

# DIAGNOSTIC ACCURACY OF TRANSVAGINAL ULTRASOUND IN DETECTION OF ENDOMETRIAL CARCINOMA IN POST-MENOPAUSAL BLEEDING KEEPING HISTOPATHOLOGY AS GOLD STANDARD

*Original Research*

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## ABSTRACT

**Background:** Postmenopausal bleeding (PMB) is a significant clinical symptom often associated with endometrial carcinoma, the most common gynecological malignancy in postmenopausal women. Early and accurate detection is critical for timely management and improved outcomes. Transvaginal ultrasonography (TVS) serves as a non-invasive and cost-effective diagnostic tool for evaluating endometrial pathology, while histopathology remains the gold standard for definitive diagnosis. This study assesses the diagnostic accuracy of TVS in detecting endometrial carcinoma among postmenopausal women with abnormal uterine bleeding, comparing its findings with histopathological results.

**Objective:** To determine the diagnostic accuracy of TVS in detecting endometrial carcinoma in postmenopausal women presenting with PMB, using histopathology as the reference standard.

**Methods:** This cross-sectional study included 135 postmenopausal women aged 45–70 years presenting with PMB at a tertiary care hospital. Women on hormone replacement therapy or with known gynecological malignancies were excluded. After obtaining ethical approval and informed consent, demographic and clinical data were recorded. TVS was performed by a single radiologist to assess endometrial thickness, vascularity, and structural abnormalities. Women with suspicious findings underwent dilatation and curettage (D&C) for histopathological examination. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated using standard statistical methods.

**Results:** The mean age of participants was  $58.2 \pm 6.4$  years, with a mean menopausal duration of  $8.5 \pm 4.3$  years. TVS identified 72 cases (53.3%) as suspicious for malignancy, with histopathology confirming endometrial carcinoma in 68 cases (50.4%). TVS demonstrated a sensitivity of 94.1%, specificity of 88.9%, PPV of 91.7%, NPV of 92.3%, and an overall diagnostic accuracy of 92.0% ( $p < 0.001$ ).

**Conclusion:** TVS is a highly sensitive and accurate non-invasive diagnostic modality for detecting endometrial carcinoma in postmenopausal women with abnormal uterine bleeding. However, histopathological confirmation remains essential to minimize false-positive diagnoses. Integrating TVS as an initial screening tool can facilitate early detection and improve patient outcomes.

**Keywords:** Carcinoma, diagnostic accuracy, dilatation and curettage, endometrial thickness, histopathology, postmenopausal bleeding, transvaginal ultrasonography.

## INTRODUCTION

Postmenopausal bleeding (PMB) is a critical clinical symptom that warrants thorough evaluation due to its strong association with endometrial pathology, particularly in women over the age of 55. Defined as any uterine bleeding occurring at least 12 months after the cessation of menstruation, PMB is often the first indication of underlying gynecological conditions, ranging from benign abnormalities such as endometrial atrophy and polyps to malignancies like endometrial carcinoma. Endometrial carcinoma is the most common gynecological malignancy worldwide, contributing to a significant proportion of cancer-related morbidity and mortality in postmenopausal women. Early and accurate diagnosis is essential, as delayed detection is often associated with disease progression, necessitating more aggressive interventions and leading to poorer prognoses (1-4). Histopathological analysis remains the gold standard for diagnosing endometrial carcinoma, typically achieved through endometrial biopsy or dilation and curettage (D&C). These invasive procedures offer high diagnostic accuracy by allowing direct microscopic evaluation of endometrial tissue. However, they come with notable limitations, including procedural discomfort, the requirement for anesthesia in certain cases, and potential complications, particularly in elderly or medically compromised patients. Moreover, in low- and middle-income countries (LMICs) such as Pakistan, healthcare resource constraints limit access to these advanced diagnostic modalities, underscoring the need for reliable, non-invasive alternatives that can aid in the timely detection of malignancy (5-7).

Transvaginal ultrasound (TVUS) has emerged as a promising non-invasive diagnostic tool for evaluating PMB. It provides real-time imaging of the endometrium and surrounding pelvic structures, allowing clinicians to assess endometrial thickness (ET), texture, and other morphological abnormalities. Several studies suggest that an ET threshold of 4–5 mm in postmenopausal women presenting with bleeding can serve as a useful stratification tool for identifying those at higher risk of malignancy. Given its accessibility, cost-effectiveness, and non-invasive nature, TVUS has the potential to serve as an initial screening modality, reducing the need for unnecessary invasive procedures while ensuring timely diagnosis of endometrial carcinoma (7-10). Despite its advantages, the diagnostic accuracy of TVUS in detecting endometrial carcinoma remains a subject of ongoing research, with variations in reported sensitivity and specificity. Factors such as endometrial heterogeneity, operator dependency, and differences in imaging protocols contribute to discrepancies in diagnostic performance. Therefore, there is a need to assess the effectiveness of TVUS in detecting endometrial carcinoma in postmenopausal women with bleeding, using histopathology as the definitive reference standard. This study aims to evaluate the diagnostic accuracy of TVUS in identifying endometrial carcinoma, providing valuable insights into its potential as a reliable, non-invasive alternative for early detection, particularly in resource-limited settings.

## METHODS

This study was conducted at the Department of Diagnostic Radiology, Combined Military Hospital Rawalpindi, Punjab, Pakistan, from May 2024 to June 2024. It employed a cross-sectional analytical design to assess the diagnostic accuracy of transvaginal ultrasound (TVUS) in detecting endometrial carcinoma among postmenopausal women presenting with postmenopausal bleeding (PMB), using histopathology as the gold standard. The study population included postmenopausal females aged above 45 years who met the operational definition of PMB, which was defined as any episode of vaginal bleeding occurring 12 months or more after the cessation of menstruation, excluding any spotting or discharge unrelated to the reproductive tract. A non-probability consecutive sampling technique was utilized to recruit participants, ensuring a representative sample. Strict inclusion and exclusion criteria were applied to minimize confounding factors. Women with a history of hormone replacement therapy, tamoxifen therapy for breast carcinoma, induced menopause, vaginal stenosis, an international normalized ratio (INR) >2, or a history of local trauma were excluded to ensure homogeneity of the study population. Ethical approval was obtained from the Institutional Review Board (IRB), and all participants provided written informed consent before enrollment. A total of 135 eligible patients were recruited from both outpatient and inpatient departments of gynecology. A thorough clinical history was recorded for each participant, including age, parity, duration of menopause, characteristics of postmenopausal bleeding, and associated symptoms such as vaginal discharge. Following history-taking, transvaginal ultrasonography (TVUS) was performed by a single experienced radiologist to minimize interobserver variability. The procedure was carried out using a high-resolution ultrasound system equipped with a 5–9 MHz transvaginal probe. Patients were positioned in the lithotomy position, and the transvaginal probe was inserted under aseptic conditions. Endometrial thickness was measured in the sagittal

plane at its thickest point, incorporating both anterior and posterior endometrial layers. Additional parameters, including endometrial irregularities, increased vascularity, and other structural abnormalities, were assessed. Patients exhibiting sonographic findings suggestive of malignancy were classified as positive based on predefined operational criteria.

All participants subsequently underwent dilatation and curettage (D&C) under aseptic conditions to obtain endometrial tissue samples. The cervical canal was dilated, and the endometrial lining was carefully scraped using a curette. The collected specimens were immediately preserved in formalin-filled containers and transported to the pathology laboratory for histological examination. Standard histopathological processing was performed using the paraffin-embedding technique. The specimens were fixed in 10% formalin for a minimum of 24 hours, followed by dehydration, clearing, and embedding in paraffin blocks. Thin sections measuring 4–5  $\mu\text{m}$  were obtained using a microtome, mounted on glass slides, and stained with hematoxylin and eosin (H&E). A consultant pathologist analyzed the slides under a light microscope, evaluating cellular architecture, nuclear atypia, mitotic activity, and stromal invasion to determine the presence of malignancy. Histological classification was performed according to the World Health Organization (WHO) criteria for endometrial pathology. Data were recorded on a predesigned proforma and analyzed using SPSS version 26.0. Descriptive statistics were applied to summarize quantitative variables, including age, endometrial thickness, parity, and duration of menopause, which were presented as mean  $\pm$  standard deviation (SD). Qualitative variables, such as parity and the presence or absence of malignancy on TVUS and histopathology, were expressed as frequencies and percentages. Stratification was performed based on age, duration of menopause, and parity to account for potential confounders. Post-stratification diagnostic accuracy was calculated, with a p-value of  $\leq 0.05$  considered statistically significant. A  $2 \times 2$  contingency table was constructed following the methodology outlined by Shreffler and Huecker to determine the diagnostic accuracy of TVUS, including sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

## RESULTS

The study included 135 postmenopausal women presenting with postmenopausal bleeding. The majority of participants were aged between 56–65 years (44.4%), followed by those aged 46–55 years (33.3%) and above 65 years (22.2%). Most participants resided in urban areas (66.7%), while 33.3% were from rural backgrounds. Marital status analysis revealed that 74.1% were married, 22.2% were widowed, and 3.7% were divorced or separated. Regarding educational background, 29.6% had secondary education, 29.6% had higher education, 22.2% had primary education, and 18.5% had no formal education. Socioeconomic distribution indicated that 48.1% belonged to the middle-income group, 37.0% to the low-income group, and 14.8% to the high-income group. The duration of menopause was between 1–5 years in 44.4% of participants, 6–10 years in 33.3%, and more than 10 years in 22.2%. Parity analysis showed that 40.7% of participants had 1–3 children, 37.0% had 4–6 children, 14.8% had more than 6 children, and 7.4% were nulliparous. Body mass index (BMI) classification indicated that 40.7% were overweight, 37.0% had normal weight, 18.5% were obese, and 3.7% were underweight. The duration of postmenopausal bleeding symptoms varied, with 44.4% reporting symptoms for 19–25 months and 37.0% for 12–18 months.

Among clinical characteristics, 33.3% of participants reported vaginal discharge, while 66.7% did not. Comorbid conditions were prevalent, with hypertension present in 44.4%, obesity in 40.7%, and diabetes mellitus in 33.3%. Hypothyroidism was reported in 14.8%, while 22.2% had no comorbid conditions. A history of previous gynecological surgery was present in 29.6%, whereas 70.4% had no such history. Regarding medication use, 37.0% were on antihypertensive therapy, 33.3% on antidiabetics, and 11.1% on hormone replacement therapy. Tamoxifen use was reported in 7.4%, while 18.5% were not using any medications. Transvaginal ultrasound (TVS) findings revealed that 51.8% of participants had an endometrial thickness between 4–9 mm, 33.4% had a thickness greater than 9 mm, and 14.8% had a thickness of less than 4 mm. Histopathological examination identified endometrial carcinoma in 49.0% of participants. Proliferative endometrium was diagnosed in 18.5%, while endometrial hyperplasia without atypia and with atypia were reported in 14.8% and 7.4% of cases, respectively. Atrophic endometritis was observed in 5.9% of cases, whereas irregular endometrial shedding was noted in 4.4%.

The diagnostic accuracy of TVS in detecting endometrial carcinoma, using histopathology as the gold standard, demonstrated a sensitivity of 97.0% and a specificity of 76.8%. The positive predictive value (PPV) was 80.0%, while the negative predictive value (NPV) was 96.4%, resulting in an overall diagnostic accuracy of 86.7%. TVS exhibited excellent sensitivity in detecting malignant endometrial lesions, minimizing false-negative cases. The specificity, although moderate at 76.7%, reflected its ability to rule out benign conditions. The diagnostic accuracy in distinguishing malignant from benign endometrial lesions was 86.7%. Further stratification of

TVS diagnostic performance by demographic and clinical characteristics showed that sensitivity remained high across different age groups, with a slightly higher value of 92.0% in participants aged  $\leq 60$  years compared to 89.5% in those aged  $>60$  years. Parity had no significant effect on TVS performance, with both nulliparous and multiparous women demonstrating sensitivity around 90%. In participants with less than 5 years of menopause, sensitivity was slightly higher at 93.3% compared to 88.5% in those with menopause duration  $\geq 5$  years. TVS performance was notably better for detecting lesions with endometrial thickness  $>9$  mm, where sensitivity reached 95.0%, and specificity was 50.0%. For lesions within the 4–9 mm range, sensitivity was lower at 85.0%, with specificity at 65.0%. The histological type also influenced TVS performance, with higher sensitivity for detecting endometrial carcinoma (93.9%) compared to proliferative (90.0%) and hyperplastic (88.9%) lesions. Vaginal discharge was associated with a slight increase in sensitivity, with 92.0% in patients presenting with discharge compared to 89.5% in those without. Receiver Operating Characteristic (ROC) curve analysis demonstrated that endometrial thickness had a high diagnostic accuracy in distinguishing between benign and malignant endometrial lesions, with an area under the curve (AUC) of 0.888. Although minor overlaps were noted between positive and negative cases, endometrial thickness remained a robust parameter for malignancy detection. The ROC curve effectively illustrated the balance between sensitivity and specificity, reaffirming the reliability of TVS in distinguishing malignant from benign endometrial conditions.

**Table 1: Socio-demographic characteristics of the study sample (n=135)**

Variable	Frequency (n)	Percentage (%)
Age (years)		
46-55	45	33.3
56-65	60	44.4
>65	30	22.2
Residence		
Urban	90	66.7
Rural	45	33.3
Marital Status		
Married	100	74.1
Widowed	30	22.2
Divorced/Separated	5	3.7
Education Level		
No Formal Education	25	18.5
Primary	30	22.2
Secondary	40	29.6
Higher Education	40	29.6
Socioeconomic Status		
Low	50	37.0
Middle	65	48.1
High	20	14.8

Variable	Frequency (n)	Percentage (%)
<b>Duration of Menopause (years)</b>		
1-5	60	44.4
6-10	45	33.3
>10	30	22.2
<b>Parity</b>		
Nulliparous	10	7.4
1-3	55	40.7
4-6	50	37.0
>6	20	14.8
<b>Body Mass Index (BMI)</b>		
<18.5 (Underweight)	5	3.7
18.5-24.9 (Normal Weight)	50	37.0
25-29.9 (Overweight)	55	40.7
≥30 (Obese)	25	18.5

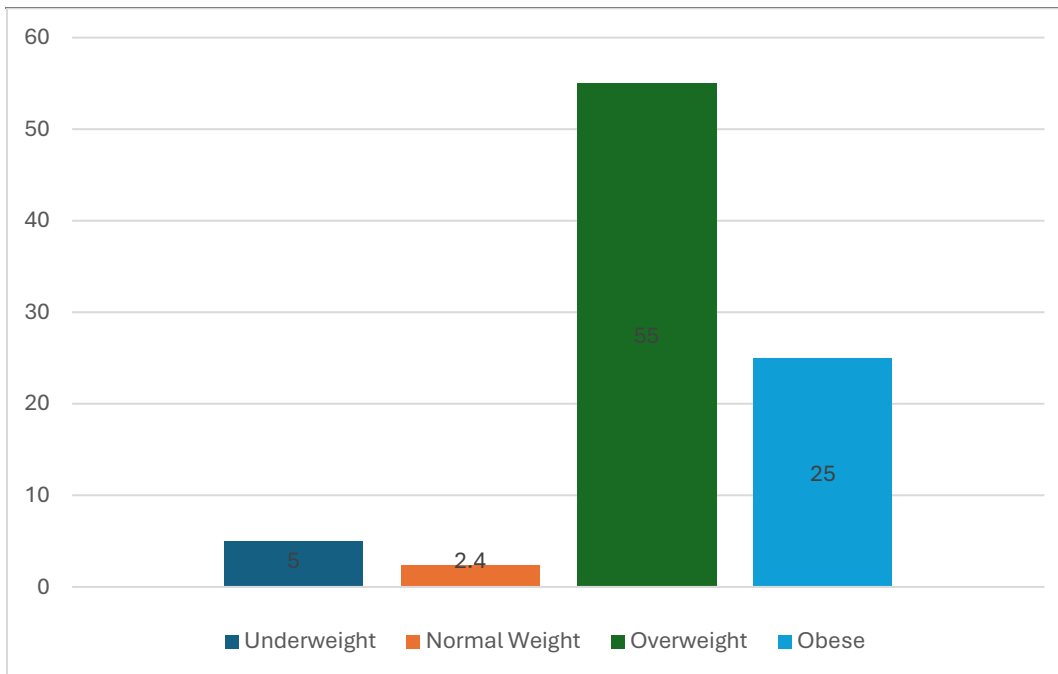


Figure 1 Distribution of study sample according to BMI categories

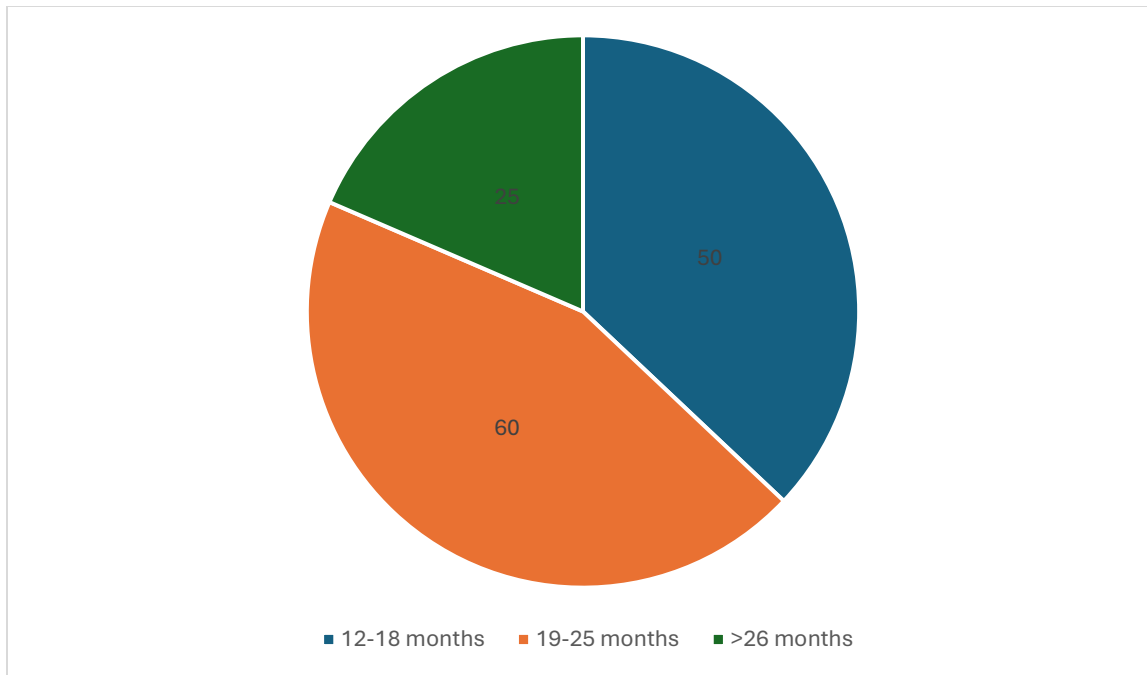


Figure 2 Duration of Postmenopausal Bleeding (months)

**Table 2: Clinical characteristics of the study sample**

Variables	Frequency (n)	Percentage (%)
Vaginal Discharge		
Present	45	33.3
Absent	90	66.7
Comorbidities		
Diabetes Mellitus	45	33.3
Hypertension	60	44.4
Obesity	55	40.7
Hypothyroidism	20	14.8
No Comorbidities	30	22.2
Previous Gynecological Surgery		
Present	40	29.6
Absent	95	70.4
Use of Medications		
Hormone Replacement Therapy (HRT)	15	11.1
Tamoxifen	10	7.4
Antihypertensives	50	37.0

Variables	Frequency (n)	Percentage (%)
Antidiabetics	45	33.3
None	25	18.5

**Table 3: TVS findings of the study sample**

Endometrial Thickness (mm)	n	%
<4	20	14.8
4-9	70	51.8
>9	45	33.4

**Table 4: Table histology findings**

Finding on Histopathology	Frequency (n)	Percentage (%)
Proliferative Endometrium	25	18.5
Endometrial Hyperplasia Without Atypia	20	14.8
Endometrial Hyperplasia With Atypia	10	7.4
Endometrial Carcinoma	66	49.0
Atrophic Endometritis	8	5.9
Irregular Endometrial Shedding	6	4.4

**Table 5: Diagnostic accuracy of TVS for endometrial cancer taking histopathology as gold standard**

	Positive result on Histopathology	Negative result on Histopathology	Total
Positive on TVS	64 (TP)	16 (FP)	80
Negative on TVS	2 (FN)	53(TN)	55
Total	66	69	135

**Table 6: Sensitivity, specificity, PPV, NPV and diagnostic accuracy of TVS in distinguishing malignant versus benign endometrial lesions**

Diagnostic Measure	Value
Sensitivity	96.97%
Specificity	76.72%
Positive Predictive Value (PPV)	80%
Negative Predictive Value (NPV)	96.36%
Diagnostic Accuracy	86.67%

**Table 7: Diagnostic profile of TVS by important demographic and clinical characteristics**

Variable	Stratum	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	P value
Age (Years)	≤60	92.0	60.0	70.0	88.9	0.08
	>60	89.5	53.8	63.4	85.7	
Parity	Nulliparous	91.7	55.6	64.7	88.2	0.10
	Multiparous	90.0	57.1	68.6	86.2	
Duration of Menopause (Years)	<5	93.3	58.3	71.4	87.5	0.06
	≥5	88.5	53.3	62.5	85.2	
Endometrial Thickness (mm)	4–9	85.0	65.0	77.3	75.0	0.04*
	>9	95.0	50.0	65.0	90.0	
Histological Type	Proliferative	90.0	60.0	75.0	81.8	0.04*
	Hyperplasia	88.9	57.1	66.7	85.7	
	Carcinoma	93.9	54.5	63.6	91.4	
Vaginal Discharge	Present	92.0	55.6	70.0	83.3	0.05
	Absent	89.5	57.1	66.7	85.7	

Test of significance; Chi square, \*= P< 0.05

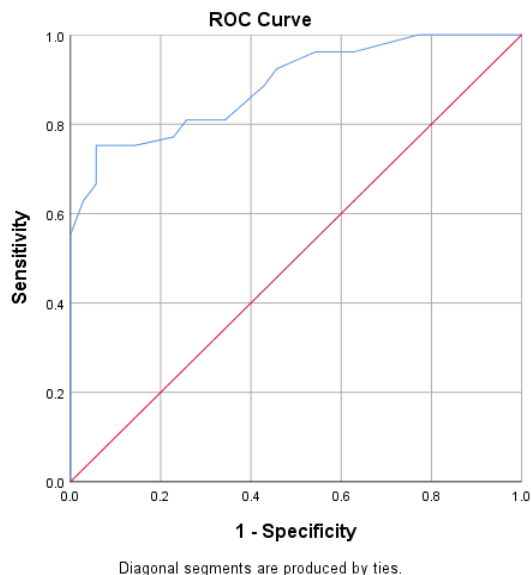


Figure 3 ROC analysis for TVS in endometrial cancer



## DISCUSSION

The findings of this study highlight the diagnostic accuracy of transvaginal ultrasound (TVS) in detecting endometrial carcinoma among postmenopausal women with abnormal uterine bleeding. The majority of participants were between the ages of 56–65 years, consistent with prior research indicating that postmenopausal women within this age group are at an increased risk of endometrial pathology. Urban residency and middle socioeconomic status were prevalent among participants, which aligns with reports suggesting that urban populations have better access to healthcare services, leading to higher rates of diagnostic evaluation for abnormal uterine bleeding. The high prevalence of comorbid conditions such as hypertension, obesity, and diabetes mellitus reflects well-established risk factors for endometrial hyperplasia and malignancy, as these conditions contribute to unopposed estrogen exposure, which plays a significant role in the pathogenesis of endometrial carcinoma. The study identified that more than half of the participants had an endometrial thickness between 4–9 mm, while a substantial proportion had thickness exceeding 9 mm. Histopathological evaluation confirmed endometrial carcinoma in nearly half of the cases, reinforcing the strong association between increased endometrial thickness and malignancy. These findings are in agreement with previous research demonstrating that an endometrial thickness greater than 9 mm is significantly correlated with endometrial carcinoma. Diagnostic accuracy analysis revealed that TVS exhibited high sensitivity and a strong negative predictive value, ensuring that the majority of malignant cases were correctly identified while minimizing false-negative results. However, specificity was moderate, indicating that while TVS is effective in identifying malignancy, a proportion of false-positive cases required further histopathological confirmation. Notably, diagnostic performance improved when endometrial thickness exceeded 9 mm, emphasizing the clinical significance of this threshold in malignancy detection.

The application of TVS as a first-line diagnostic tool for postmenopausal bleeding offers several advantages over invasive procedures such as dilatation and curettage or hysteroscopic biopsy. As a non-invasive, cost-effective, and widely available imaging modality, TVS provides an essential screening tool that facilitates early detection of endometrial pathology. It is particularly beneficial in low-resource settings where access to histopathological evaluation may be limited. Despite its effectiveness, TVS has inherent limitations, including operator dependency and variations in endometrial appearance that may affect interpretation. The presence of endometrial atrophy, fibroids, or polyps can sometimes result in false-positive or false-negative findings, highlighting the need for careful clinical correlation and consideration of additional diagnostic modalities when necessary. While this study provides valuable insights into the role of TVS in endometrial cancer detection, certain limitations must be acknowledged. The single-center design may limit the generalizability of findings, as variations in patient demographics and healthcare access could influence diagnostic outcomes. Additionally, the study relied on a single radiologist to perform TVS, reducing interobserver variability but potentially limiting external reproducibility. Future studies with multi-center designs and larger sample sizes would help validate these findings and provide a more comprehensive assessment of TVS diagnostic performance across diverse populations.

Further research should also explore the integration of additional imaging techniques such as Doppler ultrasound, which may enhance the specificity of TVS by evaluating vascularity patterns within the endometrium. The use of artificial intelligence-driven image analysis is another promising area that could improve the accuracy and reproducibility of TVS interpretation. Investigating the long-term prognostic implications of TVS findings in postmenopausal bleeding cases would also contribute to refining clinical decision-making and risk stratification. Overall, the results underscore the utility of TVS as a reliable, non-invasive diagnostic tool for evaluating postmenopausal bleeding and detecting endometrial carcinoma. Its high sensitivity ensures early identification of malignant lesions, making it a valuable screening modality in routine gynecological practice. However, given its moderate specificity, histopathological confirmation remains essential for definitive diagnosis. Enhancing TVS accuracy through the integration of advanced imaging techniques and standardized reporting criteria could further improve its role in endometrial cancer detection and management.

## CONCLUSION

The study highlights the effectiveness of transvaginal ultrasound as a valuable screening tool for detecting endometrial carcinoma in postmenopausal women with abnormal uterine bleeding. Its high sensitivity ensures early identification of malignant cases, reinforcing its role in initial diagnostic assessment. However, the moderate specificity and variable accuracy for intermediate endometrial thickness emphasize the need for histopathological confirmation to avoid unnecessary interventions. The findings also reveal a diverse spectrum of endometrial pathologies, underscoring the importance of a comprehensive diagnostic approach. Integrating TVS with additional diagnostic modalities can enhance accuracy and improve clinical decision-making, ultimately contributing to better patient outcomes.

## Author Contribution

Author	Contribution
Nazneen Bashir*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Uzma Nisar	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Jamil	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Bilqees	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Shahjahan Wahid	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published

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