
# PREDICTION OF ETIOLOGICAL RISK FACTORS FOR CHRONIC KIDNEY DISEASE IN CHILDREN: AN EVIDENCE-BASED STRATIFICATION APPROACH

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## KEYWORDS

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## ABSTRACT

*Chronic kidney disease (CKD) in children is a progressive, multifactorial disorder that often remains clinically silent until advanced stages. Delayed recognition significantly increases the risk of irreversible renal damage and progression to end-stage renal disease. According to the World Health Organization, chronic non-communicable diseases are among the leading causes of long-term morbidity worldwide, and early risk identification is critical for improving outcomes (World Health Organization [WHO], 2023).*

*This study aims to analyze etiological risk factors associated with CKD in children and to develop a theoretical framework for early risk prediction using evidence-based stratification models. A systematic review of international guidelines and peer-reviewed literature was conducted, including recommendations from Kidney Disease: Improving Global Outcomes (KDIGO, 2024) and the National Institute for Health and Care Excellence (NICE, 2023).*

*The findings indicate that congenital anomalies of the kidney and urinary tract (CAKUT), recurrent urinary tract infections, hypertension, diabetes mellitus, and exposure to nephrotoxic agents are the primary determinants of CKD progression (KDIGO, 2024; Levey & Coresh, 2012). Risk stratification models allow classification of pediatric patients into low-, moderate-, and high-risk categories, improving early detection and preventive intervention strategies.*

*The study concludes that integration of clinical, laboratory, and epidemiological data significantly enhances predictive accuracy and supports early prevention of CKD progression in pediatric populations.*

*KEYWORDS: Chronic kidney disease; children; risk*

*factors; prediction models; CAKUT; hypertension; diabetes mellitus; risk stratification; nephrology.*

**Introduction**

Chronic kidney disease (CKD) in pediatric populations represents a major global health challenge due to its increasing prevalence and irreversible progression to renal failure if not detected early. CKD contributes significantly to long-term morbidity and healthcare burden worldwide (World Health Organization [WHO], 2023).

In children, CKD is often diagnosed late because early stages are asymptomatic and clinical signs are non-specific (Levey & Coresh, 2012). This delay highlights the need for predictive approaches based on etiological risk factors.

International guidelines emphasize structured screening of high-risk populations and early identification strategies. Kidney Disease: Improving Global Outcomes recommends early stratification of pediatric patients to prevent disease progression (KDIGO, 2024). Similarly, NICE guidelines support risk-based screening approaches in children with predisposing conditions (NICE, 2023).

Therefore, identification and prediction of etiological risk factors are essential for early intervention and prevention of CKD progression.

***Prediction of Etiological Risk Factors for CKD in Children***

**1. Integrated Concept of CKD Risk Prediction in Children**

Chronic kidney disease (CKD) in children is a progressive condition characterized by irreversible nephron loss and gradual decline in renal function. Early identification of at-risk populations is essential to prevent disease progression and complications (World Health Organization [WHO], 2023).

Modern nephrology emphasizes a shift from reactive diagnosis to predictive and preventive medicine, where etiological risk factors are systematically analyzed to estimate disease probability and progression (KDIGO, 2024). This approach integrates epidemiological data, clinical evaluation, and laboratory findings into unified risk prediction models.

The conceptual framework of CKD prediction is based on three pillars:

- Etiological risk identification
- Clinical risk stratification
- Longitudinal disease progression modeling

Such integration improves early detection and supports individualized clinical decision-making.

**2. Etiological Risk Factors and Pathophysiological Mechanisms**

The development and progression of CKD in children are influenced by multiple interrelated etiological factors. The most significant determinants include congenital, infectious, metabolic, and toxic causes.

*2.1 Congenital and structural abnormalities*

Congenital anomalies of the kidney and urinary tract (CAKUT) represent the leading cause of pediatric CKD globally. These abnormalities result in reduced nephron number and impaired renal development, leading to progressive renal insufficiency (KDIGO, 2024).

*2.2 Infectious factors*

Recurrent urinary tract infections contribute to renal scarring and tubulointerstitial damage. Repeated inflammatory episodes accelerate nephron loss and reduce renal reserve capacity (Levey & Coresh, 2012).

*2.3 Metabolic and systemic diseases*

Systemic conditions such as Hypertension and Diabetes mellitus contribute to glomerular hyperfiltration, endothelial dysfunction, and progressive nephrosclerosis (KDIGO, 2024).

*2.4 Nephrotoxic exposure*

Prolonged exposure to nephrotoxic agents (NSAIDs, aminoglycosides) leads to tubular injury and chronic interstitial fibrosis.

Overall, these factors interact through inflammatory, hemodynamic, and metabolic pathways, resulting in progressive decline of glomerular filtration rate (GFR).

**3. Risk Stratification and Predictive Modeling**

Risk stratification is a fundamental component of CKD prediction. It enables classification of pediatric patients based on probability of disease progression.

Risk categories:

- Low risk: No structural or functional abnormalities
- Moderate risk: Recurrent infections or mild metabolic disorders
- High risk: CAKUT, persistent proteinuria, systemic diseases

This stratification approach is strongly supported by clinical guidelines, which recommend targeted screening for high-risk populations (NICE, 2023).

Predictive models incorporating clinical history, laboratory biomarkers, and imaging findings significantly improve early detection accuracy and reduce diagnostic delays.

**MATERIALS AND METHODS**

This study is based on an evidence-based systematic review of scientific literature and clinical guidelines.

Methodological steps included:

- Analysis of KDIGO (2024) and NICE (2023) clinical guidelines (KDIGO, 2024; NICE, 2023)
- Review of peer-reviewed articles indexed in PubMed and Scopus databases (Inker et al., 2012)
- Comparative synthesis of pediatric CKD epidemiological studies
- Theoretical modeling of risk prediction and stratification frameworks

The study follows evidence-based medicine principles integrating nephrology, epidemiology, and clinical risk assessment approaches.

**RESULTS**

*1. Etiological Risk Factors*

The main etiological risk factors associated with CKD progression in children include:

- Congenital anomalies of kidney and urinary tract (CAKUT), the leading cause of pediatric CKD (KDIGO, 2024)
- Recurrent urinary tract infections contributing to renal scarring (Levey & Coresh, 2012)
- Hypertension leading to glomerular damage

- Diabetes mellitus causing microvascularinjury
- Nephrotoxic drug exposure affecting renal tubules

These factors act through progressive nephron loss and chronic inflammation pathways (KDIGO, 2024).

*2. Risk Stratification*

Patients are classified into:

- Low-risk: no structural or functional abnormalities
- Moderate-risk: recurrent infections or mild metabolic disorders
- High-risk: CAKUT, persistent proteinuria, systemic diseases

Risk stratification improves early intervention and clinical decision-making (NICE, 2023).

*3. Prognostic Value*

Early identification of etiological factors significantly improves prediction accuracy of CKD progression and allows preventive nephrology interventions (Levey & Coresh, 2012).

**DISCUSSION**

The study confirms that CKD in children is strongly associated with identifiable etiological risk factors that can be used for prediction and prevention. CAKUT remains the most significant determinant of pediatric CKD progression (KDIGO, 2024).

The shift from traditional diagnostic models to predictive risk-based systems represents a transition toward precision medicine in pediatric nephrology. Integration of epidemiological and clinical data improves early detection and reduces progression to end-stage renal disease (NICE, 2023).

**Conclusion**

Etiological risk factor prediction plays a crucial role in early identification of chronic kidney disease in children. Risk stratification models enable early intervention and significantly reduce disease progression. Integration of evidence-based clinical guidelines improves predictive accuracy and supports preventive pediatric nephrology strategies (WHO, 2023; KDIGO, 2024).

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