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ORIGINAL RESEARCH

Ultrasonographic Assessment of Uterine Measurements and Endometrial Thickness Among Healthy Saudi Females Sample

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Aim: The present study was conducted to analyze uterine measurements and endometrial thickness throughout the menstrual cycle in Saudi healthy females of reproductive age.

Methods: This cohort study was conducted at Princess Nourah bint Abdulrahman University, Saudi Arabia, among thirty-three females of reproductive age who underwent trans-abdominal pelvic ultrasound scans across four menstrual cycle phases. Data analysis was conducted using SPSS version 26, utilizing descriptive statistics, one-way ANOVA, correlation, and regression analysis.

Results: Endometrial thickness and layers showed significant variations ($p<0.001$) across menstrual phases (early proliferative: 0.59 ± 0.21 cm, late proliferative: 0.77 ± 0.24 cm, secretory: 1.09 ± 0.40 cm, menstrual: 0.52 ± 0.35 cm). Endometrial thickness was positively correlated with number of layers ($r=0.576$, $p<0.05$). The study showed that the average uterine length, width, and thickness were 7.33 ± 0.76 cm, 3.93 ± 1.00 cm and 3.44 ± 0.55 cm, which showed stability across menstrual phases, except for width showing slight variations. Endometrial thickness was positively correlated with uterine thickness ($r=0.358$, $p<0.05$).

Conclusion: The study results emphasize the significance of using region-specific reference values in clinical practice. This approach would enable precise evaluation and treatment of gynecological problems. It is encouraged to do future study with larger populations in order to validate these results and improve the therapeutic applicability.

Keywords: endometrial thickness, endometrial layering, ultrasound, uterus, menstrual phase

Introduction

The uterus is a female pelvic organ responsible for several reproductive functions including menstruation, gestation, and labour. Anatomically, the uterus is a pear-shaped hollow organ located between the bladder anteriorly and the rectum posteriorly.[1] In adult females, the non-gravid uterus is about hand fist size with average dimensions of 8 cm long, 5 cm wide, and 4 cm thick. Its cavity has an average volume of 80 mL to 200 mL.[2]

The uterine wall consists of three layers. The inner lining is made up of two types of endometrial cells functional superficial layer and the deep basal layer. The functional layer responds to reproductive hormones and sheds causing menstrual bleeding. While the basal layer is responsible for regeneration of the superficial layer. The middle layer is made of smooth muscle cells it is called the myometrium. The outermost layer is the serosa (also known as perimetrium), which is made up of epithelial cells.[3]

The measurement of uterine size and endometrial thickness is essential in evaluating the reproductive health of women. These parameters are critical in diagnosing and managing various gynecological conditions, such as uterine fibroids, polyps, and endometrial hyperplasia.[4,5] Ultrasound imaging is a widely used non-invasive method for this

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purpose due to its accessibility, safety, and effectiveness in providing detailed visualization of pelvic structures.[6,7] The use of this technology requires an understanding of the normal anatomy and physiology of the female pelvis especially the uterus is essential for acquiring and interpreting gynecological sonographic pictures.[8]

Several studies have provided normative data for uterine size and endometrial thickness in different populations. For example, Chris-ozoko et al reported baseline measurements for Nigerian women,[9] and similar studies in Iran[10] China[11] and Pakistan,[12] underscoring the importance of region-specific reference values. These studies would be instrumental in improving the diagnostic accuracy and management of gynecological conditions in their respective regions.

Therefore, conducting a comprehensive study to measure uterus sizes and endometrium thickness among healthy Saudi females using ultrasound can provide valuable insights and enhance the overall quality of gynecological care in Saudi Arabia.

Methods

Study Design and Settings

This was a longitudinal prospective study conducted at Princess Nourah bint Abdulrahman University (PNU) ultrasound lab from November 2022 to April 2023. We involved a total number of 33 females of reproductive age. Trans-abdominal pelvic ultrasound scan was carried out by an ultrasound specialist for the females over four visits during their cycle. Inclusion criteria were: females of reproductive age, with a regular menstrual cycle, not pregnant at the study time; mother and father with Saudi nationality and with no apparent gynecological disorder. Pregnant females and those with an irregular cycle, uterine deformity, or other gynecological disorders were excluded.

Ultrasound Scan and Data Collection

The scanning was performed according to AIUM's guidelines.[13] The ultrasound scan was conducted using Philips iU22 Ultrasound Machine with a low-frequency probe. Trans-abdominal pelvic sonography was performed with a distended urinary bladder. The females were asked to lie on the examination table in a supine position. The abdomen and pelvic regions were exposed, and ultrasound gel was applied to the pelvic region. The probe was placed and moved back and forth over the pelvic region until the desired images were obtained.

Then the measures were taken. The uterine length was the distance measured from the uterus's fundus to the cervix's external os on a longitudinal view. The uterine width was the maximum distance measured at the level of the uterine fundus on a transverse view. The uterine thickness was the maximum anteroposterior distance measured also in the transverse view. The endometrial thickness was measured at the widest portion of the longitudinal view. Regarding endometrial layering, the number of layers was considered one, three, five, or six. A single layer is typically identified during menstruation and appears as one hyperechoic line. Three layers consist of one hyperechoic line and two hypoechoic lines, commonly seen in the early proliferative phase. Five layers are characterized by one hyperechoic line, two hypoechoic lines, and two additional hyperechoic lines, typically observed in the late proliferative phase. The designation of six layers refers to any configuration with more than five layers, generally noted during the secretory phase.

Data Analysis

Descriptive statistics was carried out using mean and standard deviation (M, Sd). Correlation analysis and one-way ANOVA were carried out to assess the relation of the ultrasound measurements to the length and different phases of the menstrual cycle. Regression analysis was done to determine the effect of each phase on the endometrial thickness and layers. The analysis was done using SPSS version 26 with a confidence level of 95.0%. For all - tests, a p-value of less than 0.05 was considered significant.

Ethical Consideration

The Princess Nourah bint Abdulrahman University Institutional Review Board approved the study (*IRB no. 22–1010*). This study complies with the Declaration of Helsinki, ensuring that ethical principles were upheld throughout the

research process. The research team members discussed the study's procedures with the volunteers, including protocols, risks, and advantages of participation, as well as how volunteers' information is protected. In this study, all participants gave informed consent and signed the consent form. Data were coded and kept confidential.

Results

This study included 33 healthy adult females with a mean age of 20.95 ± 0.78 years. The mean length of the menstrual cycle was 30.47 ± 2.58 days.

Ultrasound measurements of the uterus and the endometrium were conducted at each phase of the menstrual cycle (Figures 1 and 2).

- At the early proliferative phase, the mean endometrial thickness was 0.59 ± 0.21 cm, the uterine length was 7.42 ± 0.97 cm, the uterine width was 3.80 ± 1.17 cm and the uterine thickness was 3.50 ± 0.82 cm.
- At the late proliferative phase, the mean endometrial thickness was 0.77 ± 0.24 cm, the uterine length was 7.21 ± 0.84cm, the uterine width was 4.00 ± 1.14 cm, and the uterine thickness was 3.36 ± 0.64 cm.
- At the secretory phase, the mean endometrial thickness was 1.09 ± 0.40 cm, the Uterine length was 7.39 ± 1.01 cm, the uterine width was 4.29 ± 1.12 cm, and the uterine thickness was 3.44 ± 0.49 cm.
- At the menstrual phase, the mean endometrial thickness was 0.52 ± 0.35 cm, the Uterine length was 7.33 ± 1.04 cm, the uterine width was 3.63 ± 1.20 cm, and the uterine thickness was 3.47 ± 0.82 cm.

One-way ANOVA was conducted to assess the variation of the different ultrasound measurements with the menstrual cycle phases. Endometrial thickness and layers showed significant difference across menstrual phases ($p<0.001$). However, uterine length, width, and thickness showed no significant variation across menstrual phases (Table 1).

Pearson correlation was conducted to assess the correlation between uterine measurements and endometrial thickness (Table 2). Endometrial thickness was positively correlated with number of layers ($r=0.576$, $p<0.05$) and uterine thickness ($r=0.358$, $p<0.05$). No significant correlations were observed between uterine length and thickness, layers, or uterine thickness.

Linear regression analysis revealed significant associations between menstrual phases and measures of endometrial thickness and layers (Table 3). During the early proliferative phase, endometrial thickness did not change significantly ($p = 0.373$), while the endometrial layers increased significantly ($p < 0.001$). In contrast, the late proliferative phase

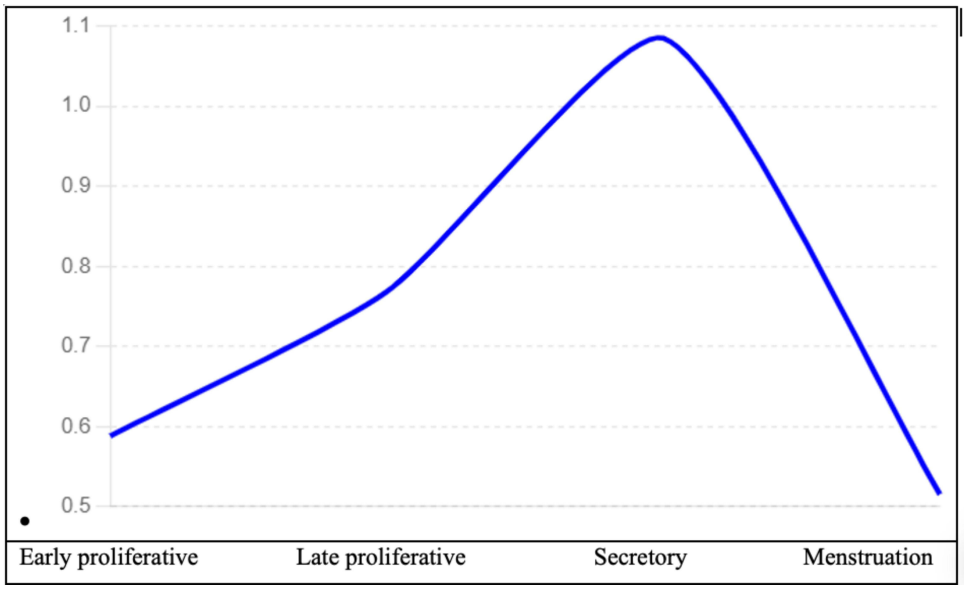

Figure 1 Endometrial thickness across menstrual phases.

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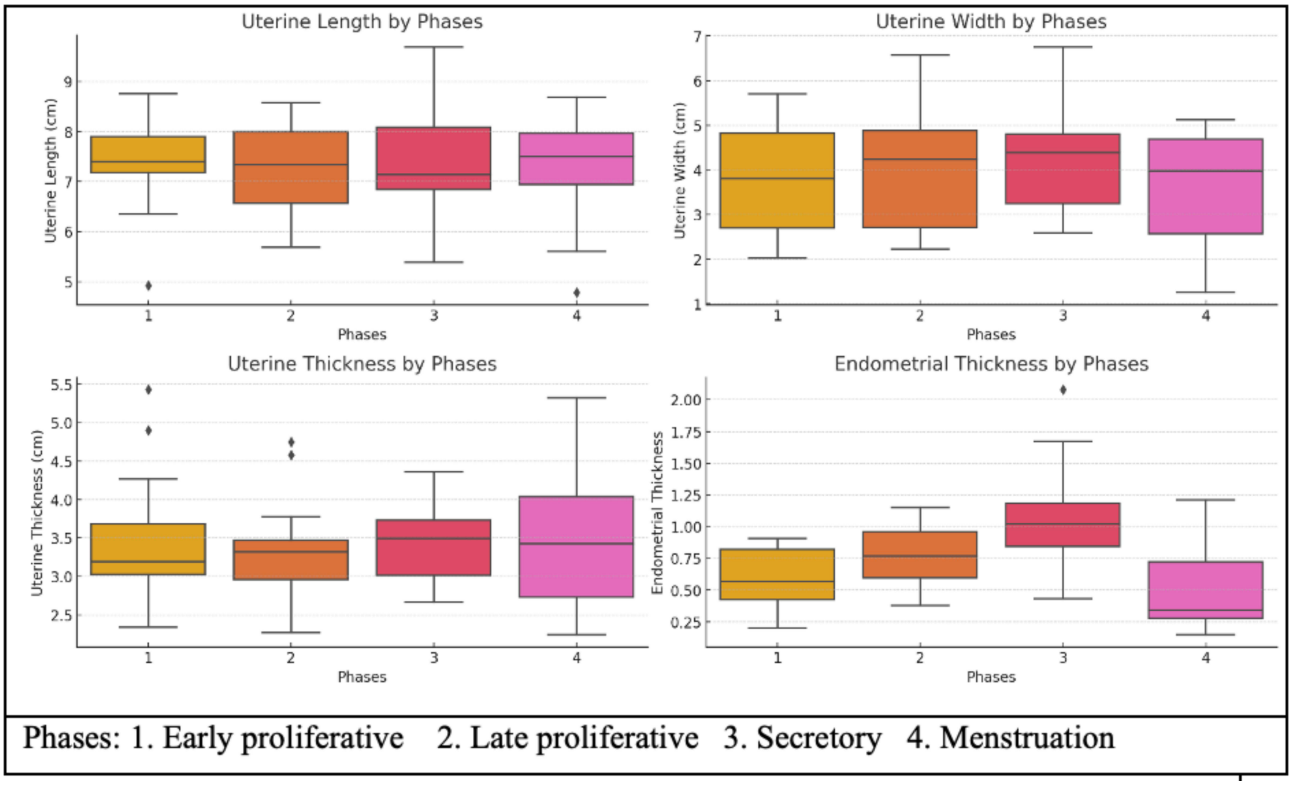

Figure 2 Uterine measurements and endometrial thickness across menstrual phases.

exhibited significant increases in both endometrial thickness ($p = 0.002$) and layers ($p < 0.001$). Similarly, during the secretory phase, there were notable significant increases in endometrial thickness ($p < 0.001$) and layers ($p < 0.001$).

Discussion

The present study aimed to measure the uterus size and endometrial thickness among healthy Saudi females using ultrasound, and analyzed their variations across menstrual cycle phases.

The study showed that the average uterine length, width and thickness were 7.33 ± 0.76 cm, 3.93 ± 1.00 cm and 3.44 ± 0.55 cm, showing variation from previous data from Nigeria and Iran,[9,10] and emphasizing on the presence regional, ethnic and environmental difference. Nevertheless, it showed no significant variation across the menstrual cycle, suggesting that the uterine size remains relatively unchanged throughout the menstrual cycle. However, the uterine width showed a slight increase during the late proliferative and secretory phases compared to the early proliferative and menstrual phases, which might indicate some degree of expansion to house the growing endometrium.

The study observed significant variations in endometrial thickness across the menstrual cycle phases. The mean endometrial thickness increased from the early proliferative phase (0.59 ± 0.21 cm) to the secretory phase (1.09 ± 0.40 cm), and then decreased during the menstrual phase (0.52 ± 0.35 cm). This pattern corresponds to the known physiological changes that occur during the menstrual cycle, wherein the endometrium thickens in anticipation of possible implantation and subsequently sheds if pregnancy does not happen,[3] however it shows some variation from the published reference ranges for endometrial thickness, particularly during the menstrual phase.[14,15]

In clinical practice, these differences affect clinical decision-making in Saudi Arabia. If the measurements fall beyond the Saudi standard ranges, they could enhance differentiating regular physiological changes that affect fertility assessment, suggest potential abnormalities, and require further investigation. This normative data can function as a benchmark for healthcare practitioners in Saudi Arabia, assisting in the precise evaluation of gynecological health and prompt identification of problems. For example, if there are deviations from these standard values, it may lead to more examination into disorders such as endometrial hyperplasia, polyps, or uterine fibroids.

Table 1 One-Way ANOVA for Uterine Measurements Across Menstrual Phases

		M ± SD	F	P value
Endometrial Thickness	Early proliferative phase	0.59 ± 0.21	19.33	0.00
	Late proliferative phase	0.77 ± 0.24		
	Secretory phase	1.09 ± 0.40		
	Menstrual phase	0.52 ± 0.35		
Endometrial layers	Early proliferative phase	2.93 ± 0.84	86.01	0.00
	Late proliferative phase	4.86 ± 0.52		
	Secretory phase	5.86 ± 0.36		
	Menstrual phase	1.77 ± 1.84		
Uterine length	Early proliferative phase	7.42 ± 0.97	0.26	0.85
	Late proliferative phase	7.21 ± 0.84		
	Secretory phase	7.39 ± 1.01		
	Menstrual phase	7.33 ± 1.04		
	Overall	7.33 ± 0.76		
Uterine width	Early proliferative phase	3.80 ± 1.17	1.67	0.18
	Late proliferative phase	4.00 ± 1.14		
	Secretory phase	4.29 ± 1.12		
	Menstrual phase	3.63 ± 1.20		
	Overall	3.93 ± 1.00		
Uterine thickness	Early proliferative phase	3.50 ± 0.82	0.21	0.89
	Late proliferative phase	3.36 ± 0.64		
	Secretory phase	3.44 ± 0.49		
	Menstrual phase	3.47 ± 0.82		
	Overall	3.44 ± 0.55		

Table 2 Correlation of Uterine Measurements with Endometrial Thickness

	Pearson's correlation coefficient
Menstrual cycle period	0.04
Thickness	1.00
Layers	0.576**
Uterine length	−0.04
Uterine width	0.16
Uterine thickness	0.358**

Note: ** Significance level <0.001.

Table 3 Linear Regression Analysis of Endometrial Thickness and Layers Across Menstrual Phases

	Endometrial thickness			Layers		
	B	OR	P value	B	OR	P value
Intercept*	0.515	1.674	0.000	1.769	0.1999	0.000
Early proliferative phase	0.073	1.076	0.373	1.162	0.2753	0.000
Late proliferative phase	0.253	1.288	0.002	3.088	0.2776	0.000
Secretory phase	0.579	1.784	0.000	4.088	0.2776	0.000
Menstrual phase	0[a]	1		0[a]		

Note: *Intercept represents the baseline variation between subjects of the study. a. Set to zero because this parameter is redundant.

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Further analysis emphasized the previous findings, revealing significant increases in endometrial thickness and layers during the late proliferative and secretory phases, implying that the endometrium is preparing for potential pregnancy. The early proliferative phase showed significant growth in endometrial layers without substantial changes in thickness, in contrast, both thickness and layers significantly increased during the late proliferative and secretory phases. This may indicate initial cellular proliferation followed by the measurable expansion consistent with the endometrial maturation.[3]

These physiological changes reflect appropriate hormonal signaling, which serves as an indicator for the appropriate reproductive health and optimal environment for implantation and development of the embryo. This fact can guide further research in understanding hormonal imbalances in certain conditions like polycystic ovary syndrome (PCOS), which leads to irregular menstrual cycle. This fact is crucial for fertility assessment, especially in cases of in vitro fertilization (IVF) when endometrial thickness and pattern play a significant role in procedure outcomes. The trilaminate appearance of the endometrium (five lines) is associated with excellent outcomes. It is considered a part of the uterine biophysical profile assessment performed before embryo transfer to ensure an optimum uterine environment for implantation.

Recognizing endometrial morphology enhances treatment and intervention timing decisions. The timing of fertility treatments, such as in IVF, can be optimized based on the menstrual cycle. For example, administering progesterone at the correct phase can increase the likelihood of successful implantation, thus improving overall treatment efficacy.

Moreover, having knowledge about the typical dimensions of the uterus and endometrium can enhance the treatment of reproductive health issues, such as the identification and tracking of infertility and other gynecological conditions.

Only 33 females were included in the study, which may restrict the generalizability of the findings. A larger sample size could enhance the strength of the results and develop localized guidelines for accurate diagnosis of gynecological conditions and fertility assessment.

Conclusion

In conclusion, this study conducted a thorough examination of uterine dimensions and the endometrial thickness in healthy Saudi females. The results provide significant standard data that can improve clinical assessments and guide future study and highlights the variations in endometrial thickness during different stages of the menstrual cycle.

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Disclosure

The authors report no conflicts of interest in this work.

References

1. Ameer MA, Fagan SE, Sosa-Stanley JN, Peterson DC. Anatomy, Abdomen and Pelvis: uterus. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing.
2. Chaudhry R, Chaudhry K. Anatomy, Abdomen and Pelvis: uterine Arteries. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing; 2023.
3. Crosbie EJ, Kenny LC, Louise C. Gynaecology by ten teachers. 274p.
4. Dotto JE, Bigozzi MA. Endometrial Hyperplasia. In: *Atlas of Hysteroscopy*. Springer International Publishing; 2020:117–123.
5. Singh G, Cue L, Puckett Y. Endometrial Hyperplasia. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing; 2024.
6. Chowdhury L. Ultrasonography in Gynecology. *J Obst Gynecol India*. 2015;65(1):65–66. doi:10.1007/s13224-014-0662-9
7. Epstein E, Van Holsbeke C, Mascilini F, et al. Gray-scale and color Doppler ultrasound characteristics of endometrial cancer in relation to stage, grade and tumor size. *Ultrasound Obstet Gynecol*. 2011;38(5):586–593. doi:10.1002/uog.9038
8. Dewald O, Khan YS. Sonography Gynecology Anatomy and Physiology. In: *StatPearls*. Treasure Island (FL): StatPearls Publishing; 2024.

9. Chris-Ozoko L, Soeze A, Oyem J, Okpeki J Ultrasonographic uterine dimensions in non-pregnant adult females at Agbor Delta State; establishment of norms. 2020.
10. Esmaelzadeh S, Rezaei N, HajiAhmadi M. Normal uterine size in women of reproductive age in northern Islamic Republic of Iran. *East Mediterr Health J*. 2004;10(3):437–441. doi:10.26719/2004.10.3.437
11. Liu Y, Zhou Q, Peng B, et al. Automatic Measurement of Endometrial Thickness From Transvaginal Ultrasound Images. *Front Bioeng Biotech*. 2022.
12. Fatima N, John A, Ali A, Amir A, Mubbarka M. Measurement of Uterus Sizes Of Multiparous Women using Ultrasound. *The Therapist*.2022;3 (1):07–10. doi:10.54393/tt.v3i1.33
13. AIUM Practice Parameter for the Performance of Duplex Sonography of Native Renal Vessels. *J Ultras Medi*. 2020;39(5):E24–9. doi:10.1002/ jum.15260
14. Sharma R, Weerakkody Y. *Endometrial Thickness*. In: Radiopaedia.org. Radiopaedia.org; 2010.
15. Valentin L, Sladkevicius P. Normal gynaecological anatomy (uterus, tubes, ovaries). In: *Ultrasound in Obstetrics and Gynaecology Book and CD-ROM*. Elsevier Ltd; 2009:285–297.