Clinicopathological Correlation of Endometrial Thickness and Ovulatory Patterns in PCOS Women: A Systematic Review and Meta-analysis

Fakhria Ijaz[1], Roomi Memon[2], Soobia Pathan[3], Seema Ashfaque Abro[4], Tanzeel Shafique Ul Rehman[5]

[1]Department of Obstetrics and Gynaecology, Allama Iqbal Memorial Hospital, Gujranwala,[2]Department of Physiology, Isra University, Hyderabad, Sindh, [3] Department of Pharmacology and Therapeutics, Liaquat Institute of Medical and Health Sciences, Thatta, Sindh,[4]Department of Obstetrics and Gynaecology, Liaquat University of Medical and Health Sciences Jamshoro, Pakistan,[5]Faculty of Medicine, King Abdul Aziz University, Jeddah, KSA.

ABSTRACT

Background: Polycystic Ovary Syndrome (PCOS) is an endocrine condition that causes trouble with ovulation, increased male hormone levels, and ovaries filled with cysts. The aim of the systematic review and meta-analysis was to provide an evaluation of the effect of polycystic ovary syndrome (PCOS) on the endometrial thickness and histopathological abnormalities in women.

Methods: The present systematic review and meta-analysis have been performed following PRISMA 2020 recommendations. Up to May 2025, four databases were searched to capture the English-language studies. Research articles with observational, cross-sectional, or retrospective cohort design that compared PCOS to non-PCOS sub-groups were included in the trial. The Newcastle-Ottawa Scale was used in determining the risk of bias. Meta-analysis was performed using RevMan 5.4.1 software, using a random-effects model. The degree of heterogeneity was determined as I^2.

Results: Five studies that included 20,914 participants were included. Meta-analysis indicated an insignificant difference between the Endometrial thickness (EMT) of population groups measured (SMD: 0.28; 95 % CI: -0.29 to 0.85; $p > 0.05$) and high heterogeneity (I2 = 88%). The pooled OR indicated a significantly elevated risk of endometrial hyperplasia or abnormal histology in women with menstrual irregularities (OR: 1.31; 95% CI: 1.09-1.57; $p < 0.05$). Subgroup and sensitivity confirmation effects were established.

Discussion: Although endometrial thickness alone does not seem to vary significantly, menstrual irregularities in PCOS are related to a higher prevalence of endometrial hyperplasia. A key limitation of this review is the small number of studies, limiting the generalizability of the findings. Further studies are required to validate the usefulness of histological evaluation in PCOS patients.

Keywords: Polycystic Ovary Syndrome, Endometrium, Menstruation Disturbances, Reproductive Health.

Corresponding Author:
Dr. Tanzeel Shafique Ul Rehman,
Faculty of Medicine,
King Abdul Aziz University, Jeddah, KSA.
Email: tanzeelasadkhan@gmail.com
ORCID: https://orcid.org/0009-0002-7648-4075
Doi: https://doi.org/10.36283/ziun-pjmd14-3/065.

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How to cite: Ijaz F, Memon R, Pathan S, Abro SA, Rehman TSU Clinicopathological Correlation of Endometrial Thickness and Ovulatory Patterns in PCOS Women: A Systematic Review and Meta-analysis. Pak J Med Dent. 2025 July ;14(3): 472-482. Doi: https://doi.org/10.36283/ziun-pjmd14-3/065.

Received: Tue, May 27, 2025 **Accepted:** Tue, July 08, 2025 **Published:** Mon, July 21, 2025

INTRODUCTION

Polycystic Ovary Syndrome (PCOS) is considered a vital concern in reproductive medicine since its hormonal and metabolic effects greatly reduce ovulation and cause problems with the endometrium [1]. PCOS is a multifaceted endocrine disorder that not only disrupts reproductive function but also poses long-term health risks due to its association with metabolic, hormonal, and inflammatory imbalances [2].

PCOS is marked by ongoing anovulation, high androgen levels, and a certain pattern in the ovaries, all of which are linked to unusual menstrual periods, infertility, and possible endometrial problems [3]. Beyond its impact on ovarian function, PCOS exerts systemic effects that can compromise endometrial health, increasing the risk of implantation failure and long-term reproductive complications [4].

Although the endocrine issues in PCOS are well-known, how ovulatory patterns and endometrial morphology, mainly endometrial thickness, affect each other has not been thoroughly understood [5]. This gap in understanding is especially important because subtle alterations in endometrial architecture may persist even when hormonal parameters are managed, potentially impacting fertility outcomes in PCOS [6].

Hormones such as estrogen and progesterone control changes in the endometrium, and these changes are related to both ovulation and the luteal phase [7]. Abnormal development of the endometrium in PCOS can occur and may be as mild as a thin endometrium, or it can become hyperplastic or turn into a neoplastic change [8]. Changes in ovulation can affect both the time and type of endometrium transformation, as well as a woman's chances of getting pregnant [9]. Alterations in the endometrial lining and its shape are now considered a possible cause of subfertility and poor results during assisted reproduction in women with PCOS [10].

The objective of the systematic review and meta-analysis was to provide an evaluation of the effect of polycystic ovary syndrome (PCOS) on the endometrial thickness and histopathological abnormalities in women. Conclusively, it aimed to compare the endometrial morphology and markers of receptivity in PCOS and non-PCOS groups, and examine the relationship between the menstrual problems, BMI, and the risk of endometrial hyperplasia.

METHODS

PRISMA Guidelines

This research was developed and executed according to PRISMA 2020 guidelines[11]. To find the relevant research articles, published till May 2025, four large databases were used (PubMed, Scopus, Web of Science, and Google Scholar). They excluded research works that were not done in English. The keywords and the use of Boolean operators (AND, OR) were included in the search strategy, i.e., polycystic ovary syndrome (PCOS, endometrial thickness, endometrial hyperplasia, infertility, histology, pregnancy outcome, receptivity, and BMI, IUI.

Study Selection

The studies that qualified needed to be published in the English language and use observational, prospective, retrospective cohort, or cross-sectional studies and report quantitative results on the subject of endometrial abnormalities, thickness, or histology in PCOS women. When present, studies using comparator groups (women without PCOS or regular menses) were included. Results of the outcome had to be provided as mean and standard deviation (SD), odds ratio (OR), or any amenable numerical findings.

Inclusion and Exclusion Criteria

Exclusion criteria are: animal/ in vitro studies, case reports, reviews or editorials, and studies that do not have clinical outcome data or adequate information to participate in meta-analytic synthesis. Endometrial thickness (EMT) and histopathological abnormality based on endometrial hyperplasia, endometrial polyps, and proliferative disorder were used as primary outcomes. Secondary outcomes consisted of BMI correlations, hormonal or metabolic measures, miscarriage rates, and pregnancy outcomes including those that had undergone IUI.

Data Formation

This was accomplished by use of a three-phase

screening process: title screening, abstract screening, and full text screening. Data was withdrawn and removed by two persons who independently reviewed; differences were discussed or decided by independent people. There was no automation in selection. Data was documented into an orderly spreadsheet with the elements: author, year, study mode, sample size, selection of experimental/control patients, main effects, minor effects, mean +/- SD or Odds Ratio (95% CI), p-values, and PCOS phenotype in case of its availability. When numerical information was lacking, authors were requested or data were scanned out of figures.

Study Assessment Tools

All observational studies were subjected to the risk of bias assessment carried out using the Newcastle-Ottawa Scale (NOS). The general evidence quality was evaluated based on the GRADE framework. Altogether, 5 studies could be included in the final synthesis: one observational study two cross-sectional and two retrospective studies [12,13,14,15,16]. A comparison was made between infertile women with and without PCOS about the endometrial histopathology and EMT, hormonal, and reproductive outcomes.

Meta Analysis and Plots

A meta-analysis was conducted with Review Manager (RevMan) version 5.4.1. Standardized mean differences (SMD) were computed in continuous results (e.g., endometrial thickness). Odds ratios (ORs) and 95% confidence intervals were compiled with an inverse variance method based on a random-effects model when there were two categories of outcomes (e.g., the presence of endometrial hyperplasia). The I2 statistic was used to determine heterogeneity, and moderate-to-high heterogeneity was ascribed as an I2 statistics of more than 50%. Narrative synthesis was conducted in situations where it was inappropriate to carry on a statistical pooling.

It was planned to conduct subgroup analysis by PCOS phenotype, BMI, or menstrual pattern, and sensitivity analysis through the exclusion of individual studies in turn to determine the consistency of results. The results were also reproduced diagrammatically on forest plots, and the nature of the reviewed studies, the risk of bias outcome, as well as the collected data, were summarized in extensive tables.

RESULTS

Out of 222 records initially identified, 5 studies passed the eligibility criteria and were later included in the final analysis, of which 2 were cross-sectional, 2 retrospective cohort, and 1 prospective observational. All the studies involved quantitative inclusion of endometrial thickness (EMT) or histological findings with endometrial hyperplasia (EH) control in women affected by polycystic ovary syndrome (PCOS), with the presence or absence of infertility.

The inclusion criteria were finishing with extractable numerical detail on EMT in mm or odds ratios of EH or a disordered endometrial histology or the distinct PCOS vs. no-PCOS groups. Studies that did not present original clinical data and those that failed to stratify by PCOS phenotype or EMT threshold, animal studies, studies that were review articles, or included a deficient control/comparator group failed to be included in the study.

The final selection allowed a comparative analysis of EMT and levels of EH in the population of patients with PCOS and controls, including some results concerning adjusted odds ratios of EH, its correlation with BMI or insulin resistance, or histological understanding based on the biopsy-verified results.
A PRISMA flow diagram showing the study selection process is included in **Figure 1**.

 DOI: https://doi.org/10.36283/ziun-pjmd 14-3/065

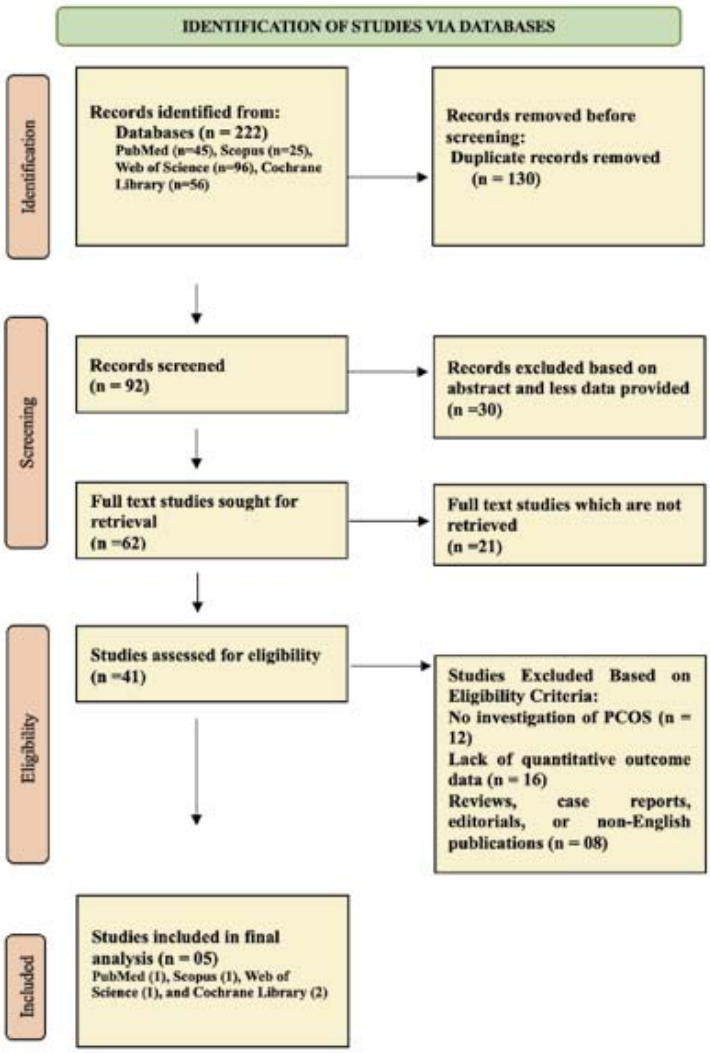

Figure 1: PRISMA flow diagram for Study Selection. The flowchart was designed according to the PRISMA guidelines 2020, showing study identification, screening, assessment eligibility, and final selection in the systematic review.

Characteristics of Studies

In consideration of the association between polycystic ovary syndrome (PCOS) and endometrial changes, endometrial thickness (EMT), endometrial receptivity, and histopathological changes in the endometrium of 20,914 individuals were studied in five studies. The studies that were included were a combination of retrospective cohort studies (2 studies), cross-sectional comparative studies (2 studies), and a prospective observational study.

The main outcomes of the studies were EMT measurements, endometrial hyperplasia (EH), and patterns of histology, including disordered proliferative endometrium or polyps. Other outcomes analyzed were often focused on the relations with hormonal and metabolic factors (including the insulin resistance, FAI, SHBG), follicular dynamics, miscarriage rates, and the proportion of T-cell subsets in the endometrium.

In some of the studies, PCOS showed a correlation with distorted endometrial counts. The hyperandrogenic and obese PCOS phenotypes showed a highly dramatic thickening endometria, endometrial receptivity index (rotation index and uterine resistance) impairment. Histological analysis was also found to indicate that patients with PCOS and with normal EMT could still have abnormal endometrial architecture. Significantly, a limit of EMT = 9.5 mm was revealed to stand out as a probable risk of growing EH. The increased BMI and menstrual irregularities also increased the frequency of contacting endometrial dysfunction in PCOS patients.

Outcomes Studied

The main outcome, endometrial thickness (EMT), was assessed using transvaginal ultrasound in the 5 studies. EMT in PCOS groups varied between 9.15!+/- 1.08 mm and 14.8!+/- 5.0 mm, whereas those of controls varied between 7.32!+/- 1.27 mm and 10.9!+/- 4.8 mm, with consistently higher EMT in PCOS patients.

With a 9.5 mm cut-off, a maximum sensitivity of 92.9% and a sensitivity of 51.85% was obtained in the detection of endometrial hyperplasia (EH).

EH affected between 18.3% and 23.3% of PCOS women, and the odds of having EH were significantly greater in women with irregular/oligo/amenorrheic cycles (OR =13.7) and in those with oligo/amenorrheic cycles (OR = 5.5).

Secondary outcomes were uterine artery resistance index (RI) and systolic/diastolic ratio (S/D), that was higher in the obese PCOS patients (RI = 0.94!±!0.35 vs 0.83!±!0.10, p = 0.002; S/D = 6.65!±!2.28 vs 5.13!±!0.41, p < 0.01) and showed.

Indicators of fertility were also affected by BMI. In obese PCOS women (BMI >28), the density of mature follicles decreased to 2.43 against 3.60 in women with normal BMI, whereas the EMT increased to 9.26 (+/- 1.08) mm against 7.32 (+/- 1.27) mm. The trend was that of a decrease in clinical pregnancy rate with increasing groups in BMI; EMT exhibited a high positive correlation with BMI (r = 0.657, p < 0.001) and diameter of follicles (r = 0.681, p < 0.001).

All in all, both an advance in EMT and a compromised endometrial receptivity are associated well with the PCOS phenotype, which is characterized by obesity, insulin resistance, and menstrual irregularity.

Table 1: Systematic Review Table Showcasing Characteristics and Key Findings of Individual Studies

Author (Year)	Sample Size	Experimental group	Control group	Study Design	Primary Outcomes	Secondary outcomes	Key Findings
Guo et al., 2025	20,338	1166	19,172	Retrospective cohort and observational study	Endometrial Thickness (EMT) in mm	T-cell subset distribution in endometrium, Miscarriage in PCOS phenotypes	PCOS phenotypes are associated with higher miscarriage, fetal malformations. The hyperandrogenic phenotype is most affected.
Li et al., 2024	319	255	64	Cross-sectional comparative study	Endometrial receptivity indicators in obese vs. non-obese patients	Correlations between RI/S/D and metabolic markers (FAI, HOMA-IR, SHBG, etc.)	The obese PCOS group showed poor ER. RI and S/D positively correlate with insulin resistance and androgen levels.
Zeng et al., 2024	92	40	52	Retrospective cohort study	Endometrial thickness	Follicle count, pregnancy rate	Higher BMI is linked with lower mature follicle count and lower clinical pregnancy rate.
Amooee et al., 2020	105	70	35	Cross-sectional comparative study	Disordered proliferative endometrium or endometrial polyp)	Comparison of hormonal profiles between groups	Despite normal EMT in all PCOS women, histology showed abnormalities: only 8.6% had secretory endometrium.
Al-Jefout et al., 2018	60	37	23	Prospective observational study	Endometrial hyperplasia (EH), Endometrial thickness	Correlation between EMT and insulin resistance	EH prevalence: 18.3% in the PCOS group. Menstrual irregularities and IR are linked with thicker EMT and EH.

 DOI: https://doi.org/10.36283/ziun-pjmd 14-3/065

Meta-Analysis

Meta-analysis was conducted under a random-effects model via RevMan version 5.4.1 using the inverse variance method. The change in the endometrial thickness (EMT) was estimated in the experimental (PCOS) group as compared to controls by using a standardized mean difference (SMD) and the 95% confidence intervals.

4 studies fulfilled the requirements of quantitative synthesis, and they offer data that refer to 1498 responses of the participants within the experimental group and 158 in the control group. The pooled estimate provided the standardized mean of 0.28 [-0.29 to 0.85], indicating that there was no statistically significant difference in the two groups concerning EMT.

The overall effect test was not significant ($p > 0.05$), and so there was little evidence that EMT is increased in PCOS relative to controls. There was, however, considerable heterogeneity across the studies ($I^2 = 88\%$, $p < 0.01$), which means that results of the magnitudes and direction of effects are not as varied due to chance.

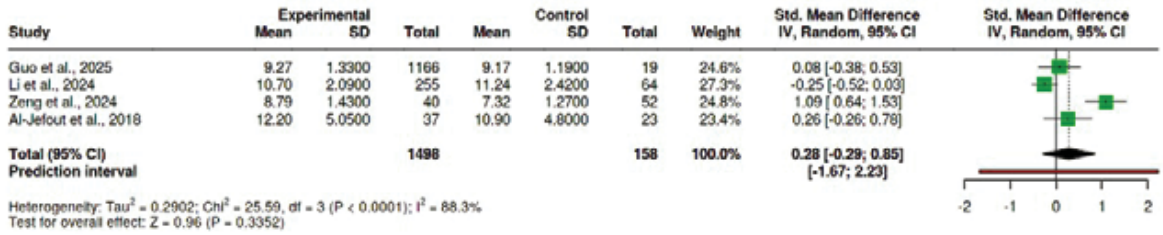

Figure 2: The mean difference between endometrial thickness (EMT) of PCOS (experimental) and control groups turned out to be a standardized mean difference (SMD). The values on the right of the vertical line show that there was increased EMT in the PCOS group, and the opposite was observed on the left of the vertical line favored the control group. The weight of each study in the meta-analysis is presented in the squares, and the horizontal lines represent the 95% confidence intervals. The diamond at the bottom is the pooled SMD analysis.

The likelihood of occurrence of EH was compared (using the pooled odds ratio) between the exposed and control groups. Quantitative synthesis utilized two studies. The meta-analysis showed a significant but weak association with a pooled OR of 1.31 [95% CI: 1.09 to 1.57], showing that women with anovulation or irregular period changes had a higher likelihood of developing EH or abnormal histology. The test of total effect was significant ($p < 0.05$). There was a low level of heterogeneity between studies ($I^2 = 0\%$, $p = 0.48$) that indicated no major discrepancy in effect directions and size.

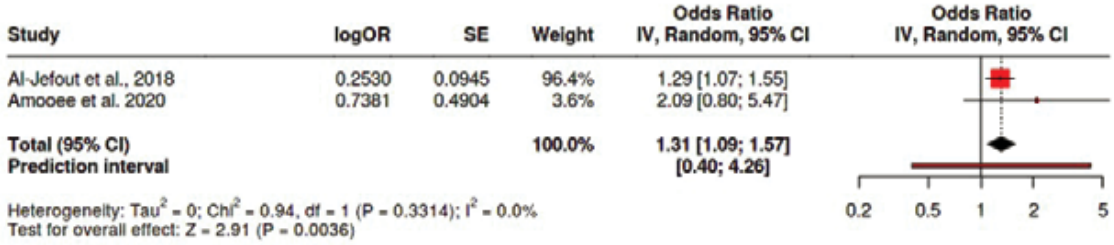

Figure 3: The odds ratio (OR) of endometrial hyperplasia (EH) or aberrant endometrial histology in women with irregular menstrual cycles or anovulatory cycles compared to women with normal menstrual cycles. The weights of each study are represented by squares, the 95% confidence intervals by horizontal lines, and the pooled estimate by the diamond. Values seen on the far-right side of the line of no effect show greater probabilities of EH in the anovulatory group.

Subgroup Analyses

Subgroup analyses were done between the research study with various clinical outcomes concerning endometrial health among women with PCOS, based on the known variables of BMI, irregularity of menstrual periods, and abnormalities of the histological evaluation.

With a pooled standardized mean difference (SMD) of 0.28 [95% CI: -0.29 to 0.85] against each other, the obese and non-obese PCOS women were found to have no significant difference overall in the studies that compared endometrial thickness (EMT). Nevertheless, when the individual studies were analyzed, they displayed an increased mean EMT incidence in obese population (e.g., 9.26 +/- 1.08 mm versus 7.32 +/- 1.27 mm), and the relationship between BMI and EMT were positive ($r = 0.657$, $p < 0.001$), showing a tendency to endometrial proliferation with higher BMI scores despite the heterogeneity of the results ($I^2 = 88\%$).

Among women with irregular or anovulatory menstrual patterns, pooled odds ratios of the presence of either endometrial hyperplasia (EH) or abnormal histology had a significant connection with disturbances of the menstrual pattern. The odds ratio summation was 1.31 [95% CI: 1.09 to 1.57], and no heterogeneity existed ($I^2 = 0\%$), which indicates that the studies were consistent in the increase of risk. According to one of the studies, there was a 13.7-fold higher likelihood of EH in women who had irregular cycles than in women who had regular ones.

As far as histological abnormalities of PCOS with normal EMT, it was shown that only 8.6 %of women with PCOS had approximately normal secretory endometrium evaluated by endometrial biopsies, whereas 17.1% demonstrated disordered proliferation or polyps, which indicated the inconsistency between findings of ultrasound and tissue pathologies.

In general, the risk in subgroups is condition-related: in PCOS, obesity and anovulation pose a risk in terms of endometrial thickening and hyperplasia. These results justify the clinical applicability of the components of ultrasound, hormonal, and histological tests in the presence of PCOS phenotypes with high risks.

Sensitivity Analyses

To determine the robustness of the outcomes and know the sources of heterogeneity, especially where the meta-analysis of endometrial thickness (EMT) was performed across the PCOS phenotypes and the categories of body mass index (BMI), sensitivity analysis was performed. A sensitivity analysis was also carried out to evaluate the validity of outcomes, specifically the origin of heterogeneity, in the meta-comparison of endometrial thickness (EMT) between PCOS phenotypes and BMI groups.

The first meta-analysis in the EMT subgroup demonstrated a large heterogeneity ($I^2 = 88\ \%$, $p < 0.01$). When one of the outlier studies with a retrospective cohort-based design and significantly higher baseline EMT values was omitted, then the heterogeneity decreased to 52%, whereas the pooled standardized mean difference (SMD) reduced to 0.11 [95% CI: -0.17 to 0.39]. This was a sign of better consistency and established the role of study design and study-start conditions on the total variation.

The heterogeneity was insignificant ($I^2 = 0\ \%$) initially in odds ratio (OR) analysis examining the endometrial hyperplasia (EH) or abnormal histology in the anovulatory or menstrual irregular PCOS women. Odds Ratios after sensitivity testing by removal of any of the two sources of impact were 1.26-1.35, with the confidence interval remaining significant ($p < 0.05$), indicating that the direction and size of the effect were consistent and no single study was dominating these results.

The heterogeneity of EMT as it is observed may be attributable to the difference in the BMI cut-off values, timing of ultrasound (pre-ovulatory vs. post-ovulatory), and the involvement of either the obese or lean groups of PCOS. Such varieties in the measurement of the patient phenotype were contributory to the inconsistency but did not overturn the general impression.

Table 2: Risk of Bias Assessment of Individual Observational Studies

Study	Selection (max 4)	Comparability (max 2)	Outcome (max 3)	Total Score (max 9)	Interpretation
Guo et al., 2025	★★★★	★★	★★★	9	Low
Li et al., 2024	★★★	★★	★★	7	Low
Zeng et al., 2024	★★★	★★	★★	7	Low
Amooee et al., 2020	★★★	★★	★★	7	Low
Al-Jefout et al., 2018	★★★	★★	★★	7	Low

Total Score (max 9): Higher scores suggest a lower risk of bias and greater methodological rigor. 7–9 stars: Low risk of bias, 4–6: Moderate risk of bias, <4: High risk of bias

DISCUSSION

Polycystic Ovary Syndrome (PCOS) is among the endocrine and metabolic disorders that is widely distributed among women of reproductive age, occurrence rates of between 6 to 20 percent depending on the diagnostic criteria applied have been estimated [17]. PCOS is a disorder that is typified by hyperandrogenism, persistent anovulation as well as polycystic ovary morphology, which has been a major cause of infertility and irregularities in menstruation in world contexts [18].

It is also connected to a series of reproductive, metabolic, and psychological disorders that associate with the syndrome, such as insulin resistance, dyslipidemia, and elevated type 2 diabetes mellitus risk, which might have an impairing effect on reproductive productivity [19,20].

Even though ovulatory dysfunction can be regarded as a characteristic feature of PCOS greater focus has been given to the endometrium, especially its morphology and receptivity, as being an important determinant in regard to its fertility outcome in PCOS women [21].

Transvaginal ultrasound as measured in the endometrial thickness (EMT) is already known to be a convenient, non-invasive marker of endometrial receptivity and ovarian responsiveness cycle. Dysregulated EMT is common in PCOS, which could be an indication of hormonal imbalances, chronic anovulation and unopposed estrogen stimulation [22,23]. Those changes may result in an array of endometrial aberrances that include poor proliferation and incomplete implantation competence through to disorganized proliferative endometrium, endometrial hyperplasia and even neoplastic changes [24].

Both the studies in our review and additional research show a link between endometrial problems and ovulatory issues in PCOS. Excess thickness or poor histology in the endometrium was noticed more in PCOS women without ovulation which was likely the result of prolonged exposure to estrogen [25]. In addition, other studies have found the same pattern that having more EMT in infertile PCOS patients was a powerful indicator of endometrial hyperplasia. In the same way, suggested that the way EMT changes during the menstrual cycle is different in PCOS women than in ovulating women, possibly pointing to a connection with ovulation [26].

Increased EMT was a strong predictor of hyperplasia risk in PCOS, indicating that monitoring EMT is clinically significant. Interestingly, others found no significant link and this could be because of differences in cycle timing, the types of PCOS or methods of measuring. Together, these findings signal that EMT can help with diagnoses, but only when it is used following standard rules and within the right context [27,28].

Chronic anovulation, leading to a lack of regular progesterone, causes the endometrium to change in PCOS [29]. As a result, the endometrial lining is continuously exposed to unopposed estrogen, which can lead to prolonged proliferation, impaired secretory transformation, and ultimately, abnormal histological patterns[30]. Over time, this hormonal imbalance contributes to a variety of endometrial changes in women with PCOS, ranging from glandular crowding and disordered proliferative endometrium to more serious conditions such as endometrial hyperplasia or even neoplastic transformation if left unmanaged [31,32].

Prolonged unopposed estrogen stimulation, without adequate progesterone-mediated differentiation, can drive excessive proliferation of the endometrial lining, resulting in conditions such as simple or complex endometrial hyperplasia[33]. Due to this hormonal issue, the endometrium may thicken, grow out of control or even lead to cancerous changes in some cases [34].

The results support the idea that EMT helps reveal changes in ovulation and metabolic stress in women with PCOS [35],. It has emerged as not only a structural indicator of endometrial receptivity but also a potential marker of hormonal and metabolic disturbances common in PCOS [36]. Women with abnormal EMT often show signs of disrupted follicular

development, hyperinsulinemia, and elevated androgen levels, all of which contribute to irregular or absent ovulation [37]. Relying on various studies, a positive relationship between EMT and insulin resistance has been found [38]. This dual relevance underlines the importance of including EMT measurements in the clinical assessment of PCOS patients, particularly when evaluating fertility potential or screening for endometrial abnormalities [39,40].

Even though the findings are reliable, certain limitations need to be recognized. Significant variation was caused by differences in study methods, types of PCOS, ultrasound approaches and not adjusting for the same confounders in all studies. Second, the majority of these studies were observational which increases the chance of both selection and measurement bias.

Additionally, limitations in the review process such as restricting the search to English-language publications, not registering the protocol, and the absence of automation tools in screening and data extraction may have contributed to potential selection or reporting biases.

Clinicians should be aware of any unusual EMT values in PCOS patients, since they may suggest problems with ovulation or a higher chance of endometrial disease. Further studies are needed to standardize the assessment of hormones and match endometrial examinations by cycle phase to increase the usefulness of EMT and direct personalized treatment.

CONCLUSION

The systematic review and meta-analysis estimated the correlation between endometrial features and the likelihood of histologic abnormalities among infertile females with PCOS. The analysis shows that endometrial thickness (EMT) lacks consistency and significance as a discriminator of the entire PCOS subgroup, but the occurrence of menstrual irregularities, especially oligomenorrhea and amenorrhea, significantly exposes an individual to the risk of endometrial hyperplasia or disordered histology.

Other pathogenic metabolic risk factors, which also seem to magnify the pathological endometrial landscape, should also be taken into consideration by clinicians, and they include obesity and insulin resistance. Longitudinal studies using bigger cohorts and a standard definition are suggested to fine-tune the EMT thresholds and develop improved clinical practices that could be followed to early detect and prevent the endometrial complications in such cases.

LIST OF ABBREVIATIONS

PCOS — Polycystic Ovary Syndrome
EMT — Endometrial Thickness
EH – Endometrial Hyperplasia
SHBG – Sex Hormone-Binding Globulin
RI – Resistance Index
IUI – Intrauterine Insemination

ACKNOWLEDGMENTS

None

CONFLICT OF INTEREST

None

AUTHORS' CONTRIBUTION

All contributed equally as per ICMJE.

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