RESEARCH PAPER

# Estimation of The Reference Value of Optic Nerve Sheath Diameter by Using Transorbital Sonography in A Healthy South Indian Population- A Cross Sectional Observational Study


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## ABSTRACT

**Background:** Optic nerve sheath diameter (ONSD) measured using transorbital ultrasonography has emerged as a reliable non -invasive surrogate marker for raised intracranial pressure. However, interpretation of ONSD measurements requires population-specific normative values, which are limited for the South Indian population. Establishing reference values is essential for improving diagnostic accuracy in emergency and critical care settings.

**Objective:** To estimate the reference values of optic nerve sheath diameter using transorbital sonography in a health y South Indian adult population and to evaluate variations with respect to age and gender.

**Methods:** This cross-sectional observational study was conducted among 1000 healthy adult participants. Individuals meeting inclusion criteria underwent transorbital ultrasonography using a linear probe to measure the optic nerve sheath diameter 3 mm posterior to the optic disc with eyes closed in the supine position. Demographic data and clinical parameters were recorded. Descriptive statistics were used to determine mean ONSD values, and inferential statistics were applied to evaluate differences between gender, age groups, and laterality.

**Results:** The mean optic nerve sheath diameter was 5.00 ± 0.31 mm in the right eye and 5.00 ± 0.32 mm in the left eye, with range s of 3.92–5.97 mm and 3.91–6.09 mm, respectively. No significant difference was observed between right and left eye measurements ($p = 0.278$), indicating bilateral symmetry. Male participants demonstrated slightly higher mean ONSD values compared to females ($p < 0.05$). Age-wise analysis showed a statistically significant increase in ONSD with advancing age, with the highest values observed in individuals aged >50 years (right eye: 5.23 ± 0.32 mm, left eye: 5.21 ± 0.33 mm) ($p < 0.001$).

**Conclusion:** This study establishes normative reference values for optic nerve sheath diameter in a large cohort of healthy South Indian adults. The findings confirm bilateral symmetry of ONSD and demonstrate modest variations with age and gender. These population -specific reference values may enhance the clinical utility of transorbital ultrasonography for rapid, non-invasive assessment of intracranial pressure in emergency and critical care settings.



**Keywords:** Optic nerve sheath diameter, ONSD, transorbital ultrasonography, intracranial pressure, emergency medicine, South Indian population.

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## INTRODUCTION

The optic nerve sheath is a continuance of the brain's meninges as well as is straight influenced by variations in intracranial pressure (ICP). Any rise in ICP is conveyed through the subarachnoid space, leading to expansion of the optic nerve sheath. Because of this anatomical continuity, the optic nerve sheath diameter (ONSD) has emerged as a reliable, non-invasive surrogate marker for perceiving elevated intracranial pressure in emergency as well as critical care settings [1]. Traditional methods for evaluating ICP, such as lumbar puncture or aggressive intracranial monitoring, although accurate, are associated with procedural risks, limited availability, and contraindications in unstable patients. Neuroimaging techniques like computed tomography (CT) and magnetic resonance imaging (MRI) can support ICP assessment,

**Author for Correspondence: Dr.Prahadheeswar* but they are time -consuming, expensive, and not always feasible in hemodynamically compromised individuals [2]. These limitations have driven the need for simple, rapid, bedside, and non-invasive diagnostic tools, positioning transorbital ultrasonographic measurement of ONSD as a promising alternative. Transorbital sonography has gained attention in earlier years because it is non-ionizing, safe, repeatable, and can be performed in any clinical setting with minimal infrastructure. The optic nerve can be visualized easily with a high-frequency linear probe, as well as the ONSD can be measured within seconds. Studies have demonstrated that ONSD measurement associates strongly y with intrusively measured ICP, making it valuable in neurosurgical emergencies, traumatic brain injury, hepatic encephalopathy, stroke, and meningitis [3]. Moreover, ultrasonography is particularly advantageous in regions with limited access to advanced neuroimaging facilities. Because of these benefits, ONSD assessment has become an integral part of point-of-care ultrasound (POCUS) protocols worldwide [4].

Though, one of the critical challenges in the clinical application of ONSD is the variability of normal reference ranges across populations. Ethnicity, age, skull anatomy, and even differences in ultrasound machines and operator technique can influence measured values. Studies conducted in Western and East Asian populations have proposed normal ONSD cu t-off values ranging among 4.5 mm and 5.9 mm for predicting elevated ICP [5]. Yet, applying these values directly to Indian populations may lead to inaccurate interpretations. India is ethnically diverse, and anatomical variations can exist across regions, reinforcing the need for population-specific normative data. The South Indian population, with its distinct biological characteristics and craniofacial morphology, may demonstrate ONSD ranges that differ from those reported in Northern Indian or non -Indian populations [6].

The lack of a standardized reference range for ONSD in healthy Indian adults poses a significant challenge in clinical decision - making. Without reliable local normative data, clinicians may under or over-estimate the risk of raised ICP, leading to delays in diagnosis or unnecessary interventions. Although a few Indian studies have attempted to determine the normal ONSD range, their sample sizes have been limited, methodologies inconsistent, or populations not exclusively healthy. Some studies have included hospital patients who may have subclinical conditions affecting ONSD, making their findings less generalizable to the healthy general population [7]. Furthermore, regional variations within India, influenced by environmental, genetic, and nutritional factors, further emphasize the need for localized research, especially in South India. Ultrasonographic measurement of ONSD is influenced by the plane of acquisition, probe frequency, and distance from the optic disc. Consistency is cruci al to ensure reproducibility. Global recommendations suggest measuring ONSD **3 mm posterior to the globe** in an axial plane because this location shows maximum distensibility of the sheath and correlates best with ICP changes [8]. However, not all studies strictly adhere to this methodology, leading to discrepancies in reported values. Therefore, establishing a well-designed study using standardized, reproducible techniques is essential to generate dependable reference data. In emergency medicine, the ability to rapidly identify raised intracranial pressure can significantly influence patient outcomes. Raised ICP is a critical manifestation of several life -threatening conditions, including traumatic brain injury, intracerebral haemorrhage, hepatic encephalopathy, as well as central nervous system infections. Delay in recognition and treatment is connected with augmented morbidity and mortality [9]. Because raised ICP is primarily a clinical and radiological diagnosis, and because clinical signs may be subtle or late-appearing, bedside ultrasonographic ONSD measurement provides an invaluable early indicator. A normal reference range appropriate for the local population enhances diagnostic confidence and guides appropriate triaging, management, and referral decisions.

The South Indian population is underrepresented in published ONSD research. Given the high burden of emergency neurological conditions in India and the increasing integration of bedside ultrasound in both urban and rural healthcare settings, establishing normative values becomes even more important. Additionally, the training and practice of point-of-care ultrasonography have expanded significantly in Indian medical institutions, especially in emergency medicine departments, making reliable reference values essential for education and clinical application [10].

Moreover, ONSD measurement using ultrasound is particularly useful in scenarios where CT or MRI may be contraindicated, such as in pregnant women, unstable trauma patients, or individuals with renal impairment. It is also valuable in remote or resource -limited settings where access to advanced imaging is scarce. In such contexts, having an accurate, population-specific ONSD reference value can help clinicians make critical decisions confidently and promptly, improving patient outcomes and reducing healthcare delays [11,12].

The current research aims to address the reference value of optic nerve sheath diameter among healthy South Indian adults using standardized transorbital sonography. By focusing exclusively on healthy volunteers and using uniform, reproducible ultrasonographic techniques, this study intends to generate reliable baseline values that can be applied in clinical practice. A cross-sectional study design ensures that measurements are taken across a representative sample of the healthy populace at a single point in time, minimizing bias as well as so long as a snapshot of normal anatomical variation.

## AIMS AND OBJECTIVES

### Aim

To estimate the reference value of optic nerve sheath diameter by using transorbital sonography in a healthy south Indian population

**Objectives**
-'To determine the mean optic nerve sheath diameter in a healthy south Indian population'

-'To assess the effect of gender, age on optic nerve sheath diameter'.

**MATERIALS AND METHODS:**
The research was conceded out in the Emergency Division of SRM Medical College Hospital as well as Research Centre, Kattankulathur, Chengalpattu for the duration of 1 year. The calculated sample size was approximately 983 members, which was rounded up to 1000 participants for ease of data collection and analysis.

**Inclusion and Exclusion Criteria**
Inclusion Criteria

- Healthy adults above 18 years of age.

**Exclusion Criteria**

- 'Orbital diseases such as optic neuritis, glaucoma, or lens opacity.'
- 'Orbital or ocular trauma.'
- 'Head injury or poly-trauma.'
- 'Optic nerve neoplasm.'
- 'History of any neurosurgical procedure.'
- 'Altered mental status or suspicion of CNS infection.'
- 'Symptoms like headache, nausea, vomiting, or blurring of vision.'
- 'Clinical signs of raised intracranial pressure or meningism.'
- 'Newly developed neurological deficits.'
- 'Conditions causing cerebral oedema, including DKA, ischemic

Infarction, hypertensive encephalopathy, acute liver failure, and cerebral venous sinus thrombosis.'

**RESULTS**

**Table 1:** Age-wise Distribution of Study Participants

| Age Group | Frequency | Percentage |
|---|---|---|
| 18–30 | 360 | 36.00% |
| 30–50 | 388 | 38.80% |
| >50 | 252 | 25.20% |
| **Total** | **1000** | **100%** |

**Table 2:** Gender-wise Distribution of Study Participants

| Gender | Frequency | Percentage |
|---|---|---|
| Male | 549 | 55.00% |
| Female | 451 | 45.10% |
| **Total** | **1000** | **100.00%** |

**Table 3:** Distribution Based on Presenting Complaints

| Presenting Complaints | Frequency | Percentage |
|---|---|---|
| General check-up | 221 | 22.10% |
| Mild eye strain | 103 | 10.00% |
| No complaints | 359 | 35.90% |
| Routine health screening | 48 | 4.80% |
| Voluntary participation | 269 | 27.00% |
| **Total** | **1000** | **100.00%** |

**Table 4:** Distribution Based on Diabetic Status

| Diabetic Status | Frequency | Percentage |
|---|---|---|
| **No** | **855** | **85.50%** |
| **Yes** | **145** | **15.00%** |
| **Total** | **1000** | **100.00%** |

**Table 5:** Distribution Based on Hypertension Status

| Hypertension Status | Frequency | Percentage |
|---|---|---|
| **No** | **888** | **88.80%** |
| **Yes** | **112** | **11.00%** |

| | | |
|---|---|---|
| **Total** | **1000** | **100.00%** |

**Table 6:** Descriptive Statistics of Vital Parameters

| Parameter | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|
| PR (bpm) | 52 | 104 | 77.41 | 8.205 |
| SBP (mmHg) | 95 | 160 | 125.47 | 10.47 |
| DBP (mmHg) | 61 | 101 | 79.44 | 6.292 |
| SPO2 (%) | 95.2 | 102.1 | 97.995 | 0.9646 |
| RR | 9 | 22 | 15.58 | 2.058 |
| Temperature (°F) | 97.2 | 99.7 | 98.417 | 0.4085 |

**Table 7:** Descriptive Statistics of ONSD (Right and Left Eye)

| ONSD | Minimum | Maximum | Mean | Std. Deviation | p-value |
|---|---|---|---|---|---|
| Right Eye (mm) | 3.92 | 5.97 | 5.00 | 0.31 | |
| Left Eye (mm) | 3.91 | 6.09 | 5.00 | 0.32 | 0.278 |

**Table 8:** Comparison of ONSD between Males and Females

| ONSD | Gender | Mean | Std. Deviation | p-value |
|---|---|---|---|---|
| Right Eye (mm) | Female | 4.97 | 0.31 | |
| | Male | 5.02 | 0.32 | 0.008* |
| Left Eye (mm) | Female | 4.96 | 0.31 | |
| | Male | 5.02 | 0.32 | 0.003* |

## DISCUSSION

The present cross-sectional observational study was undertaken to establish normative reference values of optic nerve sheath diameter (ONSD) using trans orbital ultrasonography in a large South Indian adult population. The study also evaluated the influence of age, gender, and systemic variables on ONSD, assessed bilateral symmetry between eyes, and aimed to generate population-specific reference data for clinical application. Given the increasing use of ONSD as a non-invasive surrogate marker for raised intracranial pressure (ICP), establishing reliable local reference ranges is clinically essential, particularly in emergency and critical care settings where direct ICP monitoring and advanced neuroimaging may not always be immediately available.

**Age-wise Distribution and Influence**

The study included 1000 participants with balanced age distribution across adult groups. A statistically significant increase in ONSD with age was observed ($p < 0.001$), with the highest values in individuals above 50 years. This suggests possible age-related alterations in optic nerve sheath compliance and cerebrospinal fluid dynamics.

However, earlier studies have reported conflicting findings. Vaiman et al. reported no significant association between age and ONSD in healthy individuals (13). Similarly, Schroeder et al. in a meta-analysis found no significant age effect on ONSD (15). Trollip et al. also reported no association between age and ONSD (16). The discrepancy may be due to the larger sample size and standardized ultrasonographic methodology in the present study.

**Gender Distribution and Differences**

The study demonstrated a near-balanced gender distribution, with a slight male predominance. A statistically significant but small difference in ONSD was observed between males and females ($p < 0.01$), with males showing higher values.

Shirodkar et al. also reported higher ONSD values in males (18). Kim et al. observed a sex-related association on univariate analysis, though it was not independent after adjustment (14). In contrast, Schroeder et al. and Trollip et al. reported no significant gender differences (15,16). Thus, gender differences appear minor and may have limited clinical significance.

**Bilateral Symmetry of ONSD**

The study demonstrated no significant difference between right and left eye ONSD values ($p = 0.278$), confirming strong bilateral symmetry. This supports the interchangeability of both eyes in clinical practice.Similar findings were reported by Shirodkar et al. (18) and Vaiman et al. (13), while Schroeder et al. confirmed symmetry in a large pooled analysis (15). This reinforces ONSD as a reproducible measurement.

**Influence of Systemic Conditions**

Most participants were non-diabetic and normotensive, reducing confounding effects. Schroeder et al. reported no significant influence of systemic variables on ONSD (15), and Trollip et al. similarly found no association with comorbid conditions (16). Hence, systemic disease likely had minimal impact on observed values.

**Vital Parameters and Physiological Stability**

Participants demonstrated stable physiological parameters at the time of measurement. This is important because hemodynamic instability can influence intracranial pressure and ONSD values.Shirodkar et al. emphasized that stable physiological conditions are essential for reliable ONSD measurement (18). Wani et al. also highlighted variability in unstable ICU patients (17). Therefore, physiological stability strengthens the validity of the present findings.

**ONSD Measurements and Key Findings**

Mean ONSD values were approximately 5.0 mm in both eyes, with narrow standard deviation. These values are slightly higher than some international studies but consistent with other population-based data, suggesting ethnic variability in baseline ONSD.

**Gender and Age Interaction**

Age demonstrated a stronger influence on ONSD than gender. Participants above 50 years showed the highest values. Age-related connective tissue changes and cerebrospinal fluid dynamics may explain this trend.However, earlier studies have reported no age association (13,15,16). This variation highlights the importance of population-specific reference ranges.

**Comparison with Literature**

The present findings are consistent with earlier studies regarding bilateral symmetry (13, 15,18) but differ in age and gender effects. Variability may be due to differences in imaging technique, population characteristics, and sample size.

**Clinical Implications**

The study provides normative ONSD reference values for South Indian adults, improving diagnostic accuracy for raised intracranial pressure. Bilateral symmetry supports flexible clinical use, while age-related variation suggests potential benefit of stratified reference ranges.ONSD ultrasonography remains a rapid, non-invasive, and radiation-free bedside tool, particularly valuable in emergency and critical care settings.

**Strengths of the Study**

Strengths include a large sample size (n = 1000), balanced demographic distribution, standardized measurement technique, and inclusion of clinically stable individuals. These factors enhance reliability and external validity.

## CONCLUSION

In conclusion, this study establishes normative ONSD reference values for a South Indian adult population using Trans orbital ultrasonography. The study demonstrates strong bilateral symmetry, small but significant gender differences, and a statistically significant increase in ONSD with age. Most participants were physiologically stable and free of major systemic disease, supporting the validity of the findings.

These results contribute valuable region-specific data that can enhance the diagnostic utility of ONSD in clinical practice. They also highlight the potential need for age- and gender-adjusted reference ranges in future guidelines, supporting more precise and individualized interpretation of optic nerve sheath measurements in the assessment of intracranial pressure**.**

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