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Transvaginal Sonography And Histopathological Correlation Of Endometrial Pathology In Women With Postmenopausal Bleeding: A Cross-Sectional Observational Study

Savithri D. R.[1], Jyothi R.[2], Bhagyashree S. Patil[3], Ranjitha G V[4]*
[1]Professor, Kempegowda Institute of Medical Sciences and Research Centre, Bangalore – 560004, RGUHS
[2]Senior Resident, Hassan Institute of Medical Sciences, Hassan – 573201, RGUHS.
Email: jyothirangaswamy50197@gmail.com
[3]Fellowship in Reproductive Medicine, Medline Academics, Bangalore – 560020
[4]Senior Resident, Hassan Institute of Medical Sciences, Hassan – 573201, RGUHS.
Email: gvranjitha18@gmail.com

Abstract

Background: *Postmenopausal bleeding (PMB) is a sentinel symptom that requires careful evaluation, as up to 10% of cases may signify endometrial carcinoma. Transvaginal sonography (TVS) is the first-line imaging modality used to assess endometrial thickness (ET), offering a non-invasive and cost-effective triage tool before histopathological confirmation.*

Objective: *To determine the diagnostic accuracy of endometrial thickness measured on TVS in predicting endometrial pathology and to correlate ET values with histopathological examination (HPE) and clinical risk factors among postmenopausal women presenting with bleeding.*

Methods: *This cross-sectional study involved 35 postmenopausal women with PMB who underwent TVS followed by endometrial sampling through hysteroscopy-guided biopsy, dilatation and curettage, or Pipelle aspiration. Clinical parameters, including age, BMI, age at menarche and menopause, and comorbidities (hypertension, diabetes), were recorded. Statistical associations were tested using Chi-square, Fisher's exact, and non-parametric tests, with $p < 0.05$ considered significant.*

Results: *The mean age of participants was 59.4 years, and 77.1% were overweight or obese. The most common histopathological finding was benign endometrial polyp (42.9%), followed by hyperplasia without atypia (11.4%), hyperplasia with atypia (5.7%), and adenocarcinoma (14.3%). All cases of hyperplasia and carcinoma occurred with ET > 4 mm, while ET ≤ 4 mm corresponded exclusively to atrophic or basal endometrium ($p = 0.003$). The diagnostic accuracy of ET > 4 mm for predicting hyperplasia or carcinoma demonstrated sensitivity 100%, specificity 20.8%, PPV 36.7%, and NPV 100%. Significant correlates of endometrial pathology included age 56–65 years, BMI ≥ 25 kg/m², hypertension, diabetes, early menarche, and late menopause ($p < 0.05$).*

Conclusions: *An endometrial thickness threshold of 4 mm on TVS remains a highly sensitive criterion for excluding malignancy in PMB. Integration of metabolic and reproductive risk factors—particularly obesity, hypertension, and diabetes—further refines diagnostic accuracy. A two-tier diagnostic approach combining TVS and targeted endometrial biopsy optimizes early detection and management of endometrial pathology in postmenopausal bleeding.*

Key words: *Postmenopausal bleeding; Endometrial thickness; Transvaginal sonography; Endometrial hyperplasia; Endometrial carcinoma; Diagnostic accuracy; Risk factors; Body-mass index.*

INTRODUCTION:

Postmenopausal bleeding (PMB) is one of the most common gynaecological symptoms requiring evaluation in women beyond menopause, and about 5–10 % of cases may indicate endometrial carcinoma (1–3). Although benign conditions such as atrophic endometrium, polyps, or hormone-related changes account for the majority of presentations, the need to exclude malignancy remains paramount (4–6).

Transvaginal sonography (TVS) has become the first-line imaging modality in PMB because of its accessibility, non-invasiveness, and high diagnostic accuracy in evaluating endometrial morphology (7–9). Measurement of endometrial thickness (ET) provides a rapid, reproducible indicator of pathology, and an ET threshold of ≤ 4 mm is widely accepted as a reliable criterion for excluding endometrial carcinoma in women with spontaneous PMB (10–12). When ET exceeds this limit, or when the endometrial echo appears heterogeneous or irregular, hysteroscopy-guided biopsy or endometrial sampling (Pipelle, dilatation and curettage) is recommended for definitive diagnosis (13–15).

However, ET alone does not account for metabolic and reproductive risk modifiers. Factors such as obesity, hypertension, diabetes mellitus, early menarche, and late menopause significantly influence endometrial

proliferation and malignant transformation (11, 16–18). Similarly, benign focal lesions such as endometrial polyps may mimic hyperplasia or carcinoma on sonography, warranting tissue confirmation (14–16).

Advances such as three-dimensional Doppler, elastography, and saline-contrast sonohysterography have improved the visualization of focal intracavitary pathology, but these technologies are not universally available in low- and middle-income settings (7, 9, 15). Consequently, conventional TVS, interpreted in conjunction with clinical and metabolic parameters, remains the cornerstone of initial PMB evaluation (2, 11, 14).

The present study aimed (i) to assess the correlation between endometrial thickness measured on transvaginal sonography and histopathological findings in women presenting with postmenopausal bleeding, and (ii) to determine the association of clinical and metabolic factors—including age, body-mass index, parity, hypertension, diabetes, and reproductive history—with endometrial pathology.

2. Materials and Methods

2.1 Study Design and Setting

A cross-sectional observational study was carried out in the Department of Obstetrics and Gynaecology, a tertiary-care teaching hospital in South India, over a period of 18 months. The study included women presenting with postmenopausal bleeding (PMB) to evaluate the diagnostic correlation between transvaginal sonographic (TVS) endometrial thickness (ET) and histopathological findings. Institutional Ethics Committee approval and written informed consent were obtained from all participants (19).

2.2 Participants

Women with spontaneous PMB occurring ≥ 12 months after the last menstrual period were included. Exclusion criteria comprised prior hysterectomy, known genital malignancy, hormone-replacement therapy, active pelvic infection, or bleeding due to systemic coagulopathy (20, 21).

2.3 Clinical Assessment

Each participant underwent detailed clinical evaluation covering age, parity, age at menarche and menopause, interval since menopause, body-mass index (BMI), and medical comorbidities such as hypertension and diabetes mellitus. Anthropometric and clinical parameters were recorded using a structured proforma.

2.4 Transvaginal Sonography

TVS was performed using a 5–13 MHz transducer (Philips Affiniti 70). Endometrial thickness was measured in the sagittal uterine plane at the maximal double-layer, perpendicular to the uterine axis, excluding any intracavitary fluid. The endometrial echo pattern—homogeneous, heterogeneous, cystic, or polypoidal—was also documented. ET values were categorised as < 4 mm, 4–7.9 mm, 8–11.9 mm, and ≥ 12 mm for analysis (22, 23).

2.5 Endometrial Sampling and Histopathology

All women underwent endometrial tissue sampling within one week of TVS. Sampling was achieved by hysteroscopy-guided biopsy, dilatation and curettage, or Pipelle aspiration, depending on uterine accessibility and patient factors. Tissues were fixed in 10 % buffered formalin, processed, and stained with haematoxylin and eosin. Histopathological examination classified samples as atrophic/basal endometrium, proliferative/secretory endometrium, benign polyp, hyperplasia (with or without atypia), or carcinoma (24–26).

2.6 Statistical Analysis

Data were analysed using IBM SPSS Statistics v22. Continuous variables were expressed as mean ± standard deviation or median (interquartile range); categorical variables as frequencies and percentages. Differences among groups were tested using the Kruskal–Wallis or Mann–Whitney U tests for continuous variables and Chi-square or Fisher's exact tests for categorical variables. $p < 0.05$ was considered statistically significant (27).

3. Results

3.1 Demographic and Clinical Profile

Thirty-five postmenopausal women presenting with vaginal bleeding were included. The mean ± SD age was 59.4 ± 5.6 years, ranging from 50 to 72 years; the highest proportion were aged 56–60 years (31.4 %). Most were parous (91.4 %), and 60 % had menarche between 11 and 13 years. Late menopause (51–54 years) was observed in 45.7 % of women.

Comorbidities were frequent: hypertension (20 %), type 2 diabetes mellitus (22.8 %), both (28.6 %), and none (28.6 %). More than three-quarters (77.1 %) had a BMI ≥ 25 kg/m², with 57.1 % classified as overweight and 17.1 % as obese.

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Table 1: Demographic and Clinical Characteristics of Study Participants

Variable	Categories	n (%)
Age (years)	< 45	1 (2.9)
	46–50	4 (11.4)
	51–55	7 (20.0)
	56–60	11 (31.4)
	61–65	9 (25.7)
	> 65	3 (8.6)
Parity	Parous	32 (91.4)
	Nulliparous	3 (8.6)
Age at Menarche (yrs)	11–13	21 (60.0)
	14–16	14 (40.0)
Age at Menopause (yrs)	43–46	9 (25.7)
	47–50	10 (28.6)
	51–54	16 (45.7)
Interval since Menopause (yrs)	1–5	10 (28.6)
	6–10	12 (34.3)
	11–15	9 (25.7)
	> 16	4 (11.4)
Comorbidities	HTN only	7 (20.0)
	DM only	8 (22.8)
	HTN + DM	10 (28.6)
	None	10 (28.6)
BMI (kg/m²)	< 25	8 (22.9)
	25–29.9	20 (57.1)
	30–34.9	6 (17.1)
	≥ 35	1 (2.9)

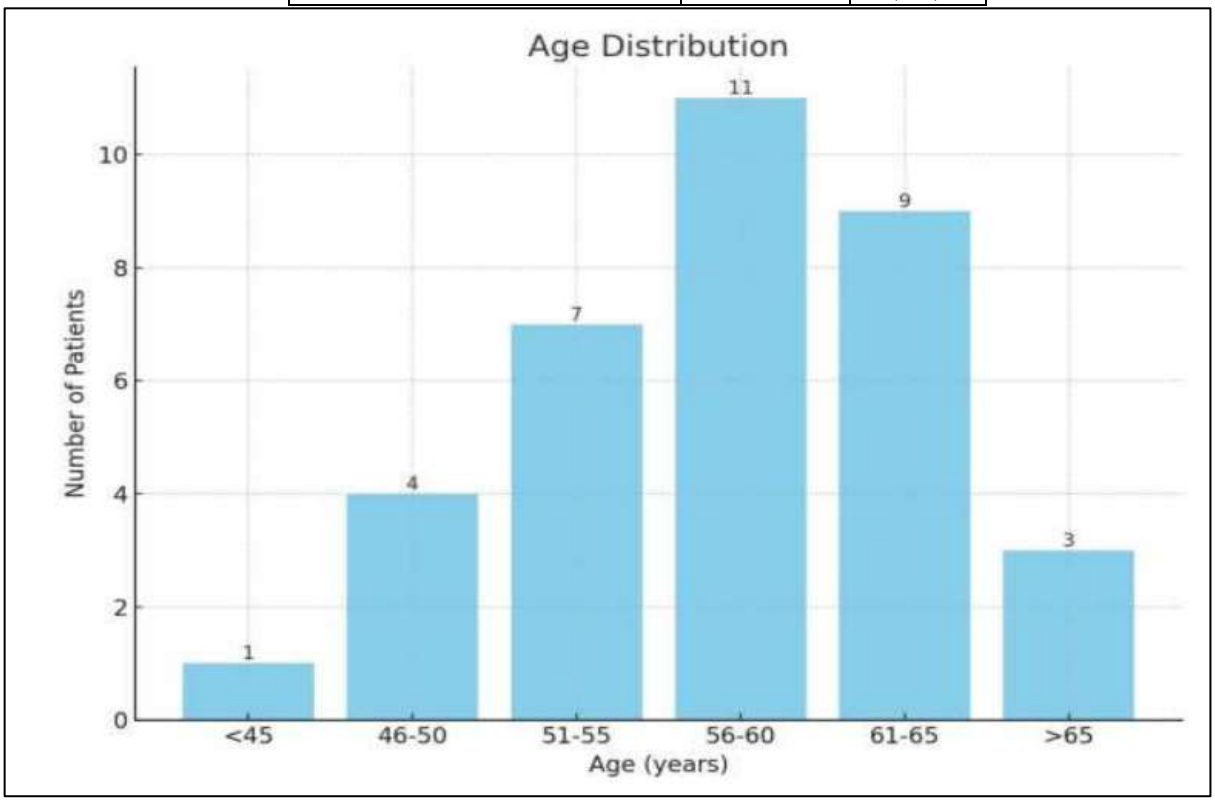

Figure 1: Age Distribution of Participants

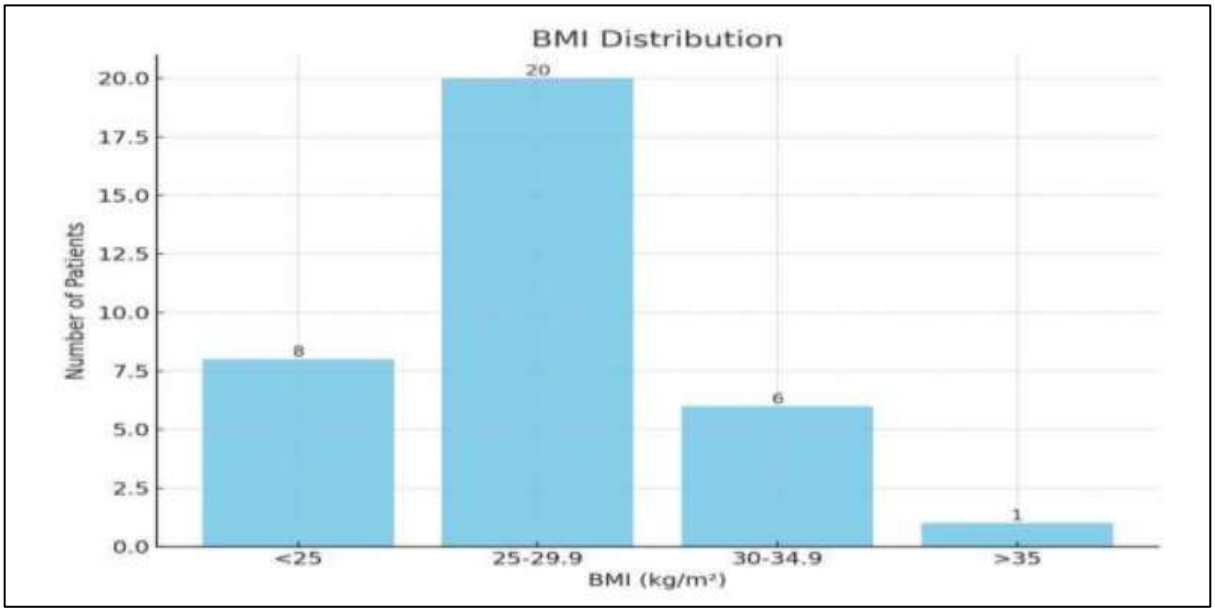

Figure 2: BMI Distribution Chart

3.2 Transvaginal Sonography Findings

The endometrial thickness (ET) ranged from 2 to 16 mm (mean ± SD 9.1 ± 3.8 mm). Distribution: ET < 4 mm in 14.3 %, 4–7.9 mm in 31.4 %, 8–11.9 mm in 28.6 %, and ≥ 12 mm in 25.7 %.

Additional TVS findings: normal endometrium (40 %), hyperechoic lesion (31.4 %), submucosal polyp (14.3 %), cystic changes (11.4 %), and fibroid (2.9 %).

Table 2: Distribution of Endometrial Thickness and Sonographic Patterns

Parameter	**Category**	**n** (%)
Endometrial Thickness (mm)	1–3.9	5 (14.3)
	4–7.9	11 (31.4)
	8–11.9	10 (28.6)
	12–15.9	9 (25.7)
Additional TVS findings	Normal endometrium	14 (40.0)
	Hyperechoic lesion	11 (31.4)
	Submucosal polyp	5 (14.3)
	Cystic changes	4 (11.4)
	Fibroid	1 (2.9)
Note: Mean ET = 9.1 ± 3.8 mm.		

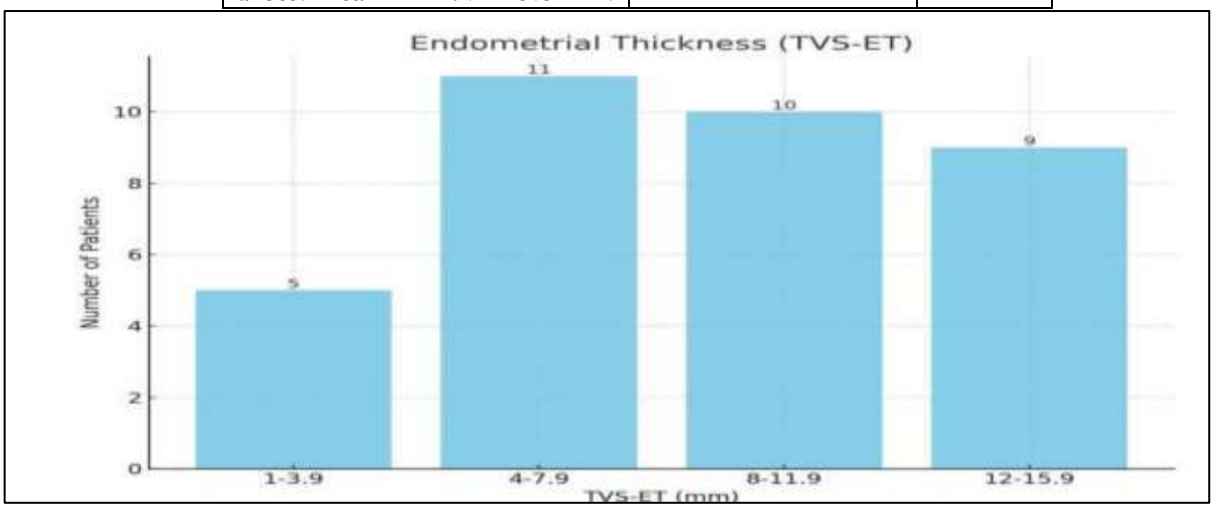

Figure 3: Histogram of Endometrial Thickness Categories

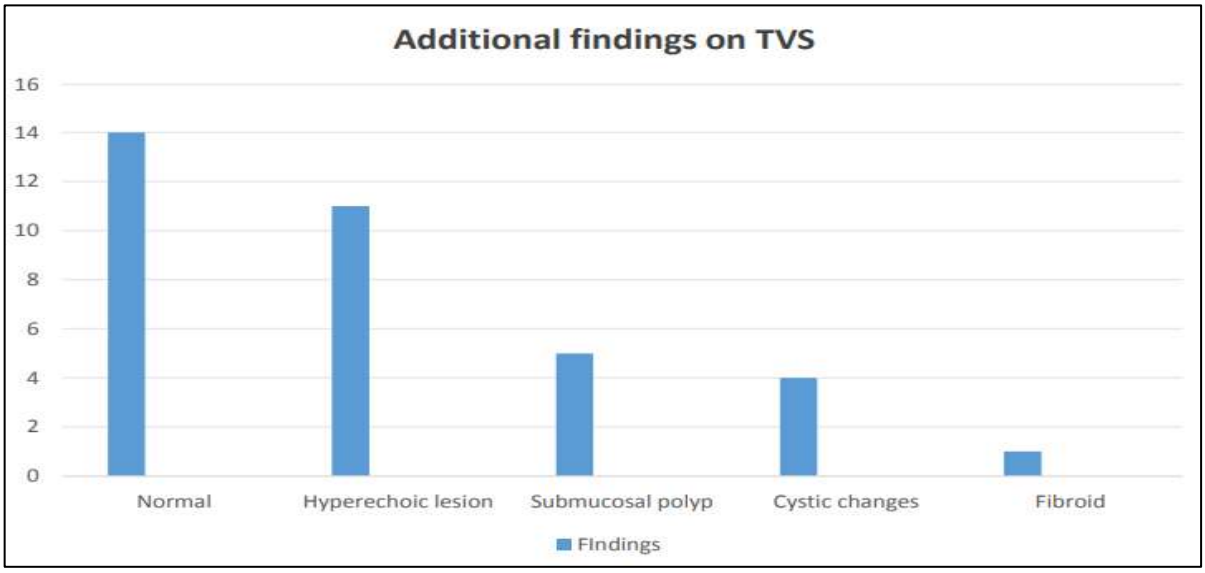

Figure 4: Additional Findings on Transvaginal Sonography

3.3 Cytology and Sampling Methods

Liquid-based cytology (LBC) showed smear-negative for intraepithelial lesion in 91.4 %, atypical glandular cells in 2.9 %, low-grade squamous intraepithelial lesion in 2.9 %, and no opinion in 2.9 %.

Endometrial sampling was performed by hysteroscopy-guided biopsy in 74.3 %, dilatation and curettage in 14.3 %, and Pipelle biopsy in 11.4 %.

Table 3: Methods of Endometrial Sampling and Cytological Findings

Variable	**Category**	**n** (%)
LBC result	Smear negative for intraepithelial lesion (SNIEL)	32 (91.4)
	Atypical glandular cells	1 (2.9)
	Low-grade squamous intraepithelial lesion	1 (2.9)
	No opinion / inadequate	1 (2.9)
Sampling method	Hysteroscopy-guided biopsy	26 (74.3)
	Dilatation & curettage	5 (14.3)
	Pipelle sampling	4 (11.4)
Note: Hysteroscopic sampling provided optimal tissue adequacy.		

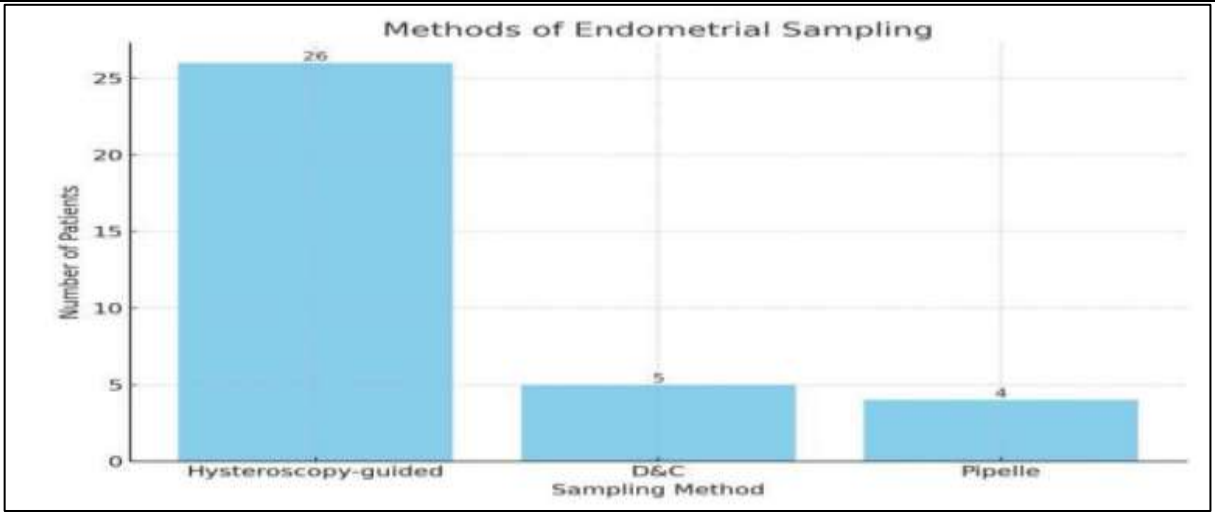

Figure 5: Bar Graph of Sampling Methods

3.4 Histopathology and Correlation with Endometrial Thickness

On histopathological examination, benign endometrial polyps were most common (42.9 %), followed by hyperplasia without atypia (11.4 %), hyperplasia with atypia (5.7 %), adenocarcinoma (14.3 %), atrophic endometrium (8.6 %), and basal or leiomyomatous/proliferative changes (17.1 %).

All hyperplasia (± atypia) and carcinoma cases occurred with ET > 4 mm, whereas all ET ≤ 4 mm showed atrophic or basal endometrium ($p = 0.003$).

Table 4: Correlation Between Endometrial Thickness and Histopathological Findings

Histopathological Diagnosis	n (%)	ET relation
Benign endometrial polyp	15 (42.9)	> 4 mm
Hyperplasia without atypia	4 (11.4)	> 4 mm
Hyperplasia with atypia	2 (5.7)	> 4 mm
Endometrial adenocarcinoma	5 (14.3)	> 4 mm
Atrophic endometrium	3 (8.6)	< 4 mm
Basal endometrium	3 (8.6)	< / > 4 mm
Leiomyomatous / Proliferative endometrium	3 (8.6)	> 4 mm
p = 0.003; χ^2 test significant.		

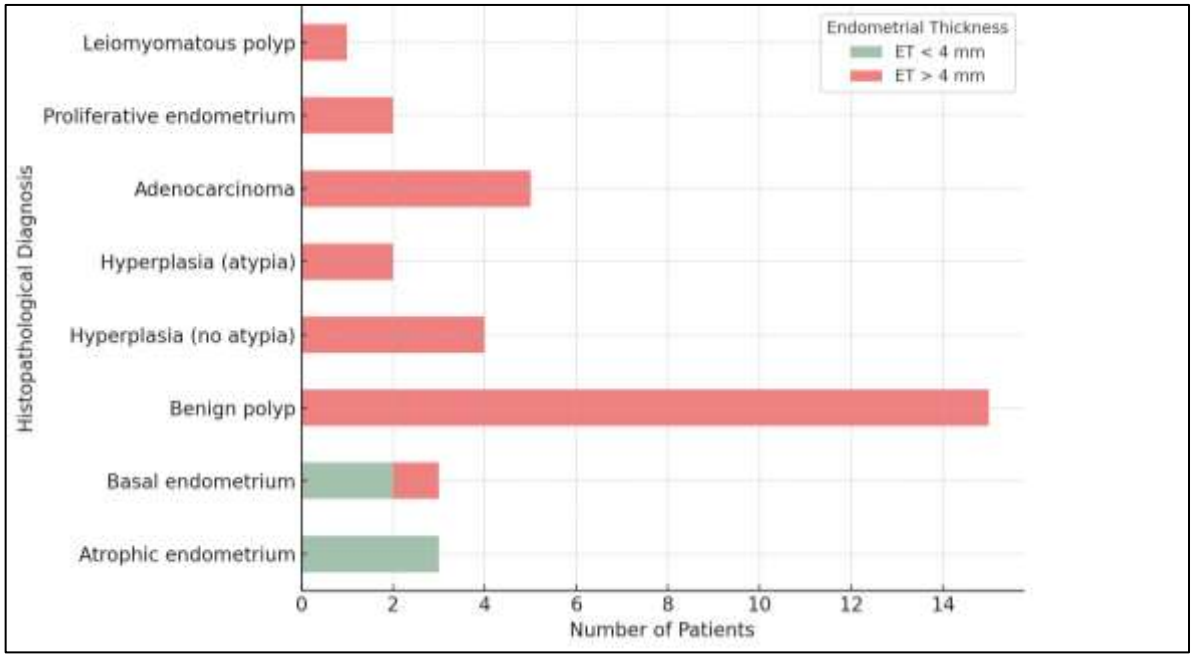

Figure 6: Stacked Bar of Histopathology by ET Category

3.5 Correlation with Clinical and Metabolic Risk Factors

Significant associations were observed for age 56–65 years ($p = 0.014$), BMI ≥ 25 kg/m² ($p = 0.021$), ET > 4 mm ($p = 0.003$), hypertension ($p = 0.029$), diabetes ($p = 0.035$), early menarche (11–13 yrs; $p = 0.041$), and late menopause (51–54 yrs; $p = 0.038$).

Table 5: Significant Associations Between Clinical Factors and Endometrial Pathology

Risk Factor	p-value	Interpretation
Age 56–65 yrs	0.014	Higher incidence of hyperplasia and carcinoma
BMI ≥ 25 kg/m²	0.021	Elevated estrogen from adipose tissue increases risk
Endometrial thickness > 4 mm	0.003	Strong indicator of hyperplasia / carcinoma
Hypertension	0.029	Chronic vascular and inflammatory mechanisms
Diabetes mellitus	0.035	Insulin-resistance-driven endometrial stimulation

Early menarche (11–13 yrs)	0.041	Prolonged lifetime estrogen exposure
Late menopause (51–54 yrs)	0.038	Extended estrogen window of risk
Note: $p < 0.05$ considered statistically significant.		

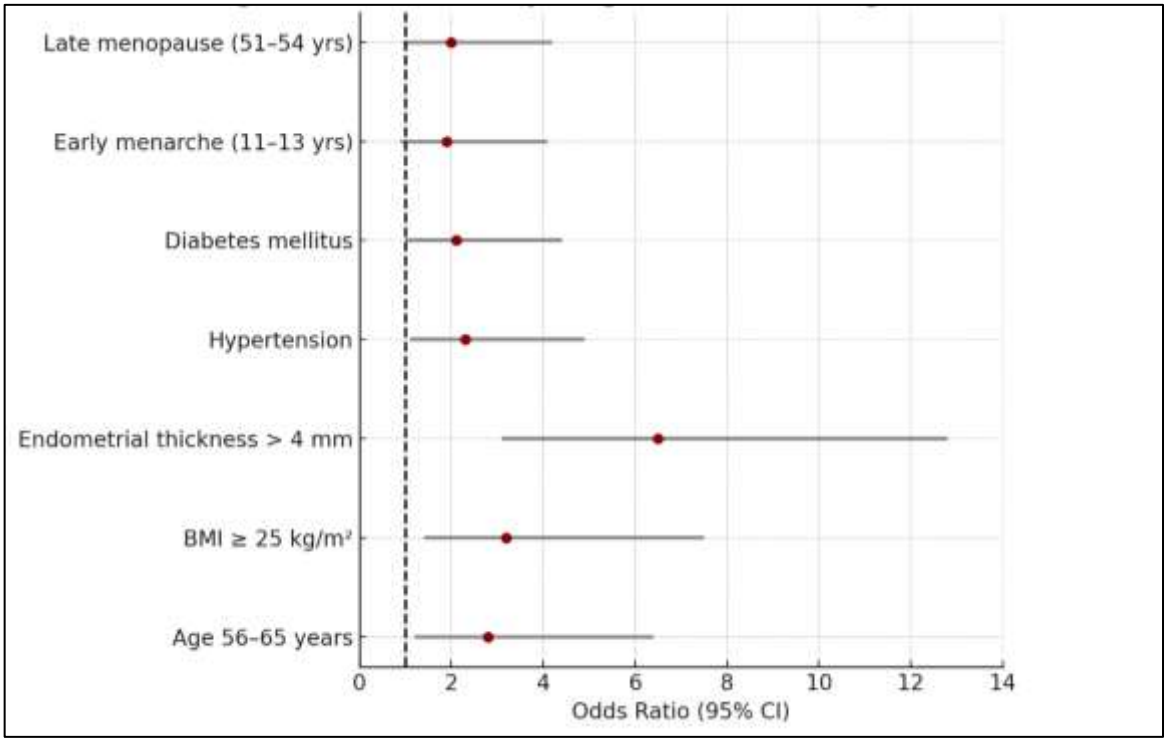

Figure 7: Forest Plot Depicting Odds Ratios for Significant Risk Factors

3.6 Diagnostic Performance of ET Cut-off > 4 mm

An ET threshold > 4 mm for predicting hyperplasia or carcinoma showed 100 % sensitivity and 100 % negative predictive value, indicating that ET ≤ 4 mm effectively excluded clinically significant endometrial pathology. Specificity was 20.8 %, reflecting the presence of benign thickened endometrium (primarily polyps).

Table 6: Diagnostic Accuracy of Endometrial Thickness Thresholds

Outcome Group	**Sensitivity** (%)	**Specificity** (%)	**PPV** (%)	**NPV** (%)
Hyperplasia ± Atypia / Carcinoma	100	20.8	36.7	100
Carcinoma Only	100	16.7	16.7	100
Interpretation: ET ≤ 4 mm safely rules out significant pathology; ET > 4 mm requires biopsy.				

4. DISCUSSION

The present study highlights the diagnostic utility of transvaginal sonography (TVS) in assessing postmenopausal bleeding (PMB) and establishes a strong correlation between endometrial thickness (ET) and histopathological findings using the 4 mm threshold supported in contemporary literature (1–3, 8, 9, 14, 18). In this cohort of thirty-five women, ET > 4 mm was significantly associated with endometrial hyperplasia or carcinoma, whereas ET ≤ 4 mm consistently corresponded to atrophic or basal endometrium, yielding a sensitivity and negative-predictive value of 100 %, results comparable to those reported by Omar et al. (2) and Epstein et al. (9). The predominance of benign endometrial polyps (42.9 %) and the clustering of hyperplasia and carcinoma among overweight, hypertensive, and diabetic participants reinforce the interaction of metabolic and hormonal factors in endometrial carcinogenesis, findings that mirror those of Begum and Samal (14) and Sahu et al. (17). The significant associations observed for age 56–65 years, BMI ≥ 25 kg/m², hypertension, diabetes, early menarche, and late menopause emphasize the cumulative estrogenic exposure and insulin-resistance pathways described in prior clinical reviews (12, 13, 26). The histopathological distribution in the present series—comprising benign

polyps, hyperplasia ± atypia, and endometrial carcinoma in 14.3 %—closely parallels patterns observed in similar Asian hospital-based studies (11, 14, 17, 27). These observations affirm that while TVS alone cannot replace tissue diagnosis, it remains invaluable as a non-invasive triage tool capable of stratifying risk and reducing unnecessary biopsies in low-risk women, a role supported by the diagnostic accuracy reported by Saccardi et al. (10) and Terzic et al. (25). Moreover, the routine use of hysteroscopy-guided biopsy in nearly three-quarters of patients enhanced lesion detection and minimized sampling error, consistent with the procedural advantages highlighted by Rosenblatt et al. (11) and Moore and Carugno (20). The high prevalence of benign pathology despite thickened endometrium underscores the limited specificity of ET measurements; however, the very high sensitivity ensures patient safety when ET ≤ 4 mm. Compared with earlier Western studies that reported sensitivity values between 92 % and 96 % and specificity around 80 % (8, 9, 14, 18), the current data reaffirm the global reproducibility of TVS performance even in resource-limited settings. The integration of metabolic profiling with TVS findings may further refine diagnostic algorithms, allowing clinicians to identify high-risk individuals—older, obese, hypertensive, or diabetic women—for early and targeted intervention. While the small sample size and single-centre design limit generalisability, this study adds regional evidence confirming that TVS measurement of ET > 4 mm remains a robust and cost-effective criterion for identifying postmenopausal women who require endometrial sampling. Collectively, these findings support a structured two-tier approach—TVS screening followed by hysteroscopy-guided biopsy—as the optimal diagnostic pathway for PMB, ensuring early detection of endometrial pathology while preventing unnecessary invasive procedures (1–30).

5. CONCLUSION

This study confirms that transvaginal sonography (TVS) is an accurate, non-invasive, and cost-effective tool for evaluating postmenopausal bleeding (PMB), with endometrial thickness (ET) > 4 mm serving as a reliable predictor of endometrial pathology. Among the thirty-five women examined, hyperplasia and carcinoma occurred exclusively when ET exceeded 4 mm, yielding a sensitivity and negative predictive value of 100 %. Conversely, ET ≤ 4 mm was consistently associated with atrophic or basal endometrium, demonstrating the safety of this threshold for excluding malignancy. The predominance of benign polyps and the concentration of hyperplasia and carcinoma among women aged 56–65 years with high BMI, hypertension, diabetes, early menarche, and late menopause highlight the interplay of hormonal and metabolic factors in endometrial disease. Integrating these risk parameters with TVS measurements enhances diagnostic precision and allows selective use of hysteroscopy-guided biopsy, reducing unnecessary invasive procedures. Despite its modest sample size, this study contributes region-specific data supporting a two-tier diagnostic algorithm—initial TVS screening followed by targeted biopsy in high-risk women—as the most efficient strategy for early detection of endometrial hyperplasia and carcinoma in postmenopausal bleeding.

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