



Point-of-Care Testing-Based Supplementary Parameters for the Early Identification of Reduced Kidney Function in Adults

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ABSTRACT

Introduction: Declining kidney function often goes undetected due to limited access to conventional laboratory testing. Pos Pembinaan Terpadu (Posbindu) provides simple point-of-care testing (POCT)-based laboratory examinations that can serve as screening parameters for early detection of kidney function impairment. This study aimed to assess the ability of POCT parameters used in Posbindu to predict decreased kidney function in adults. **Methods:** A cross-sectional study was conducted in five administrative regions of Jakarta from July 2024 to June 2025, involving participants who met the inclusion criteria. The variables included simple POCT parameters such as blood glucose, hemoglobin, hematocrit, uric acid, and lipid profile. Kidney function was determined using the estimated glomerular filtration rate (eGFR; CKD-EPI) with cutoffs of < 80 mL/min/1.73 m² and < 60 mL/min/1.73 m². Spearman correlation analysis was performed to evaluate initial associations, followed by receiver operating characteristic (ROC) analysis to assess discriminatory ability. Confidence intervals were calculated using the Fieller, Hartley, and Pearson methods. **Results:** Among the 235 respondents, 99 had an eGFR < 80 mL/min/1.73 m², and 18 had an eGFR < 60 mL/min/1.73 m². ROC analysis revealed variability in the predictive ability of the parameters for both kidney function categories: hemoglobin (area under the curve/AUC 0.494 vs. 0.524), fasting blood glucose (AUC 0.549 vs. 0.601), total cholesterol (AUC 0.562 vs. 0.503), HDL (AUC 0.512 vs. 0.457), and LDL (AUC 0.535 vs. 0.427), all of which were not significant ($p > 0.05$). The parameters with better predictive ability were uric acid (AUC 0.591, $p = 0.017$ at eGFR < 80 ; AUC 0.681, $p = 0.011$ at eGFR < 60 mL/min/1.73 m², followed by triglycerides, which showed a significant association only at eGFR < 60 (AUC 0.663, $p = 0.021$) but not at eGFR < 80 (AUC 0.561, $p = 0.109$). Uric acid demonstrated the strongest and most consistent discriminatory ability, supported by biological plausibility involving oxidative stress, endothelial dysfunction, and afferent arteriolar changes that accelerate glomerular filtration decline. Triglycerides showed a complementary but more limited role, consistent with lipid-mediated kidney injury that typically becomes more apparent at more advanced stages of function decline. Given the cross-sectional design, we could not establish causal or temporal relationships, including the possibility of reverse causality. **Conclusion:** Uric acid demonstrated the most consistent discriminatory ability for declining kidney function at both the mild and moderate-to-severe decline thresholds, whereas triglycerides showed significant discriminatory ability only at the moderate-to-severe threshold, supporting the potential of both as substitute POCT-based parameters for the early screening of declining kidney function in the adult population.

Keywords: Early detection, kidney function, POCT, substitute laboratory parameter, uric acid.



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INTRODUCTION

Chronic kidney disease (CKD) is an escalating global health challenge, with approximately 673.7 million people or 8.5% of the world's population diagnosed with CKD in 2021.^{1,2} In Asia, the burden of CKD follows a similar trend, driven by aging populations and rising rates of diabetes and hypertension. National surveys have recorded a CKD prevalence of 0.38% in Indonesia.³ Meanwhile, data from

the Indonesian Renal Registry (IRR) show a sharp increase in active hemodialysis patients in Indonesia, from approximately 21,759 in 2013 to 130,931 in 2020, with a hemodialysis prevalence of 499 per million population.^{4,5} This situation indicates that a large proportion of CKD cases are diagnosed late at advanced stages, requiring costly and complex renal replacement therapy, thereby adding to the burden on the national health system.

Various studies and clinical guidelines show that kidney function tests such as estimated glomerular filtration rate (eGFR) are the primary method for detecting kidney impairment early, even before clinical symptoms appear, enabling early intervention.^{3,6,7} However, access to comprehensive laboratory testing at the community level remains limited, hindering early detection of declining kidney function before progression to renal failure.^{6,8}

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Therefore, more practical and affordable screening approaches such as substitute laboratory parameters based on point-of-care testing (POCT) at primary care settings like the Pos Pembinaan Terpadu (Posbindu) are critically important to explore. This study assesses the ability of POCT parameters (fasting blood glucose, hemoglobin, uric acid, HDL, LDL, triglycerides, and total cholesterol) to predict declining kidney function ($\text{eGFR} < 80 \text{ mL/min/1.73 m}^2$ and $< 60 \text{ mL/min/1.73 m}^2$) in an urban adult population. The aim is to evaluate the ability of POCT parameters at Posbindu to discriminate reduced kidney function in adults and support a more efficient, broadly applicable early screening strategy. Beyond expanding screening access, using POCT surrogate parameters could help prevent CKD progression and reduce the need for renal replacement therapy.^{9,10} POCT substitute parameters are expected to become an important component of a comprehensive community-level screening strategy.

METHODS

This cross-sectional study was conducted across five administrative regions of Jakarta from July 2024 to June 2025. Participants were recruited by consecutive sampling from attendees of the Integrated Non-Communicable Disease Prevention Post (Pos Pembinaan Terpadu Penyakit Tidak Menular/Posbindu PTM) in each region who met the study criteria during the data collection period. The study population comprised adults aged 18–65 years participating in Posbindu PTM activities. The sample size was calculated using the Lemeshow formula for estimating a single population proportion: $n = Z^2 \cdot \alpha/2 \times P(1-P) / d^2$, where $Z = 1.96$ (95% confidence level), $p = 0.5$ (assumed proportion, used conservatively in the absence of a confirmed local prevalence estimate for reduced kidney function at the time of study planning), and $d = 0.05$ (5% margin of error).¹¹ This yielded a calculated minimum requirement of 384 respondents. Due to time and logistical constraints during the five-region data collection period (July 2024–June 2025), a total of 235 respondents were ultimately enrolled. This smaller-than-calculated sample size is acknowledged as a limitation, particularly for statistical power in the $\text{eGFR} < 60 \text{ mL/min/1.73 m}^2$ subgroup ($n = 18$), and is discussed further in the Limitations section.

Inclusion criteria were individuals aged 18–65 years, Posbindu PTM participants in the DKI Jakarta area during the study period, willingness to undergo simple POCT-based laboratory examinations, and provision of signed informed consent. Exclusion criteria included a prior diagnosis of chronic kidney disease by a healthcare professional, current hemodialysis or other renal replacement therapy, and incomplete laboratory data.

Independent variables comprised simple POCT parameters: fasting blood glucose, hemoglobin, uric acid, total cholesterol, HDL, LDL, and triglycerides. Hemoglobin and hematocrit were measured using the For-A6in1 device's integrated hematology module, and fasting blood glucose and uric acid were measured using the For-A6in1 device; lipid profile (total cholesterol, HDL, LDL, triglycerides) was measured using the NESCO Lipid Panel in accordance with POCT protocols at Posbindu. The Institut für Diabetes-Technologie (Universität Ulm) independently validated the For-A6in1 blood glucose measurement accuracy according to EN ISO 15197:2013/2015, demonstrating system accuracy within regulatory limits.¹² Both devices incorporate manufacturer-specified calibration procedures and built-in quality control features (control solution testing for strip verification); calibration was performed according to manufacturer guidelines before each data collection session at Posbindu. The dependent variable was kidney function determined by estimated glomerular filtration rate (eGFR) using the CKD-EPI formula (2021 CKD-EPI creatinine equation, race-free version). Serum creatinine was measured from venous blood samples analyzed at a clinical laboratory

using standard clinical chemistry methods. Moderate kidney function decline was defined as $\text{eGFR} < 60 \text{ mL/min/1.73 m}^2$ in accordance with the kidney disease: Improving Global Outcomes (KDIGO) guidelines.⁷ An $\text{eGFR} < 80 \text{ mL/min/1.73 m}^2$ was used as an exploratory operational threshold for identifying reduced kidney function, rather than as a diagnostic criterion for CKD.

Data were analyzed using Spearman correlation to evaluate initial associations between POCT parameters and kidney function decline. Receiver operating characteristic (ROC) analysis was then used to evaluate the discriminative ability of each parameter. Confidence intervals were calculated using the Fieller, Hartley, and Pearson methods to ensure the precision of AUC (area under the curve) estimates. All analyses used a significance level of $p < 0.05$.

RESULTS

This study involved 235 adult respondents, of whom 99 (42.1%) had mildly decreased kidney function ($\text{eGFR} < 80 \text{ mL/min/1.73 m}^2$) and 18 (7.7%) had moderate-to-severe kidney function decline ($\text{eGFR} < 60 \text{ mL/min/1.73 m}^2$); the remainder had normal kidney function ($\text{eGFR} \geq 80 \text{ mL/min/1.73 m}^2$). **Table 1** presents complete laboratory results.

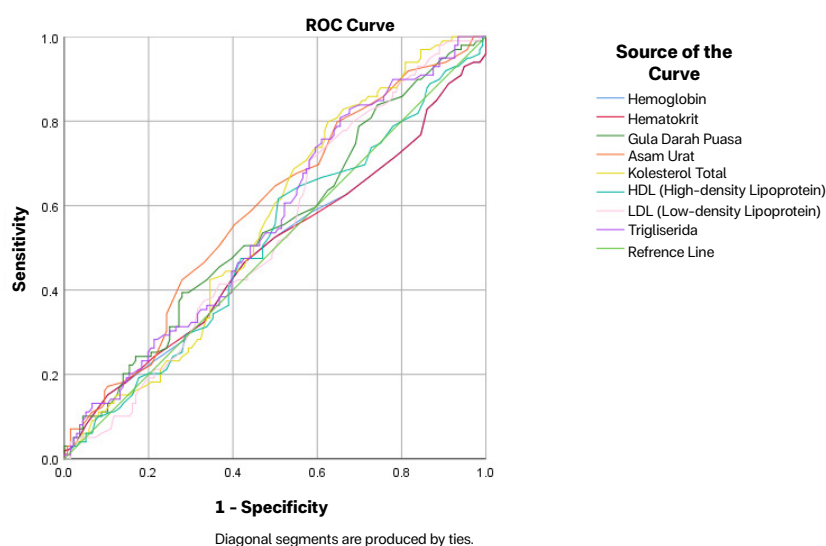
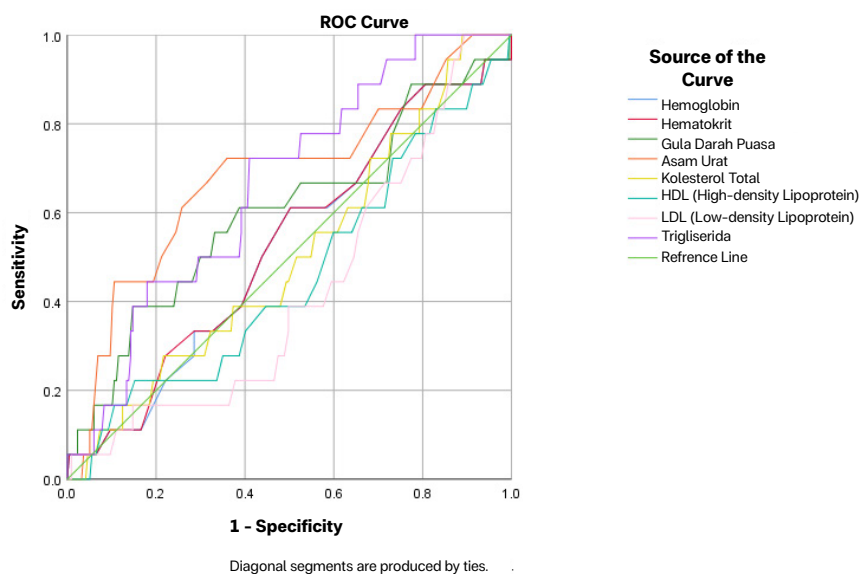
The 18 respondents with $\text{eGFR} < 60 \text{ mL/min/1.73 m}^2$ were a subset of the 99 respondents with $\text{eGFR} < 80 \text{ mL/min/1.73 m}^2$; thus, 81 respondents (34.5%) had eGFR in the range $60 < \text{eGFR} < 80 \text{ mL/min/1.73 m}^2$, while 136 respondents (57.9%) had $\text{eGFR} \geq 80 \text{ mL/min/1.73 m}^2$, as detailed in **Table 2**.

Table 1. Univariate table.

Variabel	Mean	Median (Min-Max)
Hemoglobin (g/dL)	12.141	12.2 (5.4–17.3)
Hematocrit (%)	35.83	36 (15–61)
Fasting Blood Glucose (mg/dL)	112.67	93 (59–558)
Uric Acid (mg/dL)	4.033	3.9 (2.4–10)
Total Cholesterol (mg/dL)	194.89	192 (102–307)
HDL (High-density Lipoprotein) (mg/dL)	46.89	45 (10–94)
LDL (Low-density Lipoprotein) (mg/dL)	114.41	110 (45–194)
Triglycerides (mg/dL)	172.48	144 (32–524)

**Table 2.** Distribution of eGFR categories.

Kategori eGFR (mL/min/1.73 m ²)	Number (n)	Percentage (%)
< 60 (moderate-to-severe decline)	18	7.7
60–< 80 (mild decline)	81	34.5
≥ 80 (normal)	136	57.9
Total	235	100.0

**Figure 1.** ROC (receiver operating characteristic) analysis for eGFR < 80 mL/min/1.73 m².**Figure 2.** ROC (receiver operating characteristic) analysis for eGFR < 60 mL/min/1.73 m².

Initial Spearman correlation analysis showed that most POCT parameters had weak correlations with kidney function; however, two parameters demonstrated a statistically significant negative association: uric acid ($r = -0.163$, $p = 0.012$) and triglycerides ($r = -0.139$, $p = 0.033$), indicating that increases in both parameters were associated with decreased eGFR values.

ROC analysis revealed variation in discriminatory ability among POCT parameters across the two kidney function thresholds. For eGFR < 80 mL/min/1.73 m², uric acid had the highest AUC (0.591; 95% CI 0.518–0.664; $p = 0.017$), followed by triglycerides (0.561; 95% CI 0.488–0.635; $p = 0.109$). All other parameters — hemoglobin, fasting blood glucose, HDL, LDL, and total cholesterol — were non-significant ($p > 0.05$) (**Figure 1**).

For eGFR < 60 mL/min/1.73 m², ROC analysis demonstrated improved discriminatory ability for the same parameters. Uric acid had the highest AUC (AUC = 0.681; 95% CI 0.539–0.822; $p = 0.011$), followed by triglycerides (AUC = 0.663; 95% CI 0.547–0.780; $p = 0.021$) and fasting blood glucose (AUC = 0.601; 95% CI 0.449–0.752; $p = 0.156$) (**Figure 2**).

DISCUSSION

The significant negative Spearman correlations observed for uric acid and triglycerides indicate that increases in both parameters were associated with decreased eGFR values. Similarly, in the ROC analysis for eGFR < 80 mL/min/1.73 m², uric acid showed the best discriminatory ability for detecting mild kidney function decline, with the highest AUC among all POCT parameters tested.

These findings suggest that hyperuricemia may serve as an early indicator of declining kidney function. This is consistent with a meta-analysis showing that each 1 mg/dL increase in serum uric acid is associated with an increased risk of incident CKD (OR ≈ 1.49 ; 95% CI 1.28–1.74) in non-CKD populations.¹³ Biologically, uric acid can reduce endothelial nitric oxide (NO) production and trigger oxidative stress, afferent arteriolar fibrosis, and tubulointerstitial inflammation, all of which accelerate a decline in the glomerular filtration rate.^{14,15} Accordingly, uric acid as



a POCT parameter has a strong biological rationale as a "substitute parameter" for kidney function screening. This biological plausibility is further supported by evidence that hyperuricemia and dyslipidemia contribute to early kidney damage through shared pathways of oxidative stress, systemic inflammation, and vascular endothelial dysfunction, which together promote glomerular and tubulointerstitial injury.

Given the cross-sectional design, this study cannot establish the temporal direction of the association. In particular, reverse causality cannot be excluded, as reduced kidney function may itself increase serum uric acid levels through impaired renal urate excretion.

Findings related to dyslipidemia showed moderate AUC values (0.561 and 0.663) relative to other parameters, consistent with the literature that CKD is often associated with a characteristic lipid profile: elevated triglycerides, low HDL, and a shift in LDL composition toward smaller, denser, more atherogenic particles.^{16,17} HDL and LDL in this study demonstrated low AUC values and non-significant correlations, possibly reflecting that these changes occur later in the course of CKD rather than representing early indicators. The literature supports that dyslipidemia appears even in early stages of CKD, but with considerable inter-individual variability and limited specificity as a single predictor of kidney function.¹⁷

The biological mechanisms linking dyslipidemia to declining kidney function include lipid deposition in glomeruli and tubules, lipotoxicity-driven oxidative stress and inflammation, and impaired HDL-mediated reverse cholesterol transport within the kidney.¹⁸ As the kidney begins to experience stress from accumulating triglyceride-rich lipoproteins and small LDL particles, changes in lipoprotein circulation can accelerate glomerulosclerosis and interstitial fibrosis, leading to eGFR decline. For uric acid, the proposed mechanism is that hyperuricemia causes afferent arteriolar vasoconstriction, elevated intraglomerular pressure, mesangial remodeling, and ultimately nephrosclerosis.¹⁹ Uric acid and triglyceride parameters thus have different but complementary biological bases as kidney risk indicators. We did

not analyze age separately as a factor in kidney function decline because it is already integrated into the eGFR calculation in the CKD-EPI formula. Therefore, reintroducing age into the model would risk introducing redundancy and estimation bias in the relationship between POCT parameters and kidney function.

This study has important practical implications. By using simple POCT parameters (uric acid and triglycerides) in primary care settings such as Posbindu, screening for declining kidney function can be performed earlier and more widely than by relying on conventional laboratory testing that is more expensive or unavailable in certain areas. Earlier detection allows interventions such as weight management, dietary modification, management of dyslipidemia and hyperuricemia, and blood pressure/diabetes control to begin before the patient reaches end-stage renal failure requiring renal replacement therapy (dialysis). This could reduce the number of patients entering hemodialysis and the national dialysis service burden, a particularly important goal given the upward trend in hemodialysis patients in Indonesia. Emphasis on community screening and primary care can thus constitute an effective and cost-efficient tertiary prevention strategy.

This study has several limitations. The cross-sectional design limits the ability to assess causal relationships between elevated POCT parameters and declining kidney function; the results therefore indicate associations only, not causality. Additionally, the relatively small sample size in the eGFR < 60 mL/min/1.73 m² group may reduce the statistical power of the ROC analysis, and the use of POCT devices with variable accuracy compared with conventional laboratory testing may introduce measurement bias. While the glucose/uric acid device (For-A6in1) has documented independent accuracy validation against laboratory reference methods, we did not identify an independent, peer-reviewed validation study for the lipid panel device (NESCO); its accuracy relies on manufacturer-reported specifications and built-in control solution verification. This is consistent with the broader point-of-care lipid testing literature, which generally reports somewhat

lower analytical performance compared with laboratory-based methods, and represents a potential source of measurement bias for the lipid parameters (total cholesterol, HDL, LDL, triglycerides) in this study.²⁰ The achieved sample size (n = 235) was also lower than the calculated minimum requirement (n = 384), owing to time and logistical constraints during data collection; this shortfall may further limit statistical power, particularly for the eGFR < 60 mL/min/1.73 m² subgroup. We did not analyze age separately because the CKD-EPI formula already incorporates it into the eGFR calculation. Nevertheless, age is an independent factor in the physiological decline of kidney function, and it can also influence metabolic parameters such as uric acid and lipid profiles. Excluding age as a covariate therefore represents a potential source of residual confounding, and the relationship between POCT parameters and kidney function should be interpreted with appropriate caution.

CONCLUSION

This study demonstrates that among the various simple POCT-based laboratory parameters, uric acid showed the most consistent discriminatory ability for declining kidney function, with significant negative associations at both the mild decline threshold and the moderate-to-severe decline threshold. Triglycerides showed a similar pattern, with a significant association at the moderate-to-severe decline threshold. However, its discriminatory ability at the mild decline threshold did not reach statistical significance. These findings reinforce evidence that hyperuricemia and dyslipidemia play important roles in early kidney damage through pathways of oxidative stress, inflammation, and vascular dysfunction.

Implementing POCT uric acid testing at Posbindu may be particularly valuable as a simple supplementary component of early community screening, given its consistent discriminatory ability across mild and moderate-to-severe stages of kidney function decline. In contrast, triglyceride testing may add value for identifying more advanced decline, particularly in areas with limited access to conventional laboratory services. Earlier identification of individuals with reduced kidney function may facilitate



timely risk assessment and appropriate referral for further evaluation. This study therefore affirms the potential for integrating substitute POCT testing into community screening systems as a strategic step toward prevention-based control of chronic kidney disease.

Limitations include that participants were drawn exclusively from Jakarta (a metropolitan/urban setting), so the findings cannot yet be generalized to other populations, such as rural communities. Further research with different population groups is needed, along with investigation of possible sex-related differences in these associations.

DECLARATIONS

Ethics Statement

The study was approved by the Universitas

Tarumanagara Human Research Ethics Committee (UTHREC; No. 016-UTHREC/UNTAR/VIII/2024), effective August 1, 2024. All participants provided written informed consent before data collection.

Consent for Publication

Not applicable. No identifiable participant information or images are included in this manuscript; results are reported in aggregate form.

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Author Contributions

Muhammad Fikri Dzakwan, Diana Dinali, Steve Geraldo Bustam, Shirly Gunawan, and Yohanes Firmansyah contributed to the study design, data collection, analysis, interpretation, drafting, and critical revision of the manuscript. All authors approved the final manuscript.

Conflict of Interest

The authors declare no financial or non-financial conflicts of interest.

Declaration on the Use of Artificial Intelligence

Grammarly was used to assist with English grammar and language editing because English is not the authors' first language. The authors reviewed the edited text and take full responsibility for the manuscript's content.

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