Sonographic Assessment of Optic Nerve Sheath Diameter among Apparently Healthy Paediatrics in Kano Metropolis, Nigeria

Original Article

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ABSTRACT

Background: Ultrasound has been extensively used in the diagnosis and management of ophthalmic diseases. Reference values for normal optic nerve sheath diameter (ONSD) of healthy Paediatric individuals in a population is critical in the detection of raised intra-intracranial pressure (ICP) and other eye pathologies.
Aim. This study was aimed at evaluating the ONSD of healthy Paediatrics in Kano metropolis, Nigeria.
Methods: The design of the study was prospective and cross-sectional, with duration spanning February 2022 to February 2023. Convenience sampling technique was used to enlist 420 paediatric subjects. A portable digital ultrasound machine (Nortek CS 3), with 7.5 MHz linear transducer was used as instrument for data collection. The measurement of the ONSD was made at 3 mm posterior to the globe of the eye. Data was analysed using SPSS version 25.0. With level of significance set at $\rho < 0.05$.
Results: The ranges of the right and left ONSD for male subjects were 1.9 mm to 4.5 mm and 2.0 mm to 4.6 mm, and for the female subjects was 1.8mm to 4.4 mm and 1.8 mm to 4.5 mm respectively. A statistical significant difference in ONSD between Paediatric age groups was observed ($\rho = 0.001$). Correlation of ONSD with anthropometric variables was moderate in BMI ($r = 0.361 – 0.541$) and BSA ($r = 0.301 - 0.584$) and graduated from moderate to strong in age, height and weight ($r = 0.404 – 0.788$).
Conclusion: Normal reference values for the Paediatrics ONSD have been established. A statistically significant difference in ONSD between paediatric age groups was observed. The ONSD had a moderate to strong positive correlation with the anthropometrics variables.

Keywords: Diameter, Eyes, Optic nerve sheath, Paediatric, Ultrasonography

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Introduction

Paediatrics is the specialty of medicine that is concerned with children's physical, psychosocial, developmental, and mental health [1]. Paediatric age limit is variable, with the national institute of child health and development (NICHD) classifying it in 2011 into six standard groups; Neonate (0 to 27 days), infant (28 days to 12 months), toddler (13 to 24 months), early childhood (25 months to 5 years), middle childhood (6 to 11 years), and early adolescent (12 to 18 years) [2, 3]. Paediatrics are susceptible to many disease processes as a result of the immature nature of their immune system, as such exceptional medical care is of paramount importance to reduce disease during childhood [4]. -

The optic nerve is the second of the 12 paired cranial nerves that originate from embryonic retinal ganglionic cell. It is a tubular structure of about 5cm in length, it arrives at the back of the eye enclosed in a strong sheath [5]. It is part of the central nervous system; therefore, it is surrounded by subarachnoid space and experience the same pressure change as the intracranial compartment [6, 7]. The function of the optic nerve is to carry visual impulses from the retina to the brain [8, 9]. The optic nerve cannot be regenerated if damage by myriad processes, such as ischemic, traumatic or neuro-degenerative disease like glaucoma, or hereditary optic nephropathy [10]. Previous studies have shown a direct linear relationship between increased intra-cranial pressure (ICP), and dilatation of the optic nerve sheath [11]. Therefore, monitoring of optic nerve sheath diameter (ONSD) and treatment of increased ICP in paediatric patients is crucial in the management of neurologically ill children [12, 13].

The precise measurements of ONSD by magnetic resonance imaging (MRI), computed tomography (CT), and ultrasonography (USS) can accurately predict elevated ICP [14, 15]. However, MRI and CT are expensive, claustrophobic, and time-consuming, and require patient transportation. Furthermore, CT uses high dose of ionizing radiation [12]. Ultrasonography is non-invasive, readily available, low-cost, speedy, does not use ionizing radiation. However, it has the disadvantage of being an operator dependent [14, 16]. Measurements of the ONSD by USS have established different normal values, however, there was no consensus as to the cut-off point for abnormal ONSD indicating increased ICP [17].

An intensive literature review showed that there is no published research article on normative values of ONSD among apparently healthy paediatrics in the entire northern part of Nigeria. Furthermore, the ethnicities and variation in anthropometrical variables between individuals from different geographical locations may affect the normative values [1]. In the standard practice, normative values of ONSD on healthy Paediatric should be established for references baseline in the diagnosis of ophthalmic pathologies and increase ICP. This study was aimed at evaluating the ONSD of healthy paediatric individuals in Kano metropolis Nigeria. The findings of the study could serve as a guide to the sonographers, sonologists and ophthalmologists in the diagnosis and management of patients with ophthalmic pathologies.

Materials and Methods

This was a prospective cross-sectional study conducted among apparently healthy Paediatrics in some selected hospitals in Kano metropolis, Nigeria, from February 2022 to February 2023. Ethical approval was obtained from the Human Research and Ethics Committee of the Kano State Ministry of Health. A sample size of 420 healthy paediatric subjects (210 males and 210 females) was derived using formula for unknown population sample. Informed Consent was obtained from subject's relatives. Included in the study were apparently healthy paediatrics, aged 0 - 18years, who lived in Kano State. Subjects with a history of blurred vision, severe or persistent headache, subjects with physical eye problems and subjects older than 18 years were excluded from the study.

A portable digital ultrasound machine (Nortek CS 3), with a 7.5 MHz linear transducer and electronic calipers was used as an instrument for data collection. The subject was positioned supine on the couch with the eyes close. An ultrasound gel was applied on top of the closed eyelid. A 7.5MHz linear transducer was placed gently on the closed eyelid. The scanning was performed in the transverse and

longitudinal planes of each eye in line with the technique adopted from previous studies [1, 6]. The placement of the probe was then adjusted to bring the best angle for displaying the exit of the optic nerve from the globe of the eye in keeping with the technique by Newman, et. al [20]. The widest visible retro-bulbula ONSD was measured 3mm posterior to the globe of the eye at the right angle to the retina as shown in Figure 1 using an in-built electronic caliper. For each eye, two measurements were taken and the average was documented as ONSD on the data capture sheet. Data obtained were categorized into six paediatric age groups and each group was further categorized into male and female genders. The data were subjected to Shapiro-Wilk's test for normality. Wilcoxon signed-rank test was used to compare the ONSD between the right and left eye, while the Mann-Whitney U test was used to compare the ONSD between male and female subjects. Kruskal Wallis test was used to compare the ONSD between the different age groups. Spearman Correlation was used to test for relationship between the ONSD with anthropometric variables. The data was analyzed using Statistical Package for Social Sciences (IBM SPSS) version 25.0. With statistical significance set at $p < 0.05$ -

Results

Inter and intra-operator variability was tested and there was agreement in each case (0.79 and 0.73). The ranges of the right and left ONSD for male subjects were 1.9 mm to 4.5 mm and 2.0 mm to 4.6 mm, and 1.8mm to 4.4 mm and 1.8 mm to 4.5 mm for female subjects, respectively. There was statistically significant difference found between right and left ONSD for male and female subjects ($\rho = 0.000$). However, no statistically significant difference in right and left ONSD between male and female subjects ($\rho > 0.05$). A statistically significant difference in ONSD between pediatric age groups was observed ($\rho = 0.001$). There was a strong positive correlation between the ONSD with the anthropometrics variables ($r > 0.6$).

Table 1: Anthropometric variables of the male's subject

Age groups	Anthropometric variables				
	Age	Height (cm)	Weight (Kg)	BMI (Kg/m^2)	BSA (m^2)
0 - 27 days	1.00 - 27.00	42.00 - 56.00	3.00 - 4.00	10.70 - 21.63	0.19 - 0.24
>1 - 12 months	2.00 - 11.00	44.00 - 73.00	3.00 - 10.00	10.68 - 24.99	0.19 - 0.45
13 - 24 months	13.00 - 24.00	66.00 - 91.00	17.00 - 15.00	11.89 - 21.82	0.36 - 0.59
>2 - 5 years	3.00 - 5.00	90.00 - 120.00	10.00 - 22.00	10.74 - 22.22	0.50 - 0.86
6 - 11 years	6.00 - 11.00	110.0 - 150.0	18.00 - 40.00	11.73 - 18.18	0.74 - 1.29
12 - 17 years	12.00 - 17.00	130.0 - 180.0	26.00 - 60.00	12.44 - 28.06	0.97 - 1.68

KEY: **BMI** = Body mass index **BSA** = Body surface area

Table 2: Anthropometric variables of the female's subject

Age groups	Anthropometric variables				
	Age	Height (cm)	Weight (Kg)	BMI (Kg/m^2)	BSA (m^2)
0 - 27 days	0.00 - 27.00	38.00 - 55.00	3.00- 4.50	13.45 - 21.47	0.17 - 0.26
>1 - 12 months	2.00 - 12.00	48.00 - 80.00	4.00 - 10.00	10.75 - 22.22	0.24 - 0.45
13 - 24 months	13.00 - 24.00	61.00 - 90.00	6.00 - 14.00	10.33 - 21.37	0.33 - 0.59
>2 - 5 years	3.00 - 5.00	80.00 - 110.00	12.00 - 22.00	10.74 - 23.44	0.55 - 0.78
6 - 11 years	6.00 - 11.00	100.00 - 150.0	17.00 - 38.00	10.65 - 14.50	0.70 - 1.26
12 - 17 years	12.00 - 17.00	130.00 - 170.0	25.00 - 50.0.00	11.71 - 19.53	0.95 - 1.49

KEY: **BMI** = Body mass index **BSA** = Body surface area

Table 3: Optic nerve sheath diameter of the male and female subjects

Optic nerve sheath diameter				
Age groups	**Male (n = 210)**		**Female (n = 210)**	
	RONSD (mm)	LONSD (mm)	RONSD (mm)	LONSD (mm)
0 - 27 days	1.90 - 2.50	2.00 - 2.60	1.80 - 2.50	1.80 - 2.60
>1 - 12 months	2.00 - 2.80	2.00 - 2.90	2.00 - 2.80	2.10 - 2.90
13 - 24 months	2.60 - 3.00	2.70 - 3.10	2.60 - 3.20	2.60 - 3.30
>2 - 5 years	3.10 - 3.50	3.10 - 3.60	3.00 - 3.40	3.10 - 3.50
6 - 11 years	3.50 - 4.00	3.50 - 4.00	3.40 - 3.90	3.50 - 4.00
12 - 17 years	3.80 - 4.50	3.90 - 4.60	3.10 - 4.40	3.30 - 4.50

KEY: **RONSD** = Right Optic Nerve Sheath Diameter **LONSD** = Left Optic Nerve Sheath Diameter

Table 4: Comparison between Right and Left ONSD in male and female subjects

Age groups	**Male (n = 210)**		**Female (n = 210)**	
	Mean Rank	**ρ value**	**Mean Rank**	**ρ value**
0 - 27 days	12.50	0.00	12.00	0.00
>1 - 12 months	14.50	0.00	15.50	0.00
13 - 24 months	13.00	0.00	12.00	0.00
>2 - 5 years	14.50	0.00	18.00	0.00
6 - 11 years	14.50	0.00	15.50	0.00
12 - 17 years	14.50	0.00	14.50	0.00

Table 5: Comparison of the right and left ONSD between male and female subjects.

Age groups	**RONSD**			**LONSD**		
	Male's mean rank	**Female's mean rank**	**ρ value**	**Male's mean rank**	**Female's mean rank**	**ρ value**
0 - 27 days	36.57	34.43	0.652	36.61	34.39	0.651
>1 - 12 months	37.01	33.99	0.533	37.94	33.06	0.311
13 - 24 months	37.20	33.80	0.479	37.66	33.34	0.370
>2 - 5 years	37.71	33.29	0.346	36.66	34.34	0.631
6 - 11 years	36.66	34.34	0.625	37.01	33.99	0.530
12 - 17 years	38.80	32.20	0.172	39.26	31.74	0.112

KEY: **RONSD** = Right Optic Nerve Sheath Diameter **LONSD** = Left Optic Nerve Sheath Diameter

Table 6: Comparison of the right and Left optic nerve sheath diameter between different age groups using Kruskal-wallis test

RONSD			**LONSD**		
Range (mm)	F*	p value	Range (mm)	F*	p value
1.80 – 4.50	5.00	0.00	1.80 – 4.60	5.00	0.00

KEY: **RONSD** = Right Optic Nerve Sheath Diameter **LONSD** = Left Optic Nerve Sheath Diameter

Table 7: Correlation of RONSD with anthropometric variables in male subjects

Anthropometric variables										
Age groups	**Age**		**Height**		**Weight**		**BMI**		**BSA**	
	r	P	R	P	R	P	R	P	r	P
0 - 27 days	0.701	0.000	0.608	0.000	0.601	0.001	0.464	0.000	0.584	0.001
>1 - 12 months	0.633	0.000	0.725	0.000	0.639	0.000	0.471	0.002	0.561	0.000
13 - 24 months	0.551	0.001	0.446	0.002	0.404	0.002	0.361	0.004	0.301	0.005
>2 - 5 years	0.768	0.000	0.632	0.001	0.601	0.003	0.461	0.005	0.511	0.003
6 - 11 years	0.788	0.000	0.760	0.000	0.771	0.001	0.541	0.001	0.460	0.001
12 - 17 years	0.689	0.000	0.608	0.000	0.622	0.000	0.541	0.001	0.433	0.000

KEY: **BMI** = Body mass index **BSA** = Body surface area

Table 8: Correlation of LONSD with anthropometric variables in male subjects

Anthropometric variables										
Age groups	**Age**		**Height**		**Weight**		**BMI**		**BSA**	
	R	P	R	P	R	P	R	P	r	P
0 - 27 days	0.601	0.000	0.623	0.000	0.601	0.001	0.444	0.001	0.405	0.002
>1 - 12 months	0.738	0.000	0.664	0.000	0.609	0.001	0.571	0.002	0.507	0.004
13 - 24 months	0.531	0.000	0.404	0.000	0.434	0.001	0.261	0.001	0.208	0.022
>2 - 5 years	0.681	0.000	0.609	0.001	0.639	0.001	0.430	0.003	0.413	0.001
6 - 11 years	0.688	0.000	0.660	0.000	0.671	0.000	0.411	0.001	0.480	0.001
12 - 17 years	0.711	0.000	0.741	0.000	0.655	0.002	0.461	0.001	0.503	0.001

KEY: **BMI** = Body mass index **BSA** = Body surface area

Table 9: Correlation of RONSD with anthropometric variables in female subjects

Anthropometric variables										
Age groups	**Age**		**Height**		**Weight**		**BMI**		**BSA**	
	R	P	R	P	R	P	r	P	r	P
0 - 27 days	0.601	0.000	0.608	0.000	0.661	0.001	0.441	0.000	0.493	0.001
>1 - 12 months	0.608	0.000	0.615	0.000	0.600	0.000	0.411	0.001	0.451	0.000
13 - 24 months	0.453	0.000	0.481	0.000	0.483	0.001	0.231	0.005	0.221	0.005
>2 - 5 years	0.710	0.000	0.613	0.001	0.619	0.001	0.416	0.002	0.515	0.001
6 - 11 years	0.688	0.000	0.679	0.000	0.654	0.001	0.414	0.000	0.406	0.000
12 - 17 years	0.619	0.000	0.611	0.000	0.601	0.000	0.431	0.000	0.413	0.000

KEY: **BMI** = Body mass index **BSA** = Body surface area

Table 10: Correlation of LONSD with anthropometric variables in female subjects

Anthropometric variables										
Age groups	**Age**		**Height**		**Weight**		**BMI**		**BSA**	
	R	P	r	p	R	P	r	P	r	P
0 - 27 days	0.621	0.000	0.608	0.000	0.611	0.001	0.406	0.005	0.415	0.004
>1 - 12 months	0.659	0.000	0.641	0.000	0.628	0.001	0.439	0.001	0.421	0.005
13 - 24 months	0.421	0.000	0.424	0.000	0.414	0.001	0.211	0.003	0.207	0.003
>2 - 5 years	0.463	0.000	0.613	0.000	0.603	0.001	0.471	0.001	0.429	0.001
6 - 11 years	0.633	0.000	0.618	0.000	0.604	0.000	0.453	0.005	0.417	0.004

12 - 17 years	0.677	0.000	0.638	0.000	0.617	0.002	0.453	0.000	0.426	0.000

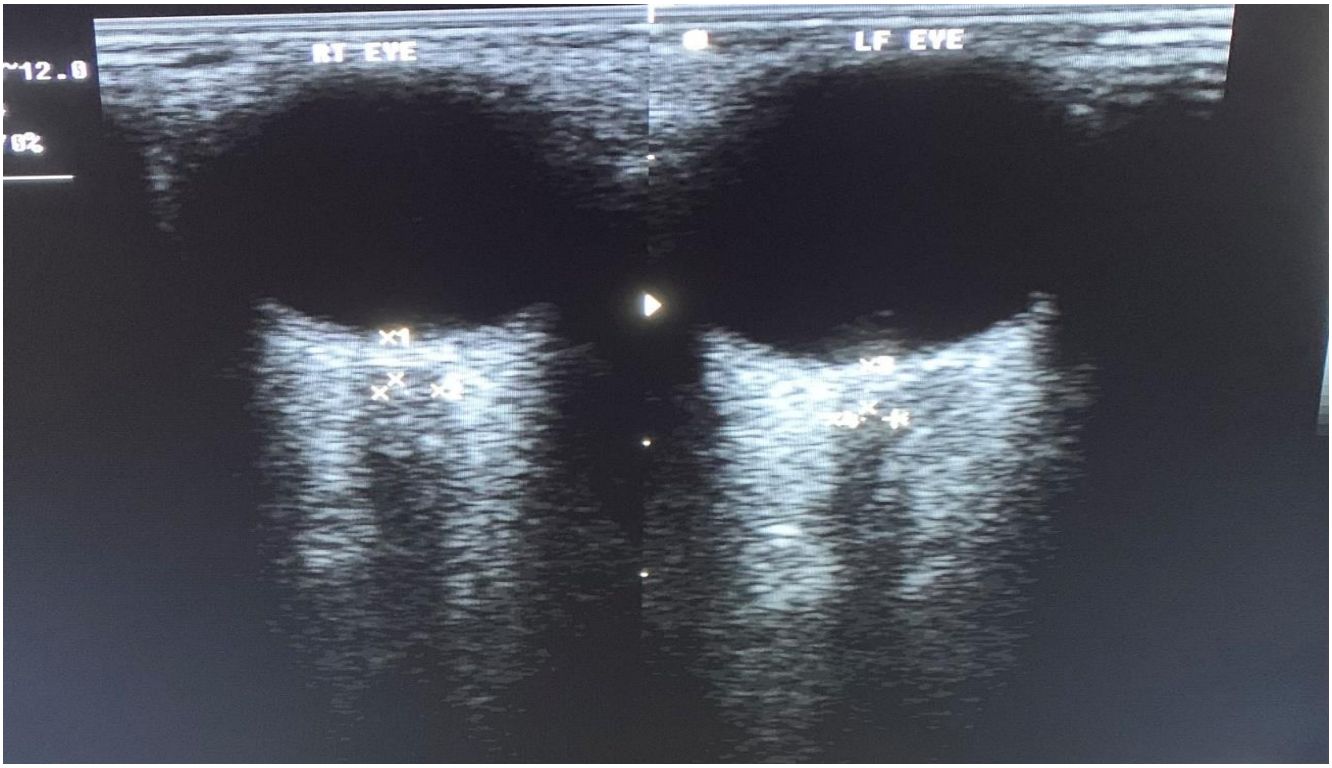

Fig i. Ocular sonogram of the right and left eyes of a 14-year-old male Subject.

Discussion

The findings of this study as shown in Tables 1 and 2 were contrary to the findings of the previous studies [13, 17-19]. The reason for the difference might be due to environmental, racial, dietary and socioeconomic status. Despite the fact that Ayodeji & Olubunmi conducted their study in Nigeria [19], they only considered paediatrics within the age range of two to sixteen years. Furthermore, none of the previous studies divided their study subjects into the six standard paediatric age groups and none of them reported the range of height, weight, BMI and BSA of their study subjects.

Our findings as shown in Table 3 allude to the fact that ONSD in paediatrics could be uniform, globally. This is in agreement with an earlier work by Ballantyne *et al*., [21]. The possible reason of the similarity might be that the two studies were conducted in similar paediatric age groups.

However, the findings of the current study as shown in Table 3 were contrary to some other studies [17, 18, 20]. The possible reason of the disagreement might be due to environmental, racial, dietary and socioeconomic differences. Furthermore, findings from the current study were similar to those reported by Sidi & Aminu [1] and Maude *et al*., [17], where the ONSD was slightly higher in males than in females, and in both cases, the left was slightly higher than the right. However, the findings were contrary to what was reported by Yapicioglua, *et al*., [18] and Ayodeji & Olubunmi [19] that reported the same values of the right and left eyes.

Findings of this study, as shown in Table 4 demonstrated a statistically significant difference between right and left ONSD for both genders. This is not in agreement with the findings by Sidi & Aminu [1], and Anas, [22].

Possible reasons for the discrepancy might be in the choice of subjects, since theirs were adults. Age difference might however be responsible for the discrepancy between our study and some other works in our locality [17, 19, 21]. More so, the findings of this study as shown in Table 5 revealed no statistically significant difference in ONSD between males and females across all the paediatric age groups, which is corroborated by previous works [1, 17, 19, 22]. Similar methodology might account for this similar findings. Findings of this study, as shown in Table 6 also show a statistically significant difference in ONSD between the different paediatric age groups. This was similar to the previous studies conducted by Ayodeji & Olubunmi [19] and Ballantyne *et al*., [21] who also reported a statistically significant difference in ONSD between different paediatric age groups. Similar methodology and population might account for this similarity.

A statistically significant and strong positive correlation was observed between right and left ONSD with the age, height, and weight in male subjects across all the paediatric age groups with the exception of toddler where correlation turned out positively moderate as shown in Tables 7 and 8, respectively. A statistically significant and moderate positive correlation was also obtained between right and left ONSD with the BMI and BSA in male subjects across all paediatric age groups with the exception of toddler which shows statistically significant weak positive correlation as shown in Table 7 and 8, respectively. This was similar to the study conducted by Ballantyne *et al*., [21] that reported significant correlation between right and left ONSD with age. However, the previous study did not report correlation between the right and left ONSD with the other anthropometrics variables. The possible reasons for the similarity might be because both studies adopted the same scanning technique and consider almost the same paediatric age groups.

A statistical significant strong positive correlation was observed between right and left ONSD with the age, height, and weight in female subjects across all the paediatric age groups with the exception of toddler which shows significant moderate positive correlation as shown in Tables 9 and 10, respectively. However, a significant moderate positive correlation was observed between right and left ONSD with the BMI and BSA in female subjects across all paediatric age groups with the exception of toddler which shows statistical significant weak positive correlation as shown in Table 9 and 10, respectively.

Limitation of study: The blood pressure, intra-cranial pressure, visual acuity, and fundoscopy of the selected subjects were not checked.

Conclusion: This study has established normative values of ONSD for paediatric individuals in Kano metropolis Nigeria. The findings of this study could be expected to serve as a guide to the sonographers, sonologists and ophthalmologists in the diagnosis and management of patients with ophthalmic pathologies.

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References

1. Sidi, M., & Aminu, M. Sonographic evaluation of optic nerve sheath diameter and anterior chamber depth of the eye among apparently healthy adult in Kano, Nigeria, *West African Journal of Radiology,2020;* 27(2): 1-8.
2. Sawyer, S.M., Azzopardi P.S., Wickremarathne, D., Patton, G.C. The age of adolescence. *Lancet Child Adolesc Health, 2018;* 2**,** 223–28.
3. Williams, K., Thomson, D., Seto, I., & Contopoulous, D.G. Standard 6: Age groups for pediatrics trial, *Pediatrics*, 2012; 129(3): S153- S159.
4. Lissauer, T., Clayden, G., Craft, A. (2015). Illustrated textbook of pediatrics. 1st Edn, Edinburgh: Mosby
5. Del Saz-Saucedo, P., Redondo, G, O., Mateu, G, A., Huertas, A, R., Ruiz, R, G., Enrique, B, P. Sonographic assessment of the optic nerve sheath diameter in the diagnosis of idiopathic intracranial hypertension. *Journal of the Neurological Sciences,* 2016; 122-127.

6. Merceron, S., & Geeraerts, T. Occular sonography fot the detection of raised intracranial pressure. *Expert Review of Opthalmology, 2008;* 3(5): 497-500.

7. Shirodkar, C.G., Rao, S.M., Mutkule, D.P., Harde, Y.R., Venkategowda, P.M., Mahesh, M.U. Optic nerve sheath diameter as a marker for evaluation and prognostication of intracranial pressure in Indian patients: An observational study. *Indian J Crit Care Med*, 2014; 18:728-34.

8. Ryan, S., Nicholas, M.M. (2004). Eustace, S. *Anatomy for Diagnostic Imaging.* 2nd ed. Philadelphia (US): Elsevier Limited

9. Ellis, H. (2002). The cranial nerves. In: Ellis H, editor. *Clinical Anatomy.* 11th ed. Oxford (UK) Ltd: Blackwell Publication: p. 365–366.

10. Chun, B.Y., & Cestari, D.M. Advances in experimental optic nerve regeneration. *Curr Opin Ophthalmol*, 2017; 28:558-63.

11. Chan, P.Y and Mok, K.L. Transorbital sonographic evaluation of optic nerve sheath diameter in normal Hong Kong Chinese adults. *Hong Kong J Emerg Med., 2008;* 20(08): 197-204

12. Adejoh, T.; Nzotta,CC. Head computed tomography: dose output and relationship with anthropo-technical parameters. West African Journal of Radiology, 2016;23(2):113-117. *DOI:* 10.4103/1115-3474.179256

13. Lan, S.-Y., Tai, H.-T., Lin, J.-J., Lan, F.-Y., Tsai, H.-Y., Lin, K.-L. Measurement of optic nerve sheath diameter by ultrasound in healthy term neonates. *Journal of pediatrics and neonatology*, 2021; 1-7.

14. Wang, L., Feng, L., Yao, Y., Deng, F., Wang, Y., Feng, J., Xing, Y. Ultrasonographic evaluation of optic nerve sheath diameter among healthy Chinese adult. *Ultrasound in Medicine and Biology, 2016;* 42(3): 683-688.

15. Adejoh, T., And Idigo, F.U. Ultrasound measurement of waist circumference & visceral adipose tissue thickness in Nigerian women. Nigerian Journal of Medical Imaging & Radiation Therapy, 2014;3(1):14-16 https://njmirt.com/issue/2014

16. Hadijat, K. Y., & Ukamaka, I. Ultrasonograhic measurement of optic nerve sheath Diameter in normal adults. *Annals of International Medical and Dental Research, 2017;* 3(2): 30-34.

17. Maude, R.R., Amir, H.M., Hassan, M.U., Osbourne, S., Sayeed, K.L., Karim, M.R. Trans-orbital sonographic evaluation of normal optic nerve sheath diameter in healthy volunteers in Bangladesh. *PLoS* 1, 2013;8: e81013.

18. Yapicioglua, H., Aslanb, N., Sertdemir, Y., Yildizdas, D., Gulasi, S., Mert, K. Determination of normal values of optic nerve sheath diameter in newborns with bedside ultrasonography. *Early Human Development, 2020;* 145: 1-5.

19. Ayodeji, A.O., & Olubunmi, O.B. Normal Sonographic Optic Nerve Sheath Diameter among children of South West Nigeria. *Journal of clinical and diagnostic Research, 2019;* 13: TC18-TC20.

20. Newman, W.D., Hollman, A.S., Dutton, G.N., and Carachi, R. Measurement of optic nerve sheath diameter by Ultrasound: A means of detecting acute raised intracranial pressure in hydrocephalus. *Br J Opthalmol*, 2020; 86(4): 1109-1113.

21. Ballantyne, J., Hollman, A.S., Hamilton, R., Bradnam, M.S., & Carachi, R. Trans-orbital optic nerve sheath ultrasonography in normal children. *Clinical radiology*, 1999; 54, 740–742.

22. Anas, I. Trans-orbital Sonographic Measurement of Normal Optic Sheath Nerve Diameter in Nigerian population. *Malays J. Med. Sci., 2014;* 21(5): 24-29.