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SOCIO-ECONOMIC STATUS, HEAD CIRCUMFERENCE AND INTELLECTUAL ABILITY AMONG RURAL ADOLESCENTS OF UNAKOTI DISTRICT OF TRIPURA, NORTH-EAST INDIA

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Abstract

Intellectual ability (IA) of adolescent is affected by head circumference (HC) achieved during childhood and socio-economic status (SES) of the parents. The present correspondence is an attempt to assess HC and SES of adolescents of Unakoti District of Tripura state to correlate them with their IA. A cross section of 508 respondents (257 boys and 251 girls) of 10-15 years was selected through purposive random sampling procedure. The SES was investigated by following Kuppaswamy's SES scale upgrading for 2007 with some modifications. The HCs of the subjects were measured in centimeter and IA was assessed by using the Standard Progressive Matrices (SPM) developed by Raven in 1938. Results revealed that there are significant differences among boys and girls of low and middle SES on the measure of their HC and IA. Moreover, the IQ score of both boys and girls was significantly correlated with their age, SES

and HC(r=0.42, p<0.01, r=0.2, p< 0.05 and r=0.23, p<0.05 respectively). So it may be hypothesized that children of the high SES and optimum HC exposed to more favorable conditions that favour the expression of their genetic potential resulting higher IA.

Key Words: *Socio-economic Status (SES), Rural Adolescents, Head Circumference (HC), Intellectual Ability (IA)*

Introduction

Adolescent, a period of transition from childhood to adulthood occupies a crucial position in life of a human being because in this period rapid growth and maturation in human development occur (WHO, 2000 & Dey, et al., 2011). This age group forms about one-fifth of world's population and in India they forms 21.4% of the total population (**Choudhury, et al., 2003**). It is a period of rapid growth and maturation in human development (Samuelson, 2000, Choudhury, et al., 2003 & Ansari, 2012).

It is well established in previous research findings that parental socioeconomic status (SES) modifies the heritability of intellectual ability of offspring (Joblonska et al., 2012). Moreover, SES by interacting on nutritional status controls the brain development in early life of an adolescent that in turn has an impact on later acquire of intellectual ability (Uddin and Nag, 2012). Capron and Duyme (1989) presented a full cross-fostering study in Nature dealing with SES and IQ and showed that children born to high SES parents score higher in intelligent test than children born to low SES parents. Low SES of the parents prevented them for applying to higher education and to better-paying jobs to improve their quality of life. The low purchasing power of the parents also prevents them to provide adequate diet to their children. As a result, under nutrition has remained the most important nutritional problem in developing countries, and at an early age affects the growth and development of children. This has been associated with retarded brain growth and functional development (Uddin and Nag, 2012 and Uddin et al., 2015). As a result, the HC of adolescents of low SES is less than their counterparts of middle or high SES and most of them are intellectually impaired.

The relationship between brain size and intelligence of adolescents has been documented (Ivanovic et al., 2002, Strupp and Levitsky, 1995, Florey et al., 1995), and that a significant correlation exists between head circumference (HC) and intelligence quotient (IQ). This suggests that difference in human brain size could be relevant in explaining the differences in intelligence and academic performance, although genetic and environmental factors like socio-economic, socio-cultural and psychological factors could be direct or indirect co-determinants of both intelligence and school performance (Vernon, et al., 2000, Wicket et al., 2000). The HC is a physical index of both past nutrition and brain development and a good predictor of later intelligence of a child (Rumsey and Repoport, 1983, Botting et al., 1998), and it is used as the most sensitive anthropometric index of prolonged under nutrition during the infancy, associated with intellectual impairment in later life (Ivanovic et al., 1989, 1996, 2000, 2004, and Toro et al., 1998).

Brief structural (Brain) description: A growing of evidence suggests that intelligence actually be closely linked to Physiological processes- especially ones going on in the nervous system and in the brain in particular (Matarazzo,1992).

Prefrontal cortex (area **9, 10, 11, 12** and **32**), the second sub-division of frontal lobe of cerebral cortex including orbital gyri , medial frontal gyrus and area 32 which is also known as **orbitofrontal** cortex – the anterior part of the cerebrum – functions as the seat of the intelligence. Parietal, occipital and temporal lobes through the association fibers act as **planning organ**. Prefrontal lobes help in complex **intellectual activities,** e.g.**,** working out mathematical problems, giving judgment etc (Sandra J.E. Langeslag, et al., 2013). Mental capability is a function of whole of the cerebral cortex and not a particular region (Kringel Bach, 2005).

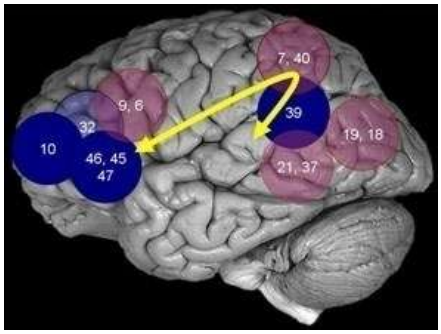

Figure 1: Pre-frontal lobe of human brain and the seat of intelligence

Figure 1 depicts the brain areas associated with intelligence and reasoning. "The frontal lobes are important to intelligence according to almost every imaging study", said Haier in 2005.

From survey of literature, it has been found that SES and HC as brain size of adolescents is closely related to their intellectual ability (Ansary, 2012, Ivanovic, et al., 2004,Vernon, et al., 2000 and Wicket et al., 2000**)**. However, there is scanty of information on this sphere from rural adolescents of Tripura.

The state of Tripura, a sub- Himalayan region, is situated in the eastern part of India and is surrounded by Bangladesh on the West, South and North. Its north-eastern boundary is demarcated by Assam and Mizoram respectively. The state had four Administrative districts. Agartala is the capital city of the state.

The state is characterized by a warm and humid tropical climate with three distinct seasons such as summer, monsoon and winter. Winter is preceded and followed by brief spells of autumn and springs respectively. The maximum and minimum humidity during the last few years were in the range of 89% to 63%. Although seventy percent of the land area is hilly, yet three distinct Physiographic zones are dissemble (i) N-S oriented hill range, (ii) undulating platue lands and (iii) low lying alluvial plains.The average rainfall is about 2400 mm. The state is drained by as many as 10 rivers which originate in the hill ranges and flow either in a northerly westerly direction through the narrow valleys. All the rivers draining the state are prone to flood during the rainy season (Nandy, 2001).

The population of the state as per 2011 census data is about 36.8 out of which about 18.7 lacs are male and17.9 lac are female. The population of the state Tripura is overwhelmingly rural being of the total population.

In January 2012, major changes were implemented in the administrative divisions of Tripura. Prior to these changes, Tripura had four districts-North Tripura (headquarters Kailashahar), Dhalai (headquarters Ambassa), West Tripura (headquarter Agartal) and South Tripura (headquarters Udaipur). Four new districts were carved out of the existing four in January 2012- Khowai, Unakoti, Sipahijala and Gomati (Bhargav et al., 2006, Das, 2008 and Uddin and Nag, 2012). Bengalese represented almost 70% of Tripura's population and the tribal population comprised 30% of Tripura's population.

In this backdrop, the present paper attempts to shed lights on the following specific aims and objectives:

1. Evaluation of socio-economic status (SES) of the parents of 10-15 years' adolescents (boys and girls) of Unokoti Tripura
2. Measurement of their head circumferences (HC) by standard techniques
3. Determination of the intellectual ability of the selected population by Raven's Standard Progressive Matrices (SPM) test
4. Finally, to establish the relationship among SES, HC and intellectual ability

Methodology

Sample of the Study

The district Unokati has an area of 591.93km^{2}and with a population of 277,335. It has three blocks namely, Kumarghat, Pechartal and Kailashahar. The growth rate, density, sex ratio and literacy rate of this district are 10.85, 469/KM, 966 and 87.58 respectively. A cross section of 508 respondents of 10-15 years was selected through purposive random sampling procedure from five Government High School of this District out 40 in the community. The total population was divided into two gender groups containing 257 boys and 251 girls. Prior to the study all necessary permission was obtained from relevant authorities. The research was conducted in agreement with the Declaration of Helsinki in 2009. The subjects were explained about the research. Then the confidentiality of information was assured and their consent in writing was taken from each participant. As they were the minor (<18 years) group the consent was also taken from their guardians. The dates of birth were collected from their admission register. Then a self administered questionnaire on children's socio-demographic features was given to each of the participants to take home for their parents to fill up. These were collected in the following day. A trained lady investigator had been engaged to collect the data from the girl students.

Tools Used

1. Kuppaswamy's SES scale upgrading for 2007 and modified according to the need of the present study (Kumar et al., 2007, Uddin and Nag, 2012).

2. Intelligence test, Standard Progressive Matrices (SPM) developed by Raven in 1938. It has been revised with time, and has three versions (coloured, standard and advanced). It specifically measures the ability to form perceptual relations and to reason by analogy. Since it is not

influenced by language, it does not require translation. It is primarily an extensive pattern completion test; norms have been developed for a number of populations, including USA, Mainland China, India and Australia etc. (Nunnallly and Bernstien, 1994, Raven, 2000, Sadock and Sadock, 2000 and Anastasi, 1998). It displays strong internal consistency (0.8-0.95) and the test-retest reliability (0.6-0.9) (Buros, 1985). Besides good correlation with other standard I.Q. tests, e.g. the Stand ford Binet, the WISC-R and the WAIS-R, ranging from 0.54-0.86 (Nunnallly and Bernstien, 1994, Sadock and Sadock, 2000). Individual scores are plotted into one of the following categories: GRADE I: Score lies at or above 95th percentile (Intellectually superior). GRADE II: Score lies at or above 75th percentile (Definitely above average in intellectual ability). GRADE III: Score lies between 25th and 75th percentiles (Intellectually average). GRADE IV: Score lies at or below 25th percentile (definitely below in intellectual capacity). GRADE V: Score lies at or below 5th percentile (Intellectually impaired) (Nunnallly and Bernstien, 1994 and Sadock and Sadock, 2000).

3. The HC of the subjects was measured in centimeter nearest to 0.1 centimeter around the head with a tape passing over the supracilliary ridges in front of the occipital protuberance (Ivanovic et al., 2004).

Statistical Techniques Used

Data processing and statistical analysis were done using the Statistical Package for Social Sciences (SPSS, version 11, 2010) to calculate the mean, standard deviation, ANOVA, t-test, chi square test, Pearson's Correlation Co-efficient (R) and level of significance.

Analysis and Interpretation

All the continuous parameters were reported as mean and standard deviation (SD) and presented according to the gender and socio-economic status with statistical testing results.

Table 1: Socio-economic Status (SES), Head Circumference (HC) and I.Q. Score on SPM in Bengali Adolescents of Unakoti District of Tripura collected during March, 2010 to February, 2013 by Age

Age (years)	Boys (n=257)			Girls (n=251)		
	SES	HC(cm)	I.Q. Score	SES	HC	I.A. Score
10 (n=40, 35)	8.5±1.78	50.6±1.28	19.51±6.92	7.72±1.58	50.13±1.6	20.29±6.95
11(n=38, 42)	7.3±1.98	50.73±1.76	25.2±12.29	7.79±1.72	49.43±1.7	22.66±9.95

12(n=31, 32)	7.5±1.32	49.97±0.99	21.9±10.94	7.22±1.23	51.02±1.4	22.5±7.25
13(n=28, 42)	7.9±1.52	51.46±1.41	27.5±11.36	7.26±1.32	51.64±1.2	27.7±8.83
14(n=42, 38)	8.4±2.76	51.86±1.1	35.21±14.58	7.25±1.42	51.58±1.2	25.2±9.57
15(n=48, 36)	8.2±2.77	52.23±1.1	31.21±14.58	7.79±1.16	51.63±1.45	26.4±9.3

From Table1, it is to be noted that HC of boys is increasing with advancement of age except in the age 12 years and 15 years and in case of girls also the HC is increasing with the advancement of age except in the age of 11 years and 15 years. In case of I. Q. score, it has also linearly increased with increase in age except in the age 12 and 15 years for boys. No linearity in the increase of I.Q. score of girls with increasing of their age was observed in the present study.Whereas, it was interesting to note that the highest HC and IA score were attained by girls at the age of 13 years but boys attained this at the age of 14.

Table 2: head circumference (hc) and i.q. score on spm in bengali adolescents of unakoti district of tripura collected during march, 2010 to february, 2013 by ses

Parameters		Low SES (n=367)	Middle SES (n=141)	Overall (508)	Low Vs Middle (p<=)
HC	Boys	51.16±1.64	52.09±1.55	51.5±1.66	0.0001
	Girls	50.93±2.95	52.29±2.72	51.23±2.95	0.001
	p<=	0.04	0.167	0.02	
IQ	Boys	26.88±12.45	36.43±10.51	30.43±12.62	0.0001
	Girls	24.97±9.22	32.2±10.09	26.49±9.76	0.0001
	p<=	0.5	0.0001	0.001	

From table-2, it was clear that the HC and IQ score achieved by boys (51.16±1.64 cm and 26.88±12.45) and girls (50.93±2.95 cm and 24.97±9.22) of low SES were less than their peers of middle SES (52.09±1.55 cm and 36.43±10.51 for boys and 52.29±2.72 cm and 32.2±10.09 for girls respectively). The difference was found to be statistically significant (p<0.0001). It was also interesting to mention that the I.Q. scores achieved by boys and girls of middle SES (30.43±12.62 for boys and 26.49±9.76 for girls) was significantly more than the score means of boys and girls of low SES (p<.0001).

Table 3: A Comparative of mean scores achieved by boys and girls of low SES and Middle SES in Bengali adolescents of Unakoti District of Tripura collected during March, 2010 to February, 2013 on the five sections of the SPM

SES	Mean ± SD Score on SPM

		Set A	Set B	Set C	Set D	Set E
Low	Boys	9.53 ± 2.26[ac]	5.88 ± 2.84[a]	4.97 ± 2.99[a]	3.21 ± 2.99[a]	1.05 ± 1.43[a]
	Girls	8.82 ± 2.27[a]	5.36 ± 2.84[a]	4.3 ± 2.63[a]	3.31 ± 2.62[a]	1.15 ± 1.43[a]
Middle	Boys	10.72 ±1.75[bc]	8.96 ±2.47[bc]	7.24 ± 2.52[b]	6.46 ± 3.42[b]	3.57 ± 3.05[b]
	Girls	10.03 ±1.34[b]	7.36 ± 2.83[b]	6.57 ± 2.84[b]	5.59 ± 2.86[b]	2.17 ± 1.18[b]

Means with different superscript letters are significantly different from each other

From Table 3 it was observed that the scored means decreased progressively across the sets. It was also to be noted that significantly higher scored means were achieved by male students of low and middle SES than girls. Moreover, a significantly higher score means were achieved by boys and girls of middle SES than their peers of low SES.

Table 4: Classification of intelligent quotient (I.Q.) of Bengali adolescents of Unakoti District of Tripura collected during March, 2010 to February, 2013

I.Q Class	Score (%)	Low SES (n=389)		Middle SES (n=119)		Overall subjects (N=508)	
		Size	%	Size	%	Size	%
Superior	70-100	2	0.51	11	9.48	13	2.56
Above Average	60-69	19	4.85	31	26.72	50	9.84
Average	50-59	79	20.31	29	25.00	108	21.26
Below Average	40-49	101	25.96	40	34.48	142	27.95
Intellectual Deficit	0-39	188	48.33	5	4.31	195	38.39

χ^2=120.44, df=4, p<0.0001

The above table showed the distribution of the children by I.Q. grades. From the analysis of the data it was found that 2.56% had superior IQ while about 31% were either average or above average. More than 65% of the children were either below average or had an intellectual deficit (Table 4). The children from low SES parents however formed majority of these. A significant difference ($p<0.0001$) was observed between the grades on IQ of children of low SES and their counterparts of middle SES.

Table 5:Correlation Co-efficient of Age, SES and HC with IA Score Achieved by Boys and Girls.

	Boys (N=257)			Girls (N=251)			Both Sex Combined		
Intellectual	Age	SES	HC	Age	SES	HC	Age	SES	HC

Ability	0.42**	0.2*	0.23**	0.2*	0.31**	0.27	0.42**	0.2*	0.23*

*Significant at 5% level, ** Significant at 1% level

From table 5 it was found that the IQ score of boys is significantly correlated with their age, SES and HC. On the other hand, in case of girls, the IQ score was significantly correlated with their age and SES but not with HC. In case of overall subjects, age, SES and HC were found to be significantly correlated with IA.

DISCUSSION

It is well known that adolescence is a period of rapid growth and maturation in human development, and that adequate nutrients are needed to support their growth spurt. Healthy eating patterns in childhood and adolescence promote optimal childhood health, growth, and intellectual development, as well as prevent health problems later in adulthood and old age (Bain et al., 2003, Deary et al., 2004). The transition may extend over variable periods of time, depending upon socioeconomic factors. Even in given culture, adolescents reveal wide variations and hence may not be a homogenous group.

SES refers to the position that an individual and a family occupy with reference to the prevailing average standard, cultural possession and participation in group activity of community. It includes both the social and economical status of an individual in the group. SES plays an important role in the life of a person. This status patterns the ways of his progress, intelligence, attitude, aptitude and even his interest. The SES pays rewards and punishment both to a person (Chaudhuri et al., 1998).

The stark inequalities in health of adolescents of India are due to under nutrition at an early age and socioeconomic factors (Education, Occupation and Income) of their parents. In the long run this may affect their proper intellectual development. The low purchasing power of the parents prevents them to provide adequate diet to their children.This has been associated with retarded brain growth and functional development. Low SES of the parents also prevented them to provide materials (e.g., books, music lessons, computers) and familial support (e.g., help from parents on homework, engagement in school-related activities) to promote intellectual development (Bradley and Corwyn, 2002). Besides other detrimental possible environmental and genetic factors of maturation in early age damages brain and induce biochemical changes which affect the intellectual ability of adolescents.

From our study with the adolescents of 10 to 15 years of Unakoti District of Tripura, we have found that children belong to middle SES class achieved significantly better in SPM than low SES class (Table 3). SES was also found to be significantly correlated with IA of boys and girls ($r=0.2$, $p<0.05$ and $r=0.31$, $p<0.01$ respectively). This also offer support by the research findings of many previous authors in India and abroad (Uddin and Nag, 2013, India Study Channel.com, 2011, Kishiyama, et al., 2009, Capron and Duyme, 1989, Duncan et al., 1994, Bradley and Corwyn, 2002 and Johnston, et al., 1987). Kumar (2013) found in his studies with 13-15 years' adolescents of semi urban areas of Simdega District, Jharkhand that children who had below average I.Q. were mainly belonging to low SES which is also a supportive evidence of our findings.

Moreover, Most of the population of Tripura was landless and they did not have any adequate fertile land for adequate income from cultivation etc. That is why most of the parents of the respondents involved in labour class, and due to their occupation their income was very low. The data also showed that most of the parents (29.14%) of the rural adolescents of Unokoti Tripura District have primary education which may be due to the poor economic condition and large family size (Uddin and Nag, 2012). This in turn may affect the brain development of adolescents. According to the measure of SES by Liu et al., (2004), it was found that education level and household income was substantially lower among minority communities. Most of the subjects of our study were belonging to Muslim minority community. Muslim constitute sizeable portion of Indian population but are socially, economically and educationally backward (Sachar Committee Report-2005). Bengalese of rural Tripura was also involved in various types of professions like cultivation, business, service, caste occupation etc. Lantz et al. (1998) and Dhargupta et al., (2009) suggested that income is perhaps the strongest and most robust predictor of health because to some extent the impact of the other socioeconomic status (SES) variables are mediated through it.

Head circumference is an anthropometric indicator of past nutrition and brain development. No doubt, there will be exciting attempts over the next several years to determine what it is about the large brain size that is beneficial to cognitive processing (Bartholomeusz et al., 2002, Ivanovic et al., 1996, Toro et al., 1998 and Vernon et al., 2000). Some authors have pointed out that large brains have more neurons and therefore, a greater number of synaptic connections, which may

mean a higher I.Q. (Pakkenberg and Gundersen, 1997). The long term malnutrition in childhood due to low SES of the parents is mainly responsible for ill development of prefrontal lobe of cerebral cortex in later life (Uddin et al., 2015). As a result, the HCs and corresponding brain sizes of those adolescents become low. This results in intellectual impairments (Ivanovic et al., 2002). With some exception in most cases it was found in the present study that children with low HC scored significantly less in SPM (Table 2). Moreover, HC was found to be significantly correlated with the IA score for both boys and girls ($r=0.36$ and 0.23, $p<0.05$ and 0.001 respectively).

It was observed that a large proportion of the children belonged to intellectual deficit and there was significantly higher number of children from low SES background and with substandard HC (Table 2 and 4). This could be attributed to environmental factors, such as adequate nourishment, availability of learning facilities, which are available for the children from middle SES.

There are, however, many factors other than malnutrition which were not evaluated in the present study may cause a suboptimal head circumference, brain development and intelligence (Dobbing, 1984). Older theories of malnutrition considered intellectual deficiencies to result only from damage to the brain. Current theories point out that malnutrition affects intellectual development by interfering with overall health, energy level, rate of motor development and growth (Brown and Pollitt, 1996). In low SES, all these negative factors appear exacerbated, because children have been living in adverse environmental conditions throughout their life, resulting in delayed intellectual development and scholastic achievement (Ivanovic et al., 1996).

We do not have clear explanation for these findings, although we can hypothesize those children of the high SES and HC exposed to more favorable environmental conditions that favour the expression of their genetic potential to achieve the higher IA. Selection bias may be the potential weakness, since the present study is based on adolescents involved in school. Therefore, the results should be generalized with caution. The nature of development of brain was measured only by anthropometric method. Other methods viz; nutrient intake, clinical study have been planned to include in the future study.

Suggestion and Conclusion

The children of high SES and optimum HC expose to more favorable conditions that favour the expression of their genetic potential to achieve high IA. Whereas, low SES of parents and under

nutrition during childhood period lead to irreversible impairment of mental development, brain size and mental function in later life. Effective measures may be planned to improve their present SES for the upliftment of nutritional status of school children, which in turn have positive impact on their intellectual ability. The findings of the study should be considered as a statistical associations and do not represent a cause-and-effect relationship.

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