



Congress Abstract

Early Detection of Chronic Kidney Disease: An Umbrella Review of Cystatin C, Albuminuria and Artificial Intelligence

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ABSTRACT

Introduction: Chronic kidney disease (CKD) is frequently diagnosed after clinically meaningful loss of kidney function. Creatinine-based estimated glomerular filtration rate (eGFR) may fail to identify early renal dysfunction, while cystatin C, albuminuria and artificial intelligence (AI)-based prediction models may improve early detection and risk stratification. This umbrella review synthesizes current evidence regarding the diagnostic and prognostic value of these approaches and identifies limitations to their clinical implementation.

Methods: We synthesized published systematic reviews and meta-analyses evaluating adults with CKD or individuals at risk of CKD. Evidence addressing cystatin C, albuminuria, or AI/machine-learning models for CKD detection or progression was considered. Outcomes included diagnostic accuracy, sensitivity, specificity, area under the receiver operating characteristic curve (AUC), and prognostic associations. Findings were summarized descriptively according to reported pooled estimates and study limitations.

Results: A meta-analysis of 19 studies evaluating serum cystatin C for CKD detection reported pooled sensitivity of 0.85 (95% CI, 0.81–0.89), specificity of 0.87 (95% CI, 0.84–0.90), and AUC of 0.92 (95% CI, 0.90–0.94). Another meta-analysis including 35 studies and 23,667 participants found that the combined creatinine/cystatin C CKD-EPI equation achieved 7.50% higher accuracy than creatinine-based eGFR alone. A 2025 systematic review of risk-factor-based CKD screening included 24 studies from 11 countries; eGFR was used in 22 studies and albumin-creatinine ratio in 14, while confirmed CKD prevalence ranged from 4.4% to 17.1%. For AI, a systematic review identified 68 eligible studies from 648 records, but only 6/68 were conducted in clinical settings. A subsequent meta-analysis of 33 AI studies reported pooled sensitivity of 0.43, specificity of 0.92 and AUC of 0.89, with substantial heterogeneity.

Conclusion: Cystatin C and combined creatinine/cystatin C assessment demonstrate improved diagnostic performance compared with creatinine-based assessment alone. Albuminuria remains an important component of targeted CKD screening, while AI models show promising predictive performance but limited clinical validation. Prospective multicenter studies integrating biomarkers and interpretable AI models are warranted to establish whether these approaches improve clinically meaningful early CKD detection.

Keywords: Chronic Kidney Disease; Early Detection; Cystatin C; Albuminuria; Artificial Intelligence; Machine Learning; eGFR