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Assessment of Evan's Index in North-Western Nigeria using Computerised Tomography

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors contributed in research design, data collection and manuscripts write up. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: To determine the Evan's Index of Nigerians using computerized tomography in Sokoto North-Western Nigeria.
Study Design: Retrospective cross- sectional.
Place and duration of study: Department of Anatomy Usmanu Danfodiyo University Sokoto and Department of Radiology Usmanu Danfodiyo University Teaching Hospital Sokoto, between January, 2020 and January, 2022.
Methodology: Normal brain CT scans of one hundred and seventy-eight subjects from the Radiology Department of the Usmanu Danfodiyo University Teaching Hospital, whose ages ranged from 1 to 70 year. The Evans index was determined by the ratio of the measured distance between the tips of the frontal horns of lateral ventricles and the inner skull tables at the midpoint of the cranium in axial plane.
Results: The Evan's indexes were larger in male than the females and these differences were not statically significant except in the age group 51-60years where statistically significant difference

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was observed between male and female (p=0.042). The minimum Evan's index was 0.02cm in male and 0.01 females and the maximum bi-frontal index was 0.40cm in male and 0.38cm in females.

Conclusion: The Evan's indexes and it relation with sex and age in our environment was determined.

Keywords: Determination; evan's index; tomography; Nigerians.

1. INTRODUCTION

"Evans index (EI) is one of the ventriculographic indices used in diagnosing ventricular enlargements and changes in the brain ventricles in medical disorders such as Alzheimer's disease (AD) and Psychiatric disorders such as Schizophrenia" [1]. "It is a ratio which compares the maximum width of the frontal horns of the lateral ventricle to the maximum transverse diameter of the inner table of the skull. It also serves as an indirect marker of ventricular volume and medical disorders such as Huntington's disease" [2,3]. "There exist a strong correlation of EI with ventricular volume Ambarki and Toma reported a ratio of = 0.94 and = 0.619, respectively" [2,3].

"Evan's index (EI) has been extensively used in the diagnosis of idiopathic normal pressure hydrocephalus, in the assessment of outcome of patients with shunt placement which is the primary mode of treatment" [4]. "It can also use in the assessment of visual complications of childhood hydrocephalus" [5]. "Evans felt the need for a quantitative expression to describe more accurately the degree of enlargement of the cerebral ventricles and to define normal limits of the cerebral ventricles, and linear measurements were adopted" [5]. "He defined and computed a ratio of transverse diameter of the anterior horns to the greatest internal diameter of the skull in the sagittal direction" [5].

"The normal index range for children was 0.20 to 0.25 and the ratio of 0.25 to 0.30 represents early ventricular enlargement while values above 0.30 define ventricular enlargement" [5].

"The digital CT scan machines currently in use also allow real time measurement of various dimensions of the ventricular system thus assisting in understanding its anatomy" [6]. "In patients with hydrocephalus following tuberculous meningitis; linear measurements are more reliable than volumetric ratios" [7,8]. "In the elderly, it is even more imperative to differentiate between the various causes of ventricular enlargement which could have overlapping clinical symptoms e.g. normal ageing, Alzheimer's disease, idiopathic normal pressure hydrocephalus, Parkinson's disease and dementia with Lewi bodies" [7].

2. MATERIALS AND METHODS

This is a retrospective study involving one hundred and seventy-eight (178) normal brain CT scans of subjects from the Radiology Department of the Usmanu Danfodiyo University Teaching Hospital, whose ages ranged from 1 to 70 year. The CT scan images were retrieved from the hospital database backed up storage discs in the CT library. This study was conducted between Jan 2020 and Jan 2022, following an ethical approval granted by the institutional ethical committee. Images were taken with a NEUSOFT C 3000 Spiral CT machine Dual Slide Helical CT Scanner, (2005) model at 5mm slice thickness.

The images were viewed on the computer aided Digital Imaging and Communication in Medicine (DICOM) viewer using the RadiAnt Version 4.2 software. Measurements were taken to the nearest 0.1 millimeters.

The Evans index was determined by the ratio of the measured distance between the tips of the frontal horns (AHT) of lateral ventricles at the level of interventricular foramen, in axial plane and that of the distance between the inner skull tables at the midpoint of the cranium (Mid intracranial diameter), in axial plane.

> **Evans Index**= anterior horns tip (AHT) / mid intracranial diameter (MICD)

Statistical analysis was done using Sigmastat 2.0 for windows San Rafael CA. Statsoft (1995). Data were presented in tables and figure, and expressed as means and standard deviation. Differences in Evan's Index with respect to sex were examined using Student's t test. One-way analysis of variance was used to analyze for variations across age groups. $P < 0.05$ was considered as statistically significant.

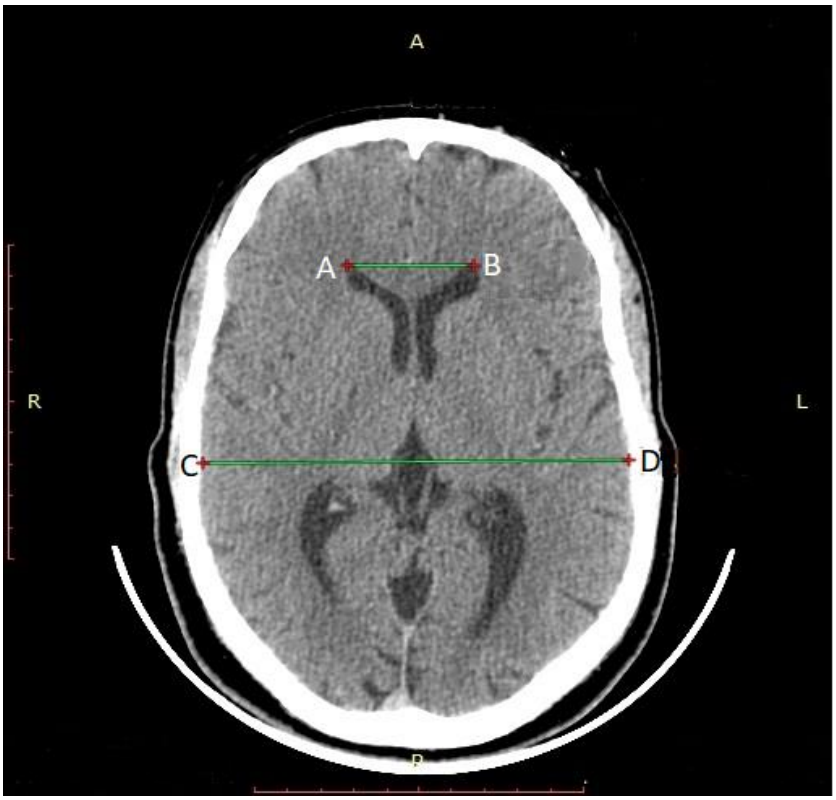

Fig. 1. A CT image showing measurement Evan's index; determined by the ratio of the measured distance between the tips of the frontal horns (A-B) of lateral ventricles and the distance between the inner skull tables at the midpoint of the cranium (C-D), in axial plane

Inclusion Criteria: The Participants were from Nigeria, they are aged between 1 and 70 years and the brain CT scans were described as normal by a radiologist with respect to: a) Normal cerebral ventricular size, form, shape and periventricular translucency, b) brain parenchyma appears normal with no evidence of space occupying lesions and c) perfect positioning of the patient. With the Passage of the lowest tomographic section through a line 15–20 degrees to and 1cm above the cantho-meatal line which represent the base of the skull.

Exclusion Criterion: The brain CT scans with Poor quality of the scan images and evidence of space occupying lesions, cerebral hemorrhage and asymmetric of lateral ventricles were excluded from the study.

Statistical analysis was done using Sigmastat 2.0 for windows San Rafael CA. Statsoft (1995). Data are presented in tables and figure, and expressed as means and standard deviation. Differences in Evans Index with respect to sex were examined using Student's t test. One-way analysis of variance was used to analyze for variations across age groups and any significant correlation for the indices with the age using scatter diagram $P < 0.05$ was considered as statistically significant.

3. RESULTS AND DISCUSSION

3.1 Evans Indexes of the Different Age Group for Both Male and Female

The Evans index was observed to be generally larger in males than females, but the differences are statistically insignificant among the various age groups ($p > 0.05$). The Evans index in both male and female was observed to increase rapidly in the age group 1-10 years and 11- 20 years. There after there is a gradual increase in Evans index up to the 7th decade. The Evans index increases from first to the seventh decades in both males and females. The least Evans index observed was 0.26 cm in males and 0.24 cm in females and these are seen in the age group 11-20 years in both male and female. The greatest Evans index observed was 0.32 cm in males and 0.31 cm in females and these were observed in the age group 61-70 years in both male and female.

Table 1. Evans indexes of the different age group for both male and female

	Males (N=112)			Females (N=66)			
Age	**Means±SD AHT**	**Means±SD MICD**	**Evans Index**	**Means±SD AHT**	**Means±SD MICD**	**Evans Index**	**Pvalue**
1-10	25.35±3.72	120.4±4.74	0.21	25.14±1.73	110.5±2.74	0.22	0.237
11-20	26.21±2.65	119.8±1.67	0.21	25.25±2.62	108.6±3.67	0.21	0.073
21-30	26.37±3.34	133.4±2.38	0.20	25.91±3.39	121.5±5.38	0.23	0.085
31-40	25.44±3.19	114.2±4.14	0.22	25.12±4.16	109.1±1.14	0.22	0.078
41-5	30.4±2.46	119.9±3.45	0.25	29.43±2.42	112.4±1.45	0.26	0.094
51-60	33.71±4.28	113.5±1.23	0.29	32.74±6.20	107.2±3.23	0.30	0.087
61-70	36.62±3.22	130.3±5.27	0.28	35.61±2.28	127.1±4.27	0.28	0.079

N=Number, AHL=Anterior horn length, MICD=mid-intracranial distance, SD=standard deviation
There was no statistical significant difference between sexes and same age groups as p>0.05

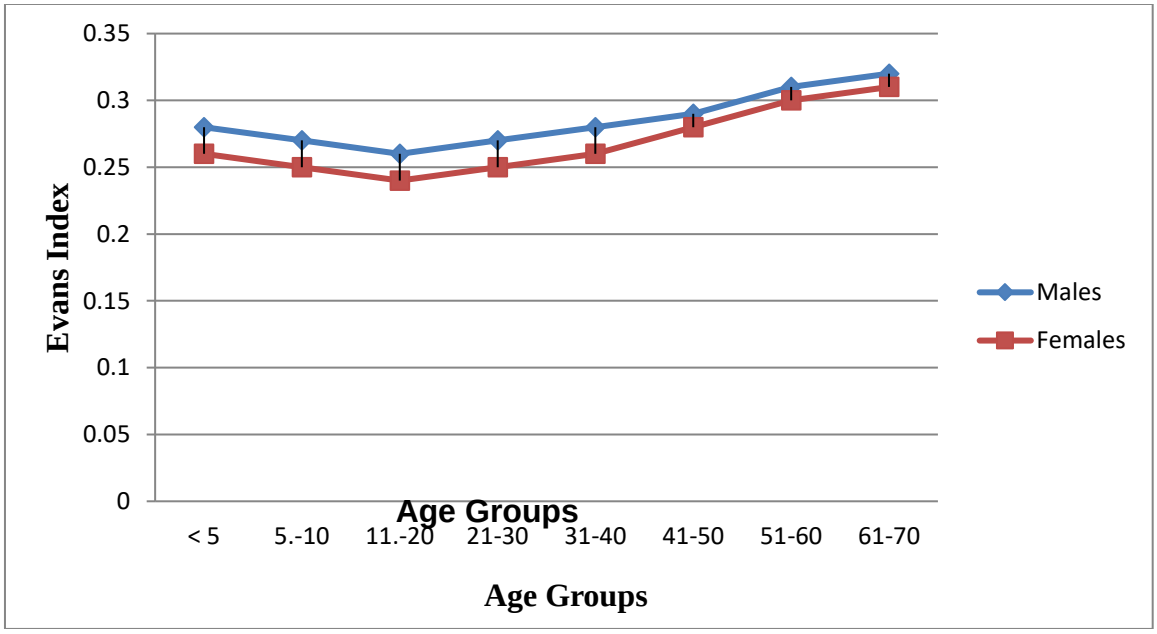

Fig. 2. Graphical representation of Evan's index of the different age groups for both males and females

3.2 Discussion

"Evan's Index (EI) is a quantitative criterion which has been used extensively in assessing ventriculomegaly and the mean value in this study agrees with those studies previous done on Caucasian" [1,2,3,6]. "Studies by Ambarki et al. and Toma et al. showed strong correlation of Evan's Index with ventricular volume and reported value 0.94 and 0.619 for male and female respectively. These values a slightly larger than what was observed in this study which was 0.32 cm in males and 0.31 cm in females" [1,2].

In the current study the Evan's Index was observed to be larger in male than the females and these differences were not statically significant except in the age group 51-60 years where statistically significant difference was observed between male and female. In males there was a gradual decline in the Evan's Index from the age 1-10 years to the age of 40 years where it remained constant until the age 60 years when it begins to increase again. However, in female the decline was observed in the age group; 1-10, 11-20 and 51-60 years Furthermore, the smallest Evan's indexes were observed in the age group 21-30 years in the male and 5-10 years in the female. Whereas the largest Evan's indexes were observed in the age group 2-4 years and 61-70 years in male and age group 41-50 years and 61-70 years in female. The changes in the Evan's index observed across the age group in both sexes could be explained by the various normal brain changes that occurred

with advancing age. This is contrary to the findings of Haug who reported a smaller Evan's Index in females than in males in individuals above 15 years old while the reverse was the case in individuals below 15 years old in the same study [8-10].

The Evan's Indexes in the current study was observed to increase with advancing age. Similar findings were reported by other researchers [11,12]. "These changes may be due to shrinkage of brain tissue with advancing age, while the cerebrospinal fluid spaces which include the ventricles increase in size in order to compensate for the atrophying brain parenchyma, leading to physiologic ventricular enlargement" [12].

The smallest Evans index observed was 0.26cm in males and 0.24cm in females and these were seen in the age group 11-20yaers in both male and female. The largest Evans indexes observed in this study were 0.32cm in males and 0.31cm in females, seen in the age group 61-70years in both male and female. This finding concur with the findings of Ahmed et al. in Zaria reported that the Evans Index (EI) does not exceed 0.3. They did not find a statistically significant difference in Evans ratio between males and females [13]. Odebode et al. "from Ibadan in their study among Yorubas in Western Nigerian in University of Ibadan employed it in assessing the relationship of ventricular size with visual function in children with hydrocephalus" [14]. Poca et al. [15] in their study found "EI to be of good predictive index in management of post-traumatic ventriculomegaly". "In the current study the Evan's Index was observed to be larger in male than the females and these differences were not statically significant. This is in in agreement with the findings of Hamidu et al. who also reported that, the mean of Evans index to be larger in males than females, but like in the current study the difference was not statistically significant" [16]. This is due to the fact that the brain substance shrinks with age, while the cerebrospinal fluid spaces which include the ventricles increase in size in order to compensate for the atrophying brain parenchyma, leading to physiologic ventricular enlargement.

The Evans index values obtained in the current study was slightly more than the value of 0.21 reported by Reddy et al in their study with mean [17]. This could be attributed to the fact that in their study there more percentage of the older population as compared to the current studies. In addition, difference could be due to racial and ethnic difference in size of the skull.

Takeda et al. reported "Evans ratio of 0.271 and 0.262 in the Japanese male and female population, respectively" [18]. While, a study by Sema et al among Turkish reported values of 0.27 and 0.28 for males and females, respectively [19]. These values are slightly higher than those observed in our study. The differences observed could be due to racial and ethnic difference in size of the skull.

4. CONCLUSION

Evans Index is a quantitative criterion which has been used extensively in assessing ventriculomegaly.

This study has provided the Evan's index in our environment that could serve as base line data and as reference point in feature. The Evan's index shows positive correlation with age. The least index was seen in early decade while, the largest occurred in the late decade of life in both males and females. Thera was a declined in the Evan's index in first two decades, while, the declined was marked in the later decades in both male and female. These changes may be the result brain changes that occurs with advancing age.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Scott ML, Golden CJ, Ruedrich SC, Bishop RJ. Ventricular enlargement in major depression. Psychiatry Research. 1983;8: 91-93.
2. Ambili P. Ct measurements of two cerebroventricular indices and their relation

with age. Journal of Evidence Based Medicine Health. 2017;4(6):303-306.
3. Toma AK, Holl E, Kitchen ND, Watkins LD. Evans' index revisited: The need for an alternative in normal pressure hydrocephalus. Neurosurgery. 2011;68: 939–44.
4. Hashimoto M, Ishikawa M, Mori E, Kuwana N. Study of INPH on Neurological Improvement (SINPHONI). Diagnosis of idiopathic Normal pressure hydrocephalus is supported by MRI-based scheme: A prospective cohort study. Cerebrospinal Fluid Research. 2010;7:18.
5. Idowu OE, Balogun MM. Visual function in infants with congenital hydrocephalus with and without myelomeningocoele. Childs Nervous System. 2014;30:327–30.
6. Gallia GL, Rigamonti D, Williams MA. The diagnosis and treatment of idiopathic normal pressure hydrocephalus. Nature Clinical Practice Neurology. 2006;2(7):375-81.
7. Ishii K, Kanda T, Harada A, Miyamoto N, Kawaguchi T, Shimada K. Clinical impact of the callosal angle in the diagnosis of idiopathic normal pressure hydrocephalus. Europian Radiology. 2008;2(18):2678–83.
8. Von Bezing H, Andronikou S, van Toorn R, Douglas T. Are linear measurements and computerized volumetric ratios determined from axial MRI useful for diagnosing hydrocephalus in children with tuberculous meningitis? Childs Nervous System. 2012;28:79–85.
9. Moore DW, Kovanlikaya I, Heier LA, Raj A, Huang C, Chu KW. A pilot study of quantitative MRI measurements of ventricular volume and cortical atrophy for the differential diagnosis of normal pressure hydrocephalus. Neurology Research International. 2012;71:8150.
10. Haug G. Age and sex dependence of size of normal ventricles on computed tomography. Neuroradiology. 1977;14(4): 201-204.
11. Gyldensted C, Kosteljanetz M. Measurements of the normal ventricular system and hemispheric sulci of 100 adult patients with computed tomography. Neuroradiology. 1977;14:138-192.
12. Skullerud K. Variations in the size of the human brain. Influence of age, sex, body length, body mass index, alcoholism, Alzheimer changes, and cerebral atherosclerosis. Acta Neurology. 1985;102:1-94.
13. Ahmed UH, Solomon ED, Sefiya AK, Banabas D, Abdullahi J, Olaniyan F. Third and fourth cerebral ventricular sizes among normal adults in Zaria-Nigeria. Sub-Saharan African Journal Medicine. 2015;2:89-92.
14. Odebode TO, Shokunbi MT, Malomo AO, Familusi JB, Agbeja-Baiyeroju AM, Ogunseyinde AO. The relationship between ventricular size and visual function in children with hydrocephalus. African Journal of Medical Sciences, 1998;27:213–8.
15. Poca MA, Sahuquillo J, Mataró M, Benejam B, Arikan F, Báguena M. Ventricular enlargement after moderate or severe head injury: A frequent and neglected problem. Journal Neurotrauma 2005;22:1303–10.
16. Hamidu AU, Olarinoye-Akorede SA, Ekott DS, Danborno B, Mahmud MR, Balogun MS. Computerized tomographic study of normal Evan's index in adult Nigerians. J Neurosci Rural Pract. 2015;6:55–8. [PMC free article] [PubMed] [Google Scholar]
17. Reddy VU, Hegde KV, Agrawal A, Pathapati RM, Arumulla M. Normative values for Evan's index on CT scan for apparently healthy individuals. J Anat Soc India. 2015;64:137–40. [Google Scholar]
18. Takeda S, Hirashima Y, Ikeda H, Yamamoto H, Sugino M, Endo S. Determination of indices of the corpus callosum associated with normal aging in Japanese individuals. Neuroradiology. 2003;45:513–8. [PubMed] [Google Scholar]
19. Sema P, Yasemin OF, Mahmut O, Gül KA, Hilmi YA. Morphometric MRI study of the brain ventricles in healthy Turkish subjects. Int J Morphol. 2019;37:554–60.

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