

## A Study to Assess the Normal Values of Ovarian Volume for Women in Singapore Using Transabdominal Ultrasound

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### ABSTRACT

**Background.** The objective of this yearlong study of patients referred for transabdominal pelvic ultrasound was to determine the normal values of ovarian volume in a sample of the local population. Patient selection was paramount in selecting a “sonographically normal” cohort for statistical analysis. Hitherto unpublished data of normal ovarian volumes were obtained which could impact future patient management.

**Methods.** We collected the data of ovarian volumes from 198 patients referred for transabdominal pelvic ultrasound to the department of diagnostic radiology at 2 polyclinics and a local community hospital and subjected these to statistical analysis. Mean ovarian volume and median values of ovarian volumes for 3 different age groups were computed and the results analysed.

**Results.** Normal values of ovarian volume were obtained for a sample of the local population which could be of invaluable assistance to radiologists and sonographers performing transabdominal pelvic sonography in Singapore.

**Conclusion.** This study provided reference values for ovarian volumes for the local population, hitherto unpublished.

*Keywords:* normal ovarian volume, ultrasound pelvis

### INTRODUCTION

Transabdominal ultrasonography of the female pelvis is a common investigative procedure and has the advantage of being a non-invasive, quick procedure with a relatively high level of accuracy. In a routine pelvic scan, assessment of ovarian size is useful in the early detection of ovarian pathology. Polycystic ovarian syndrome, neoplasms and cysts are common causes of enlarged ovaries and sonographically determined ovarian size can contribute to their early detection.

The medical literature and textbooks give conflicting values for normal ovarian size and to the best of our knowledge, no data on normal ovarian values are currently available with respect to the Singapore population. As such, this yearlong study was undertaken to determine the normal values of ovarian volume in a sample of the local population.

### METHODS

This study had been approved by the Ethics Committee of the Singapore General Hospital. The study population comprised 198 patients between the ages of 15 and 45 who had been referred to the X-ray Departments of Tampines and Geylang Polyclinics and the X-ray Department of the Ang Mo Kio Community Hospital for pelvic scans. Patients with “sonographically normal” ovaries were selected for the study, using the following inclusion criteria:

1. Patients must not have any ultrasonically detectable pathology of the uterus, ovaries or adnexae. The only exception being the presence of nabothian cysts in the cervix, which were accepted as being of no clinical significance.
2. Follicular cysts were acceptable up to a size of 2.5cm.<sup>1</sup> A similar upper limit was imposed on corpus luteal cysts.

- Patients with 10 or more cysts arranged peripherally in one or both ovaries were excluded as this is a major feature of polycystic ovarian syndrome.<sup>2</sup>

We selected patients in the reproductive age group of 15 to 45 years, as this constitutes the majority of patients seen in our cohort. The sample sizes for the individual pre-puberty, puberty and menopausal age groups were comparatively small and probably insufficient for statistical analysis. As this study had a bearing on patient management (our patients were referred for diagnostic purposes), a cut-off value for what constituted an “enlarged ovary” needed to be defined. Using the data of Munn *et al* and Dewbury *et al*, an ovarian volume of 14cc was assigned as the upper limit of normal. Measurements above this were considered “equivocal or enlarged”, meriting further investigation.<sup>3,4</sup> Cases with equivocal or enlarged readings were excluded from the study.

#### Measurement of Ovarian Volume

Each patient was scanned with a full bladder and each ovary was measured in 3 planes. The ovarian volume was calculated using the prolate ellipsoid formula — length × width × thickness × 0.523.<sup>4</sup> This formula is a simplification of the equation for volume of an ellipsoid: volume of an ellipsoid in cubic centimeters =  $\frac{4}{3} \times \pi \times ((\text{longitudinal diameter in cm})/2) \times ((\text{anteroposterior diameter in cm})/2) \times ((\text{transverse diameter in cm})/2)$ .<sup>5</sup>

Length and depth measurements were obtained from parasagittal views whilst width measurements were obtained from transverse views (Figs. 1a and 1b). Overdistension of the bladder can displace the ovaries out of the field of view of the sector probe and it was necessary in some cases to have the patients empty half of the contents of the bladder so as to adequately visualise the ovaries.

The ovaries may occasionally be obscured by bowel shadows, with the left side more commonly obscured (by sigmoid gas) than the right.<sup>6</sup> Patients with only one ovary visualised were not included in the study.

The results were tabulated and subjected to statistical analysis.

#### Statistical Analysis

##### Subjects

A total of 198 women aged between 16 to 45 years (mean 32.5, SD 8.6) were studied.



Fig. 1a. Length and depth measurements of the ovary in the parasagittal plane.



Fig. 1b. Width measurement of the ovary in the transverse plane.

#### Data analysis

Data analysis was performed using SPSS for Windows, version 10.1.3. Exploratory data analysis tools like scatterplots and descriptive statistics (mean, median, SD, range, percentiles) were used to examine the distribution of the ovarian volumes by age. Correlation between age and ovarian volume was measured using the Pearson correlation coefficient. Age was broken down into 3 age groups: (15, 25), (25.1, 35) and (35.1, 45). The distribution of ovarian volumes was found to be skewed and not following a normal distribution. So, median and 90th percentile range which is the range from 5th to 95th percentile were reported for the various age groups. Comparison test of the volume between right and left ovaries was carried out using the Wilcoxon Signed Rank test and comparison between the age groups by Kruskal-Wallis and Mann-Whitney test.

Table 1. Ovarian volume reference range by age group.

Age Group (Years)	n	Median (ml)	90th Percentile Range (ml)
15–25	50	6.29	(1.29, 11.95)
25–35	56	5.20	(2.02, 10.83)
35–40	91	4.00	(1.40, 8.92)

Table 2. Normal ovarian volume from various published sources.

Author of Book/Publication	Normal Ovarian Size in Pre-menopausal Women (cc)	Mode of Investigation e.g. Transvaginal Scan
Sutton D <sup>7</sup>	< 7.5	Not Mentioned
Sanders RC <sup>8</sup>	4*	Transabdominal
Pavlik EJ <sup>9</sup>	4.9* ± 0.03 Upper Limit of 20cc	Transvaginal Sonography
van Nagell JR Jr <sup>10</sup>	6.8* Upper Limit of 18cc	Transvaginal Sonography
Munn CS <sup>11</sup>	6.48* Upper Limit of 13.84cc	Transabdominal Sonography
Oppermann K <sup>12</sup>	7.1* ± 3.1	Transvaginal Sonography
Cohen HL <sup>13</sup>	9.8* ± 5.8 Upper Limit of 21.9cc	Transabdominal Sonography

\* Mean or Average Volume

## RESULTS

The median and interquartile (25th to 75th percentile) range for the difference between left and right ovarian volumes was  $-0.2$  ( $-1.9, 1.3$ ) ml. As no significant difference ( $p=0.334$ ) was found between volumes of left and right ovaries, we simply used the mean of the right and left ovaries in all subsequent analysis. The median and 90th percentile range for the overall group of women in our study was 5.20ml and 1.63 to 10.20ml. Ovarian volume was negatively correlated to age ( $R=-0.336$ ,  $p < 0.0005$ ) (Figs. 2 and 3). The reference range of ovarian volume by age group is presented in Table 1. Patients in the 35 to 45 age group had significantly smaller ovarian volume than patients in the 15 to 25 ( $p < 0.0005$ ) and 25 to 35 age groups ( $p=0.001$ ).

## DISCUSSION

A literature search revealed data of normal ovarian volumes (Table 2). The mean ovarian volume ranged from 4.9 to 9.8cc with a maximum upper limit of 22cc. Data from our study of a sample of the Singapore population showed an average volume of 5.2cc with a 90th percentile range from 1.63 to 10.2cc. There was no significant difference in mean volumes of the right and left ovaries.

Correlation with age showed a decreasing mean volume with increasing age in our study. This is consistent with the findings of Pavlik *et al* who showed a statistically significant decrease in ovarian volume with each decade of life from age 30 to 70.<sup>9</sup> A study by Cohen *et al* also drew a very similar conclusion.<sup>13</sup>

We did not correlate mean ovarian volume with menstrual cycle or with height and weight. However, the study by Cohen *et al* showed no significant relationship between ovarian volume and phase of menstrual cycle or with height and weight.<sup>13</sup>

There are several limiting factors in our study. Since our study consisted of patients referred for pelvic ultrasound, they were for the most part “symptomatic”. We had to define criteria so as to include only those deemed to be “sonographically” normal. It was also necessary to set an upper limit of ovarian volume (from published studies) for our sample, as our findings had a bearing on further patient management. This might have had some impact on our data analysis. However, it should be mentioned that this is the first project of this nature in Singapore and we were able to draw some useful data with reference to normal ovarian volume from our sample study.

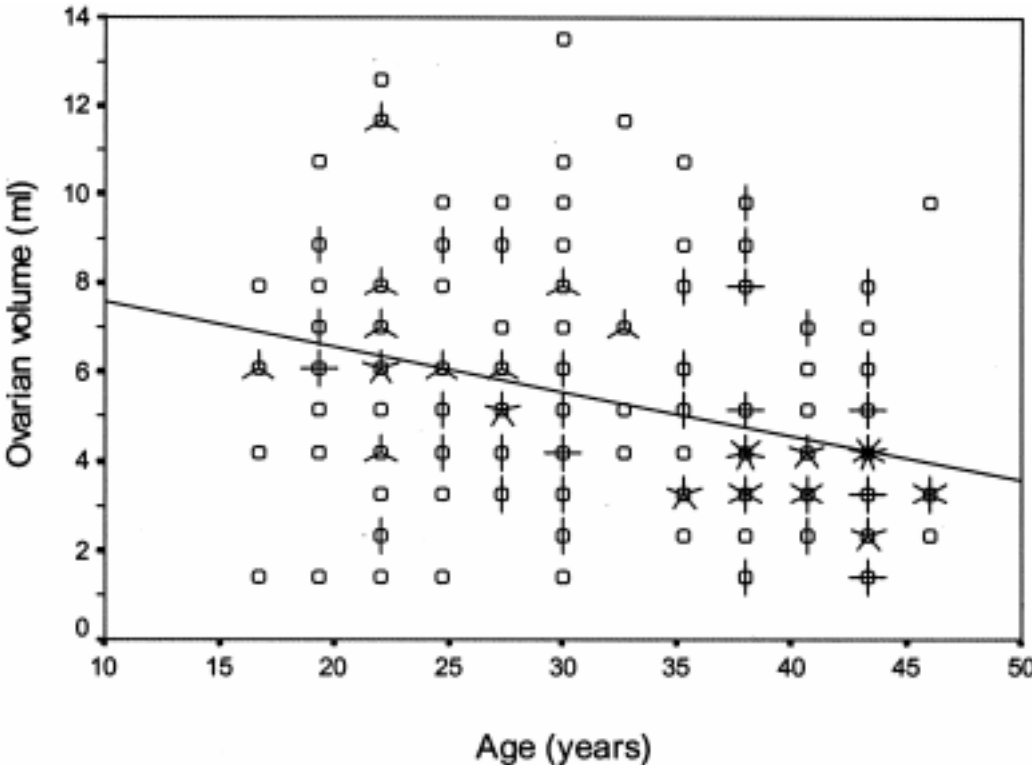


Fig. 2. Scatterplot of ovarian volume by age with a linear trend line showing a negative correlation of ovarian volume with age.

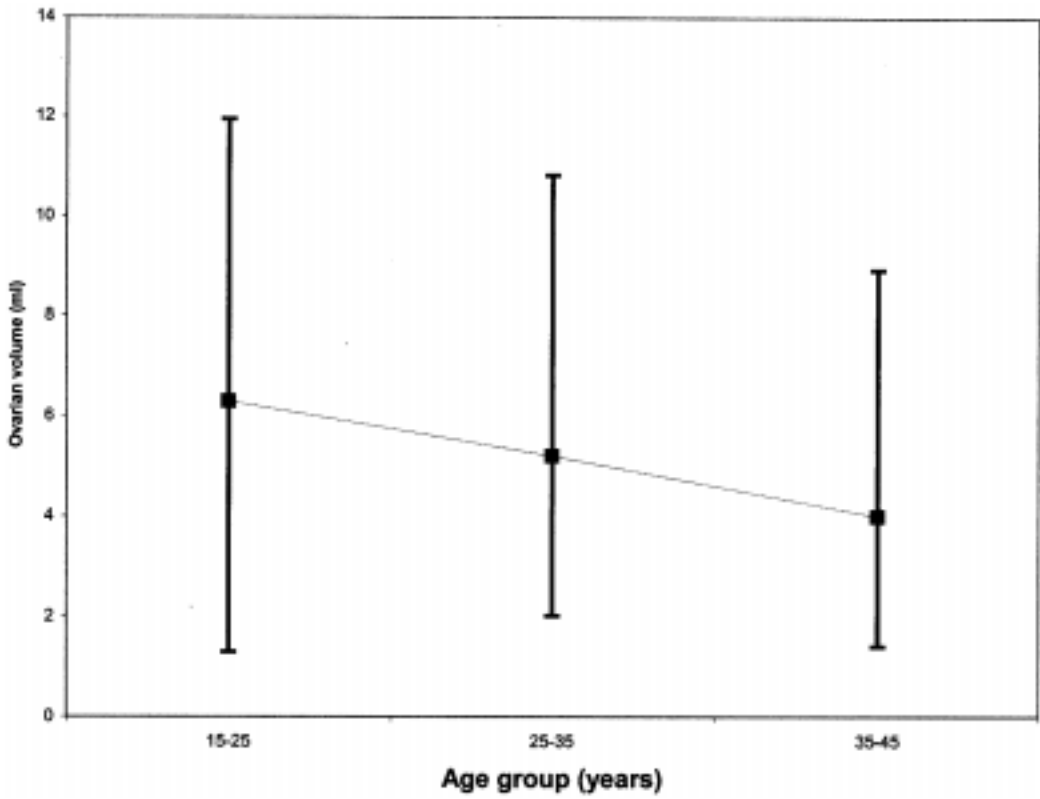


Fig. 3. The 5th percentile, median and 95th percentile for ovarian volumes for the 3 age groups of women.

A prospective study of normal female volunteers in the local population would perhaps yield data more reflective of a “normal” population range.

We did not delve into the merits and demerits of transvaginal ultrasound in the assessment of ovarian volume as this was beyond the scope of our present publication. It would perhaps be pertinent to mention that transvaginal scans have been shown to be more accurate in the measurement of ovarian volumes and in the analysis of ovarian structures.

## CONCLUSION

The aim of this yearlong project was to determine the normal ovarian volume of a sample of the local population. Our study provided some invaluable reference values, which hitherto have not been published. These data could have a future impact on patient management in patients referred for pelvic sonography.

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