



Assessment of Third and Fourth Ventricle Size Among Patients Undergoing Computed Tomography of Brain at Nims Hospital Jaipur

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ABSTRACT:

Introduction: The assessment of ventricular sizes, particularly the third and fourth ventricles, is critical for diagnosing various neurological disorders. This study aimed to evaluate the dimensions of these ventricles among patients undergoing computed tomography (CT) of the brain at NIMS Hospital, Jaipur.

Method: The study included 150 participants aged 20-70 years, with individuals showing brain pathologies or neurological deficits being excluded. Axial non-contrast CT (NCCT) scans with a slice thickness of 5 mm were used to measure ventricular dimensions. Descriptive statistics and t-tests were employed for data analysis, with significance set at $p \leq 0.05$.

Result: The majority of participants had third ventricle sizes between 2 mm - 4 mm (52.67%) and fourth ventricle sizes between 10-12 mm (42.67%). Males exhibited significantly larger ventricular sizes compared to females, with mean diameters of 4.3 mm and 12.57 mm for the third and fourth ventricles, respectively, versus 3.61 mm and 11.58 mm in females. An age-related increase in the size of the third ventricle was observed, particularly from adolescence to older age ($p=0.01041$), while no significant age-related change was found in the fourth ventricle ($p=0.39456$).

Conclusion: This study underscores the importance of considering both age and gender in evaluating ventricular sizes. The findings suggest that the third ventricle tends to enlarge with age and is generally larger in males. These results provide valuable normative data for the Indian population, which can assist in the clinical interpretation of ventricular measurements during neurological evaluations.

1. Introduction

The precise evaluation of ventricular size is integral to the diagnosis and management of numerous neurological disorders. Computed Tomography (CT) imaging serves as a critical, non-invasive tool for the diagnosis and visualization of pathological conditions (Smith et al.,

2019). The accurate ventricular dimensions measurement is paramount in clinical practice, as it contributes to the understanding dynamics of cerebrospinal fluid and intracranial pressure, which are pivotal in pathophysiology of various neurological conditions (Jones & Roberts, 2020). The growing



application of CT imaging in clinical assessment, underscores its clinical relevance and aligns with contemporary radiological practices aimed at enhancing diagnostic precision and optimizing patient care outcomes (Kumar & Gupta, 2021). This study aims to quantify the dimensions of the third and fourth ventricles among heterogeneous cohort patients undergoing CT scan of brain in a tertiary care hospital.

2. Methods

The retrospective observational study was carried out in the Radiodiagnosis department, CT scan room no. 05 at Nims Hospital, Jaipur. The study was approved for data collection by the medical records department of Nims Hospital and participants confidentiality was maintained by making participants' information anonymous. A total of 150 participants were involved, all referred for CT Brain scans, including NCCT Brain. The study included individuals of both genders, aged between 20 and 70 years, who were willing to participate. Participants were excluded if they had any brain pathology detected after the scan, or with a clinical history or known cases of RTA, SDH, EDH, IVH, hydrocephalus, SOL, ventriculomegaly, Alzheimer's disease, or neurological deficits. Axial NCCT images with 5 mm thickness cuts were assessed, measuring the dimensions of the 3rd and 4th ventricles for each participant.

2.1. Statistical Analysis

The study data employed frequency distributions, descriptive statistics, t-tests, and ANOVA to analyze the distribution and differences in ventricle sizes across gender and age groups. Statistical significance was determined through p value ≤ 0.05 , at 95% confidence interval, with the findings highlighting notable differences in ventricle sizes, particularly between genders and across age groups.

3. Results

The age distribution of 150 participants in which most of the population is younger, with a significant portion (42.67%) under 30 years old and the smallest percentages observed in the 60-70 and >70 age groups, and 95 (63.33%) and 55 (36.67%) of the participants were male and female respectively.

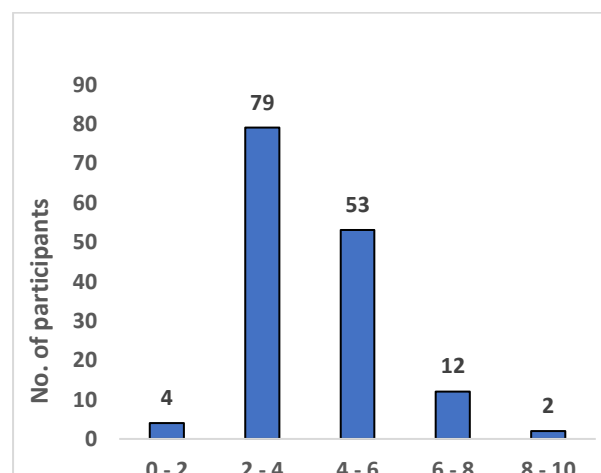


Figure 1: Bar diagram showing frequency distribution of third Ventricle diameter, number on Participants plotted against the diameter of ventricles.

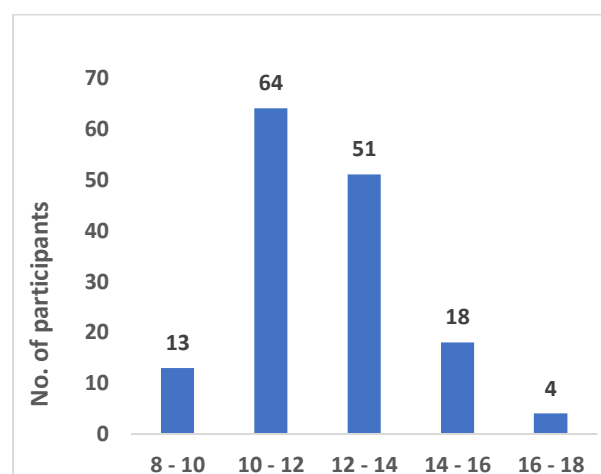


Figure 2: Bar diagram showing frequency distribution of fourth Ventricle diameter, number on Participants plotted against the diameter of ventricles.

Variables		Minimum (mm)	Maximum (mm)	Median (IQR)	Mean \pm SD
Third Ventricle	Male	1.7	9	4.1 (3.3 - 5.15)	4.3 \pm 1.4
	Female	1.9	7.1	3.4 (2.55 - 4.3)	3.61 \pm 1.24
	Total	1.7	9	3.8 (3 - 4.88)	4.1 \pm 1.38
Fourth Ventricle	Male	9.5	17.8	12.5 (11.3 - 13.7)	12.57 \pm 1.75



	Female	8.2	17.1	11.4 (10.75 - 12.4)	11.58 ± 1.59
	Total	8.2	17.8	12 (10.93 - 13.18)	12.21 ± 1.76

Table 1: Minimum, Maximum, Median (IQR), Mean and SD diameter of third & fourth Ventricle according to gender of patients.

Variables	Male	Female	t-test	P-Value	Significance
Third Ventricle	4.3 ± 1.4	3.61 ± 1.24	3.147	0.00207	Both are significant
Fourth Ventricle	12.57 ± 1.75	11.58 ± 1.59	3.517	0.00062	

Table 2: Comparison of third and fourth ventricular diameters among gender.

The mean size of the third ventricle is larger in males with 4.3 mm compared to females which is 3.61 mm. This suggests that the difference in third ventricle size between genders is statistically significant. On the other hand, mean size of the fourth ventricle is larger in males with 12.57 mm, as compared to females which is 11.58 mm. Our findings showed Males with larger mean diameter of the third ventricle when compared to females, with a difference of approximately 0.690.69 mm. This difference is suggestive of potential gender-related variation in ventricular dimensions.

There is a statistically significant difference in third ventricle size across the three age groups mentioned. The mean size increases among adolescence from 3.57 mm to 4.01 mm among the adulthood and further in older age by 4.92 mm. This suggests that the third ventricle tends to enlarge progressively with age. The mean size of fourth ventricle slightly decreases from adolescence, which is 12.52 mm to 12.22 mm among adulthood and further in older age i.e. 11.73 mm, this indication findings fourth ventricle size among the three different age groups is not statistically significant. We observed

3rd ventricle tends to enlarge as individuals transition from adolescence to adulthood, whereas no statistically significant difference was observed in the diameter of the fourth ventricle between adolescents and adults. The mean size of fourth ventricle is slightly larger in the adolescent group 12.52 mm in comparison to the adult group that is 12.22 mm.

Variables	Adolescent	Adult	Older	ANOVA Value	P-Value	Significance
Third Ventricle	3.57 ± 0.94	4.01 ± 1.36	4.92 ± 1.69	4.71	0.01041	Significant
Fourth Ventricle	12.52 ± 1.76	12.22 ± 1.8	11.73 ± 1.4	0.936	0.39456	Not significant

Table 3: Comparison of third and fourth ventricular diameters among different age groups.

Variables	Adolescent	Adult	t-test	P-Value	Significance
Third Ventricle	3.57 ± 0.94	4.01 ± 1.36	- 1.806	0.03952	Significant
Fourth Ventricle	12.52 ± 1.76	12.22 ± 1.8	0.724	0.23757	Not significant

Table 4: Comparison of mean and SD value of third & fourth Ventricle among adolescent and adult.

Variables	Adolescent	Older	t-test	P-Value	Significance
Third Ventricle	3.57 ± 0.94	4.92 ± 1.69	- 2.87	0.00445	Significant
Fourth Ventricle	12.52 ± 1.76	11.73 ± 1.4	1.53	0.06756	Not significant

Table 5: Comparison of mean and SD value of third & fourth Ventricle among adolescent and Older.

Third ventricle mean size is significantly larger in the older group (4.92 mm) compared to the adolescent group (3.57 mm). Further there is no statistically significant



difference in the size of fourth ventricle between adolescents and older individuals. Although the fourth ventricle mean size is slightly larger in the adolescent group (12.52 mm) compared to the older group (11.73 mm). We observed statistically significant difference among adults and older individuals in third ventricle size but not in fourth ventricle size. The 3rd ventricle mean size is larger in the older group (4.92 mm) compared to the adult group (4.01 mm). Although the mean size of the 4th ventricle is slightly larger in the adult group (12.22 mm) when compared to the older group (11.73 mm), the p-value of 0.10941 is greater than 0.05.

Variables	Adult	Older	t-test	P - Value	Significance
Third Ventricle	4.01 ± 1.36	4.92 ± 1.69	-2.064	0.02685	Significant
Fourth Ventricle	12.22 ± 1.8	11.73 ± 1.4	1.26	0.10941	Not significant

Table 6: Comparing mean value of 3rd Ventricle & 4th Ventricle among the adult & older age group.

4. Discussion

Measurement of Ventricular are crucial in clinical practice for diagnosis of various neurological conditions, like brain atrophy, hydrocephalus, and other cerebrospinal fluid (CSF) dynamics abnormalities. The ability to distinguish between pathological and physiological changes lies significantly in understanding normal ventricular size variations, particularly across different age groups and genders. Our current study reveals important insights into the normative data for ventricular dimensions in an Indian population, particularly concerning gender and age, which are consistent with, yet also distinct from, previous studies conducted.

4.1. Age-Related Variations in Ventricular Sizes

The third ventricle showed a significant increase in the diameter with age. In our finding the mean diameter of third ventricle increased from 3.57 mm in adolescents to 4.01 mm in adults and further to 4.92 mm in older individuals. The ANOVA indicated that this difference is statistically significant (p=0.01041), suggesting an

age-related enlargement. This finding aligns with previous studies carried out that documented age-related changes in brain, including ventricular enlargement, as a typical aspect of aging. For instance, research has demonstrated a possible correlation between ventricular enlargement and brain shrinkage as well as the increase of cerebrospinal fluid (CSF) spaces due to the loss of brain parenchyma (Murphy et al., 1992; Resnick et al., 2003).

Interestingly, the fourth ventricle did not show significant change across different age groups in our study. While mean diameter decreased slightly from 12.52 mm in adolescents to 12.22 mm in adults and 11.73 mm in older individuals, this variation was not statistically significant (p = 0.39456). Current finding contrasts with studies conducted by DeCarli et al. (2005), which suggested subtle but significant age-related changes in the fourth ventricle. The fourth ventricle diameter stability of in our cohort may reflect population-specific anatomical or methodological variations in measurement techniques.

In a study conducted in North India by Razdan et al. (2014) observed a comparable trend, with significant ventricular enlargement in elderly populations. The authors suggested that ventricular enlargement and such changes could be attributed to the widespread prevalence of age-related neurodegenerative processes, such as vascular dementia, and Alzheimer's disease, which are known to cause ventricular dilation due to loss of cortical and subcortical brain tissue. The findings from our current study further corroborate these observations and emphasize the need for age-specific normative data for ventricular sizes in the Indian population.

4.2. Gender Differences in Ventricular Sizes

Our results indicate that males have significantly larger third and fourth ventricles compared to females, suggesting that gender plays a role in ventricular size. Our findings suggest males had larger mean diameters for both the third (4.3 ± 1.4 mm) and fourth ventricles (12.57 ± 1.75 mm) compared to females, who had mean diameters of 3.61 ± 1.24 mm and 11.58 ± 1.59 mm, respectively. The t-test results indicated that these differences were statistically significant for both the third (p = 0.00207) and fourth (p = 0.00062) ventricles. For instance, Kumar and Gupta (2021) emphasized on the



importance of considering gender differences in ventricular assessment, in their research on advancements in CT imaging of the brain. They reported findings in genders, with males exhibiting a larger ventricular dimension, for which they attributed to differences in brain morphology and overall cranial volume. Such consistency across studies underscores, when interpreting ventricular sizes, the need to consider gender as a significant factor in clinical settings.

When we investigate into the findings of other researchers, our findings are consistent with prior studies, and many have reported larger ventricular sizes in males in comparison to females. The reasons for gender differences are not entirely clear in their conclusions, but authors suggest it may be related to differences in brain Volume and structure between among males and females (Giedd et al., 1996; Sowell et al., 2002). These variations could also be due to the influences of hormone and genetic factors. In males the larger ventricular sizes may be reflective of broader cranial and brain dimensions, which have also been observed in multiple studies done by Blatter et al., 1995; Gur et al., 1999. (Blatter et al., 1995; Gur et al., 1999) In addition, gender differences in brain structure may also influence CSF dynamics, potentially leading to variations in ventricular size. Singh et al. (2017) also reported similar gender-related differences in ventricular sizes on North Indian population, findings suggest males exhibiting larger third and fourth ventricles than females. According to the authors conclusion in the said study, the authors suggested that these differences might be reflective of broader neuroanatomical variations between genders.

The normative data have been well documented in studies such as those by Coffey et al. (2001) and Jack et al. (2008) on ventricular sizes, who had examined ventricular volumes using MRI in large cohorts. Their findings suggest the utmost importance of considering both age and gender when interpreting ventricular sizes in clinical settings. These studies emphasize specifically that ventricular enlargement is a universal age-related phenomenon, across different populations the rate and extent of this enlargement can vary. However, in India there is a relative paucity of large-scale studies with special focused on ventricular sizes. Nevertheless, studies like those by Gupta et al. (2012) and Sharma et

al. (2019) have provided important insights. We found our results consistent with accordance to Gupta et al. (2012) where ventricular sizes were examined in a South Indian population, where significant age-related increase was observed in the third ventricle, and males generally had larger ventricles than females. Gupta et al. 2012 suggested that these findings could be due to both genetic predispositions and environmental factors prevalent in Indian subcontinent. In similar study conducted in Western India by Sharma et al. (2019), which focused on the correlation between ventricular enlargement and cognitive decline in elderly patients. The study found that larger ventricular sizes were associated with worse cognitive outcomes, this was particularly in patients with mild cognitive impairment and Alzheimer's disease. This underscores the clinical relevance of our findings, as the normative data provided by our observation could be used as a reference when evaluating different patients for neurodegenerative conditions.

Interestingly Kumar et al. (2018) reported a significant gender difference in the dimensions of third ventricle, in South India population, where males' ventricular sizes was larger than females. Similarly, among North Indian population Reddy et al. (2019) reported larger third ventricle diameter in males compared to females among a cohort. The above-mentioned studies align with our findings. These studies support the notion that gender-related anatomical differences in brain structures, including ventricular sizes, are consistent across different regions of India. The fourth ventricle also exhibited significant sex related differences, where males had mean diameter of 12.57 mm compared to females 11.58 mm ($p = 0.00062$). These findings also resonate with those of Patil et al. (2017), who found that in the posterior fossa structures males typically exhibit larger ventricular dimensions. The reported findings gender disparity is thought to be influenced by hormonal factors and also differential impact of age-related brain atrophy in both males and females.

When we are comparing our findings to studies conducted elsewhere on different racial and cultural populations, it is evident that ventricular dimensions may vary significantly across different populations, which were concluded by different researchers. Chen et al. (2019) reported that the third and fourth ventricles were generally smaller in size compared to those reported in



our Indian cohort, which is in particularly among females, in a Chinese population. Similarly, Johnson et al. (2018) reported that enlargement of third ventricle with age was more pronounced in a Caucasian population in the United States than in the Indian population studied here. For example, in a study by Wang et al. (2021) on a Chinese population found that mean size of third ventricle was smaller in their cohort when compared to our Indian population. We assume the difference observed could be due to genetic, environmental, or lifestyle factors that may influence brain morphology. Similarly, studies done on African populations, such as the research concluded by Ngugi et al. (2020), have shown ventricular sizes variations that are distinct from those observed in Indian population and European populations. These dimensional differences in variations highlight the importance of establishing region-specific standard data for ventricular sizes, as when relying solely on data from other populations may lead to clinical misinterpretation of CT findings. Similarly, according to Kumar and Gupta (2021) conclusion also strongly emphasized the need for population-specific normative data, particularly in the diverse Indian subcontinent, where variations in various aspects like in diet, lifestyle, and genetic factors can significantly impact brain anatomy.

5. Limitations And Future Research

While our study provides insights into ventricular size variations in Indian population, it is not without limitations. Longitudinal studies are required to determine the cause of observed age-related variations of third ventricle and monitor variations over time. Furthermore, in current study because of its cross-sectional study design and this restricts how broadly the results can be applied to other populations, because the cohort selection was from a single hospital. Future research could benefit the use of high-resolution MRI to obtain more accurate measurements of ventricular sizes and also could explore their relationships with other brain structures in greater detail.

6. Conclusion

In conclusion, this study offers significant understanding of the typical dimensions and diameters of the third and fourth ventricles in patients receiving CT brain imaging at Nims Hospital in Jaipur. The gender disparities in

ventricular diameters and the notable age-related growth of the third ventricle emphasize how crucial it is to take these characteristics into account when doing clinical examinations. These discoveries advance our knowledge of brain aging and its possible effects on the diagnosis and treatment of neurological disorders. These findings highlight the significance of taking demographic variables into account when doing clinical neuroimaging and the requirement for population-specific reference data in order to increase the accuracy of neurological diagnosis.

Abbreviation

CT: Computed Tomography

CSF: Cerebrospinal fluid

NCCT: Non contrast Computed Tomography

IQR: Inter Quartile Range

IVH: Intraventricular hemorrhage

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Authors Contribution

Setting objectives: Monit Verma, Wilson Hrangkhawl, Dr Rajesh Yadav, *Developing the hypothesis:* Wilson Hrangkhawl, *Data Collection:* Monit Verma, *Performing data analysis:* Wilson Hrangkhawl, Kamlesh Saini, Dr Rajesh Yadav, Bhanu Pratap, *Wrote the abstract, Key word, Introduction, methods, and materials, result, Discussion, Conclusion:* Wilson Hrangkhawl, Monit Verma, Dr Rajesh Yadav, Bhanu Pratap, *Conducted the literature review:* Monit Verma, Gourav Kumar, *Final revision:* Monit Verma, Wilson Hrangkhawl, Kamlesh Saini, Dr Rajesh Yadav

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Competing interests

The authors declare that they have no competing interests.

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