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Association of Haematological and Haemostatic Parameters with Female Reproductive Hormones: A Systematic Review and Research Synthesis of Mechanisms, Clinical Correlations, and Implications for Practice

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Abstract

Background: Female reproductive hormones exert systemic effects extending beyond reproductive physiology to influence hematopoiesis, immune regulation, endothelial integrity, and haemostatic balance. Cyclical and life-stage hormonal variations significantly alter haematological and coagulation parameters.

Objective: To systematically review and synthesize evidence on the association between female reproductive hormones and haematological and haemostatic indices, including mechanistic pathways and clinical implications.

Methods: A systematic review of peer-reviewed literature was conducted using electronic databases (PubMed, Scopus, ScienceDirect, and Google Scholar). Studies assessing associations between oestrogen, progesterone, FSH, LH, prolactin and haematological (RBC indices, WBC counts, platelet parameters) and haemostatic variables (coagulation factors, anticoagulant proteins, fibrinolysis markers) were included. Mechanistic, observational, and interventional studies were synthesized narratively.

Results: Oestrogen enhances erythropoiesis through upregulation of erythropoietin gene expression and bone marrow responsiveness, increases hepatic synthesis of coagulation factors, reduces anticoagulant activity, and modulates endothelial nitric oxide pathways. Progesterone influences leukocyte distribution, promotes immune tolerance, and modulates platelet reactivity. Pregnancy induces haemodilution, physiological anaemia, leukocytosis, gestational thrombocytopenia, and marked hypercoagulability. Combined hormonal contraceptives increase thrombotic risk via elevated fibrinogen, factor VII, and activated protein C resistance. Menopause is associated with increased inflammatory markers, altered lipid profile, and prothrombotic tendency.

Conclusion: Female reproductive hormones significantly regulate haematological and haemostatic systems through complex endocrine-hematologic interactions. Consideration of hormonal status is essential in laboratory interpretation, thrombotic risk assessment, and clinical decision-making.

Keywords: Oestrogen; Progesterone; Haematology; Haemostasis; Coagulation; Pregnancy; Menstrual Cycle; Hormonal Contraception

Introduction

The interaction between endocrine and hematologic systems represents a critical component of female physiology. Reproductive hormones, particularly oestrogen and progesterone, exert regulatory effects on erythropoiesis, leukocyte kinetics, platelet production, vascular endothelium, and coagulation pathways [1]. These effects vary across the menstrual cycle, pregnancy, postpartum period, and menopause.

Globally, thromboembolic disease remains a major contributor to maternal morbidity and mortality [2]. Similarly, iron deficiency anaemia disproportionately affects women of reproductive age due to menstrual blood loss and pregnancy demands [3]. Understanding hormone-driven physiological variations is therefore essential for accurate diagnosis and risk stratification.

Emerging molecular evidence demonstrates that oestrogen receptors (ER-α and ER-β) are expressed in hematopoietic stem cells and megakaryocytes, indicating direct endocrine-bone marrow communication [4]. Progesterone receptors are also present on immune cells, suggesting immunomodulatory influence [5]. This systematic review synthesizes mechanistic and clinical evidence linking female reproductive hormones with haematological and haemostatic parameters.

Methodology

Search strategy: A structured search was performed using combinations of keywords

"Oestrogen and Erythropoiesis", "Progesterone and Coagulation", "Menstrual Cycle and Haematologic Parameters", "Pregnancy and Haemostasis", "Oral Contraceptives and Thrombosis".

Inclusion criteria

- Human studies (observational, cohort, case-control, randomized trials)
- Studies evaluating hormonal levels with hematologic or coagulation parameters
- English language publications

Exclusion criteria

- Case reports without laboratory correlation
- Non-human experimental models without translational relevance

Data synthesis findings were grouped under

Erythropoiesis, leukopoiesis, thrombopoiesis, coagulation, fibrinolysis, and endothelial modulation.

Physiological Basis of Hormonal Regulation

Oestrogen

Oestrogen increases transcription of erythropoietin in renal peritubular cells [6]. It enhances survival of erythroid progenitors and reduces apoptosis via anti-oxidative pathways [7].

In the liver, oestrogen stimulates synthesis of fibrinogen and clotting factors VII, VIII, IX, and X [8]. It also reduces antithrombin III and protein S activity, promoting a procoagulant state [9]. Endothelial cells exposed to oestrogen demonstrate increased nitric oxide production, improved vasodilation, and altered expression of adhesion molecules [10].

Progesterone

Progesterone modulates T-lymphocyte responses, shifting immunity toward Th2 dominance during pregnancy [11]. It influences platelet membrane receptors and may reduce excessive aggregation in certain phases of the menstrual cycle [12].

Gonadotropins and Prolactin, FSH and LH

These hormones indirectly influence hematologic parameters *via* regulation of ovarian steroidogenesis [13]. Prolactin enhances lymphocyte proliferation and cytokine release [14].

Effects on Erythrocyte Parameters

1. Menstrual Cycle Studies demonstrate modest cyclical variation in haemoglobin, with lower levels during menstruation due to blood loss [15]. Mid-cycle oestrogen peaks may enhance erythropoietic drive.

2. Pregnancy Plasma volume expansion increases by 40-50% by the third trimester, exceeding red cell mass expansion (20-30%), leading to physiological anaemia of pregnancy [16]. Despite haemodilution, erythropoietin levels are elevated [17].

3. Menopause Reduced oestrogen levels post-menopause are associated with increased haematocrit and viscosity in some populations, possibly contributing to cardiovascular risk [18].

Effects on Leukocyte Dynamics

Pregnancy induces leukocytosis, primarily neutrophilia, mediated by hormonal and cortisol effects [19]. Progesterone supports immune tolerance by suppressing cytotoxic T-cell activity [20].

Oestrogen influences B-cell maturation and antibody production [21]. High oestrogen states are associated with increased susceptibility to certain autoimmune conditions.

Effects on Platelets

Oestrogen stimulates megakaryocyte maturation and platelet production [22]. Mean Platelet Volume (MPV) may vary during menstrual phases.

Gestational thrombocytopenia occurs in approximately 7-10% of pregnancies due to haemodilution and increased platelet consumption [23].

Coagulation and Haemostatic Modulation

Pregnancy-induced hypercoagulability

Pregnancy increases fibrinogen levels by up to 50% and elevates factors VII, VIII, IX, and X [24]. Protein S levels decrease, while resistance to activated protein C increases [25].

Hormonal contraceptives

Combined oral contraceptives increase relative risk of venous thromboembolism by 2-4 fold depending on oestrogen dose and progestin type [26]. They elevate fibrinogen, prothrombin fragments, and D-dimer levels.

Menopause and hormone replacement therapy

Postmenopausal women on hormone replacement therapy exhibit increased thrombotic risk, particularly during the first year of therapy [27].

Molecular Mechanisms

Oestrogen receptor activation in hematopoietic stem cells influences differentiation pathways *via* STAT5 and MAPK signalling [28]. Progesterone modulates NF-κB mediated inflammatory pathways [29].

Endothelial expression of tissue factor is influenced by hormonal milieu [30]. Reduced fibrinolysis during pregnancy is mediated by elevated plasminogen activator inhibitor-1 and 2 (PAI-1, PAI-2) [31].

Clinical Implications

1. Interpretation of CBC in pregnancy requires trimester-specific reference ranges.

2. Thrombotic risk assessment must consider contraceptive use.

3. Evaluation of anaemia in menstruating women must account for cyclical variation.

4. Hormone replacement therapy requires coagulation risk screening.

Research Gaps

1. Limited African population data.

2. Need for longitudinal studies linking hormonal profiles with haemostatic markers.

3. Genetic polymorphism influence on hormone-coagulation interaction.

Conclusion

Female reproductive hormones exert significant regulatory control over haematological and haemostatic systems. Through genomic and non-genomic mechanisms, these hormones influence erythropoiesis, immune modulation, platelet production, coagulation factor synthesis, and fibrinolytic balance. Recognition of these physiological interactions is essential in clinical, particularly in pregnancy, contraceptive use, and menopause management.

References

1. Greer JP. Wintrobe's Clinical Hematology. 14th ed. 2019.
2. World Health Organization. Trends in maternal mortality. 2025.
3. Milman N. Iron prophylaxis in pregnancy --general or individual and in which dose? Ann Hematol. 2006; 85: 821-828.
4. Nakada D, Oguro h, Levi BP, Ryan N, Kitano A, Saitoh Y, et al. Oestrogen increases hematopoietic stem-cell self-renewal in females and during pregnancy. Nature. 2014; 505: 555-558.
5. Szekeres-Bartho J. Progesterone and immune regulation. Am J Reprod Immunol. 2002; 47: 1-8.
6. Masuda S. Regulation of erythropoietin gene expression. Blood. 1994; 84: 2773-2778.
7. Lee YH. Oestrogen and oxidative stress in erythrocytes. J Endocrinol. 2010; 204: 143-152.
8. Scarabin PY. Hormones and venous thromboembolism mong postmenopausal women. Arterioscler Thromb Vasc Biol. 2014; 17: 34-37.
9. Rosendaal FR. Venous thrombosis : a multicausal disease. Lancet. 1999; 353: 1167-1173.
10. Mendelsohn ME, Karas RH. The protective effects of oestrogen on the cardiovascular system. N Engl J Med. 1999; 340: 1801-1811.
11. Piccinni MP. Progesterone and Th2 responses. Nat Rev Immunol. 2007; 7: 889-900.
12. Feuring M. Progesterone effects on platelets. Thromb Res. 2002; 105: 147-152.
13. Hall JE. Endocrinology of the menstrual cycle. N Engl J Med. 2015; 372: 123-132.
14. Matera L. Prolactin in immune regulation. Immunol Today. 1997; 18: 122-126.
15. Hallberg L, Högdahl AM, Nilsson L, Rybo G. Menstrual blood loss and iron deficiency. Acta Med Scand. 1966; 180: 639-650.
16. Pritchard JA. Changes in blood volume during pregnancy and delivery. Am J Obstet Gynecol. 1965; 26: 393-399.
17. Cotes PM. Erythropoietin in pregnancy. Br J Haematol. 1989; 73: 10-15.
18. Stevenson JC. Menopause and cardiovascular risk. Lancet. 2000; 356: 1543-1549.
19. Lurie S. Leukocytosis in pregnancy. Obstet Gynecol Surv. 2008; 63: 348-352.
20. Arck PC, Hansen PJ, Jericevic BM, Piccinni M, Szekeres-Bartho J. Progesterone during pregnancy: endocrine-immune cross talk in mammalian species and the role of stress. Am J Reprod Immunol. 2007; 58(3): 1-10.
21. Straub RH. The complex role of estrogens in inflammation. Endocr Rev. 2007; 28: 521-574.
22. Valera MC. Oestrogen and megakaryopoiesis. Blood. 2009; 114: 215.
23. Burrows RF, Kelton JG. Fetal thrombocytopenia and its relation to maternal thrombocytopenia. N Engl J Med. 1993; 329: 1463-1466.
24. Brenner B. Haemostatic changes in pregnancy. Thromb Res. 2004; 114: 409-414.
25. Hellgren M. Hemostasis during normal pregnancy and puerperium. Semin Thromb Hemost. 2003; 29: 125-130.
26. Lidegaard Ø, Løkkegaard E, Svendsen AL, Agger C. Hormonal contraception and risk of venous thromboembolism: national follow-up study. BMJ. 2009; 339: b2890.
27. Rossouw JE, Anderson GL, Prentice RL, LaCroix AZ, Kooperberg C, Stefanick ML, et al. Risks and benefits of estrogen plus progestin in healthy postmenopausal women: principal results From the Women's Health Initiative randomized controlled trial. JAMA. 2002; 288: 321-333.
28. Nakada D, Oguro H, Levi BP, Ryan N, Kitano A, Saitoh Y, et al. Estrogen increases haematopoietic stem cell self-renewal in females and during pregnancy. Nature. 2014; 505: 555-558.
29. Hardy DB, Janowski BA, Corey DR, Mendelson CR. Progesterone receptor plays a major antiinflammatory role in human myometrial cells by antagonism of nuclear factor-kappaB activation of cyclooxygenase 2 expression. Mol Endocrinol. 2006; 20: 2724-2733.
30. Coughlin SR. Thrombin signalling and protease-activated receptors. Nature. 2000; 407: 258-264.
31. Kruithof EK, Tran-Thang C, Gudinchet A, Hauert J, Nicoloso G, Genton C, et al. Fibrinolysis in pregnancy: a study of plasminogen activator inhibitors. Blood. 1987; 69: 460-466.