Abstract
Chronic Kidney Disease (CKD) has become a significant public health issue, with over 850 million individuals affected worldwide, as reported by Jager et al. (2019). The increasing prevalence of risk factors such as diabetes and hypertension is directly contributing to the rising incidence of CKD. Early detection and accurate diagnosis are crucial to managing CKD progression, which is often complicated by comorbid conditions such as diabetes mellitus and hypertension. Hussain et al. (2021) discuss the importance of biomarkers and risk factors in the diagnosis and treatment of diabetic kidney disease, emphasizing early intervention. Burnier and Damianaki (2023) further highlight the role of hypertension as a cardiovascular risk factor in CKD, underscoring the significance of managing hypertension to prevent kidney disease progression.

In the realm of CKD diagnosis, advancements in glomerular filtration rate (GFR) measurement and proteinuria detection are vital. Inker and Titan (2021) provide insights into the clinical applications of GFR estimation, while Levey and Inker (2017) review the latest methodologies for assessing kidney function. Laboratory tests measuring proteinuria, particularly albumin, are critical in screening for CKD and predicting disease progression, as demonstrated by Martin (2011).

The integration of artificial intelligence (AI) and machine learning (ML) techniques has shown great promise in improving the accuracy of CKD diagnosis and management. Ho et al. (2024) discuss recent trends in the use of AI and ML in kidney care, highlighting the potential of these technologies to enhance prediction models and patient outcomes. The application of ensemble learning techniques, as shown by Asif et al. (2023), further demonstrates how ML can refine predictive models, improving CKD detection accuracy.

Literature Review
Chronic Kidney Disease (CKD) is a growing global health issue, affecting over 850 million individuals worldwide, according to estimates by Jager et al. (2019). The burden of CKD is closely tied to the increasing prevalence of diabetes and hypertension, two of the most significant risk factors. Diabetic kidney disease, a subtype of CKD, has been recognized as a major complication of diabetes. Hussain et al. (2021) provide an overview of its prevalence and biomarkers, emphasizing the critical need for early detection to mitigate progression. Additionally, Burnier and Damianaki (2023) underscore hypertension's role as a cardiovascular risk factor in CKD, highlighting the importance of effective blood pressure management to slow CKD progression.

Epidemiological data consistently support the link between CKD and major cardiovascular risk factors. Kovesdy (2022) updated the epidemiology of CKD, noting how diabetes and hypertension, along with aging populations, contribute to a rise in CKD cases globally. Primary care clinicians play a pivotal role in early detection and management, as described by Vassalotti et al. (2016). The authors propose practical guidelines to enhance CKD outcomes in primary care settings, which are crucial in preventing CKD's progression to more advanced stages.

The diagnostic assessment of CKD heavily relies on glomerular filtration rate (GFR) and proteinuria. Inker and Titan (2021) discuss core methodologies for GFR estimation, emphasizing the value of accurate measurements in clinical practice. Similarly, Levey and Inker (2017) review GFR assessment methodologies, illustrating their significance in both clinical and research

settings for tracking CKD progression. Laboratory screening for proteinuria, particularly measuring albumin in urine, is another critical diagnostic indicator of CKD, as outlined by Martin (2011).

From a clinical perspective, advancements in CKD diagnostics and monitoring have also spurred research into machine learning (ML) applications in kidney care. Ho et al. (2024) review the latest trends in artificial intelligence (AI) and ML within kidney care, suggesting that AI can enhance CKD prediction and patient management. Such innovations underscore the importance of integrating AI in healthcare to support early diagnosis and intervention. Ensemble learning and hyperparameter optimization, as discussed by Asif et al. (2023), have shown promise in improving predictive accuracy, particularly in chronic disease management.

The integration of ML into healthcare, especially for diseases like CKD, reflects a broader trend. Kolasa et al. (2024) conducted a systematic review of ML applications across various healthcare domains, noting its potential to enhance clinical outcomes through precise prediction and personalized treatment strategies. This potential is echoed in Awan et al.'s (2024) comparative study, where ML models were successfully applied to predict and diagnose complex health conditions.

In conclusion, CKD research and care have increasingly emphasized the need for early diagnosis and monitoring due to the high prevalence and significant impact of CKD on public health. This literature underscores the role of advanced diagnostics, preventive strategies, and innovative ML approaches in addressing CKD, paving the way for more proactive and effective management strategies.

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