

# Normative Parameters of Evans Index using Computerized Tomographic Scan in Individuals of Kashmiri Ethnicity

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## ABSTRACT

**Introduction:** Knowledge of the ventricular size is important for the initial and precise diagnosis of hydrocephalus. Evans index is a valuable parameter in diagnosis of the NPH, follow up cases of VP shunt, dementia and many other pathologies. Therefore, having a baseline reference data of the Evan's index will be helpful in a wide range of clinical pathologies. Our aim was to establish normal values for Evans index in a Kashmiri indian population as none has been found in the Kashmiri medical literature.

**Material and Methods:** Axial computerized tomographic brain scans of 300 normal subjects were reviewed. EI was measured as the linear ratio of the widest anterior horn width of the cerebral lateral ventricles to the widest inner diameter of the skull.

**Results:** Of them, 185(61.66%) of the patients were males and 115 (38.33%) were females; their ages ranged from 6 to 96 years with a mean age of 47 years. The images were acquired using a 16 slice CT machine. The mean value for Evans index for the studied population was  $0.264 \pm 0.03$ . The EI increased with age and it was slightly higher among males. The difference in Evans value in males and females was not statistically significant. Individuals above 60 years old had the highest Evans values in both sexes.

**Conclusion:** This study established the ranges of normal value for Evans index in a Kashmiri population. It agrees with the diagnostic cut-off value of  $> 0.3$  for hydrocephalus and it compares well with that of the Caucasians.

**Keywords:** Lateral ventricle, Computerized tomography, Evans index, Kashmiri, Hydrocephalus

## INTRODUCTION

Ventricles constitute 2 percent of brain volume.82 percent of the ventricular volume is contributed by lateral ventricles.<sup>1</sup> Ventricular enlargement caused due to Imbalance in the production and absorption of cerebrospinal fluid is called hydrocephalus.<sup>2</sup> For the precise and early diagnosis of type of hydrocephalus, knowledge of ventricular size is essential. Computed Tomography (CT) is an accepted procedure in the identification of wide range of pathologic abnormalities and measuring the ventricular size accurately. In Kashmir scenario, CT still remains an easily available, affordable and faster mode of brain imaging. Ventricular size can be obtained by linear or volumetric measurements, out of which the linear ratios of the width of ventricles to the width of brain or skull is an easiest reproducible method. Evan's Index is one such ventriculo graphic index. It is the ratio which compares the maximum width of the frontal horns of lateral ventricles to the maximum transverse diameter of

inner table of the skull at the same level.<sup>3</sup> For the diagnosis of Normal Pressure Hydrocephalus (NPH), follow-up cases of ventriculoperitoneal shunt<sup>4</sup>, alcoholism, dementia, this index is an important parameter. Thus developing a baseline reference data of Evan's index will be useful in a wide range of clinical conditions for this population where such data is unavailable. Our aim was to establish normal values for Evans index in a Kashmiri indian population as none has been found in the Kashmiri medical literature.

## MATERIAL AND METHODS

Ethical consideration does not permit that healthy individuals with no clinical symptoms be subjected to ionizing radiation. Therefore, CT scans of neurologic patients which were reported to be normal were reviewed for this study. Being a retrospective study, patient consent was not required however; this research was approved by the ethics committee of govt medical college Hospital. Scan reports of 450 patients that were reported as normal were reviewed independently alongside their images by two radiologists. However, a total of 300 patients were finally selected and were analyzed for the study. They consisted of 185 males and 115 females and ranged between 6 and 96 years old. CT images were obtained from the local database of the CT machine and back up compact discs from the CT archives. The study was done using the department's Siemens 16 slice CT scanner 3mm slice thickness. The images were than viewed on computer monitor using a meter rule with which, following measurements were made as seen in Figure 1.

$EI = a/b$

## Exclusion criteria

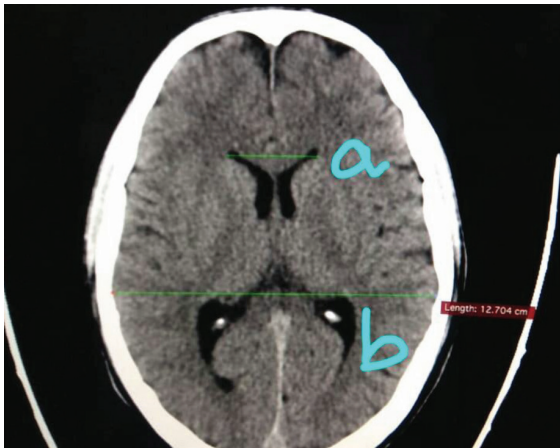
Seven patients whose study has been deteriorated due to movement were not included in the study population. Also, two patients were not selected who had only descriptive report of normal without a final conclusion.

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**How to cite this article:** Majid Jehangir, Iqbal Hussain Dar, Amandeep Sahota, GH Hassan, Kaleem Mustafa, Aamir Javaid. Normative parameters of evans index using computerized tomographic scan in individuals of Kashmiri ethnicity. International Journal of Contemporary Medical Research 2018;5(6):F1-F3.

**DOI:** <http://dx.doi.org/10.21276/ijcmr.2018.5.6.2>



**Figure-1:** a- Illustrative axial CT section of one of the selected patients showing how measurements were taken. Total Anterior horn width (TAHW): a Maximum intracranial diameter (MICD): b- Evans index (EI) was derived by calculation for each patient as:  $a/b$

### STATISTICAL ANALYSIS

Statistical analysis was done using spss software. Statistical analysis was done using SPSS software version 16.0. Descriptive statistics like mean and percentages were used for the analysis.

### RESULTS

The difference in Evans value in males and females was not statistically significant. Individuals above 60 years old had the highest Evans values in both sexes.

There were a total of 300 healthy individuals between 6 and 96 years, with a mean of 47. Of them, 185 (61.66%) of the patients were males and 115 (38.33%) were females. The mean value for Evans index for the studied population was  $0.264 \pm 0.03$ . The EI increased with age and it was slightly higher among males. There was no much variation in calculation of Evan's index from CT scan. Evan's index can be calculated fairly accurately by multiple observers, which can be appreciated in the form of very small standard deviations. We found that less than 5% of patients were having ventriculomegaly but there were no clinical symptoms related to ventriculomegaly (table-1).

Age group (years)	Mean evans index
0-10	0.24
010-20	0.25
20-30	0.25
30-40	0.26
40-50	0.25
50-60	0.27
60-70	0.26
70-80	0.28
80-90	0.29
90+	0.3

### DISCUSSION

EI being a quantitative criterion has been used extensively in assessment of ventriculomegaly and the mean value agrees with those of previous Caucasian studies in this study.<sup>5-9</sup> We also found that EI is increased with advancing age as reported

by the other authors.<sup>8,9</sup> The reason being brain parenchyma shrinks with age, while cerebrospinal fluid spaces which also include the ventricles increase in size, to compensate for the atrophying brain substance. However this physiologic ventricular enlargement does not cause Evans ratio to exceed 0.3. No statistically significant difference in the Evans ratio between males and females was found in our study. Haug has reported that females as compared to males has a smaller ventricular system above 15 years of age, while values were reverse in the individuals below 15 years old in the same study.<sup>10</sup>

Idiopathic normal pressure hydrocephalus consists of triad of dementia, urinary incontinence and gait disturbance and is potentially a reversible cause of dementia in the elderly. It responds well to CSF shunting procedures. The disruptive effects of severe cerebral atrophy on memory, autonomic function and cognitive ability and could then be averted.<sup>5</sup> The ventricular enlargement could be quantitatively assessed by Evans index, with diagnostic cut off value of  $>0.3$  based on international guidelines.<sup>7</sup> In presence of the clinical symptoms EI could be adequate for the diagnosis. Our finding also supports that this defining criterion ( $EI > 0.3$ ) could be used in the diagnosis of hydrocephalus in our own environment. EI is also an acceptable predictive index in post-traumatic ventriculomegaly as stated by Poca et al<sup>11</sup> while Odebode et al.<sup>12</sup> used it in determining the inter relation of visual function and ventricular size in children suffering from hydrocephalus. Here is the comparison of different studies measuring EI in different populations.

Study	Evan's Index
Present study	$0.264 \pm 0.03$
Hamidu A U et al., <sup>13</sup>	$0.252 \pm 0.04$
Patnaik P et al., <sup>14</sup>	$0.27 \pm 0.035$
Kosourov AK et al., <sup>15</sup>	0.22 to 0.28
Wilk R et al., <sup>16</sup> (Pediatric sample)	0.218 to 0.312
Sari E et al., <sup>17</sup> (Pediatric sample)	0.23 to 0.28

### CONCLUSION

In this presentation, the authors have determined the range of normal values of Evans index in a Kashmiri indian population using computerized tomography.

### REFERENCES

- Akdogan I, Kiroglu Y, Onur S, Karabulut N. The volume [1] fraction of brain ventricles to total brain volume: a computed tomography stereological study. *Folia Morphol (Warsz)*. 2010; 69:193-200.
- Haslam RHA. Hydrocephalous. In: Behrman RE, Kliegman[2] RM, Nelson WE, Vaughan VC. (eds). *Nelson Text Book of Pediatrics*, 14th edition. Philadelphia, W.B. Saunders Co 1992; page 1487.
- Hamidu AU, Olarinoye-Akorede SA, Ekott DS, Danborn[3] B, Mahmud MR, Balogun MS. Computerized tomographic study of normal Evans index in adult Nigerians. *J Neurosci Rural Pract*. 2015;6:55-58.
- Hashimoto M, Ishikawa M, Mori E, Kuwana N. Study of [4] INPH on Neurological Improvement (SINPHONI).

- Diagnosis of idiopathic Normal pressure hydrocephalus is supported by MRI-based scheme: A prospective cohort study. *Cerebrospinal Fluid Res.* 2010;7:18.
5. Moore DW, Kovanlikaya I, Heier LA, Raj A, Huang C, Chu KW, et al. A pilot study of quantitative MRI measurements of ventricular volume and cortical atrophy for the differential diagnosis of normal pressure hydrocephalus. *Neurol Res Int.* 2012;2012:718150.
  6. Ambarki K, Israelsson H, Wählin A, Birgander R, Eklund A, Malm J. Brain ventricular size in healthy elderly: Comparison between Evans index and volume measurement. *Neurosurgery.* 2010;67:94–9.
  7. 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.
  8. Gyldensted C, Kosteljanetz M. Measurements of the normal ventricular system with computer tomography of the brain. A preliminary study on 44 adults. *Neuroradiology.* 1976;10:205–13.
  9. 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. *ActaNeurolScand Suppl.* 1985;102:1–94.
  10. Haug G. Age and sex dependence of the size of normal ventricles on computed tomography. *Neuroradiology.* 1977;14:201–4.
  11. Poca MA, Sahuquillo J, Mataró M, Benejam B, Arikian F, Báguena M. Ventricular enlargement after moderate or severe head injury: A frequent and neglected problem. *J Neurotrauma.* 2005;22:1303–10.
  12. Odebo TO, Shokunbi MT, Malomo AO, Familusi JB, Agbeja-Baiyerolu AM, Ogunseyinde AO. The relationship between ventricular size and visual function in children with hydrocephalus. *Afr J Med Med Sci.* 1998;27:213–8.
  13. Hamidu AU, Olarinoye-Akorede SA, Ekott DS, Danborno [3] B, Mahmud MR, Balogun MS. Computerized tomographic study of normal Evans index in adult Nigerians. *J Neurosci Rural Pract.* 2015;6:55-58.
  14. Patnaik P, Singh V, Singh S, Singh D. Lateral ventricle ratios [7] correlated to diameters of cerebrum-A study on ct scans of head. *J Anat Sciences.* 2014; 22:5-11
  15. Kosourov AK, Gaivoronskij IV, Rokhlin GD, Blagova IA, Panfilenko [12] AF. In vivo assessment of various parameters of the brain ventricles with magnetic resonance tomography. *Morfologija.* 2002;122:71-73.
  16. Wilk R, Kluczevska E, Syc B, Bajor G. Normative values for [15] selected linear indices of the intracranial fluid spaces based on CT images of the head in children. *Pol J Radiol.* 2011;76:16- 25.
  17. Sari E, Sari S, Akgün V, Özcan E, İnce S, Babacan O, Saldır M, [16] et al., measures of ventricles and Evans' Index: From neonate to adolescent. *PediatrNeurosurg.* 2015;50:12-17.

**Source of Support:** Nil; **Conflict of Interest:** None

**Submitted:** 14-05-2018; **Accepted:** 16-06-2018; **Published:** 27-06-2018