AMERICAN ACADEMIC PUBLISHER

INTERNATIONAL JOURNAL OF MEDICAL SCIENCES

ISSN NUMBER: 2692 - 5206 Volume 5. No 12. December ,2025

PHYSIOLOGY OF KIDNEYS IN PREGNANT RATS

Shadiyeva Shodiya Shuhratovna

Email: shodiyashodiyeva86@gmail.com

https://orcid.org/0000-0003-0170-7940

Asian International University.DSc .

Abstract: Pregnancy is accompanied by profound physiological changes in the maternal organism, including significant adaptations of renal function. Pregnant rats are widely used as an experimental model to study renal physiology due to similarities in fundamental regulatory mechanisms with humans. This article analyzes anatomical and functional changes in the kidneys of pregnant rats, renal hemodynamics, glomerular filtration rate, tubular reabsorption, and hormonal regulation of water–electrolyte balance. Understanding these mechanisms is essential for modeling pregnancy-related renal disorders and evaluating pharmacological interventions.

Keywords: pregnancy, kidneys, rats, glomerular filtration rate, renal physiology, hormonal regulation.

Introduction

The kidneys play a central role in maintaining homeostasis by regulating fluid volume, electrolyte composition, and acid–base balance. During pregnancy, renal function undergoes adaptive changes due to increased circulating blood volume, elevated metabolic demands of the developing fetus, and hormonal fluctuations. Experimental studies on pregnant rats provide valuable insight into physiological renal adaptations and serve as a basis for understanding pregnancy-associated renal pathologies in humans.

Anatomical and Functional Changes of Kidneys During Pregnancy

In pregnant rats, a moderate increase in kidney mass is observed, associated with enhanced renal perfusion and hypertrophy of nephrons. Although the general renal architecture remains intact, functional activity of nephron segments increases. The proximal tubules exhibit heightened reabsorptive capacity, facilitating effective conservation of essential substances under increased filtration conditions.

Renal Hemodynamics and Glomerular Filtration

One of the most significant physiological changes during pregnancy is an increase in renal blood flow. In pregnant rats, renal blood flow may rise by 30–50% compared with non-pregnant females. This leads to an increased glomerular filtration rate (GFR), enabling more efficient elimination of metabolic waste products from both maternal and fetal organisms. Elevated GFR is considered an adaptive response preventing accumulation of potentially toxic metabolites.

Tubular Reabsorption and Excretion

AMERICAN ACADEMIC PUBLISHER
INTERNATIONAL JOURNAL OF MEDICAL SCIENCES
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Despite increased GFR, pregnant rats do not demonstrate excessive loss of proteins or electrolytes under normal physiological conditions. This is explained by enhanced tubular reabsorption of sodium, water, glucose, and amino acids. At the same time, excretion of nitrogenous waste products such as urea and creatinine is increased, supporting metabolic balance throughout gestation.

Hormonal Regulation of Renal Function

Hormonal regulation plays a crucial role in renal adaptations during pregnancy. Elevated levels of estrogen, progesterone, renin, and aldosterone are observed in pregnant rats. Activation of the renin–angiotensin–aldosterone system promotes sodium and water retention, contributing to the expansion of circulating blood volume. Vasopressin further regulates water reabsorption, preventing dehydration and maintaining osmotic stability.

Significance of Experimental Studies

Experimental investigation of renal physiology in pregnant rats is of considerable scientific and clinical importance. These models allow researchers to simulate pregnancy-related complications such as gestational hypertension and proteinuria, as well as to assess the renal safety of pharmacological agents during prenatal development. The findings obtained from such studies may be partially extrapolated to human pregnancy.

Conclusion

Pregnancy in rats is associated with complex adaptive changes in renal physiology aimed at maintaining homeostasis and supporting fetal development. Increased renal blood flow, elevated glomerular filtration rate, and intensified tubular reabsorption represent key adaptive mechanisms.

Experimental studies using pregnant rats remain an essential tool for advancing the understanding of both normal and pathological renal physiology during pregnancy.

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AMERICAN ACADEMIC PUBLISHER
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ISSN NUMBER: 2692 - 5206 Volume 5. No 12. December ,2025

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