

Does Virtual Brain Autopsy Could be Used as a Clue for Detection of Personal Identity?

Mohamed A M¹, Ghada M E², Sherin S G³, Makloph MG⁴

¹M.Sc. Medico-Legal Authority , Ministry of Justice, ²Professor of Forensic Medicine and Clinical Toxicology Department of Forensic Medicine And Clinical Toxicology, Fayoum University, ³Professor of Forensic Medicine and Clinical Toxicology Department of Forensic Medicine and Clinical Toxicology, cairo university, ⁴Lecturer of Forensic Medicine and Clinical Toxicology Department of Forensic medicine and clinical toxicology, Fayoum University

Abstract

Background: virtual autopsy nowadays show great success in human identification. Nowadays single Computerized tomography of the brain could help answering many questions regarding the identity of humans, it could lead us to the gender ,weight and height roughly of the person in question.

Patients and Methods: cross- sectional study during the period April 2019 till Mars2020 , One hundred and fifty participant aged between 15 and 29 years old were involved in the current study after taking their written and verbal consent or their caregiver and doing C T Brain for every one of the studied participant.

Results: brain volume is statistically significant with weight , height, gender of the studied participant hence we could use CT Brain to know the brain volume and then we could suspect weight , height and even gender so we can reach to the identity of the individual.

Conclusion: We me be no longer in need of doing autopsy where virtual autopsy could find the answer to many questions in research, where a correlation was found between brain volume ,gender, weight and height.

Key words : computerized tomography Gender, height, virtual, weight.

using computer assisted tomography and magnetic resonance imaging. [2]

Introduction

Brain size determination is a growing topic in anatomy anthropometry and determination of human identity^[1]. Estimation of the brain size could be done either by weighting brain at autopsy, using filler in the cranial cavity and measuring it, measuring the exterior size of the head or by using virtual autopsy of the brain

With advance in technology of brain radiology , correlation between brain size and gender could be founded [3]. there is correlation between increasing age and decrease in brain volume in a study^[4], while in other study^[5] found no link between age and brain size .

Cerebrum volume creates from birth to youth with the fastest improvement before the fifth year. Between the ages 16-20-year, cerebrum volume shows up at its maximal total and won't create after that through life. The volume is around 1260 cm³ in men and 1130 cm³ in women, despite that there was individual variation . [6]

Finally, it's known, the typical cerebral volume is about 10 % greater in youngsters than young women in children . [7]

Corresponding author:

Dr: Mohammed Goma Makloph

E-mail: dr_mmakloph@yahoo.com

Phone number :00201063062903

Address: Egypt, Fayoum governorate, Dalla

Zip code:63511

Subjects and Methods

Study design

This study is a cross-sectional study during the period April 2019 till March 2020.

Study sample

One hundred and fifty participants aged between 15 and 29 years old were involved in the current study after taking their written and verbal consent or their caregiver.

They were divided into 3 groups according to their age (15-19, 20-24, 25-29 years old).

Inclusion criteria include Egyptian citizen more than 15 years old and below 30 years old.

We exclude those who refuse to participate, those above 29 and below 15 years old, those with past history of chronic disease or head injury or those who are presently ill.

Data collection

The following information was gathered:

Age from their birth certificate, Sex, weight using a weight scale and height using a measure and measuring length in standing position with bare feet.

CT Scanning of the head is done in the radiology department in Fayoum University Hospital using multi-cut CT machine (Ranging from 8 - 64 cut for each second).

Three measurements were taken (antero-posterior length, breadth and Cranial height). The Maximum antero-posterior length, Maximum breadth were assessed at the midventricular cut of CT head at the level of prominent frontal horn of lateral ventricles (Fig 1), while cranial height is measured between the internal acoustic meatus to the highest point of bregma (basibregmatic height).

Brain volume calculation was done by multiplying the three measurements above.

The gained data will be grouped and analyzed.

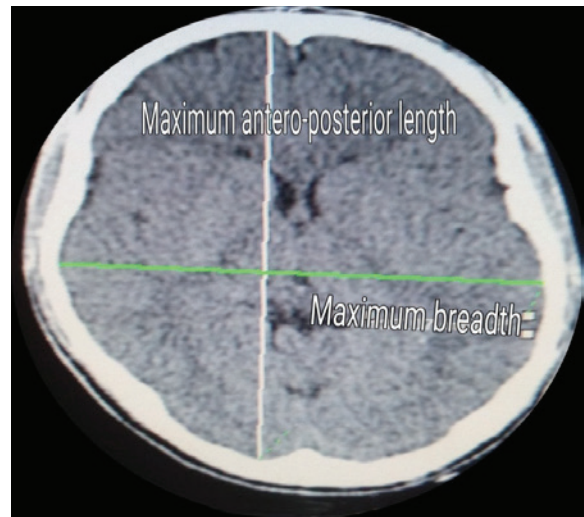


Fig 1: maximum antero-posterior length, Maximum breadth

Statistical analysis

The collected data were organized, tabulated, and statistically analyzed using statistical package for social science (SPSS Inc, version 21). For quantitative data, the mean and standard deviation (SD) were calculated. Student's-t test, or one-Way ANOVA, when appropriate, was used as a test of significance. Categorical data were presented as frequencies and percentages; chi-square (χ^2) was used as a test of significance, correlation coefficient test (person test) was done and linear regression analysis performed. For interpretation of the results of tests of significance, significance was adopted at $P \leq 0.05$ in the results.

Results

Descriptive statistics. Distribution of the studied subjects regarding demographic data and brain volume (No=150). The mean \pm SD of all participants was 21.7 \pm 4.4 years for age, 66 \pm 13.4 for weight/kg, 163.7 \pm 8.7 for height/cm, 24.4 \pm 4.3 for body mass index and 2265 \pm 291.7 for brain volume. The range was 14.2 - 28.6 for age, 43-106 for weight, 141-183 for height, 16.6-38.3 for body mass index and 1184.6-3187 for brain volume.

Analytical statistics:

Table (1):Brain volume in relation to gender of the studied subjects.

Brain volume/cm ³	Sex groups		t test	P value
	Male (n=73)	Female (n=77)		
Mean±SD	2416.36±228.13	2086.45±220.18	9.004 <0.001*	
Range	1944-3187	1184.6-2792		

t: student t test, *: significant

Table 1 shows that male had brain volume (2416.36±228.13) more than female (2086.45±220.18) with really high statistically significant differentiation, P <0.001).

Regarding Brain volume in relation to different age groups.

F test: ANOVA test shows that there was no genuinely through and through difference between different age and brain volumes (P= 0.103)

Table (2):Pearson correlation between weight and height with brain volume.

	Brain volume/cm ³	
Weight /kg	R	0.378
	P-value	0.001*
Height /cm	R	0.526
	P-value	0.001*

R: Pearson correlation coefficient, *:significant

Table 2 shows that there was basic positive association between’s brain volume concerning weight, height .(fig 2)

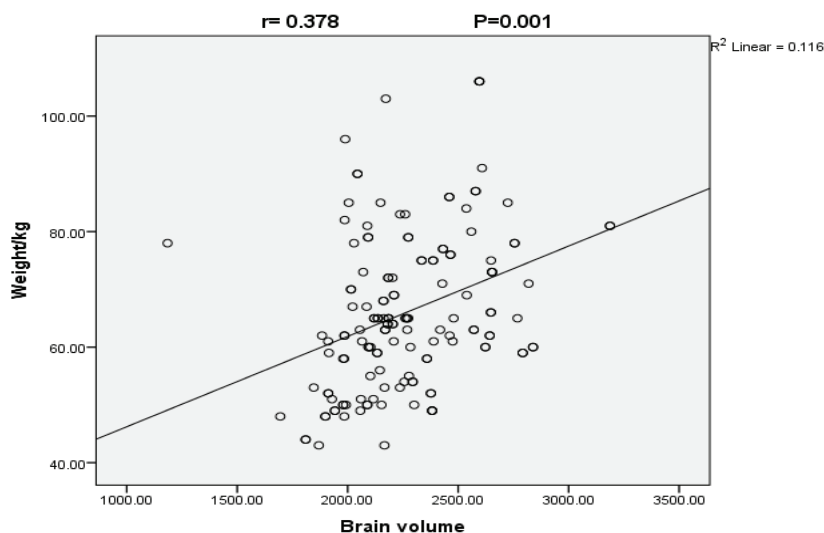


Fig. (2):Correlation between brain volume and weight/kg of the studied subjects.

Table (3): Correlation between weight, height and brain volume among females and males .

	Brain volume		
		Females	Males
Weight /kg	R	0.493	0.421
	P-value	0.001	0.004
Height /cm	R	0.586	0.520
	P-value	0.001	0.001*

R: Pearson correlation coefficient***:** significant

Table 3 shows significant positive association between’s brain volume concerning weight, height and BMI ($p < 0.001$) among females. Additionally between brain volume concerning, weight, and height among male subjects ($P < 0.001$). (fig 3)

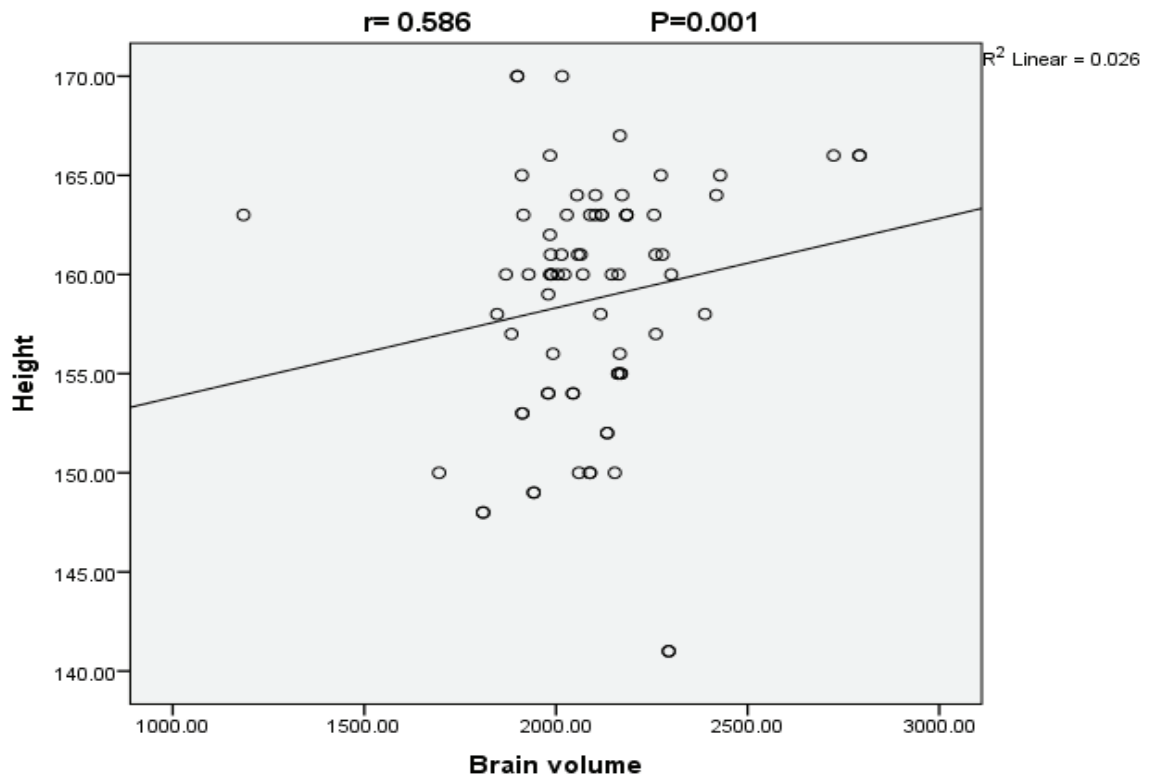


Fig.(3):Correlation between height/cm and brain volume among female.

Table (4): Multi-linear regression analysis of brain volume regarding age, weight and gender.

Variables	P-value	B constant
Age	0.010	-0.170
Gender	0.001	-0.450
Height	0.001	0.268

Table 4 shows that age, sex and height were verifiably significant self-sufficient parts with brain volume with p regard (<0.001)

Discussion

Cerebrum volume creates from birth to youth with the most rapid advancement before the fifth year. Between the ages 16-20, brain volume shows up at its maximal total and won't create after that through life.^[8-9]

These assessments have entered another zone utilizing present day progresses, for instance, allowing imaging and brain checks specially volume which was assessed by assessment of skull through the head surface. Skull length, width and height are used for determination of brain volume.^[10]

Incalculable examinations were directed to choose the association between skull volume and weight. The vast majority of these assessments were on dry bone or radiologic pictures. Positive relations were found between skull volume and height, weight, age in the both sexes.^[11]

In the present assessment we explored the association of brain volume with age, weight, height in a specific age gathering (15 - 29 years) to act as an illustration of general youth people of Egypt.

Our results arrive in a comparative line with cross-sectional examination drove on 286 subjects by Bayat PD. et al., (2012)^[12] to look at the association of skull size and cerebrum volume of Arak University of Medical Sciences understudies with their age, weight, height and weight record. Age of their analyzed subjects were in go 18-26 years old with mean 20.52±2.44 years, 150 subjects (52.45%) of the examined subjects were females and 136 subjects (47.55%) were males. mean

stature was 169.3±19 cm with men weight was 64.01±12 kg and mean weight record was 22.19±4.8 kg/m², concerning mind volume and weight were 1276.94±310 mm³ and 1321.61±32.2 g, respectively.

Another examination was finished by Acer N. et al., (2007)^[13] on 366 subjects (226 people, 140 females). their degrees were 17-26 years old which were close to our results. The mean age was (19.83±1.96) a long time. In like manner, the mean weight was (65.34 ± 8.88) kg., and the mean height was (174.21±8.18) cm,. The strategies for cranial breaking point which in an indirect manner reflects the cerebrum volume were 1411.64±118.9 cm³ .

The current assessment demonstrated that male had cerebrum volume (2440.7 ±240.8 cm³) more imperative than female (2089.7± 225.6 cm³) with statistically significant basic qualification (P <0.001). Our results agreed with Aylward EH. et al., (2002)^[14] They found that a critical effect was found for sex (male personalities were greater than female cerebrums). This may be a result of the sex contrasts in size is move by progressively unequivocal cerebrum regions, also exhibit that men have a bigger amygdala and hypothalamus, while women have a for the most part greater caudate and hippocampi.

Moreover, a couple of assessments were coordinated to choose the association between skull volume and weight found cerebrum volume among male was more unmistakable than female anyway was lower than our results. Gault D. et al., 1988^[15]; MacKinnon IL., 1955)^[16] revealed that mean skull volume was through and through higher in males (1393.31±111cm³) diverged

from females ($1168.71 \pm 102 \text{ cm}^3$). Moreover, Manjunath KY., (2002)^[17] who reported skull volume in males and female to be $1152.813 \pm 279.16 \text{ cm}^3$ and $1117.82 \pm 99.09 \text{ cm}^3$ exclusively, which is lower than our examination. Acer N. et al. (2006)^[18] decided the inside skull volume to be $1311 \pm 133 \text{ cm}^3$ which is close to whole refined in the present of our assessment ($1184.6-3187 \text{ cm}^3$)

Also, in the examination which drove by Bayat PD. et al., (2012)^[12] on 286 subjects to investigate the association of skull size and brain volume with their age height and weight record. They found that Mean skull record was 1.99 ± 0.26 in males and 2.20 ± 0.3 in females, referred to data were on a very basic level remarkable among males and females. Regardless, Golalipour MJ. et al., (2005)^[19] have uncovered skull volume to be $1420.60 \pm 85 \text{ cm}^3$ in males and $1227.2 \pm 120 \text{ cm}^3$ in females Turkmen race, which is closer to our examination. Another the assessment performed by Aylward EH. et al., (2002)^[14] found a development in supreme cerebrum volume in subjects some place in the scope of 8 and 12 years of age, yet not for those more prepared than 12 years of age. This come not entirely agreed with our results

The current examination exhibited that there was important positive connection between cerebrum volume with weight and height, in any case there no basic association between brain volume with age. The current assessment, mind volume demonstrated enormous negative relationship with age among females. While, cerebrum volume showed positive relationship with weight, height among males and females ($p < 0.05$)

Our results come in simultaneousness with another examination by Bayat PD. et al., (2012)^[12] found a positive connection between cerebrum volume and anthropometric records, for instance, height, weight, age and weight document in the two sexual directions which supports the eventual outcomes of Gustafson's examination (Gustafson D. et al., 2004)^[20].

Moreover, Acer N. et al., (2006)^[18] decided within skull volume to be $1311 \pm 133 \text{ cm}^3$ which was extraordinary and lower with the whole refined in the current examination ($2265 \pm 291.7 \text{ cm}^3$). There was a positive association between mind rundown and cerebrum volume; in any case, this association is basically more grounded in females. Another examination drove

by Ward M.A. et al., (2005)^[21] found that extension in skull volume was connected with increase in height, weight and there was real connection between's both age and skull volume. inhibitor insecticides poisoning.

Conclusion

CT brain could help to solve the problem of identity of the subjects where brain volume significantly related to weight, height and gender.

Conflict of Interest : The author declare that there is no presence for conflict of interest

Source of Fund : This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Ethical Consideration: This study was approved by the Fayoum Faculty of Medicine Research Ethical Committee. The study was conducted after explaining the study's aims. Verbal and written consents were obtained from all participants included in the study and each person had the right to refuse to participate in the study.

References

- [1] Navarrete F., Blezer L., Pagnotta M., De Viet S., Todorov S., Lindenfors P. et al. Primate brain anatomy. New volumetric MRI measurements for neuroanatomical studies. *Brain, behavior and evolution.* (2018); 91 (2), 109 – 117.
- [2] Beheshti I., Gravel P., Potvin O., Dieumegarde L. and Duchesne S. A novel patch-based procedure for estimating brain age across adulthood. *Neuroimage.* (2019); 197, 618 - 624.
- [3] Ocklenburg S. and Gunturkun O. (2017). The lateralized brain: The neuroscience and evolution of hemispheric asymmetries. *Academic Press.* (2017). ,265 DOI: 10.1016/C2014-0-03755-0
- [4] Suk B.Jae M.K., Jin H.C., Myung-Hoon H and Je R. Association between cerebral atrophy and osteoporotic vertebral compression fractures. *PLoS one.* (2019); 14 (11). <https://doi.org/10.1371/journal.pone.0224439>
- [5] Hasan M., Moeller G. and Narayana A.. DTI-based segmentation and quantification of human brain lateral ventricular CSF volumetry and mean diffusivity: validation, age, gender effects and

- biophysical implications . Magnetic resonance imaging. (2014) ;**32 (5)** , 405 - 412 .
- [6] Gilmore H., Knickmeyer C. and Gao W. Imaging structural and functional brain development in early childhood . *Nature Reviews Neuroscience*. (2018) ; **19 (3)** , 123 .
- [7] Wierenga M., Sexton A., Laake P., Giedd N., Tamnes K, et al. A key characteristic of sex differences in the developing brain : Greater variability in brain structure of boys than girls . *Cerebral cortex* . (2018) ;**28 (8)** , 2741 - 2751 .
- [8] Yokum S. and Stice E. Initial body fat gain is related to brain volume changes in adolescents : A repeated measures voxel based morphometry study . *Obesity*. (2017) ; **25 (2)** , 401 - 407 .
- [9] Golalipour J. and Hosseinpour R. Estimation of the cranial capacity and brain weight of Iranian female newborns . *European Journal of Anatomy*. (2020) ; **10 (2)** , 49 - 52 .
- [10] Weis S., Sonnberger M., Dunzinger A., Voglmayr E., Aichholzer M., Kleiser R. et al. Meninges . In *Imaging Brain Diseases* , Springer , Vienna. (2019) ; 179 – 189 .
- [11] Mann D., Frank G., Glickman E., and Towe L. Brain and Body Size Relations among Spotted Hyenas (*Crocuta crocuta*) . *Brain , behavior and evolution*.(2018) ; **92 (1-2)** , 82 - 95 .
- [12] Bayat D., Ghanbari A., Sohoulı P., Amiri S. and Sari-Aslani P. Correlation of skull size and brain volume, with age , weight , height and body mass index of Arak Medical Sciences students. *Int. J. Morphol*. (2012) ; **30 (1)** , 157 - 61 .
- [13] Acer N., Usanmaz M., Tugay U., and Ertekin T. Estimation of cranial capacity in 17 - 26 years old university students . *Int. J. Morphol*. (2007) ; **25 (1)** , 65 - 70 .
- [14] Aylward H., Minshew J., Field K., Sparks F., and Singh N. Effects of age on brain volume and head circumference in autism . *Neurology* . (2002) ; **59 (2)** , 175 - 83 .
- [15] Gault D, Brunelle F, Renier D, and Marchac D. The calculation of intracranial volume using CT scans . *Child’s Nervous System* . (1988) ;**4 (5)** ; 271 - 3 .
- [16] MacKinnon L.. The relation of the capacity of the human skull to its roentgenological length . *Ajr*(1955) ; **74** ,1026 .
- [17] Manjunath Y. Estimation of cranial volume-an overview of methodologies . *J Anat Soc India*. (2002) ; **51 (1)** , 85 - 91 .
- [18] Acer N., Sahin B., Ekinçi N., Ergür H., and Basaloglu H. Relation Between Intracranial Volume and the Surface Area of the Foramen Magnum . *J. Craniofac. Surg*. (2006) ; **17** , 326 - 30 .
- [19] Golalipour J., Jahanshahi M. and Haidari K.. Estimation of cranial capacity in 17-20 years old in South East of Caspian Sea Border (North of Iran) . *Int. J. Morphol*(2005) ; **23 (4)** , 301 – 4.
- [20] Gustafson D., Lissner L., Bengtsson C., Bjorkelund C. and Skoog I. A 24- year follow-up of body mass index and cerebral atrophy. *Neurology*. (2004) ; **63** , 1876 - 81 .
- [21] Ward A., Carlsson C., Trivedi A., Sager A., and Johnson C. The effect of body mass index on global brain volume in middle-aged adults : a cross sectional study . *BMC Neurol*. (2005) ; **5** , 23 .