JOURNAL OF THE MEDICAL WOMEN'S ASSOCIATION OF NIGERIA

Established in 2004 April 2026 Volume 11: No 1

Original Article

Access this article online

Quick Response Code:

Website: www.jmwan.org.ng

https://doi.org/10.71526/jmwan.v11i1.90

Ultrasound Ovarian Volume Assessment as Marker of Ovarian Reserve in Women: A Cross-Sectional Study

Agazie, Kelechi Christian,[1] Robinson, Ebbi Donald[1], Ijeruh, Olukunmi Yetunde,[1] Nwankwo, Nelson Chukwuemeka[2]

[1]Department of Radiology
Rivers State University Teaching Hospital
Port Harcourt , Nigeria.

[2]Department of Radiology
University of Port Harcourt Teaching Hospital
Port Harcourt , Nigeria.

Corresponding Author:
Ebbi Donald Robinson
Department of Radiology
Rivers State University Teaching Hospital
Port Harcourt , Nigeria.
ebbi.robinson@ust.edu.ng

Abstract

Introduction: Ovulatory disorders are a cause of infertility in women and can be assessed by ultrasonography. The study aimed to determine ovarian volume in females with infertility at the Rivers State University Teaching Hospital, Port Harcourt.

Methods: This prospective cross-sectional study included females aged 18 to 45 years referred for ovarian volume (OV) evaluation. OV was assessed by transvaginal sonography using a 6.5 MHz endocavitary transducer on a GE ultrasound machine (Model: Logiq F6, SN-635528WXO, 2017). Data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 25 for Windows. Results were presented in graphs, charts, and tables. Pearson's correlation, t-test, and chi-square test were used to assess statistical significance, correlation between variables, and differences among the study groups.

Results: The mean age was 31.50 years and 34.12 years for the control and case groups, respectively. The mean ovarian volume (MOV) was 9.23±1.86 ml and 6.23±2.07 ml for the control and case groups, respectively. The prevalence of diminished ovarian reserve was 22.3%. There was a negative correlation between mean OV and age in both the control and case groups.

Conclusion: The study showed an age-related decline in mean OV and a prevalence of diminished ovarian reserve of 22.3%. This indicates that ultrasound ovarian volume assessment is a valuable marker of ovarian reserve.

Keywords: Ovarian volume, Transvaginal Sonography, Infertility, Ovarian Reserve

Cite as: Agazie KC, Robinson ED, Ijeruh OY, Nwankwo NC. Ultrasound Ovarian Volume Assessment as a Marker of Ovarian Reserve in Women: A Cross-Sectional Study. J Med Women's Assoc Niger. 2026;11(1):90. doi: 10.71526/jmwan.v11i1.90

Print ISSN: 3043-4742 Online ISSN: 3043-4750

Background

Female infertility affects an estimated 48 million women, with the highest prevalence reported in South Asia, Sub-Saharan Africa, North Africa and the Middle East, and Central and Eastern Europe and Central Asia.[1] The ovaries are the female gonads in which the female gametes, known as oocytes, are produced. The size and appearance of the ovaries vary according to age and the stage of the menstrual cycle.[2,3] In young adults, the ovaries are almond-shaped and measure approximately 3 cm in length, 1.5 cm in width and 1 cm in thickness.[3] Following menopause, no active follicles remain, and the ovaries become smaller with a wrinkled surface.[3]

Ovulatory disorders account for approximately 30% of the causes of female infertility.[1] Despite being born with a substantial number of primordial cells, which are the precursor cells of the germline, women experience a gradual depletion of ovarian reserve and a decline in fertility during the middle years of their reproductive lifespan.[4,5]

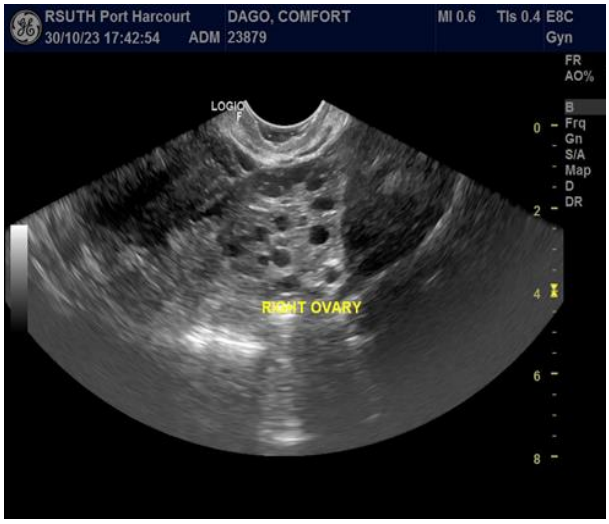
The residual oocyte–granulosa cell repertoire available for reproduction at a given age is referred to as the ovarian reserve (OR). Various ovarian reserve tests (ORTs) are used to assess an individual's quantitative ovarian reserve, including the day-3 follicle-stimulating hormone (FSH) assay, antral follicle count (AFC), Doppler assessment of ovarian blood flow, and ultrasonographic assessment of ovarian volume.

Ultrasonography is the principal method used for ovarian volume assessment. It is a cost-effective, readily available and safe imaging modality. The most common approaches for evaluating the ovaries are the transabdominal and transvaginal routes. The transvaginal approach provides a more accurate volumetric assessment. On ultrasonography, the ovary typically demonstrates a homogeneous echotexture with a centrally located echogenic medulla. Several small anechoic follicles are usually observed peripherally within the cortex, as shown in Figure 1. Echogenic foci are common, non-shadowing and may be diffusely distributed. During the early proliferative phase, numerous follicles are present. In the pre-ovulatory phase, one follicle becomes dominant, measuring between 2 and 2.5 cm, while the remaining follicles undergo atresia. Following ovulation, the corpus luteum develops. It has a variable sonographic appearance but is typically hypoechoic or isoechoic.[6]

There is a paucity of data on ovarian reserve in Nigeria, highlighting the need for the present study. Furthermore, this study will contribute to the existing body of knowledge on the evaluation of female infertility, including patient assessment, selection, care and management options. Therefore, this study sought to determine ovarian volume in females undergoing investigation for infertility and to evaluate its usefulness as a marker of ovarian reserve.

Figure 1. Transvaginal sonogram of the pelvis - showing the right ovary harboring multiple well defined anechoic antral follicles.

Print ISSN: 3043-4742 Online ISSN: 3043-4750



Method

This was a hospital-based prospective cross-sectional study conducted at Rivers State University Teaching Hospital (RSUTH) over a period of six months, from June to November 2022. A total of 260 women participated in the study. The study population comprised two groups of women of reproductive age. The control group consisted of volunteer fertile women recruited from the hospital's family planning clinic who were using non-hormonal contraceptive methods, had no previous history of subfertility or reproductive disorders, and had given birth to one or more children. The case group comprised women who presented to the Radiology Department for the investigation of infertility.

Sample Size Calculation

The sample size for this study was determined using power analysis for comparing two independent proportions. Based on a reported infertility prevalence of 32.0% from a previous hospital-based cross-sectional study conducted in Delta State, Nigeria, the minimum sample size required to achieve 90% statistical power at a 95% confidence level was calculated. The analysis yielded a minimum requirement of 114 participants per group. To account for an anticipated non-response rate of 10%, the sample size was adjusted to 127 participants per group. Consequently, a total of 254 women (127 per group) were targeted for recruitment, and the final sample size was rounded up to 260 participants.

Participant Selection Criteria

Participants were recruited into either the fertile or infertile study group based on clearly defined clinical criteria. Fertile women were defined as those who had achieved at least one spontaneous pregnancy resulting in a live birth. Conversely, infertile women were defined as those who had failed to achieve pregnancy after at least 12 months of regular, unprotected sexual intercourse. All participants provided written informed consent prior to enrolment.

To be eligible for inclusion in the study, women in both groups were required to have regular menstrual cycles and no history of smoking. Participants were also required to have no history of ovarian or tubal surgery. Furthermore, transvaginal ultrasonography was used to confirm the absence of ovarian abnormalities and to ensure adequate visualisation of the ovaries. Any use of hormonal contraception must have been discontinued at least two months prior to recruitment.

Exclusion criteria were applied to minimise potential confounding factors. Women were excluded if they had ovarian abnormalities, such as polycystic ovaries or

Print ISSN: 3043-4742 Online ISSN: 3043-4750

ovarian endometriosis, uterine malformations or other uterine pathologies, or a history of smoking. Additional grounds for exclusion included a history of ovarian or tubal surgery, current or recent pregnancy, menopause, or the use of hormonal contraceptives within two months preceding recruitment. Finally, women whose ovaries could not be adequately visualised on transvaginal ultrasonography and those who declined to provide informed consent were also excluded.

Data Collection

Data were collected from patients referred to the Ultrasound Unit of the Radiology Department of RSUTH for infertility investigations who met the inclusion criteria and provided informed consent during the study period. Data were also collected from the control group, comprising volunteer fertile women attending the family planning clinic who were using non-hormonal contraceptive methods, met the inclusion criteria, and provided informed consent. Information regarding participants' age, height and weight was documented.

Technique

Participants underwent transvaginal ultrasonography using a 6.5 MHz transvaginal probe attached to a GE ultrasound machine (Logiq F6, SN-635528WXO) for the measurement of ovarian volume during the early follicular phase of the menstrual cycle (days 4–8).

Prior to the examination, participants were instructed to empty their urinary bladder. Informed consent was obtained following an adequate explanation of the procedure in the presence of a chaperone. The participant was positioned supine on the examination couch, with a support placed beneath the pelvis to facilitate downward angulation of the probe during scanning. The knees were flexed, and the feet were positioned flat on the couch approximately shoulder-width apart. To prevent cross-contamination between participants, the researcher wore disposable gloves and covered the transvaginal probe with a disposable sheath, usually a latex condom. An adequate amount of ultrasound coupling gel was placed inside the tip of the condom before it was carefully rolled over the probe. Particular care was taken to eliminate any trapped air that could interfere with ultrasound transmission. Finally, the covered probe was lubricated to facilitate comfortable insertion.[7]

Following localisation of both ovaries in longitudinal and transverse planes adjacent to the iliac vessels, round or oval sonolucent structures within the ovaries were identified as follicles.

Follicles measuring less than 8 mm in diameter were counted sequentially from the lateral to the medial margin of the ovary to determine the antral follicle count (AFC).

Although standardised transvaginal ultrasonography protocols were employed throughout the study, the possibility of operator-dependent measurement variability could not be completely excluded. Efforts to minimise such variability included the use of experienced personnel and adherence to uniform measurement techniques.

Ovarian Volume Measurement

Print ISSN: 3043-4742 Online ISSN: 3043-4750

The volume of each ovary was calculated by measuring three perpendicular diameters (longitudinal, anteroposterior and transverse) and applying the ellipsoid volume formula.[8]

Volume = 0.523 × Length × Height × Width[8]

Mean ovarian volume (MOV) was calculated for each participant by averaging the volumes of both ovaries, as illustrated in Figure 2.

Anthropometric Measurements

Participants' height and weight were measured using a Z-16 Stadiometer (Wincom Company Limited, China, 2017). Body mass index (BMI) was calculated from the measured height and weight and categorised into six groups: underweight (<18.5 kg/m²), normal weight (18.5–24.9 kg/m²), overweight (25.0–29.9 kg/m²), obesity class I (30.0–34.9 kg/m²), obesity class II (35.0–39.9 kg/m²), and obesity class III (≥40.0 kg/m²).

Figure 2. Transvaginal Sonogram of the right ovary, longitudinal and transverse views showing.

Statistical Analysis

The collected data were coded and entered into the **Statistical Package for the Social Sciences (SPSS)** version 25 for analysis using descriptive and inferential statistical methods.[9] The results were presented in tables, figures and charts. Qualitative variables were expressed as proportions, while quantitative variables were summarised using appropriate descriptive statistics and compared using the independent-samples *t*-test. Pearson's correlation coefficient was used to assess the relationships between variables within the study groups. For all statistical analyses, a *p*-value of less than 0.05 was considered statistically significant.

Ethical Considerations

Ethical approval for this study was obtained from the Ethics Committee of Rivers State University Teaching Hospital (RSUTH) prior to the commencement of the study.

Results

A total of 260 women, comprising 130 infertile women and 130 fertile women, were recruited for the study. As shown in Table 1, the mean age of the infertile group was 34.12 ± 6.03 years, while that of the fertile group was 31.50 ± 5.28 years (p = 0.0001). In the infertile group, 129 participants were married and one was widowed, whereas in the fertile group, 115 were married, 12 were widowed and three were single mothers. Among the infertile and fertile groups, 84 and 96 participants, respectively, had attained tertiary education, as shown in Table 1.

The age range of participants in the study population was 18–51 years, with a median age of 33 years and a mean age of 32.81 ± 5.80 years (Table 1). The modal age group was 26–30 years, comprising 81 participants, followed by the 31–35 years age group (n = 69) and the 36–40 years age group (n = 60).

Table 2 shows that 119 (45.8%) participants were overweight, 124 (47.7%) were classified as obesity class I, four (1.5%) were classified as obesity class II, 12 (4.6%) had normal body weight, and one participant (0.4%) was classified as obesity

Print ISSN: 3043-4742 Online ISSN: 3043-4750

class III. No participant was classified as underweight.

The mean ovarian volume (OV) across the different age groups in both the fertile and infertile categories is presented in Table 3. Overall, an age-related decline in ovarian volume was observed with increasing age (Table 3).

Women younger than 25 years had mean ovarian volumes of 10.41 ± 2.31 mL and 7.68 ± 2.60 mL in the fertile and infertile groups, respectively (p = 0.0001). Those aged 26–30 years had mean ovarian volumes of 10.00 ± 1.47 mL and 6.98 ± 1.80 mL, respectively. Participants aged 31–35 years had mean ovarian volumes of 9.11 ± 1.64 mL and 6.36 ± 2.25 mL in the fertile and infertile groups, respectively (p = 0.0001). Women aged 36–40 years had mean ovarian volumes of 7.92 ± 1.28 mL and 5.69 ± 1.58 mL, respectively (p = 0.0001). Participants older than 41 years had the lowest ovarian volumes in both groups, measuring 6.45 ± 1.34 mL and 4.90 ± 1.69 mL in the fertile and infertile groups, respectively (p = 0.0001).

A comparison of the mean values of the biophysical and sonographic parameters in infertile and fertile women is presented in Table 4. A statistically significant difference was observed in the mean ovarian volume between the infertile group (6.23 ± 2.07 mL) and the fertile group (9.23 ± 1.86 mL) (p = 0.0001). The mean ± standard deviation (SD), median and range of ovarian volume in the study population were 7.73 ± 2.47 mL, 7.93 mL and 3.00–13.85 mL, respectively. Figure 3 illustrates that the mean ovarian volume was significantly lower in the infertile group (6.23 ± 2.07 mL) than in the fertile group (9.23 ± 1.86 mL) (p = 0.0001).

The scatter plot demonstrated a negative correlation between age and mean ovarian volume in the fertile group, indicating that ovarian volume decreased with increasing age (Figure 4). A similar negative correlation between age and mean ovarian volume was observed in the infertile group, suggesting that ovarian volume also declined as age increased (Figure 5).

Table 5 presents the Pearson correlation coefficients (r) and corresponding p-values describing the relationships among age, body mass index (BMI) and mean ovarian volume (MOV) in both infertile and fertile women. Among infertile women, there was a statistically significant moderate positive correlation between age and BMI (r = 0.288, p = 0.001), indicating that BMI tended to increase with age. There was also a statistically significant negative correlation between age and MOV (r = −0.398, p = 0.0001), demonstrating that mean ovarian volume decreased as age increased. Furthermore, an inverse relationship was observed between BMI and MOV (r = −0.289, p = 0.001), indicating that higher BMI was associated with lower ovarian volume.

Among fertile women, no statistically significant correlation was observed between age and BMI (r = 0.084, p = 0.344). However, a statistically significant negative correlation was found between age and MOV, which was stronger than that observed among infertile women (r = −0.499, p = 0.0001), as shown in Table 5.

Print ISSN: 3043-4742 Online ISSN: 3043-4750

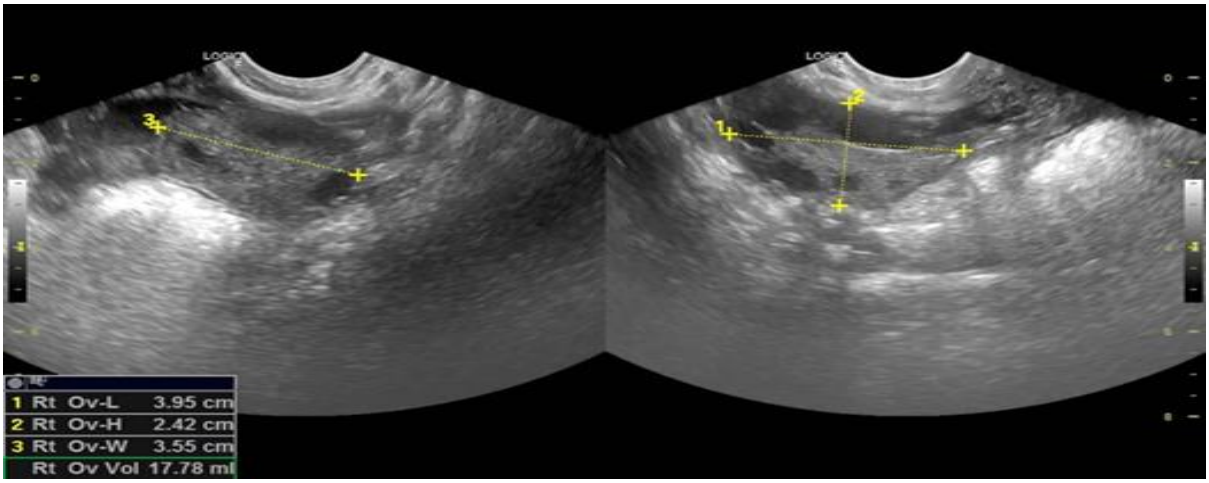


Table 1. Socio-demographic characteristics of participants

Variables	Fertile N = 130 n (%)	Infertile N = 130 n (%)	Total N = 260 n (%)	Chi-square	p-value
Age (years)					
≤ 25 years	12 (9.2)	12 (9.2)	24 (9.2)	14.697	0.005*
26 – 30years	50 (38.5)	31 (23.8)	81 (31.2)		
31 – 35years	38 (29.2)	31 (23.8)	69 (26.5)		
36 – 40 years	24 (18.5)	37 (28.5)	61 (23.5)		
≥ 41 years	6 (4.6)	19 (14.6)	25 (9.6)		
Mean age ± SD	31.50 (5.28)	34.12 (6.02)			0.0001*
Marital status					
Married	115 (88.5)	129 (99.2)	244 (93.8)	13.285	0.0001*
Widow	12 (9.2)	1 (0.8)	13 (5.0)		
Single	3 (2.3)	0 (0.0)	3 (1.2)		
Educational level					
Secondary	34 (26.2)	46 (35.4)	80 (30.8)	2.600	0.107
Tertiary	96 (73.8)	84 (64.6)	180 (69.2)		
Occupation					
Government employed	15 (11.5)	12 (9.2)	27 (10.4)	6.326	0.502
Private employed	19 (14.6)	13 (10.0)	32 (12.3)		
Self employed	26 (20.0)	20 (15.4)	46 (17.7)		
Housewife	27 (20.8)	36 (27.7)	63 (24.2)		
Student	14 (10.8)	18 (13.8)	32 (12.3)		

Print ISSN: 3043-4742 Online ISSN: 3043-4750

Table 2. Age and Body Mass Index of the Study Population

Variables	Frequency	Percentage
Age (years)		
≤ 25 years	24	9.2
26 – 30years	81	31.2
31 – 35years	69	26.5
36 – 40 years	61	23.5
≥ 41 years	25	9.6
Body Mass Index		
<18.5 (Underweight)	0	0.0
18.5 – 24.9 (Normal)	12	4.6
25 – 29.9 (Overweight)	119	45.8
30 – 34.9 (Obesity Grade I)	124	47.7
35 – 39.9 (Obesity Grade II)	4	1.5
≥40 (Obesity Grade III)	1	0.4

Table 3. Mean ovarian volume of participants in the different age groups

Variables	Fertile Mean ± SD	Infertile Mean ± SD
Age (years)		
≤ 25 years	10.41 ± 2.31	7.68 ± 2.60
26 – 30years	10.00 ± 1.47	6.98 ± 1.80
31 – 35years	9.11 ± 1.64	6.36 ± 2.25
36 – 40 years	7.92 ± 1.28	5.69 ± 1.58
≥ 41 years	6.45 ± 1.34	4.90 ± 1.69
	*ANOVA = 33.686 ; p-value = 0.0001**	*ANOVA = 5.883 ; p-value = 0.0001**

Print ISSN: 3043-4742 Online ISSN: 3043-4750

Table 4. Comparative analysis of the biophysical and sonographic parameters in fertile and Infertile women

Variables	Infertile (N=130) Mean ± SD	Fertile (N=130) Mean ± SD	p-value
Age (years)	34.12±6.03	31.50±5.28	0.0001*
MOV	6.23±2.07	9.23±1.86	0.0001*
BMI (Kg/m^2)	28.79±2.98	30.70±3.89	0.0001*

*Statistically significant

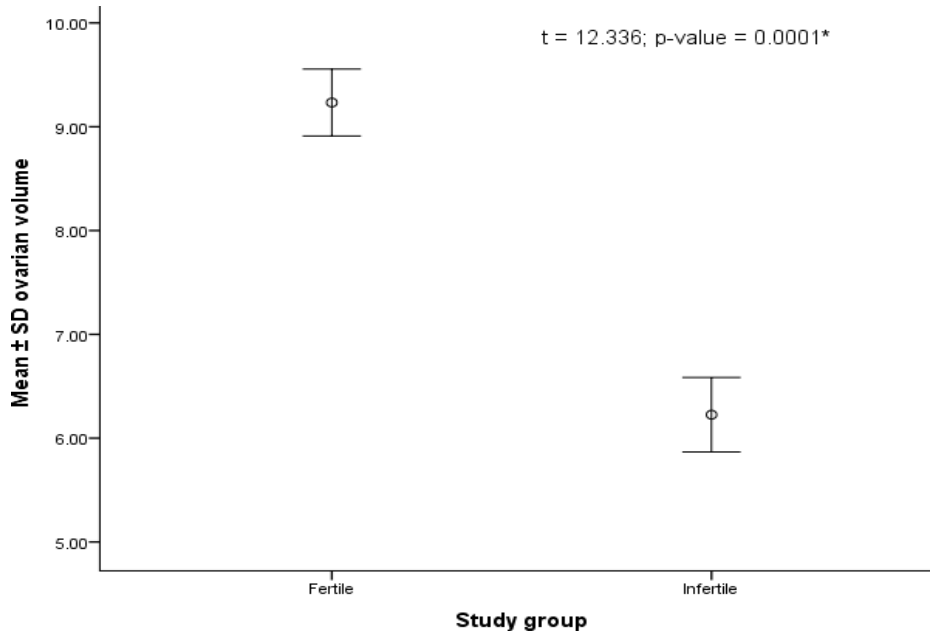


Figure 3 Error bar chart showing the mean ovarian volume of women across the study groups

Print ISSN: 3043-4742 Online ISSN: 3043-4750

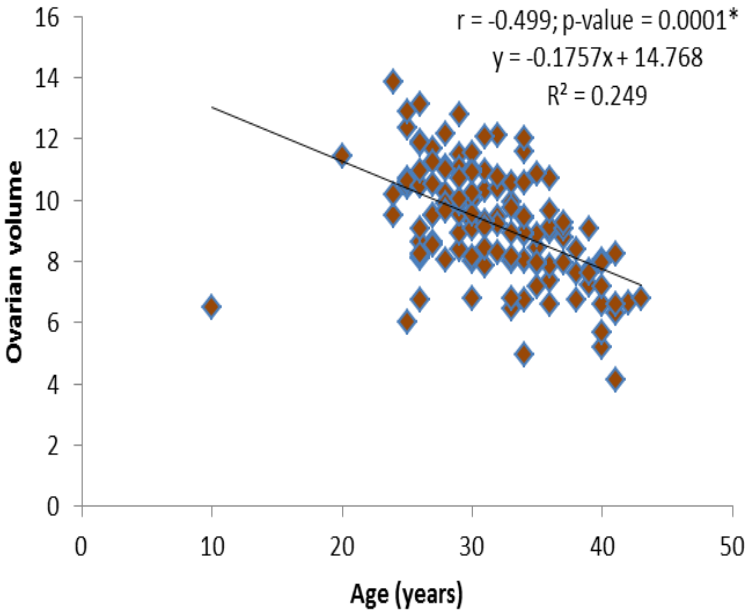
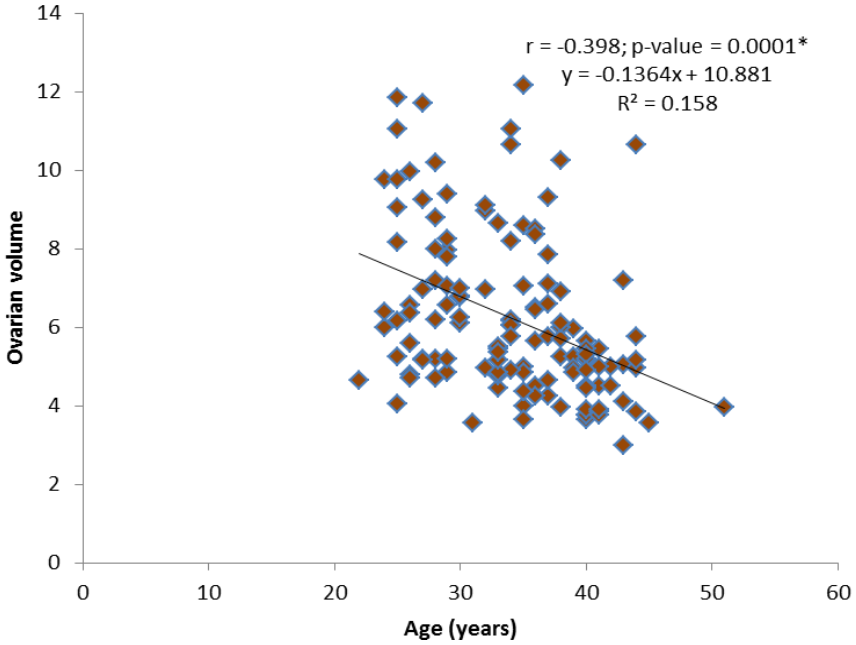


Figure 4. Scatter plot showing correlation between mean OV and age in years among the fertile group

Figure 5. Scatter plot showing correlation between mean OV and age in years among the infertile



group

Table 5. Correlation matrix of biophysical and sonographic parameters

Print ISSN: 3043-4742 Online ISSN: 3043-4750

	INFERTILE			FERTILE		
Parameters	Age	BMI	MOV	Age	BMI	MOV
Age (years)						
***r*- value**	1			1		
***P*-value**						
BMI						
***r*- value**	0.288	1		0.084	1	
***P*-value**	0.001*			0.344		
MOV						
***r*-value**	-0.398	-0.289	1	-0.499		1
***P*-value**	0.0001*	0.001*		0.0001*		

MOV (Mean Ovarian Volume), BMI (Body Mass Index)

Discussion

The mean age of the control group was 31.50 years, whereas that of the case group was 34.12 years. A total of 236 participants (90.8%) in the study population were older than 25 years, while 24 (9.2%) were younger than 25 years. These findings are similar to those reported by Agarwal et al.[10] in India in a prospective observational case–control study involving 30 women evaluated for infertility and 30 women with proven fertility as controls. In that study, 60–70% of participants were older than 25 years, while 30–40% of both the case and control groups were younger than 25 years, with no significant difference in the mean ages of the case and control groups (26.77 versus 26.73 years). Nayak et al.[11], also in Central India, reported a similar pattern, with mean ages of 27.86 and 28.80 years for the case and control groups, respectively, while Islam et al.[12] in Cairo, Egypt, reported mean ages of 31.4 and 29.6 years, respectively. Zhou et al.[13] in China reported a mean age of 36.92 years, while Hung Yu Ng et al.[14] in Hong Kong reported a mean age of 36.0 years in a similar study. The similarity in the mean ages across these studies may largely be attributed to the comparable methodologies employed and the fact that women in their third decade of life constitute a substantial proportion of the reproductive-age population.

Studies conducted by Islam et al.[12], Nayak et al.[11] and Agarwal et al.[10] in Egypt, Central India and Eastern India, respectively, reported no significant differences in BMI among their study populations. These findings differ from those of the present study, which demonstrated mean BMI values of 28.79 kg/m² and 30.70 kg/m² in the

Print ISSN: 3043-4742 Online ISSN: 3043-4750

infertile and fertile groups, respectively, with a statistically significant difference. This discrepancy may be attributable to the relatively smaller sample sizes used in the earlier studies compared with the present study.

The mean ovarian volume (OV) was significantly lower in the infertile group (6.23 ± 2.07 mL) than in the fertile group (9.23 ± 1.86 mL) (p = 0.0001). A significant age-related decline in ovarian volume was also observed across age groups in both the fertile and infertile categories. Women younger than 25 years had mean ovarian volumes of 10.41 ± 2.31 mL and 7.68 ± 2.60 mL in the fertile and infertile groups, respectively, whereas women aged 41 years and above had mean ovarian volumes of 6.45 ± 1.34 mL and 4.90 ± 1.69 mL, respectively. Overall, a negative correlation was observed between ovarian volume and age in both the case and control groups.

This finding is consistent with reports by Hung Yu Ng et al.[14], Scheffer et al.[15], Erdem et al.[16] and Sharara et al.[17] Ovarian volume generally increases from birth to puberty and is believed to peak shortly thereafter, which may explain the relatively larger ovarian volumes observed among participants younger than 25 years in both study groups. Previous studies have also shown that ovarian volume correlates strongly with follicular density in women older than 34 years and that larger ovarian volumes are associated with more favourable assisted reproductive technology outcomes, whereas smaller ovarian volumes are associated with poorer outcomes.[18]

Mean ovarian volumes were comparatively lower among infertile women in the present study. Similar observations were reported by Erdem et al.[16], who found a mean ovarian volume of 3.1 ± 1.6 mL, Lass et al.[18], who reported a mean ovarian volume of 6.3 ± 3.1 mL, and Sharara et al.[17], who reported a mean ovarian volume of 6.0 ± 4.7 mL. Erdem et al.[16] recruited women aged between 35 and 45 years, which may explain the considerably lower ovarian volumes observed in their study. This finding is consistent with the established age-related decline in ovarian volume as women approach menopause. Studies involving older women are therefore more likely to report lower mean ovarian volumes than studies that include a broader reproductive age range, as was the case in the present study.

Pavlik et al.[19], in a large cohort study of women undergoing ovarian cancer screening, reported a mean ovarian volume of 6.1 ± 0.06 mL and demonstrated a significant decline in ovarian volume with each successive decade of life between the ages of 30 and 70 years.

Nwankwo et al.[20], in a prospective study involving 50 non-pregnant women aged 18–43 years attending a private radiodiagnostic facility in Port Harcourt, Nigeria, assessed ovarian volumes using transvaginal ultrasonography and reported a mean ovarian volume of 9.8 mL, with a significant age-related decline across study groups. This finding is similar to that of the present study and may be attributed to similarities in geographical location, ethnicity, socioeconomic characteristics and dietary

Print ISSN: 3043-4742 Online ISSN: 3043-4750

patterns. Socioeconomic status may influence reproductive health through multiple pathways, including access to healthcare services, utilisation of fertility treatments, nutritional status, environmental exposures and health-seeking behaviour. Women from lower socioeconomic backgrounds may experience delayed diagnosis and treatment of reproductive disorders and may be disproportionately affected by infections and other health conditions that adversely affect fertility. Differences in educational attainment and reproductive health awareness may also influence the timing of presentation for infertility assessment. These contextual factors should be considered when comparing findings across populations and geographical regions.

The present study demonstrated a gradual decline in ovarian volume across age groups. However, Agarwal et al.[10] reported no significant differences in median ovarian volume between fertile and infertile women in their study involving 30 participants in each group at a university teaching hospital in India. This discrepancy may be attributable to the relatively small sample size. Zhou et al.[13] reported a mean ovarian volume of 6.74 ± 2.57 mL among 319 infertile women in Beijing, China. However, no statistically significant differences were observed across their study groups, with mean ovarian volumes of 6.51 ± 1.65 mL, 6.46 ± 2.54 mL, 6.92 ± 2.58 mL and 6.57 ± 2.87 mL in groups 1–4, respectively (p = 0.716). In contrast, the present study found significant differences in ovarian volume between study groups. One possible explanation is that participants in the study by Zhou et al.[13] were women undergoing in vitro fertilisation (IVF) and intracytoplasmic sperm injection (ICSI), many of whom may have received pre-treatment therapies that influenced ovarian volume. Differences in socioeconomic conditions, healthcare access and standards of living between China and Nigeria may also have contributed to the observed variations.

A close association between the biophysical parameters (age and BMI) and sonographic mean ovarian volume was observed in both study groups, consistent with the findings of Agarwal et al.[10] and Erdem et al.[16] Chronological age is closely related to reproductive age, and the age-related decline in ovarian reserve observed in this study is consistent with findings reported worldwide. At puberty, the initiation and maintenance of reproductive function are associated with an optimal body weight or BMI.[21] However, no clear relationship was established between BMI and sonographic markers of ovarian reserve in adult women, as no significant difference was demonstrated between the fertile and infertile groups with respect to optimal BMI and obesity.

The prevalence of diminished ovarian reserve in the present study was 22.3%. This finding is comparable to that reported by Kate et al.[22] in the United States, who reported a prevalence of 19%. However, Agarwal et al.[10], Nayak et al.[11] and Erdem et al.[16] did not determine the prevalence of diminished ovarian reserve in their studies. The slight difference between the prevalence observed in the present study and that

Print ISSN: 3043-4742 Online ISSN: 3043-4750

reported in the United States may be attributable to differences in racial, socioeconomic and geographical characteristics between the populations studied.

Small ovarian volumes are recognised as an early indicator of diminished ovarian reserve and have been associated with higher cancellation rates during IVF cycles among infertile women. Syrop et al.[23] reported a cancellation rate of 20% among women with ovarian volumes less than 3 mL, while Lass et al.[18] reported a cancellation rate of 52.9%. The cross-sectional design of the present study limits the ability to establish a causal relationship between reduced ovarian volume, lower follicle counts and infertility outcomes.

Ovarian volume measurement is an indirect biomarker for estimating ovarian reserve in women. Evidence from studies conducted worldwide suggests that ovarian volume correlates well with ovarian reserve. Although the ovarian volume values reported in the present study are slightly lower than those reported in Western populations, such differences may be explained by variations in socioeconomic status, ethnicity and geographical location. The present study demonstrated a strong inverse relationship between ovarian volume and age, supporting the utility of sonographic ovarian volume as a predictor of reproductive potential among Nigerian women of reproductive age. Consequently, ovarian volume assessment may assist in the selection of patients for assisted reproductive technologies, potentially improving treatment outcomes. Ovarian reserve assessment is also valuable in treatment planning, monitoring treatment response and predicting prognosis among infertile women.[13]

Conclusion

The findings of this study demonstrated a significant difference in mean ovarian volume between infertile and fertile women. An age-related decline in ovarian volume was also observed across the study population. The prevalence of diminished ovarian reserve was found to be 22.3%. These findings further support the role of mean ovarian volume as an important sonographic marker for the assessment of ovarian reserve.

However, the findings should be interpreted in light of certain limitations, including the cross-sectional study design, which precludes causal inference, and the potential influence of unmeasured confounding variables. Furthermore, the study population was recruited from a single institution, which may limit the generalisability of the findings to other populations.

Future prospective multicentre studies involving larger and more diverse populations are recommended to validate these findings and establish temporal relationships. Further research should also examine the influence of hormonal profiles, ethnic variations, socioeconomic status, dietary factors and other reproductive health determinants on ovarian volume and fertility outcomes. Such studies may provide

Print ISSN: 3043-4742 Online ISSN: 3043-4750

a more comprehensive understanding of the role of ovarian volume in female infertility. Sonographic ovarian volume is a useful indicator of ovarian reserve and should be routinely assessed during the evaluation of the female reproductive system. Longitudinal studies investigating the predictive value of sonographic ovarian reserve markers, biochemical ovarian reserve markers and age in relation to fertility outcomes should also be encouraged.

References

1. Stuart Lavery. Female pelvic organs anatomy In: Gynecology by Ten Teachers 20th edition. Helen Bickerstaff and Louise C. Kenny (eds.); CRC Press Taylor & Francis Group London 2017; 92.
2. Bates JA, Taft L, Gopalan V, Mahony BS. Ultrasound evaluation of the female pelvis. In: Rumack CM, Wilson SR, Charboneau JW, Levine D, editors. *Diagnostic Ultrasound*. 5th ed. Philadelphia: Elsevier; 2018. p. 1033–81.
3. Nayak PK, Mukherjee C, Mitra S. The relevance of antral follicle count (AFC) as a marker of ovarian reserve in normal and infertile women in a tertiary care centre in Central India. Int J. Reprod Contracept Obstet Gynecol. 2018; 7: 4711-4.
4. https://en.wikipedia.org/w/index.php?title=female_infertility&oldid=960435235. Accessed on 20/08/23.
5. Mascarenhas MN, Flaximan SR, Boerma T, Vanderpoel S, Stevens GA. National Regional and Global Trends in Infertility Prevalence since 1990. A Systematic Analysis of 277 Health Surveys. PLoS Med. 2012; 9(12).
6. Paul B, Adam WM, Mitchell CH, and Jeremiah CH. Applied Radiological Anatomy. Cambridge. 2012; (2): 278-284.
7. Moorthy RS. Transvaginal Sonography. Med J Armed Forces India. 2000; 56 (3):181-183
8. Biliaminu SA, Abdulazeez IM, Okesina AB, Olatinwo AW, Omokanye LO, Adunmo GO et.al. Evaluation of Ovarian reserve in assisted reproductive facilities; Biochemical and other alternatives: Pros and cons -A review article. SJMLS 2017: 2(1):183-191
9. IBM Corp. IBM SPSS Statistics for windows version 25.0 [Internet]. Armonk, NY: IBM Corp; 2017. Available from: https://hadoop.apache.org Accessed on 06-01- 2023
10. Agarwal A, Verma A, Agarwal S, Shukla RL, Jain M, Srivastara A.

Print ISSN: 3043-4742 Online ISSN: 3043-4750

Antral follicle count in normal (fertility proven) and infertile Indian women. Indian J. Radiol Imaging. 2014; 24(3): 297-312

11. Nayak PK, Mukherjee C, Mitra S. The relevance of antral follicle count (AFC) as a marker of ovarian reserve in normal and infertile women in a tertiary care centre in Central India. Int J. Reprod Contracept Obstet Gynecol 2018; 7: 4711-4.

12. Islam Y, Aboulghar MM, Al-Ebrashy AE, Abdel-Aziz O. The value of different ovarian reserve tests in the prediction of ovarian response in patients with unexplained infertility. Middle East Fertility Society Journal 2019; 21(2): 69-74

13. Zhou SJ, Zhao MJ, Li C, Su X. The comparison of evaluative effectiveness between antral follicle count/age ratio and ovarian response prediction index for the ovarian reserve and response functions in infertile women. Medicine 2020; 99(36):e21979 Available from doi:10.1097/MD.0000000000021979

14. Hung Yu Ng E, Yeung WS, Fong DY, Ho PC. Effects of age on hormonal and ultrasound markers of ovarian reserve in Chinese women with proven fertility. Hum Reprod. 2003;18(10):2169–74.

15. Scheffer GJ, Broekmans FJ, Looman CW, Blankenstain M, Fauser BC, de Jong FH. The number of antral follicles in normal with proven fertility is the best reflection of reproductive age. Human Reproduction 2003;18(4): 700-706.

16. Erdem M, Erdem A, Biberoglu K, Arslan M. Age-related changes in ovarian volume, antral follicle counts and basal follicle stimulating hormone levels: comparison between fertile and infertile women. GynecolEndocrinol. 2003; 17:199-205

17. Sharara FI, McClamrock HD. The effect of aging on ovarian volume measurements in infertile women. Obstet Gynecol. 1999; 94: 57-60

18. Lass A, Skull J, McVeigh E, Margara R, Winston RML. Measurement of ovarian volume by transvaginal sonography before ovulation induction with human menopausal gonadotropin for in vitro fertilization can predict poor response. Human Reproduction.1997; 12(2): 294-297.

19. Pavlik E, DePriest PD, Gallion HH, Ueland FR, Reedy MB, Kryscio RJ et al. Ovarian volume related to age. GynecolOncol. 2000; 77, 410-412

Print ISSN: 3043-4742 Online ISSN: 3043-4750

20. Nwankwo NC, Maduforo CO. Transvaginal ultrasound measurement of ovarian volume in Port Harcourt. Journal of Medicine and Medical Science. 2011; 2(9); 1080-1084.

21. Broekmans FJ, Knee J, Hendricks DJ, Mol BW, Lamback B. A systematic review of tests predicting ovarian reserve and IVF outcome. Human Reproduction Update. 2006; 12 (6) ; 685-718.

22. Kate D, Sunni LM, Mae W, Alan HD, Michal JH, Anthony P. Diminished Ovarian Reserve in the United States Assisted Reproductive Technology Population: Diagnostic Trends Among 181,536 cycles from the Society for Assisted Reproductive Technology Clinic Outcomes Reporting System. Fertility and Sterility. 2015; 104(3): 612-619.

23. Syrop CH, Dawson JD, Husman KJ, Sparks AET, VenVoorhis BJ. Ovarian volume may predict assisted reproductive outcomes better than follicle stimulating hormone concentration on day 3. Human Reproduction. 1999; 14, (7): 1752-1756.

Print ISSN: 3043-4742 Online ISSN: 3043-4750

Print ISSN: 3043-4742 Online ISSN: 3043-4750

Print ISSN: 3043-4742 Online ISSN: 3043-4750