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Original Research Article

Ultrasonic optic nerve diameter measurement among pregnant women in a specialist hospital, Port Harcourt, Rivers State, Nigeria

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ABSTRACT

Background: Elevated intracranial pressure (ICP) during pregnancy can pose significant health risks. Ultrasonic measurement of optic nerve diameter offers a safe, non-invasive method for assessing ICP. Establishing normative data for optic nerve diameter in pregnant women is essential for future evaluations. This study aims to document the optic nerve diameter in healthy pregnant women and examine associations with maternal characteristics, including age, parity, and body mass index (BMI).
Methods: An eight-month prospective cross-sectional study involving 559 healthy pregnant women attending the Radiology department of a specialist hospital in Port Harcourt, Nigeria was conducted. Demographic and anthropometric data were collected. Optical nerve diameters were measured via ultrasound at 3 mm behind the globe, and statistical analyses, including Pearson correlation coefficients, were performed to assess relationships with maternal factors.
Results: The mean age of participants was 29.95 years (SD±6.34). The mean right and left optic nerve diameters were 0.57 cm (SD±0.082) and 0.58 cm (SD±0.08). Significant negative correlations were found between optic nerve diameter, age (left r =-0.158, p=0.001), and parity (right: r=-0.100, p=0.007). No significant associations were observed with weight, height, or BMI.
Conclusion: This study establishes baseline optic nerve diameter measurements for healthy pregnant women, with significant correlations observed with age and parity. These findings contribute to understanding maternal health and provide a foundation for further research on optic nerve diameter as an indicator of ICP in pregnancy. Multi-Centre studies are recommended to validate and expand upon these results.

Keywords: Ultrasound, Pregnant women, Optic nerve diameter, Nigeria

INTRODUCTION

Raised intracranial pressure (ICP) poses significant health risks during pregnancy, impacting both maternal and fetal outcomes.[1] Traditional monitoring methods often require invasive procedures, prompting the exploration of non-invasive alternatives like ocular ultrasound.[1] This technique allows for safe and accessible measurement of optic nerve diameter, providing vital information on ICP changes. Thus, non-invasive methods are proposed /planned as an alternative/substitute for managing these patients, such as computed tomography (CT), transcranial Doppler ultrasound, spectroscopy of near-infrared, magnetic resonance imaging (MRI) and visual evoked potentials.[2] Currently, computed tomography (CT) is widely used in the assessment of neurological complications; however, it is a difficult method to perform in critically ill patients in intensive care units and expensive with the risk of radiation exposure. Also, spectroscopy and Doppler ultrasound require specialized equipment and experienced examiners. Ocular ultrasound for optic nerve diameter measurement is considered a non-invasive, safe, and easy-to-perform procedure to assess the anatomical features/characteristics of the optic nerve.[1] It is

an accessible, sensitive, and specific technique for non-invasively detecting increased optic nerve ICP.[3] The optic nerve is an extension of the central nervous system. Meninges and cerebrospinal fluid cover the optic nerve, an anatomical concept explaining the papilloedema that occurs with increased intracranial pressure fluctuations.[1]

This study aims to establish normative data for optic nerve diameter in healthy pregnant women, contributing valuable insights for future assessments in high-risk populations. By providing reference values, this study aims to enhance the clinical management and monitoring of ICP during pregnancy.

METHODS

Study design

This prospective cross-sectional study.

Study place

The study conducted in the Radiology department of a Specialist hospital in Port Harcourt.

Study duration

The study period was between September 2023 and May 2024.

Sample size

A total number of 559 patients were recruited into the study.

Ethical approval

Ethical approval was obtained, and data analysis was performed.

Demographic indices such as age, parity, gestational age, weight, height and BMI were obtained. Their weight was measured in kilograms (kg), height was measured in meters(m), and their BMI (Body mass index) was calculated in kg/m.^{2} An ultrasound scan of the optic nerve was done alongside the obstetric scan, and the optic nerve diameter was taken. In addition to the obstetric scan, an ocular scan was done using a high-frequency linear probe. The mean diameter of the optic nerve was measured 3 mm behind the globe, perpendicular to the optic nerve axis bilaterally and the values recorded.

Inclusion criteria

The study included healthy pregnant women presenting for routine obstetric ultrasound examinations.

Exclusion criteria

Pregnant women who declined to provide consent were excluded from the study.

Statistical analysis

Data obtained was analysed using the SSPS 21.0 version, and statistical significance was set at <0.05.

RESULTS

Socio-demographic characteristics

Table 1 shows the socio-demographic analysis of 559 pregnant women. The majority (89.27%) were between 20 and 39 years old, with a mean age of 29.95 years (SD±6.34). The age ranged from 14 to 54, with only 4.47% of participants aged 10-19 and 0.54% aged 50-59, indicating a typical reproductive age group. 76.92% completed secondary education, while 11.09% had university degrees. Only 1.25% had no formal education.

Anthropometric parameters

Table 2 presents the anthropometric parameters of 559 pregnant women, highlighting significant health insights. The average weight is 69.74 kg (SD±16.40), and the height is 157.93 cm (SD±9.57), indicating considerable variability.

The average BMI is 28.29 (SD±7.94), categorising most women as overweight or obese (59.21%). Specifically, 5.37% are underweight, 35.42% normal weight, 22.00% overweight and 37.21% obese.

Maternal characteristics

The analysis of maternal characteristics for 559 pregnant women indicates that the median parity is 1, suggesting many are first-time mothers. The interquartile range of [0.5-2] implies that most participants have had one or no previous pregnancies. The mean gestational age is 14.09 weeks (SD±4.80), with 99.64% of women under 37 weeks, signifying a predominance of early pregnancies.

Optic nerve measurements

Figure 4. The analysis of optic nerve diameters in 559 pregnant women reveals a mean right optic nerve diameter of 0.57 cm (SD±0.082) and a mean left optic nerve diameter of 0.58 cm (SD±0.08). The left optic nerve shows a wider range of measurements, from 0.06 cm to 0.87 cm, suggesting more significant variability, particularly with a notably low minimum diameter that could indicate potential abnormalities.

Pearson correlation analysis of optic nerve diameter with age, parity, weight, height, and BMI

Table 5 shows the correlation analysis of optic nerve diameters in 559 pregnant women, revealing significant relationships between the left optic nerve diameter and age (Pearson r=-0.158, p=0.001), indicating that older age may be associated with a decrease in diameter.

A negative correlation is also observed between the right optic nerve diameter and parity (Pearson r=-0.100, p=0.007), suggesting that higher parity may reduce the diameter. However, weight, height and BMI show no significant correlations with optic nerve measurements.

Table 1: Socio-demographic characteristics (n=559).

Variables	Frequency	(%)
Age		
10-19	25	4.47
20-29	228	40.79
30-39	271	48.48
40-49	32	5.72
50-59	3	0.54
Mean ± SD	29.95±6.34∞	
Range	(14-54)	
Educational level		
None	7	1.25
Primary	60	10.73
Secondary	430	76.92
University	62	11.09

∞=Mean ± Standard Deviation

Table 2: Anthropometric parameters (n=559).

Variables	Frequency	(%)
Weight (kg)		
Mean±SD	69.74±16.40∞	
Range	(32-121)	
Height (cm)		
Mean±SD	157.93±9.57∞	
Range	(116-190)	
BMI		
Mean±SD	28.29±7.94∞	
Range	(11.89-74.32)	
BMI category		
Underweight (<18.5)	30	5.37
18.5 and 24.9	198	35.42
Overweight 25 and 29.9	123	22.00
Obesity ≥30	208	37.21

∞=Mean ± Standard Deviation

Table 3: Maternal characteristics (n=559).

Variables	Frequency	(%)
Parity		
Median	1α	
IQR	(0.5-2)	
Parity		
0	186	33.27
1-3	359	64.22
≥4	14	2.50
Gestational age		
Mean±SD	14.09±4.80∞	
Range	(6-37)	
Gestational age		
<37	557	99.64
≥37	2	0.36

∞=Mean ± Standard Deviation, α=Median, Inter-quartile Range

Table 4: Optic nerve measurements. (n=559).

Variables	Mean±SD
Mean optic nerve diameter (Right)	
Mean±SD	0.57±0.082
Range	(0.4-0.80)
Mean optic nerve diameter (Left)	
Mean±SD	0.58±0.08
Range	(0.06-0.87)

Table 5: To assess how Age, parity, weight, height and BMI are associated with selected parameters using the Pearson correlational coefficient analysis.

Variables	Age, parity, weight, height and BMI			
	The Pearson correlation coefficient, r	95.0% confidence interval for r		P value
		Lower bound	Upper bound	
Optic nerve - right	0.065	-1.768	11.900	0.146
Optic nerve - left	-0.158	-20.996	-5.409	0.001*
Optic nerve - right	-0.100	-2.277	-0.364	0.007*
Optic nerve - left	0.030	-0.665	1.516	0.444
Optic nerve - right	0.014	-1.561	7.262	0.205
Optic nerve - left	-0.019	-9.193	0.868	0.105
Optic nerve - right	-0.022	-12.020	6.856	0.591
Optic nerve - left	0.066	-2.386	19.139	0.127
Optic nerve - right	0.026	-3.929	8.903	0.447
Optic nerve - left	-0.051	-12.649	1.983	0.153

*Statistically significant ($p<0.05$)

DISCUSSION

The findings from this study provide valuable insights into the relationships between optic nerve diameters and various maternal characteristics, including age, parity, weight, height and BMI, among a cohort of 559 pregnant women. Given the significance of the optic nerve as an indicator of potential intracranial pressure and overall maternal health, understanding these correlations is essential. This article aims to interpret the implications of the observed relationships, highlight potential clinical relevance, and suggest avenues for further research to enhance maternal care and monitoring during pregnancy.

This study's findings indicate that the mean right and left optic nerve diameters were 0.57 cm and 0.58 cm, respectively. These measurements align with previous studies on normative optic nerve diameters in various populations.[6,9-11] However, significant negative correlations were observed between optic nerve diameter and maternal age (Pearson r =-0.158, p=0.001) and parity (Pearson r =-0.100, p=0.007).

This contrasts with Davaryari et al, and Dargahi et al.[4,5] Also, Fallah et al, and Nikpour et al, disagree with our findings.[6,7] In their respective studies, there were no significant association between optic nerve diameter with age and parity. This difference could be explained based on study population categorization, sample /sampling method, and location. However, this index study agrees with Rad et al, which had a significant association with age and optic nerve diameter.[8] This could be possible due to the study population. As age increases, physiological changes, including increased adipose tissue and possible alterations in cerebrospinal fluid dynamics, could influence optic nerve morphology.[12] This trend is significant given the implications of elevated ICP, which may progressively affect older pregnancies. Moreover, the negative correlation observed with parity suggests that higher numbers of previous pregnancies may also be associated with reduced optic nerve diameters. This finding adds a layer of complexity to understanding the factors that may predispose women to complications related to ICP, as previous pregnancies might alter anatomical structures and physiological responses.

The significance of optic nerve diameter measurements in a clinical setting cannot be understated, particularly in high-risk populations, such as pregnant women who may experience hypertensive disorders, as is seen commonly in this environment.[13] Increased ICP can lead to severe complications, early identification of atypical optic nerve dimensions using ultrasound may serve as a non-invasive method for monitoring maternal health. By establishing normative values within the context of this demographic, these benchmark values can serve for future assessments.

In antenatal care management, given the increase in gestational hypertension and preeclampsia observed in many maternal populations like ours, healthcare providers should consider incorporating ultrasound measurements of

the optic nerve into routine antenatal care for women at risk, as it will give information about potential intracranial hypertension, thus reducing maternal mortality and morbidity as well as perinatal and postnatal death.[12]

CONCLUSION

This study successfully establishes baseline measurements for optic nerve diameters in healthy pregnant women, identifying significant correlations with age and parity. These findings underscore the importance of regular monitoring of optic nerve health in maternal care, particularly in populations at risk for increased ICP.

The limitations of this study include the lack of intrapartum and postpartum follow-up. This would have given a comprehensive picture of how optic nerve diameters change throughout pregnancy and into postpartum recovery. Future studies should aim to include longitudinal tracking of optic nerve dimensions to capture these dynamic changes over time.

Additionally, this study was conducted in a single centre, which may limit the generalizability of the findings to broader populations, particularly in diverse geographical and demographic contexts. Multi-centre studies are necessary to validate these findings across different maternal populations, allowing for a more robust understanding of variations in optic nerve diameter. Future research should investigate the underlying mechanisms linking maternal age, parity and optic nerve diameter taking into consideration various other factors such as socioeconomic background and medical history.

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