

Determination of weight of human brain for population of Ethiopia- an Autopsy Study

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Abstract: *Background:* Medical documentations and teaching dictums as to age related changes in weight of the Brain, and weight of the Brain in respect to gender and Race are the issues need to be addressed again & again. Though the available literature do mention normal weight of the Brain to that given population under study but populations of third world like Ethiopia lack sufficient data as to the normal weight of the brain. *Objective:* This study was done at St Paul Hospital & Millennium Medical College Addis Ababa, to determine the normal weight of the Brain in Ethiopian population in the capital city of Ethiopia from September 2016 to April 2017. *Method:* Total of 902 autopsies were conducted during the study period. All the vital organs in the dead body fulfilling inclusion criteria are dissected as per the standard autopsy protocol and were weighed. *Results:* Average weight of the Brain in adults was 1272.16 grams, lowest weight was grams, Heaviest Brain was of 1570 grams. These findings were discussed with other references across the globe and conclusions were drawn. *Conclusion:* Average weight of the Brain Ethiopian population studied is 1287.5685715 grams, Average weight of the Brain in male 1343.972857 grams, Average weight of the Brain in Female 1231.164286 grams, there is significant difference between Male & Female Brain weights with P value of 0.0039. There is significant rapid loss of Brain weight after 65 years of age.

Keywords: Brain Weight, Average Brain Weight, Correlation, Normal Brain weight

Introduction

Identity of abnormal depends on normal, hence it's time quote that "what mind does not know eyes cannot see, hands can't feel". Often in the practice of Forensic Pathology, during conduct of medico-Legal Autopsy state of the given organ whether it's normal or abnormal by the size, shape, color, contour, margins or the weight does matter to conclude opinion as to the cause of death or the contribution of preexisting disease in un-natural causes of death, matter's the most. The normal weight of vital organs that too of human Brain weight in relation to the Race [1-4].

Age and Sex still is matter of uncertainty as to normal weight to that given population in order to correlate even with Qualifications, achievements or also of intelligence quotient (IQ). Most of the text books of recent editions of Anatomy and

Physiology [14-21] don't mention weight of organs [5-13] though it's vital information. Few of the Text books Forensic Medicine' do mention weight of normal Brain. Hence, this study was under taken to enhance the existing literature available for reference as normal for that age & sex of the person.

Hypothesis: Ho: There is No significant difference between Average Brain weight of Male & Females

Hypothesis: Ha: There is significant difference between Average Brain weight of Male & Female

Objectives

1. To collect & record weight of the Brain.
2. To correlate the recorded weight of the Brain to age & sex.

Material and Methods

The author & colleagues of the author during the period of September 2016 to April 2017 at St Paul Hospital & Millennium Medical College have conducted medico-legal post mortem examination on 902 dead bodies.

Inclusion criteria:

- Brain normal in its appearance with all parts intact.
- Brain with Subarachnoid bleed after clearing of ventricles & sub-arachnoid space by, thorough gentle wash.

Exclusion criteria:

1. Brain which is contused lacerated with missing parts of it are excluded from the study,
2. Infected necrotic Brain.
3. Brain with primary tumor's or secondary's from elsewhere.

Method: Following procedure was followed before & during autopsy.

1. Weight of the dead body was recorded thrice on platform type of weighing scale before placing it on the autopsy table, after removal of all the cloths & articles, average of three reading was recorded as the weight whole body.
2. Routine autopsy procedure of external examination & by standard primary incisions coronal incision for the scalp & I shape incision for Neck, Chest & Abdomen were taken.
3. The skull was dissected by using hack saw & chisel if necessary by V incision at asterion of side of the skull.
4. The duramatter was cut & removed anteriorly along the skull incision line, till level of lambdoid suture posteriorly, the falx cerebri was separated from it's anterior attachment to Cristae galli reflected backwards. Brain was lifted backwards by holding frontal lobes by left hand fingers with examination & cutting of 1-6 cranial nerves at as far as possible from Brain. The Tentorium cerebella was cut by pushing the Brain to one side & vice-versa. Now whole pushed backwards against the occipital bone. Now pons, medulla & cerebellum were

examined were lifted backwards to facilitate separation of medulla oblongata by cutting of 7th to 12 the cranial nerves as far as away from the Brain and as low as possible from spinal cord in all the cases by making V incision on anterior surface of the spinal cord. The whole brain was taken out, any intracranial bleeds of various types were identified & washed thoroughly by gentle flow of tap water from the Sulcus & folds of Brain matter, inclusive of intra-ventricular hemorrhages and CSF by making incision through corpus collosum. Now the brain was weighed on the organ weighing scale the weight was recorded in the original post mortem report and research data chart.

5. All the internal organs were examined in situ first, later were removed from the body cavity by en-mass technique and examined individually as a routine for the evidence of disease, congenital anomalies or wounds.
6. All the information required as to the name, age, sex, history as furnished by the police, treatment details if any in brief & autopsy findings, were recorded in the master chart.
7. Results thus obtained are subjected analysis by Software: *SPSS 21.0 version*, Statistical test: *Two sample T test*

Results

Total of 757 cases were studied after exclusion (16.075%) of cases which does not fulfill the criteria of inclusion (145) in the study. Out of 757 cases 618 were male and 139 were female, 60 cases were having brain weight of more than 1400 grams, Out of which only 15 (5.769 %) cases were female.

Three new born babies in the study had average Brain weight of 381 grams, three cases in the age range of 7 months to 8 months of infancy the average Brain weight was 756.66 grams. Hence Brain achieves 60% of its adult weight (1287. 56 grams in this study) within a year after birth during infancy.

There were 8 cases between 2-6 years of age , where in average weight of the Brain in these cases was found to be 1096.43 grams, that mean's the Brain achieves it's 85 % (1096.43

grams) of adult weight (1287. 56 grams in this study) by 6 years of age.

	Average weight (Male)	Average weight (Female)
Mean	1343.972857	1231.164286
Variance	1772.351757	4642.345862
Observations	7	7
Hypothesized Mean Difference	0	
Df	10	
t Stat	3.726516298	
P (T<=t) one-tail	0.001966422	
t Critical one-tail	1.812461102	
P (T<=t) two-tail	0.0039	
t Critical two-tail	2.228138842	

Total of 123 cases (16.24 %) of age range from 11-71+ years were having average brain weight of 1351-1400 grams. Average mean weight of Brain for the mean age range was 1375.25 grams.

P-value: 0.0039: So, $P\text{-value} < \alpha$, that is $0.0039 < 0.05$, that is Reject Null Hypothesis (Ho) at 5% level of significance. Therefore, there is *significant* difference between Average Brain weight of Male & Female by flowing statistical method

Discussion

Number of autopsies conducted during the study from November 2016 to April 2017 are 902 out of which 142 cases were excluded as Brain was in pieces, Decomposed, Sever infections, Space occupying lesions, Intra-cerebral hemorrhages or the researcher was on leave, etc.

Hence present study included only 757 cases. The minimum weight of the Brain in the age range from 11 years to 70+ years was one male dead body having weight of the Brain between 1000-1050 grams, while Largest and heaviest Brain was in male in the age range of 31-40 years weighing 1570 grams with cerebral edema, due to natural cause of death being Acute on chronic lung & Liver disease.

Age	Less than 1000		1001-1050		1050-1100		1101-1150		1151-1200		1201-1250		1251-1310		1301-1350		1351-1400		1401+1450		1451+		Total age wise	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
New Born	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	3
1 year	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
6 years	1	2	-	-	-	-	-	3	-	1	-	-	-	1	-	-	-	-	-	-	-	-	1	7
7-10 yrs	-	-	-	-	-	-	-	-	1	-	-	-	1	1	-	-	1	1	-	-	1	-	3	3
11-20 yrs	-	-	-	-	-	-	2	-	1	2	1	5	2	5	2	6	4	9	3	18	-	47	18	
21-30 yrs	-	-	-	-	1	1	1	6	3	12	0	10	9	26	7	31	2	29	6	49	-	164	38	
31-40yrs	-	-	-	-	1	1	3	0	10	3	10	3	24	5	23	3	31	3	33	2	32	-	167	21
41-50yrs	-	-	1	-	2	1	3	1	4	3	6	3	13	4	13	2	23	3	13	3	21	-	99	20
51-60yrs	-	-	-	-	-	0	3	2	7	1	7	3	8	3	13	2	7	2	6	0	18	-	69	15
61-70yrs	-	-	-	-	1	1	0	1	3	3	7	1	6	1	3	1	7	0	7	1	6	-	40	9
71 +yrs	-	-	-	-	-	0	2	1	6	0	5	1	5	0	2	0	2	0	2	0	1	-	25	2
Total	4	8	1		4	4	14	9	36	16	49	12	71	26	86	17	108	15	99	15	146	-	618	139

Out of 757 cases where Brain was intact, measurable by weight were included in the study 618 (81.638 %) were male dead body & 139 (18.361 %), were female dead bodies. The weight of Human Brain gradually decreases considerably over the period of age from 11 years to 70 years. Ratio of decrease of Brain weight for mean age irrespective of sex of the person is as follows;

- Between 15.25 to 25.25 years is 0.73 grams %,
- Between 25.25 to 35.25 years is 0.984 gram %,

- Between 35. 25 to 45.25 years is 0.794 grams %,
- Between 45.25 to 55.25 years is 0.880 grams %,
- Between 55.25 to 65.25 years is 1.180% grams %
- After 65 years of age 4.380 % grams %

Decrease in Brain weight was found to be more rapid (0.984 gram %,) in the mean age range of 25.25 to 35.25 years, relatively more rapid (1.180% grams %) in the age range

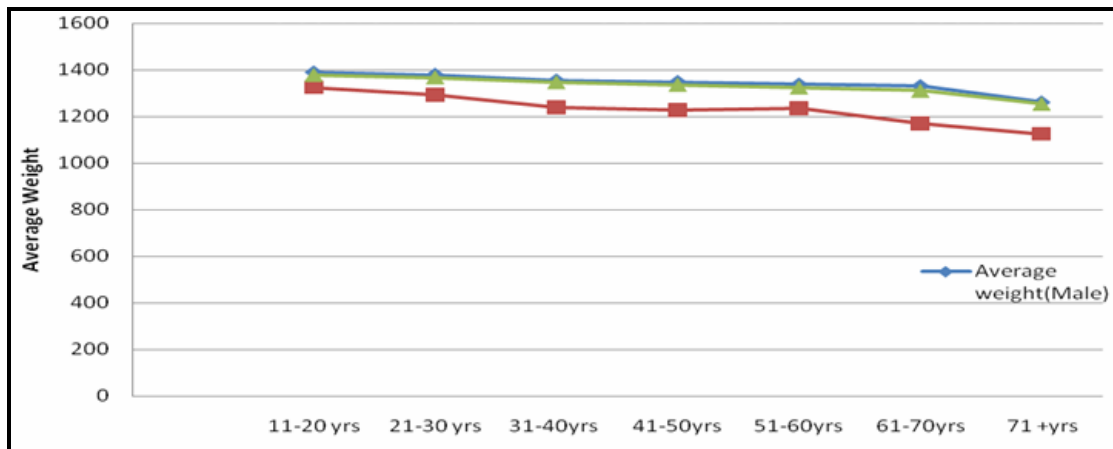
55.25 to 65.25 years and most rapid after 65 years 4.380 grams% to the total weight of the Brain Correlation between Age group and Brain weight of males are -0.95 , That there is *High degree of Negative correlation* two variables.

The scatter plot depicts that the Human Brain weight is Highest at around 20 years of age, which declines steadily till the age of 60-65 years, after that more rapidly. There were three male new born dead body, weighing 395, 505 & 490 grams each (Average weight of Brain at full term new born mean weight is around 463.333grams), However Sheaff MT et al. [20], Post mortem technique Hand book, mention weight of new

born on average 380 grams which is much less than Ethiopian population under study.

Table-3: Average mean weight of Brain for the mean age range		
Age	Number of Cases	Average weight
11-20 years	65	1378.83 grams
21-30 years	202	1368.76 grams
31-40 years	188	1347.96 grams
41-50 years	119	1337.26 grams
51-60 years	84	1325.50 grams
61-70 years	49	1311.21 grams
71+ years	27	1255.13 grams
	734	1332.09 grams

Fig-1: Scatter Plot (Male, Female and Both)

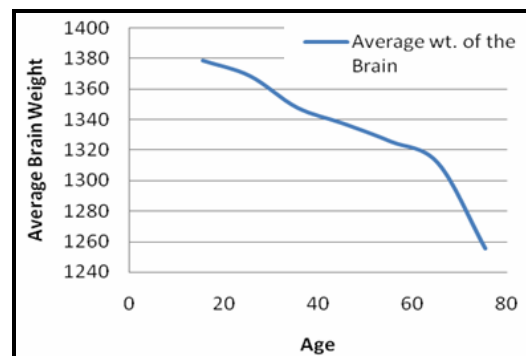


Average weight of new born being 2200 grams, Hence weight of the Brain in full term new born is around 21.045 % of average weight of new born. There were no cases around one year of age in this study.

One case, said to be child of 6 years as per police requisition, where in dental age was 9-11 years the weight of the Brain was 1270 grams. Three cases of male children of 7-10 years age, as per the police while dental age of all the three was around 12-14 years (Adolescents) & weight of the Brain was above 1300 grams (One of them Brain weight was more than 1450 grams). The mean weight of the Brain above 6 years till adolescence is 1361.25 grams. Michael T. et al. [20], Post mortem technique Hand book, mention weight of Brain in adolescents 1150 grams which is much

lower in comparison with Ethiopian male population (1361.25 grams) studied.

Fig-2: Scatter Plot (Male & Female)



Among the 618 male cases 611 cases were above 11 years, only one case in the age group of 41-50 years Brain weight was 1000 to 1050

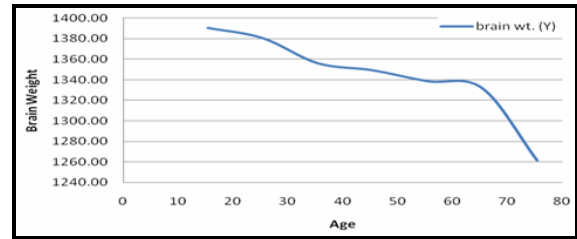
grams. In the age range of 4 (0.654 %) cases were having Brain weight between 1050-to 1100 grams, in the age range of 31 to 70 years. In age range of 11 to 70+ years of age 14 (2.291 %) cases, Brain weight was between 1100 to 1150 grams, 36 cases 1151 to 1200 grams, in 49 cases 1201 to 1250 grams, In 71 cases 1251 to 1300 grams, 85 cases 1301 to 1350 grams, 107 cases 1351 to 1400 grams, 99 cases Brain weight was 1401to 1450 grams and in 145 cases Brain weight was more than1450 grams.

Total 611 cases of adult male Brain were studied, in the age range of 11 to 70 plus years and Brain weight was ranging from minimum of 1000 grams to 1450 plus grams, average weight of the Brain among the male was 1313.175 grams for Ethiopian adult male population which is correlating with average weight of the Brain mentioned in Modi Text book [19] of Medical Jurisprudence mention average weight of adult male Brain 1342.36 grams. In same book there is mention as to the normal average Brain weight in adult male Mumbai population-1288.6 grams, which is much lesser than Ethiopian adult male population 1313.175 grams. Pakkenberg H & voigt J [14]. Brain weight of the [5] Dane’s, St Elizebeth Hospital in Washington, Total of 2752 Brain’s examined, mean weight was 1300 (Male) grams, this is lesser than Ethiopian adult male Brain weight while [5] Baily & Bennin study, report normal weight of the Brain in adult male 1345 grams (Male), while in present study for Ethiopian population, average Brain weight is 1313.175 grams which is significantly lesser.

Male:

Correlation between Age group and Brain weight of males are -0.92 , that is there is *High degree of Negative correlation* between those variables. Our observations in this study match study conducted by Gur RC, Gunning-Dixon FM, [1] Turetsky BI, Bilker WB, Gur RE - Some brain regions undergo volume decline as age advances and those changes are more common in men than females and there is an evidence for it. Results of average of Brain weight for adult male Ethiopian population (1313.175 grams), is much less compared to Range of weight of adult Brain mentioned in [16] Parikh’s Text Book (1350-1400 grams), [17] KS Narayanreddy Text Book (1400 grams) and [21] Harsh Mohan, Text Book of Pathology (1400 grams).

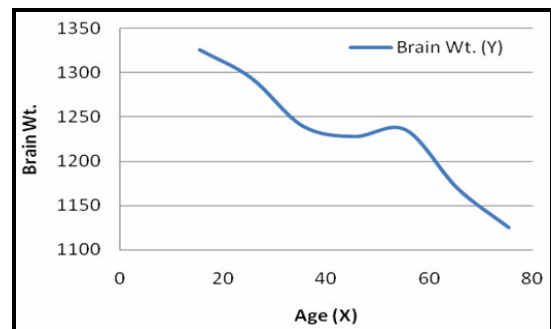
Fig-3: Scatter Plot (Male)



Female:

There were Three female new born dead body examined said to be of full term, by applying Haas rule by measuring length of fetus, age ranging from 9 to 10 Lunar months having Mean Brain weight of 381.66 grams. Michael T. Sheaff, Deborah J. Hopster [20] Post mortem technique Hand book mention Weight of the Brain in New born 380 grams (The author does not mention sex of fetus) which corresponds with our study for Ethiopian female new born.

Fig-4: Scatter diagram (Female)



There were three cases of less than one year age around 5 to 8 months of infancy, having Brain weight of 670grams, 830 grams and 770 grams with mean average weight of this age range was 756.66 grams, statistically proving human Brain attains 50% of its adult weight by 7-8 months of infancy. The author of this article proposes that average weight of the in Female new born, double’s by first birth day.

There were Five Female cases in the age range of 2nd year to 5 years, of which 2 of these 4 cases having average Brain weight of 960 grams, while, remaining three cases of the age 4& 5 years, the mean weight of the Brain was 1075 grams. Average weight of the female Brain at around 6 years is 1075 grams. Correlation between Age group and Brain

weight of males are -0.97 , That is there is *high degree of Negative correlation* between those variables.

The average weight of the Brain for both sex is in the line of weight of Brain of the male subjects, since ratio of the Female to male subjects is around 1:6. Hence the blue line in scatter is merging with green color for male cases.

Average weight of female new born in Ethiopian population is 422.50 grams, Michael T. Sheaff, Deborah J. Hopster [20] Post mortem technique Hand book mention average Brain weight of new born 380 grams, which is lesser than Ethiopian population studied. Average weight of the female Brain at around one year age is 756.66 grams,

Both Sex;

In the 7-10 years age range, while Dental age was above 11-12 years, the mean weight of the Brain was 1308.58 grams.

The mean weight of the Brain for the age range of 2 years to 6 years was 1096.43 grams. This study has a limitation of not having studied white

population comparison to study done by Ho KC et al. [3] Analysis of the brain weight of 1,261 subjects, aged 25 to 80 years, show that the mean brain weight decreases in order from white men to black men to white women to black women.

Conclusion

The average weight of the Brain Ethiopian population studied is 1287.56 grams, Average weight of the Brain in male was 1343.972857 grams. Average weight of the Brain in Female was 1231.164286 grams. There is significant difference between Male & Female Brain Weight with P value of 0.0039. There is significant rapid loss of Brain weight after 65 years of age.

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