cranial capacity is an indirect approach to evaluate the size of the brain. Cranial capacity can be calculated as per the formula suggested by Hrdlicka and Montagu given below (10).
Male Cranial Capacity=0.000337 (L-11) (B-11) (H-11) + 406.01cc.
Female Cranial capacity = 0.000400 (L-11) (B-11) (H-11) + 206.60 cc.
L: Length of the cranium.
B: Breadth of the cranium.
H: Height of the cranium.

2. Cephalic index
Cephalic index = (Bi-parietal distance/ Cephalic height) x 100.

3. Cephalic length-height index
Cephalic length-height index = (Cranial height/Cranial length) x 100.

4. Transverse craniofacial index
Transverse cranio-facial index = (Bizygomatic distance/ Biparietal distance) x 100.

5. Facial index
Facial index = (Bizygomatic distance/Facial height) x 100.

6. Nasal index
Nasal index = (Nasal breadth/ Nasal length) x 100.

7. Head shapes
The cephalic index is categorized into different classes to find the head shapes. The categories of head shapes are shown in Table 4.

Statistical analysis
Statistical analysis was performed using SPSS version 22.0. Quantitative Variables were expressed as mean ± standard deviation. Qualitative variables were expressed as frequency and percentage. Differences between groups of quantitative variables were evaluated by unpaired t-test. Between groups, comparisons of qualitative variables were analyzed by Chi-square test. A p-value obtained > 0.05 was considered statistically significant.

Result
The anthropometric analyses were carried out by measuring height, weight, cephalic dimensions, canthal and pupillary measurements and craniometrical Indices and cephalic Indices were calculated. A significant change in the height (Table 1) was noted in males in the study groups I and III (p<0.005). Weech's formula was applied to find out the expected height at different age groups; Age in years X 6 + 77. According to this formula, the expected heights are 107cm, 119 cm, and 131 cm respectively for

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group I, group and group III respectively. In group I study groups showed a lesser value in both genders as the controls subjects exhibited a higher value than the expected height. In group II, only the females in the control group exhibited higher values than the expected height while the height of all the subjects in the control group of group III was greater than the expected value. No significant changes were observed in the weight (Table 1) of the study groups when compared to that of the control groups in all age groups. Expected weight of the subjects was calculated using Weech's formula (Age in years X2 + 8, for age group 1-6 years and Age in years X 7- 5/2, for age group 7-12 years) and was noted as 18 kg, 22 kg and 29 kg respectively for group I, II and III. A significantly low occipito frontal dimension (p<0.001) and high cranial height (p<0.001) values were noted in males in all study groups. Similarly, the female subjects in the study groups were observed with significantly low (p<0.001) values in occipito frontal dimension, anterio-posterior dimension, facial height, and nasal length. No significant differences were found between the canthal and pupillary measurements of the study and control subjects (Fig. 1). (Table 3). Based on the observed cephalic indices all mentally retarded subjects were categorized under ultradolichocephalic and hyperdolichocephalic.

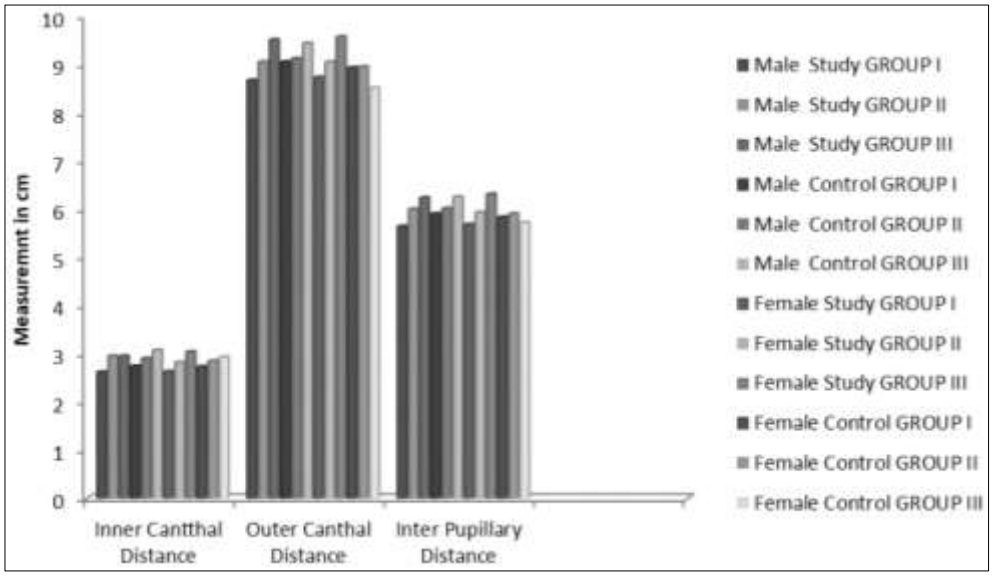

Fig 1: Comparitive analysis of inner canthal, outer canthal and interpupilary distance in mentally retarded and normal children

Table 1: Comparison of height and weight in mentally retarded and normal children

Age group (years)	Male		Female		Male		Female	
	Study group	Control group	Study group	Control group	Study group	Control group	Study group	Control group
4 & 5	103.43 ±11.35*	116.40 ±5.34	104.51 ±9.3	112.03 ±8.57	17.12 ±4.62	17.60 ±2.57	16.67 ±6.35	17.90 ±3.34
6 & 7	125.33 ±4.40	126.05 ±9.91	118.25 ±5.12	123.83 ±7.94	25.08 ±3.98	20.38 ±4.61	21.13 ±5.04	21.83 ±5.34
8 & 9	126.73 ±8.18**	144.19 ±16.72	128.28 ±5.54	131.07 ±13.04	31.41 ±10.27	38.40 ±17.01	25.00 ±2.53	29.00 ±10.98

Values are expressed as mean ± S.D, Oneway ANNOVA followed by unpaired t test * p<0.001, ** p<0.05

Table 2: Comparisons of cephalic dimensions between control and mentally retarded children

Cranial Measurements (cm)	Male Study Group			Male Control Group		
	Group I	Group II	Group III	Group I	Group II	Group III
Occipito frontal Dimension	9.59±0.79*	9.95±0.51*	10.07±0.77*	25.87±0.95	27.73±0.85	26.60 ±5.41
Cephalic length	15.78 ± 1.12	16.95±1.22	16.85 ±0.75	16.36±0.31	16.17±1.23	16.87 ±1.31
Bi-parietal Dimension	7.77±1.36	9.52±1.34	8.66±0.93	9.71 ±0.76	9.52±0.59	10.74 ±0.77
Cranial Height	13.37±1.05*	16.00±0.93*	14.89 ±1.14 *	11.85±0.58	12.90±0.53	13.18 ±0.79
Facial height	10.04 ±0.96	10.60 ±1.06	10.90 ±1.11	10.54±0.67	10.77±0.48	11.05 ±0.42
Bi-zygomatic Distance	11.28 ±0.79	11.40 ±0.49	11.99 ±0.92	11.58±0.63	11.92±0.59	12.02 ±0.80
Nasal length	4.32 ±0.61	4.03 ±0.38	4.31 ±0.66	4.23 ±0.29	4.35 ±0.64	4.69 ±0.32
Nasal Breadth	2.81 ±0.63	3.10 ±0.16	3.17 ±0.44	2.73 ±0.17	3.15 ±0.29	3.23 ±0.38
	Female Study Group			Female Control Group		
	Group I	Group II	Group III	Group I	Group II	Group III
Occipito frontal Dimension	9.63 ±0.47 *	9.95 ±0.42*	10.12±0.51*	25.95±1.07	25.80±1.36	28.16 ±0.81
Cephalic length	14.97 ±1.27 *	15.83 ±1.44	16.68 ±1.40	16.26±0.52	16.00±0.94	16.56 ±0.58

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Bi-parietal Dimension	8.39 ±0.35	9.29 ±0.46	13.37 ±0.68	9.35 ±0.4	11.02±1.09	13.19 ±0.55
Cranial Height	13.63±0.25*	15.20±0.44*	13.35±0.92*	11.35±0.84	13.80±0.73	11.35 ±0.60
Facial height	9.57 ±0.21 *	9.90 ±0.58	10.68 ±0.88	10.2 ±0.31	9.95 ±0.70	10.69 ±0.39
Bi-zygomatic Distance	11.13 ±1.3	11.42 ±0.78	11.51 ±0.41	11.71±0.57	11.65±1.20	11.54 ±0.30
Nasal length	3.77 ±0.4*	3.87 ±0.27	4.13 ±0.55*	4.36 ±0.32	4.33 ±0.50	4.62 ±0.26
Nasal Breadth	2.9 ±0.46	2.97 ±0.26 *	3.09 ±0.36	2.78 ±0.13	2.63 ±0.19	3.00 ±0.24

Values are expressed as mean ± S.D, Oneway ANNOVA followed by unpaired t test * p<0.001, ** p<0.05

Table 3: Comparitive analyses of cephalometric indices innormal and mentally retarded children

Cephalometric Indices	**Male Study Groups**			**Male Control Groups**		
	Group I	**Group II**	**Group III**	**Group I**	**Group II**	**Group III**
Cephalic Index	58.16 ±8.04[a]	59.61 ±5.34[a]	59.53±3.88[a]	81.56 ±5.35	77.76 ±4.73	73.84±7.32
Cephalic Length Height Index	84.73 ±4.49[a]	88.49 ±5.18[d]	94.39±6.18[a]	70.28 ±3.75	73.51 ±7.24	79.77±4.21
Cranial Capacity	406.01 ±0[b]	406.01 ±0.01[d]	406.02 ±0.01[d]	406.02 ±0.01	406.03 ±0 4.31	406.03 ±0.01
Transverse Cranio-facial Index	145.17 ±8.26[c]	127.51 ±6.19[d]	119.74±5.79	119.25 ±4	128.86 ±1.8	125.21±4.48
FaciaI Index	112.92 ±9.32[d]	108.39 ±11.95	110.59 ±9.04	110.23 ±8.7	110.84 ±7.04	108.72 ±5.95
NasalIndex	66.14 ±15. 79	77.25 ±3.36	74.4 ±12.06	64.8 ±5.87	73.41 ±9.44	68.87 ±7.24
Body Mass Index	15.81 ±2.48[d]	12.77 ±2.04[d]	17.68 ±4.73	12.96±1.4	15.95 ±2.1	19.69 ±6.86
	Female Study Groups			**Female Control Groups**		
	Group I	**Group II**	**Group III**	**Group I**	**Group II**	**Group III**
Cephalic Index	61.61 ±4.14[d]	63.17 ±3.61[d]	61.16±3.44[a]	82.38 ±11.82	77.17 ±9.88	79.86±6.08
Cephalic Length Height Index	91.04 ±5.71[a]	89.70 ±6.68[d]	96.09 ±6.52[a]	70.38 ±4.86	80 ±5.57	86.25 ±5.01
Cranial Capacity	206.5 ±0[b]	206.61 ±0.01	206.6 ±0.01[d]	206.6 ±0.01	206.6 ±0.01	206.61 ±0 2.97
Transverse Cranio-facial Index	132.67 ±7.89	127.31 ±5.15	122.92 ±4.76	125.24 ±3.14	125.53 ±2.07	105.71±3.02
Facial Index	116.36±13.26	115.92±13.62	108.47 ±9.97	114.88 ±6.27	116.89 ±4.37	108.04 ±3.61
NasalIndex	76. 75±5.48[e]	76.87 ±6.53[b]	76.18 ±14.77	64.23 ±6.77	60.91 ±3.41	65.02 ±.73
Body Mass Index	14.91 ±3.29	14.08 ±2.42	16.69 ±5.03	14.18 ±1.45	14.95±2.37	15.22 ±1.58

Values are expressed as mean ± S.D, Oneway ANNOVA followed by unpaired t test a- p<0.001, b- p<0.05, c -p 0.038, d- p< 0.05

Table 4: Classifications of headshapes according to cephalomatric indices

Shapes of head	**Cephalic index**	**Percentage of occurrence**	
		Study group	**Control group**
Ultradolichocephalic	<64.9	78	7.7
Hyperdolichocephalic	65.0 – 69.9	22	5.8
Dolichocephalic	70.0 – 74.9	0	23.1
Mesocephalic	75.0- 79.9	0	26.9
Brachycephalic	80.0-84.0	0	15.4
Hyperbrachycephalic	85.0 - 89.0	0	15.4
Ultrabrachycephalic	>90.0	0	5.8

Discussion

Though a slight reduction in the height of the subjects was noted in other groups, none was statistically significant other than the males in the study group I. The present study partially agrees with the findings of Sukinder [14], where growth in mentally challenged individuals is found retarded when compared to normal individuals. Although the study subjects were observed to possess less weight and their respective control groups exhibited a higher value than the expected weight, the differences were not statistically significant. In contrast to the present findings, Sanjay and Nadgir reported a significant reduction in height (p<0.001) and weight (p< 0.001) of mentally retarded subjects when compared to normal individuals [11, 12]. Obesity in mentally retarded adults was previously reported by Hoey [13]. The interlinkage of physical and mental retardation was clearly observed from the lower values in height and weight in the study conducted by Hoadley in 1929 {14}. The growth pattern not only depends on malnutrition but also on the heredity of an individual. Mentally retarded children in the present study groups are dependent and were assisted by parents or caretakers. If proper caring and assistance can be given the level of malnutrition in any functionally dependent person can be reduced. The above quoted findings of the study advocate that the study subjects were well cared for and were not malnourished. Morphological changes in mentally challenged individuals have great importance and their quantitative evaluation is being extensively done worldwide [15-18]. Significant changes were noted in the cranial and facial measurements of the study subjects in all age groups. The finding of the present study also coincides with the findings of Krogmanand Romi [19, 4]. Where decreased values of cranial dimensions were observed in the mentally retarded male and female subjects. Similar finding was also discussed by many other researchers [19, 20, 21]. The cranial capacities of study subjects (all male and 161 females) were significantly low when compared to the normal. Study groups were found to possess low transverse cranio-facial index when compared to normal children. An interesting finding of the present study is that most of the normal control subjects are brachycephalic *i.e.*, cephalic index of more than 80, followed by

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mesocephalic and dolichocephalic, most of the mentally retarded subjects were ultra-dolichocephalic followed by hyper dolichocephalic which is inconsistent with the findings of Shukla *D et al.* [22] where the mean cephalic index of the mentally retarded group was 82% (brachycephalic head shape). In the present study head size of the mentally retarded is smaller compared to the normal children. The size of the brain indirectly corresponds to cranial capacity, and hence decreases in the cranial capacity of mentally retarded children support the view that brain size is smaller in them [20, 21]. The findings of the presents study concur with the findings of Sunitha (2016) while researchers like Nagarkar, *et al.* [23] and Shailaja *et al.,* [24] suggest that dominant head shapes of mentally retarded are brachycephalic and normal children are mesocephalic. Hyper brachycephalic subjects with mental retardation were also reported [25] found. Microcephaly has been associated with mental retardation [9]. Growth reduction of the brain can also be evident by the decreased values of cranial index; length-height index and facial index putting forward a slower growth of the cranium. The present study suggests that the smaller head size of the idiopathic mentally retarded children reflects their brain size and hence cephalometric indices can be used as an important tool to detect and measure mental retardation in children Anthropometry, being an important tool to find out the level of intellectual functioning in children can pave way for finding out and rehabilitation of underperforming children to improve motor function and to prevent body deformities especially which occur during puberty.

Limitations of the study include the difficulty in availing case history as the family members abandoned many of the subjects and some were reluctant to reveal the details. Inadequate cooperation of mentally retarded children made the study time consuming.

Conclusion

The present study has clearly explicated the association between mental ability and cephalometric indices, in mentally retarded children with pure idiopathic reasons. The study confirmed that the anthropometric parameters used in the present study are well suited to indirectly analyze mental ability and can be applied to sort out the under performers thereby they can be given more attention and thus the mentally retarded can achieve milestones like normal children.

References

1. Kaur P, Chavan BS, Lata S, Kaur A, Tinku S, Arora Y, *et al*. Early intervention in developmental delay. Indian Journal of Pediatrics. 2006;73(5):405–408. https://doi.org/10.1007/bf02758561
2. Battaglia A, Carey JC. Diagnostic evaluation of developmental delay/mental retardation: An overview. American Journal of Medical Genetics. Part C, Seminars in Medical Genetics. 2003;117C(1):3–14. https://doi.org/10.1002/ajmg.c.10015
3. Galasso C, Lo-Castro A, El-Malhany N, Curatolo P. Idiopathic mental retardation and new chromosomal abnormalities. Italian Journal of Pediatrics, 2010, 36(1). https://doi.org/10.1186/1824-7288-36-17
4. Romi S, Das L. Anthropometric Analysis in Mentally Retarded Children of South Kerala, IOSR J Dent. Med. Sciences. 2017;16:59-63.
5. Tanne K, Tanaka E, Sakuda M. Association between malocclusion and temporomandibular disorders in orthodontic patients before treatment. Journal of Orofacial Pain. 1993;7(2):156–162. https://pubmed.ncbi.nlm.nih.gov/8358361/
6. Desai SS. Down syndrome. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics. 1997;84(3):279–285. https://doi.org/10.1016/s1079-2104(97)90343-7
7. Elder LM, Dawson G, Toth K, Fein D, Munson J. Head circumference as an early predictor of autism symptoms in younger siblings of children with autism spectrum disorder. Journal of Autism and Developmental Disorders. 2008;38(6):1104–1111. https://doi.org/10.1007/s10803-007-0495-9
8. Singh A. Burden of disability in a Chandigarh village. Indian Journal of Community Medicine: Official Publication of Indian Association of Preventive & Social Medicine. 2008;33(2):113. https://doi.org/10.4103/0970-0218.40880
9. Pryor HB, Thelander H. Abnormally small head size and intellect in children. The Journal of Pediatrics. 1968;73(4):593–598. https://doi.org/10.1016/s0022-3476(68)80275-6
10. Stojanowski CM, Euber JK. Technical note: Comparability of Hrdlička's Catalog of crania data based on measurement landmark definitions. American Journal of Physical Anthropology. 2011;146(1):143–149. https://doi.org/10.1002/ajpa.21578
11. Butler MG, Pratesi R, Watson MS, Breg WR, Singh DN. Anthropometric and craniofacial patterns in mentally retarded males with emphasis on the fragile X syndrome. Clinical Genetics. 2008;44(3):129-138. https://doi.org/10.1111/j.1399-0004.1993.tb03863.x
12. Sanjay P. Cranial anthropometry in 600 North Indian adults, Int J Anat. Res. 2013;1(2):115-18. ISSN 2321- 42872012 6:18-21.
13. Hoey E, Staines A, Walsh D, Corby D, Bowers K, Belton S, *et al*. An examination of the nutritional intake and anthropometric status of individuals with intellectual disabilities: Results from the SOPHIE study. Journal of Intellectual Disabilities: JOID. 2017;21(4):346–365.

ISSN:0975 -3583,0976-2833 VOL12, ISSUE 05, 2021

https://doi.org/10.1177/1744629516657946
14. Hoadley MF. Note on the Association of Relative Laterality of Hand and Eye from the Cambridge Anthropometric Data Biometrika. 1929;21:5-12.
15. Winick M, Rosso P. Head circumference and cellular growth of the brain in normal and marasmic children. The Journal of Pediatrics. 1969;74(5):774–778. https://doi.org/10.1016/s0022-3476(69)80140-x
16. Roche AF, Seward FS, Sunderland S. Growth changes in the mongoloid head. Acta Paediatrica (Oslo, Norway: 1992). 1961;50(2):133–140. https://doi.org/10.1111/j.1651-2227.1961.tb08032.x
17. Woodhouse W, *et al*. Head circumference in autism and other pervasive developmental disorders J Child Psychol Psychiatry. 1996;37:665-71.[PMID: 8894947]
18. Eissler R, Longenecker LP. The common eye findings in mongolism. American Journal of Ophthalmology. 1962;54(3):398–406. https://doi.org/10.1016/0002-9394(62)93757-1
19. Krogman WM. Studies in growth changes in the skull and face of Anthropoids. V. Growth changes in the skull and face of the Orang-utan The AmJof Anatomy. 1930;46:315-53.
20. Shukla AP. A study of cranial capacity and cranial index of Indian skull. J. Anat. Soc. India , 1966, voume15,pages: 31-35
21. Arole V, *et al*. Cephalometric analysis in speech and hearing impaired children. J Anat. Soc. India. 1981;30:3.
22. Shukla D, *et al*. Locations for South Asian Diaspora, Annual Review of Anthropology. 2001;42:5.
23. Nagarkar A, Sharma J, Tandon SK, Goutam P. The clinical profile of mentally retarded children in India and prevalence of depression in mothers of the mentally retarded. Indian Journal of Psychiatry. 2014;56(2):165. https://doi.org/10.4103/0019-5545.130500
24. Shailaja CM, *et al*. Study of cephalic index and associated etiological factors in mentally challenged children Antomica Karnataka. 2011;5:66-71.
25. Lemay JF, Herbert AR, Dewey DM, Innes AM. A rational approach to the child with mental retardation for the Paediatrician. Paediatrics & Child Health. 2003;8(6):345–356. https://doi.org/10.1093/pch/8.6.345
26. Tager-Flusberg H, Joseph RM. Identifying neurocognitive phenotypes in autism. Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences. 2003;358(1430):303-314. https://doi.org/10.1098/rstb.2002.1198