REVISTA CIE

RESEARCH CONGRESS POSTERS

Revista de Investigación Educativa
Edición Especial | Vol. 2
ISSN: 3061-8657 | Enero-Junio 2026

Adaptation of renal function in individuals with chronic kidney disease: a literature review

Adaptación de la función renal en personas con enfermedad renal crónica: revisión de literatura

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Abstract

Chronic kidney disease is characterized by a progressive and irreversible loss of renal function that triggers various adaptive mechanisms aimed at maintaining homeostasis and the glomerular filtration rate. Among these mechanisms, glomerular hyperfiltration, hypertrophy of the remaining nephrons, and activation of neurohormonal systems—particularly the renin–angiotensin–aldosterone system—are prominent. Although these compensatory responses allow temporary preservation of renal function, evidence shows that they contribute significantly to progressive structural damage, promoting glomerulosclerosis, chronic inflammation, and interstitial fibrosis. The objective of this review was to analyze the main mechanisms of renal function adaptation in individuals with chronic kidney disease and their role in disease progression. A narrative review of the scientific literature was conducted through a systematic search of articles in biomedical databases, selecting studies that addressed the physiological, hemodynamic, and structural changes associated with renal adaptation. The findings indicate that sustained hyperfiltration and the activation of inflammatory and fibrogenic mediators accelerate functional renal deterioration. Overall, these results underscore that adaptive mechanisms, while initially protective, represent a key factor in the progression of chronic kidney disease, highlighting the importance of their early identification and the development of therapeutic strategies aimed at limiting their deleterious effects and delaying disease progression.

Keywords: chronic kidney disease; renal adaptation; glomerular hyperfiltration; compensatory mechanisms; renal progression

Resumen

La enfermedad renal crónica se caracteriza por una pérdida progresiva e irreversible de la función renal que desencadena diversos mecanismos de adaptación con el objetivo de mantener la homeostasis y la tasa de filtración glomerular. Entre estos mecanismos destacan la hiperfiltración glomerular, la hipertrofia de las nefronas remanentes y la activación de sistemas neurohormonales, particularmente el sistema renina-angiotensina-aldosterona. Aunque estas respuestas compensatorias permiten preservar de manera temporal la función renal, la evidencia demuestra que contribuyen de forma significativa al daño estructural progresivo, favoreciendo la esclerosis glomerular, la inflamación crónica y la fibrosis intersticial. El objetivo de esta revisión fue analizar los principales mecanismos de adaptación de la función renal en personas con enfermedad renal crónica y su papel en la progresión de la enfermedad. Se realizó una revisión narrativa de la literatura científica mediante la búsqueda sistematizada de artículos en bases de datos biomédicas, seleccionando estudios que abordaron los cambios fisiológicos, hemodinámicos y estructurales asociados a la adaptación renal. Los hallazgos indican que la hiperfiltración sostenida y la activación de mediadores inflamatorios y fibrogénicos aceleran el deterioro funcional renal. En conjunto, estos resultados subrayan que los mecanismos adaptativos, si bien inicialmente protectores, representan un factor clave en la progresión de la enfermedad renal crónica, lo que resalta la importancia de su identificación temprana y del diseño de estrategias terapéuticas dirigidas a limitar sus efectos deletéreos y retrasar la evolución de la enfermedad.

Palabras clave: enfermedad renal crónica; adaptación renal; hiperfiltración glomerular; mecanismos compensatorios; progresión renal

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Fecha de recepción: 08/julio/2025 | **Fecha de aceptación:** 02/octubre/2025 | **Fecha de publicación:** 26/marzo/2026

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INTRODUCTION

Chronic Kidney Disease (CKD) is one of the most prevalent pathologies at the population level. It involves a progressive loss of renal function, and its adaptation is the result of the physical and chemical processes that participate in the activities of the organism.

OBJETIVE

Analyze the elements involved in renal adaptation: enzymes, proteins, and hormones; the stability of renal function and the adaptability of other systems in response to renal needs

METHODOLOGY

A search was conducted in various databases to identify up-to-date information obtained through the development of research based on the scientific method.

PubMed, Google Scholar, Elsevier.

Boolean search operators such as: Chronic Kidney Disease AND functional compensatory.

RESULTS

Yamahara et al.	the functions of the nutrient-sensing complex (mTORC1), autophagy, and ketone bodies... during fasting... ketone bodies inhibit mTORC1, showing renoprotective potential
Fattah et al.	The greater the tubular load, the greater the recruitment of the membrane and the expression of tubular transport proteins, inducing hypertrophy and improving transport capacity, but increasing oxygen consumption and wear
Lu et al.	The overexpression of active GSK3β suppresses the function of Nrf2 in response to stress, whereas the dominant-negative form restored the antioxidant response.

CONCLUSIONS

The mechanisms of adaptation show how the kidney adapts to the progressive loss of more than 80.0% of its functional mass, from hyperfiltration with prior hypertrophy, nephron loss, and even renoprotective mechanisms mediated by ketone bodies

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