West African Journal of Allied Health Sciences

Advancing Allied Health Research in West Africa

www.wajahs.org

eISSN: 3115-4581 **pISSN: 3115-4573**

Original Article

Volume 2, Issue 2, August 2026

Significantly Elevated Uterine Artery Doppler Indices and Impaired Subendometrial Perfusion Characterise Infertile Women in a North-Eastern Nigerian Population: A Case-Control Study

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Abstract

Background: Infertility is a major reproductive health burden in Sub-Saharan Africa, where prevalence rates reach 20–46%. Endometrial receptivity, critically dependent on adequate uterine perfusion, is a key determinant of successful implantation. Doppler ultrasound provides a non-invasive means to assess uterine hemodynamics, yet locally derived data from Nigerian populations remain scarce.

Objectives: This study aims to determine and compare uterine artery Doppler indices and subendometrial blood flow patterns between infertile and fertile parous women in Maiduguri, Nigeria, a region within Africa's high-prevalence infertility belt.

Methods: This prospective case-control study was conducted over a 13-month period involving 300 newly diagnosed cases of infertile women and 300 age-matched fertile parous controls. Transvaginal Doppler ultrasound was performed during the mid-luteal phase. Uterine artery pulsatility index (PI) and resistivity index (RI) were measured, and subendometrial blood flow was classified into zones (1–4). Main outcome measures were mean uterine artery PI, RI, and distribution of subendometrial blood flow zones.

Results: The mean age was 30.3$\pm$7.0 years for cases and 34.7$\pm$6.9 years for controls ($p<0.001$). Infertile women exhibited significantly higher uterine artery impedance: mean RI was 0.79$\pm$0.07 vs. 0.73$\pm$0.06 ($p<0.001$), and mean PI was 2.15$\pm$0.56 vs. 1.69$\pm$0.30 ($p<0.001$). Subendometrial perfusion was markedly reduced in the infertile group ($p<0.001$); while all controls (100%) displayed optimal Zone 3 flow, only 54.3% of infertile women did. Furthermore, 45% of infertile women had a clinically high RI (>0.8) compared to none in the control group. Age-adjusted ANCOVA confirmed that Doppler differences persisted independently of age (RI: F=112.45, $p<0.001$; PI: F=128.73, $p<0.001$). Subgroup analysis showed both primary and secondary infertility had similarly elevated Doppler indices compared to controls ($p<0.001$ for all comparisons).

Conclusion: Infertile women in this population demonstrate significantly impaired uterine perfusion, evidenced by elevated Doppler indices and reduced subendometrial blood flow. These findings support the integration of Doppler ultrasound into the diagnostic work-up for infertility in similar resource-limited settings, as it identifies a potential, reversible contributor to poor endometrial receptivity.

Keywords: Infertility; Uterine artery Doppler; Pulsatility index; Resistivity index; Subendometrial blood flow; Endometrial receptivity; Nigeria.

 DOI: 10.67891/19dx3411

Received: June 10, 2026 **Reviewed: August 13, 2026** **Accepted: August 14, 2026**

Introduction

Infertility, defined as the failure to achieve a clinical pregnancy after 12 months of regular, unprotected intercourse, is a global reproductive health challenge with profound psychosocial and economic consequences (Ombelet et al., 2008; Zegers-Hochschild et al., 2017). The burden is disproportionately high in

Sub-Saharan Africa, often termed the "infertility belt," where prevalence rates range from 20–46%, compared to 10–15% in developed nations (Mascarenhas et al., 2012; Obuna et al., 2012). In Nigeria, infertility is a leading reason for gynecological consultations and is associated with significant stigma, particularly for women (Oladokun et al., 2018; Panti & Sununu, 2014).

The evaluation of infertility requires reliable, accessible, and cost-effective diagnostic tools. While etiologies are multifactorial, successful implantation hinges on a receptive endometrium, which is critically dependent on adequate uterine perfusion (El-Mazny et al., 2011; Wang et al., 2010). Doppler ultrasonography provides a non-invasive, real-time, and affordable method to assess uterine hemodynamics by measuring impedance indices – the pulsatility index (PI) and resistivity index (RI) – in the uterine arteries, and by visualizing subendometrial blood flow (Kupesic & Kurjak, 1993; Steer et al., 1990). Studies in other populations have linked high uterine artery impedance and poor subendometrial flow with implantation failure, recurrent pregnancy loss, and reduced success in assisted reproduction (Cacciatore et al., 1996; Steer et al., 1994).

Despite the high prevalence of infertility in Nigeria, there is a paucity of local data on uterine hemodynamic parameters. While hysterosalpingography and MRI have roles in infertility evaluation, these tools are invasive or inaccessible in resource-limited settings. Doppler ultrasound offers a non-invasive, affordable alternative that directly assesses the vascular component of endometrial receptivity (Steinkeler et al., 2009). This study, therefore, aimed to determine uterine artery PI, RI, and subendometrial blood flow patterns in infertile women compared to fertile controls in Maiduguri, North-Eastern Nigeria. We hypothesized that infertile women would exhibit significantly higher uterine artery impedance and poorer subendometrial perfusion.

Materials and Methods

Study Design and Setting

This was a prospective case-control study conducted at the Department of Radiology, University of Maiduguri Teaching Hospital (UMTH), from April 2022 to May 2023. Ethical approval was obtained from the UMTH Research and Ethics Committee (Approval No: UMTH/REC/2022/04/12), and written informed consent was secured from all participants.

Participants

Case Group: 300 women aged 15–49 years, newly diagnosed with primary or secondary infertility of at least one year's duration, referred from the gynecology clinic.

Control Group: 300 age-matched, fertile parous women who had delivered a live baby within the preceding 6–12 months, recruited from the family planning clinic.

Exclusion Criteria for both groups: Women with uterine anomalies (e.g., huge fibroids, congenital malformations), active pelvic inflammatory disease, significant medical comorbidities (e.g., diabetes, hypertension), history of pelvic surgery, or incidental pregnancy on scan.

Ultrasound Examination

All scans were performed in the mid-luteal phase (days 19–23 of a 28-day cycle) by a single operator using a GE Logiq P5 ultrasound system with a multi-frequency transvaginal transducer. After a preliminary B-mode scan, color Doppler was used to identify the uterine arteries at the cervicocorporal junction. Pulsed-wave Doppler was applied with an angle of insonation as close to 0° as possible. The angle was maintained at $\leq$30° (range 15–30°) for all measurements, and angles $>$30° were rejected to minimise angle-related error. The PI and RI were automatically calculated by the machine's software from three consecutive uniform waveforms and averaged for the right and left sides to give a mean PI and RI per patient.

Subendometrial blood flow was assessed using color Doppler mapping in a longitudinal uterine view and classified semi-quantitatively as follows:

- **Zone 1:** Flow at the endometrial-myometrial junction only.
- **Zone 2:** Flow penetrating the hyperechoic outer endometrial margin.
- **Zone 3:** Flow reaching the inner hypoechoic endometrial zone (considered optimal perfusion).
- **Zone 4:** Flow extending to the endometrial cavity (not observed in this study).

Statistical Analysis

Data were analyzed using SPSS version 23.0. Continuous variables (PI, RI, age) were presented as mean $\pm$ standard deviation and compared using the independent samples t-test. Categorical variables (subendometrial flow zones, parity) were presented as frequencies/percentages and compared using the Chi-square test. To address the significant age difference between groups, an analysis of covariance (ANCOVA) was performed with age as a covariate to confirm that Doppler index differences persisted independently of age. A p-value of <0.05 was considered statistically significant. A sub-analysis defined "high" RI as >0.8 and "high" PI as >3.0 based on referenced normative values (Alcazar & Kudla, 2012; Kupesic & Kurjak, 1993; Steer et al., 1994).

Sample size was calculated a priori using the independent samples formula for case-control comparisons. Based on a presumed mean RI difference of 0.06 between groups (from prior literature: Steer et al. 1994 (Steer et al., 1994)), with standard deviations of 0.07 and 0.08, α=0.05, power=80%, a minimum of 246 participants per group was required. Allowing for 20% attrition, the target sample was 307 per group, which we rounded to 300 per group based on recruitment feasibility during the 13-month study period.

Results

Demographic and Clinical Characteristics

The socio-demographic data are summarized in Table 1. The infertile group was significantly younger and, by definition, had lower parity, with 69.3% being nulliparous. A higher proportion of controls reported a history of miscarriage (46.0% vs. 27.7%, p<0.001).

Table 1: Socio-Demographic and Clinical Characteristics of the Study Population

Characteristic	Infertile group (n=300)	Fertile control group (n=300)	*p*
Age (years)			
Mean $\pm$ SD	30.28$\pm$6.98	34.72$\pm$6.94	<0.001
Range	18–46	20–48	
Age group, n (%)			
≤20	6 (2.0)	2 (0.7)	<0.001
21–30	147 (49.0)	88 (29.3)	
31–40	113 (37.7)	145 (48.3)	
41–50	34 (11.3)	65 (21.7)	
Parity, n (%)			
Nulliparous	208 (69.3)	0 (0)	<0.001
Primiparous	20 (6.7)	33 (11.0)	
Multiparous	66 (22.0)	176 (58.7)	
Grand multiparous	6 (2.0)	91 (30.3)	
History of miscarriage, n (%)	83 (27.7)	138 (46.0)	<0.001

SD = Standard Deviation.

Uterine Artery Doppler Indices and Subendometrial Blood Flow

Uterine artery Doppler parameters are detailed in Table 2. The mean RI and PI were significantly higher in the infertile group compared to the fertile controls (RI: 0.79 vs. 0.73; PI: 2.15 vs. 1.69; both p<0.001). The between-group differences in RI and PI remained highly significant after adjusting for age in ANCOVA (RI: F=112.45, p<0.001; PI: F=128.73, p<0.001), confirming that the observed differences are attributable to infertility status rather than the age disparity between groups.

Table 2: Uterine Artery Doppler Indices and Subendometrial Blood Flow

Parameter	Infertile group (n=300)	Control group (n=300)	t	*p*
Uterine artery Doppler (Mean ± SD)				
Resistivity Index (RI)	0.79±0.07 (Min: 0.50, Max: 0.93)	0.73±0.06 (Min: 0.52, Max: 0.80)	15.890	<0.001
Pulsatility Index (PI)	2.15±0.56 (Min: 0.73, Max: 3.66)	1.69±0.30 (Min: 0.88, Max: 2.70)	16.959	<0.001
Subendometrial blood flow zone, n (%)				
Zone 1 (Poor)	89 (29.7)	0 (0)		
Zone 2 (Moderate)	48 (16.0)	0 (0)		<0.001
Zone 3 (Good)	163 (54.3)	300 (100)		
Classification of indices, n (%)				
High RI (>0.8)	135 (45.0)	0 (0)		<0.001
High PI (>3.0)	12 (4.0)	0 (0)		<0.001

SD = Standard Deviation.

The distribution of subendometrial blood flow zones differed dramatically between groups ($p<0.001$) (Figure 1). All 300 control women (100%) exhibited optimal Zone 3 perfusion. In contrast, among the 300 infertile women, only 163 (54.3%) had Zone 3 flow, while 89 (29.7%) had Zone 1 and 48 (16.0%) had Zone 2 flow.

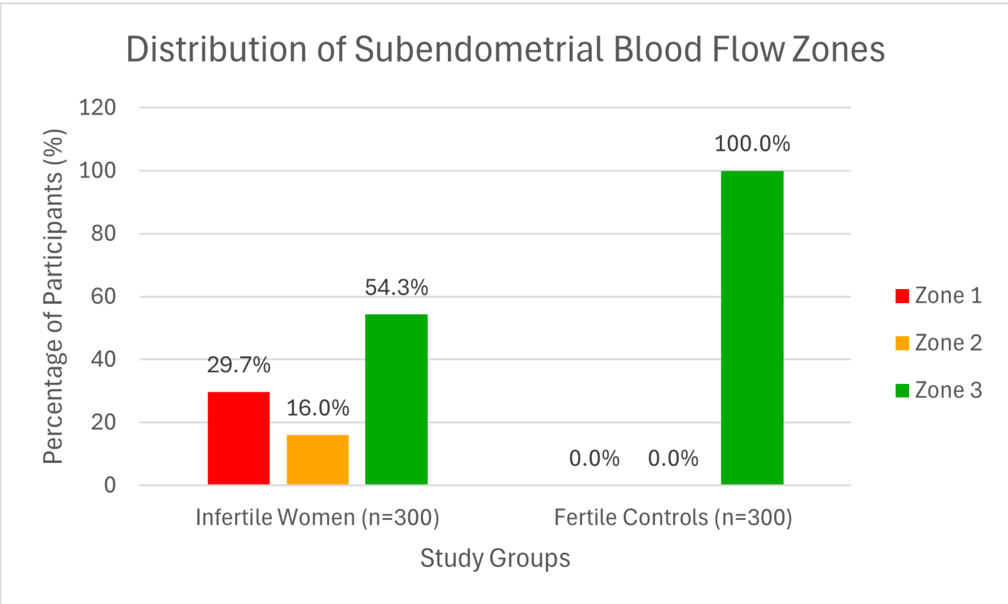

Figure 1: Distribution of Subendometrial Blood Flow Zones in Infertile Women. Bar chart comparing the semi-quantitative assessment of subendometrial perfusion. Blood flow was classified as Zone 1 (flow at endometrial-myometrial junction), Zone 2 (flow penetrating outer endometrial margin), or Zone 3 (flow reaching inner endometrial zone, considered optimal). All fertile control women (100%) demonstrated Zone 3 flow. In contrast, a significantly lower proportion of infertile women (54.3%) had Zone 3 flow, with the remainder exhibiting impaired perfusion (Zones 1 or 2). ($p < 0.001$, Chi-square test).

Subgroup Analysis: Primary vs Secondary Infertility

Subgroup analysis comparing primary (n=208) and secondary (n=92) infertility revealed that both subtypes had significantly elevated RI and PI compared to controls ($p<0.001$ for all comparisons). The mean RI was 0.80±0.07 in primary infertility and 0.78±0.06 in secondary infertility ($p=0.083$); mean PI was

2.18±0.58 vs 2.09±0.51 (p=0.091). Zone 3 perfusion was present in 52.4% of primary and 58.7% of secondary infertility cases (p=0.312). While both groups were similarly affected, the trend toward slightly better perfusion in secondary infertility warrants further investigation in larger studies.

Discussion

This case-control study provides compelling evidence from a high-prevalence region that infertile women have significantly altered uterine hemodynamics compared to their fertile counterparts. Our findings demonstrate elevated uterine artery PI and RI, alongside substantially compromised subendometrial perfusion in the infertile group during the midluteal phase, a critical window for endometrial receptivity. The age-adjusted analysis confirmed that these differences are attributable to infertility status rather than the age disparity between groups.

The significantly higher mean uterine artery RI (0.79) and PI (2.15) in our infertile cohort align with the pathophysiological concept of increased vascular impedance, suggesting reduced diastolic flow and, consequently, diminished perfusion pressure to the endometrium (Raine-Fenning et al., 2004; Steer et al., 1994). This creates a potentially hostile endometrial environment for blastocyst attachment and early placentation. Our results are consistent with previous studies in other populations reporting elevated Doppler indices in women with unexplained infertility (Cacciatore et al., 1996; El-Mazny et al., 2013). The finding that the differences persisted after age adjustment strengthens the causal inference, as uterine artery impedance is known to vary with age. Notably, the older control group would be expected to have higher (not lower) impedance indices, making our observed differences potentially conservative.

The most striking and clinically intuitive finding is the profound disparity in subendometrial blood flow. While every fertile woman exhibited optimal (Zone 3) flow, nearly half (45.7%) of the infertile women had only peripheral (Zone 1 or 2) perfusion. This visual Doppler assessment directly reflects microvascular perfusion at the tissue level and strongly supports the hypothesis of impaired endometrial receptivity in a large subset of infertile women (Wahab et al., 2011). Our results corroborate the work of Wang et al. and Chien et al., who associated better endometrial flow zones with higher implantation and pregnancy rates (Chien et al., 2002; Wang et al., 2010). The finding that 45% of our infertile cohort had a clinically "high" RI (>0.8) further quantifies the scale of this potential contributor to infertility in our setting.

The subgroup analysis comparing primary and secondary infertility revealed that both subtypes demonstrated similarly elevated Doppler indices and impaired perfusion compared to controls, with no statistically significant differences between the two groups. This suggests that impaired uterine perfusion is a common feature across infertility types in this population. The non-significant trend toward slightly better perfusion in secondary infertility (RI 0.78 vs 0.80; Zone 3 flow 58.7% vs 52.4%) may reflect prior uterine vascular adaptation from pregnancy, though this requires further study with larger sample sizes.

The clinical utility of these findings is substantial, particularly in resource-limited environments like ours. Doppler ultrasound is affordable, non-invasive, and readily available. Identifying a cohort of women with "high-resistance" uteri and poor subendometrial flow allows for targeted therapeutic interventions. Evidence suggests that interventions such as low-dose aspirin, pentoxifylline, or vaginal sildenafil may improve uterine perfusion and subsequent pregnancy outcomes (Check et al., 2002; Lazzarin et al., 2009). In resource-limited settings like ours, identifying impaired perfusion via Doppler is particularly valuable as it may guide low-cost, targeted therapies before resorting to expensive assisted reproduction. Therefore, integrating this assessment into the standard infertility work-up could stratify patients and guide personalized adjuvant therapy, potentially improving natural and assisted conception rates without resorting immediately to more expensive and invasive options.

Study Limitations

The semi-quantitative assessment of subendometrial flow, while clinically useful and previously validated, is operator-dependent. Future studies with 3D power Doppler and VOCAL software would provide more objective quantification. The case and control groups were not perfectly matched for age and miscarriage history; however, ANCOVA confirmed that the Doppler differences were independent of age. The cross-sectional design cannot establish causality, only association. Longitudinal studies tracking perfusion changes with treatment and pregnancy outcomes are needed. The control group was recruited from post-partum women attending family planning clinics. While this ensured proven fertility, it introduces a potential selection bias, as post-partum uterine perfusion may differ from that of non-pregnant women at other reproductive stages. The results may not fully generalise to all fertile women, particularly those at different parities or stages of reproductive life.

The higher prevalence of miscarriage history in the control group (46.0%) compared to cases (27.7%) is a noteworthy confounder. Prior miscarriage may itself be associated with altered uterine perfusion, though the direction of effect is uncertain. Some studies suggest that recurrent miscarriage is associated with elevated uterine artery impedance, which would mean our control group – with more miscarriage history – might be expected to have higher (not lower) impedance. This would make our observed findings potentially conservative. Conversely, if post-partum vascular remodelling from the successful pregnancy that followed prior miscarriages improves perfusion, this could partially explain the lower impedance in controls. The cross-sectional design cannot disentangle these effects. Future longitudinal studies with detailed reproductive histories are needed.

The clinical thresholds for 'high' RI (>0.8) and 'high' PI (>3.0) used in our sub-analysis are based on previously published normative values (Alcazar & Kudla, 2012) and align with thresholds used in other studies (Kupesic & Kurjak, 1993; Steer et al., 1994). However, these cut-offs derive from predominantly Caucasian populations and have not been validated in Sub-Saharan African settings. We regard these thresholds as exploratory, and their local applicability warrants validation in future multi-centre normative studies.

Conclusion

This study establishes that infertile women in Maiduguri, North-Eastern Nigeria, have significantly impaired uterine perfusion, characterized by elevated uterine artery Doppler indices and reduced subendometrial blood flow during the implantation window. Both primary and secondary infertility subtypes demonstrate similar perfusion impairment compared to fertile controls. These findings underscore the role of uterine hemodynamics in infertility and advocate for the inclusion of Doppler ultrasound in the diagnostic algorithm in similar settings. By identifying impaired perfusion, clinicians can consider targeted vasodilatory therapies, potentially enhancing endometrial receptivity and improving reproductive outcomes for women in high-prevalence infertility regions.

Declarations

Data Availability Statement

The datasets generated and/or analysed during the current study are not publicly available due to participant confidentiality and ethical restrictions but are available from the corresponding author upon reasonable request and with approval from the UMTH Research and Ethics Committee.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of Interest

The authors declare no conflicts of interest.

Author Contributions

Zara Baba Shettima: Conceptualization, methodology, data acquisition, investigation, writing – original draft, project administration.

Mohammed Lawan Mohammed: Conceptualization, methodology, supervision, validation, writing – review & editing.

Maryam Abba Goni: Data curation, formal analysis, visualization, writing – original draft.

Tijjani Abba Ibrahim: Data curation, formal analysis, software, writing – review & editing.

Umar Hassan Umar: Investigation, resources, validation, writing – review & editing.

Abubakar Farate: Investigation, resources, methodology, writing – review & editing.

Zara Mohammed Bata: Data acquisition, project administration, visualization.

Abubakar Garba Farouk: Supervision, methodology, validation, writing – review & editing.

All authors have read and approved the final manuscript.

Acknowledgements

The authors gratefully acknowledge the support of the consultants and staff of the Departments of Radiology and Gynaecology, University of Maiduguri Teaching Hospital. We also extend our sincere appreciation to all the study participants.

References

Alcazar, J. L., & Kudla, M. J. (2012). Normal uterine artery pulsatility index in the midluteal phase: A preliminary study. *Journal of Ultrasound in Medicine*, *31*(10), 1543–1548.

Cacciatore, B., Simberg, N., Fusaro, P., & Tiitinen, A. (1996). Transvaginal doppler study of uterine artery blood flow in in vitro fertilization-embryo transfer cycles. *Fertility and Sterility*, *66*(1), 130–134.

Check, J. H., Graziano, V., Lee, G., Nazari, A., & Gandy, P. (2002). Effect of vaginal sildenafil on the outcome of in vitro fertilization (IVF) after multiple IVF failures attributed to poor endometrial development. *Fertility and Sterility*, *78*(5), 1073–1076.

Chien, L. W., Au, H. K., Chen, P. L., Xiao, J., & Tzeng, C. R. (2002). Assessment of uterine receptivity by the endometrial-subendometrial blood flow distribution pattern in women undergoing in vitro fertilization-embryo transfer. *Fertility and Sterility*, *78*(2), 245–251.

El-Mazny, A., Abousalem, N., & Elshenoufy, H. (2013). Doppler study of uterine hemodynamics in women with unexplained infertility. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, *171*(1), 84–87.

El-Mazny, A., Abou-Salem, N., El-Sherbiny, W., & Saber, W. (2011). Outpatient hysteroscopy: A routine investigation before assisted reproductive techniques? *Fertility and Sterility*, *95*(1), 272–276.

Kupesic, S., & Kurjak, A. (1993). Uterine and ovarian perfusion during the periovulatory period assessed by transvaginal color doppler. *Fertility and Sterility*, *60*(3), 439–443.

Lazzarin, N., Vaquero, E., Exacoustos, C., Bertonotti, E., Romanini, M. E., & Arduini, D. (2009). Low-dose aspirin and omega-3 fatty acids improve uterine artery blood flow velocity in women with recurrent miscarriage due to impaired uterine perfusion. *Fertility and Sterility*, *92*(1), 296–300.

Mascarenhas, M. N., Flaxman, S. R., Boerma, T., Vanderpoel, S., & Stevens, G. A. (2012). National, regional, and global trends in infertility prevalence since 1990: A systematic analysis of 277 health surveys. *PLoS Medicine*, *9*(12), e1001356.

Obuna, J. A., Ndukwe, E. O., & Ugboma, H. A. (2012). Clinical presentation of infertility in an outpatient clinic of a resource poor setting, southeast nigeria. *International Journal of Tropical Disease & Health*, *2*(2), 123–131.

Oladokun, A., Arulogun, O., Oladokun, R., Morhason-Bello, I. O., Bamgboye, E. A., & Okonofua, F. E. (2018). Infertility and psychological distress among women in a nigerian population. *African Journal of Reproductive Health*, *22*(1), 95–103.

Ombelet, W., Cooke, I., Dyer, S., Serour, G., & Devroey, P. (2008). Infertility and the provision of infertility medical services in developing countries. *Human Reproduction Update*, *14*(6), 605–621.

Panti, A. A., & Sununu, Y. T. (2014). The profile of infertility in a teaching hospital in north western nigeria. *Sahel Medical Journal*, *17*(1), 7–11.

Raine-Fenning, N. J., Campbell, B. K., Kendall, N. R., Clewes, J. S., & Johnson, I. R. (2004). Endometrial and subendometrial perfusion are impaired in women with unexplained subfertility. *Human Reproduction*, *19*(11), 2605–2614.

Steer, C. V., Campbell, S., Pampiglione, J. S., Kingsland, C. R., Mason, B. A., & Collins, W. P. (1990). Transvaginal colour flow imaging of the uterine arteries during the ovarian and menstrual cycles. *Human Reproduction*, *5*(4), 391–395.

Steer, C. V., Tan, S. L., Mason, B. A., & Campbell, S. (1994). Midluteal-phase vaginal color doppler assessment of uterine artery impedance in a subfertile population. *Fertility and Sterility*, *61*(1), 53–58.

Steinkeler, J. A., Woodfield, C. A., Lazarus, E., & Hillstrom, M. M. (2009). Female infertility: A systematic approach to radiologic imaging and diagnosis. *RadioGraphics*, *29*(5), 1353–1370.

Wahab, H. A., El-Din, D. S., Zain, E., Abdelgany, M., & Youssef, M. A. (2011). Uterine artery doppler and subendometrial blood flow in patients with unexplained recurrent miscarriage. *Middle East Fertility Society Journal*, *16*(3), 209–214.

Wang, L., Qiao, J., Li, R., Zhen, X., & Liu, Z. (2010). Role of endometrial blood flow assessment with color doppler energy in predicting pregnancy outcome of IVF-ET cycles. *Reproductive Biology and Endocrinology*, *8*, 122.

Zegers-Hochschild, F., Adamson, G. D., Dyer, S., Racowsky, C., de Mouzon, J., Sokol, R., et al. (2017). The international glossary on infertility and fertility care, 2017. *Human Reproduction*, *32*(9), 1786–1801.