

Research Article

The Precision Of Estimated Glomerular Filtration Rate Formulas In Prospective Living Kidney Donors From Vietnam.

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Abstract

For transplants to be effective and kidney donation practices to be protected, a precise evaluation of the glomerular filtration rate (GFR) in potential living kidney donors (PLKDs) is necessary. Many people consider scintigraphy-measured GFR (mGFR) to be the clinical reference standard. A number of estimated GFR (eGFR) formulas have been created, including the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI), Cockcroft–Gault (CG), and the Modification of Diet in Renal Disease (MDRD); however, none of them have been specifically validated for Vietnamese PLKDs. The purpose of this study was to compare the accuracy of eGFR formulas to mGFR in PLKDs. **Methods:** From January 2014 to December 2020, 189 PLKDs at Cho Ray Hospital in Vietnam were examined in this convenient retrospective analysis. Several formulas were used to determine the eGFR, and 99mTechnetiumdiethylenetriaminepentaacetic acid was used to compare it to the mGFR. Bland-Altman plots, accuracy, and bias were utilized to evaluate the importance of the eGFR readings. **Findings:** 94.20 mL/min/1.73 m² was the median mGFR (interquartile range [IQR]: 88.40–100.50). The following were the eGFR values: 77.52 mL/min/1.73 m² (IQR: 70.50–86.33) for CG; 76.14 mL/min/1.73 m² (IQR: 68.05–83.37) for MDRD; 106.80 ± 15.24 mL/min/1.73 m² for CKD-EPI cystatin C 2012; 96.44 ± 13.40 mL/min/1.73 m² for CKD-EPI creatinine 2012; 88.74 ± 13.27 mL/min/1.73 m² for CKD-EPI creatinine 2021; and 101.32 ± 12.82 mL/min/1.73 m² for creatinine cystatin C 2021 in CKD-EPI. The CKD-EPI creatinine cystatin C 2012 formula is one of these. (P₃₀ = 98.96%) and 2021 (P₃₀ = 97.92%) had the best agreement with the mGFR because of their narrow boundaries of agreement, minimal bias, and good accuracy in the Bland–Altman plots. **Conclusions:** For donor screening, the CKD-EPI equations based on creatinine and cystatin C are trustworthy resources.

Keywords : creatinine, cystatin C, glomerular filtration rate, kidney donation, living donors, and Vietnam.

INTRODUCTION

With living donors as a source of donors, kidney transplantation is acknowledged as the best treatment for end-stage renal disease [1]. Usually in good health, living kidney donors voluntarily take on the danger of giving a kidney to patients or family members, without anticipating any advantages for themselves. Kidney donation is typically safe, according to research, with a low risk of perioperative mortality (0.03%) and few short-term hazards for healthy donors [2]. Removing one kidney does not harm the majority of healthy donors, not adversely affect the remaining kidney's function [3]. However, there is still much to learn about the long-term dangers for kidney donors [4–7]. For a transplant to be effective and kidney donation procedures to remain safe, prospective live kidney donors must have their kidney function accurately evaluated

[8]. One predictor of kidney function has been identified as the glomerular filtration rate (GFR) [9]. The glomerular filtration rate (mGFR) is assessed with an exogenous material like inulin, is considered the top standard while being costly and time-consuming. A common clinical reference standard for determining GFR is the renal dynamic imaging method, which uses radioisotopes such as iothalamate radioiodine 131I or 125I, chromium-51 ethylenediamine tetraacetic acid, and 99mTechnetium-diethylenetriamine pentaacetic acid—[99mTc-DTPA] [9,10].

Calculating the estimated glomerular filtration rate (eGFR) using mathematical formulas based on serum creatinine or cystatin C is the most widely used technique in clinical practice to evaluate GFR. This method makes GFR evaluation quicker and more economical. The Modification of Diet in Renal Disease is one of the most popular eGFR equations. The

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Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI), Cockcroft–Gault (CG), and MDRD formulae are useful resources for categorizing kidney function and determining GFR [11–14]. Despite the fact that there are numerous formulas for determining eGFR, none of them have been proven to be accurate substitutes for mGFR in evaluating prospective Vietnamese kidney donors. Consequently, we carried a research to assess the precision of results obtained using GFR-estimating formulas (MDRD, Cockcroft–Gault, CKD-EPI) in comparison to the mGFR in prospective Vietnamese kidney donors as determined by ^{99m}Tc-DTPA renography.

MATERIALS AND METHODS

From January 2014 to December 2020, this retrospective investigation was carried out in the kidney transplant assessment room at Cho Ray Hospital in Ho Chi Minh City, Vietnam. They included potential kidney donors who were at least eighteen years old. Creatinine in serum, serum All subjects had their ^{99m}Tc-DTPA GFR and Cystatin C tested. The medical staff conducted physical examinations and reviewed medical histories. The exclusion criteria included pregnancy because of its physiological effects on renal function and GFR assessment, a history of primary renal or systemic diseases affecting kidney function, and the use of nephrotoxic drugs (such as aminoglycosides, NSAIDs, and cimetidine) that impair kidney function and alter GFR measurement. MDRD [14], Cockcroft–Gault [15], CKD-EPI cystatin C 2012 [12], CKD-EPI creatinine cystatin C 2012 [12], CKD-EPI creatinine 2021 [16], and CKD-EPI creatinine cystatin C 2021 [16] were the formulas used to determine the eGFR. The mGFR as determined by ^{99m}Tc-DTPA was contrasted with these estimates. The measurement of mGFR with ^{99m}Tc-DTPA is easy to use, quite accurate, and able to assess split renal function. Furthermore, it has been suggested as a substitute for inulin clearance as the benchmark for calculating GFR [9, 10].

Ethical Considerations

The Can Tho University of Medicine and Pharmacy's Ethics Committee on Biological Research gave its approval to this study (No. 536/PCT-HĐĐĐ; November 5, 2021). Every participant enrolled after being properly informed of the study's goals and methods after giving permission to take part in the research. Every participant was free to deny participation or to leave at any time, and their right to privacy was respected.

Statistical Analysis

SPSS Statistics version 22 was used for all statistical analyses. The mean $\pm$ standard deviation (SD) was used to represent continuous variables having a normal distribution, and the median and interquartile range were used to represent those

with a skewed distribution. IQR). Frequency and percentage (%) were used to summarize categorical variables. We assessed the performance of several prediction equations in terms of their bias and accuracy. The 95% confidence limits were utilized to convey the absolute magnitude of the discrepancies, and bias was defined as the median difference between mGFR and eGFR. The definition of accuracy represents a percentage of eGFR values that fall between $\pm 10\%$ (P10), $\pm 20\%$ (P20), and $\pm 30\%$ (P30) of the mGFR. In order to facilitate efficient medical decision-making based on the eGFR, the P30 value acts as a clinical accuracy indicator [17]. The agreement between eGFR and mGFR was assessed using Bland-Altman consistency analysis.

Using a two-sided 5% significance level, we calculated that we would be able to detect the expected mean differences between eGFR and mGFR with 80% power. Considering a standard deviation of 0.55, a maximum difference of 1.31, and a mean difference of 0.01 and 96.2% [18], with a minimum of 179 individuals needed overall. Age, BMI, and sex all underwent subgroup analyses.

RESULTS

Of the 189 possible kidney donors we looked at, 106 (56.08%) were female and 83 (43.92%) were male. Of the participants, 84.13% were over 40, and the median age was 51 years (IQR: 42–56). The predicted GFR values were determined utilizing a number of

The following were the formulas: 77.52 mL/min/1.73 m² (IQR: 70.50–86.33) (Cockcroft–Gault); 76.14 mL/min/1.73 m² (IQR: 68.05–83.37) (MDRD); 106.80 $\pm$ 15.24 mL/min/1.73 m² (CKD-EPI cystatin C 2012); 96.44 $\pm$ 13.40 mL/min/1.73 m² (CKD-EPI creatinine 2021); and 101.32 $\pm$ 12.82 mL/min/1.73 m² (CKD-EPI creatinine cystatin C 2021). Using ^{99m}Tc-DTPA, the measured GFR was 94.20 mL/min/1.73 m² (IQR: 88.40–100.50). Table 1 provides a description of the study participants' demographic and descriptive attributes.

DISCUSSION

Healthy persons who were donating kidneys to family members suffering from end-stage renal illness participated in the current study. The most accurate formulas were CKD-EPI creatinine cystatin C 2012, CKD-EPI creatinine 2021, and CKD-EPI creatinine 2021. P30 > 90% across the estimated formulas.

According to the 2002 Kidney Disease Outcomes Quality Initiative standards, the CKD-EPI equation continuously reached the clinically relevant threshold of P30 > 75%, with values above 90% being preferable [17]. Kakde et al. conducted a study on kidney donors in South Asia. With a P10 accuracy of 43% and a P20 accuracy of 72%, the CKD-EPI

creatinine cystatin C 2012 formula had the highest accuracy. In general, the CKD-EPI formulas showed less bias and higher accuracy than the Cockcroft–Gault and MDRD formulas [19]. Additionally, Mroz et al. discovered that the CKD-EPI formulas had a higher accuracy (P10) than the MDRD and Cockcroft–Gault formulas: the Cockcroft–Gault equation exhibited 20% accuracy, 27% accuracy for the MDRD equation, 33% accuracy for the CKD-EPI creatinine 2009 equation, 40% accuracy for the CKD-EPI cystatin C 2012 equation, and 37% accuracy for the CKD-EPI creatinine cystatin C 2012 equation [20]. Pottel et al. examined data from 11 studies that included both a population with renal illness and a population in good health. They discovered that the CKD-EPI creatinine 2009, CKD-EPI cystatin C 2012, and CKD-EPI creatinine cystatin C 2012 formulae' accuracies (P30) when were 88.1%, 80.4%, and 88.2%, respectively, and the mGFR was 80 mL/min/1.73 m² [21]. Additionally, a study conducted in Mexico on 97 healthy people showed that the CKD-EPI formula performed much better than the MDRD formula in all comparisons (accuracy, correlation, and bias) [22], and comparable findings were noted in Asian populations [19, 23].

According to our data, the GFR in healthy kidney donors was underestimated by the Cockcroft–Gault and MDRD equations, which had larger (negative) bias and lower accuracy. The 2012 and 2021 CKD-EPI creatinine cystatin C equations shown increased precision, decrease bias, and the Bland-Altman plots' reduced bounds of agreement, demonstrating their excellent agreement with the mGFR.

The CKD-EPI equations based on creatinine and cystatin C were more accurate in women, those under 25, and people 40 years of age and older. In contrast, males under 40 years of age and those with a BMI over 25 The CKD-EPI creatinine 2021 showed superior performance in terms of age. These results imply that age, gender, and BMI have a major impact on kidney donors' eGFR accuracy.

Giron-Luque et al. [24] assessed 799 possible living kidney donors by contrasting the 24-hour creatinine clearance value with the calculation methods for CKD-EPI creatinine 2009, MDRD, and Cockcroft–Gault creatinine. Even though the GFR was overestimated by all three models, the CKD-EPI equation was the most accurate and least dispersed, with a higher accuracy in females and those who are younger than 40. The accuracy of the MDRD, Cockcroft–Gault, and CKD-EPI formulae was 48.8%, 41.5%, and 78.2%, respectively, according to a study conducted in Pakistan with 207 possible kidney donors. D, CKD-EPI, and Cockcroft–Gault formulae to be 48.8%, 41.5%, and 78.2%, in that order. The accuracy of the eGFR determined using these formulae was unaffected by the donors' body mass index or level of obesity [25]. Lemoine and colleagues examined 209 obese people and also discovered that the CKD-EPI formula was useful for evaluating renal function in this group [26].

Carla Burballa et al. examined the relationship between the projected GFR in living kidney donors based on the MDRD and CKD-EPI formulae and the measured GFR determined using 99mTc-DTPA. Additionally, all formulae understated the eGFR in comparison to the mGFR, whereas for screening kidney donors, the CKD-EPI formula proved more appropriate [27].

Two equations that eliminate race and increase the precision of kidney function evaluation were created in 2021 by Inker et al. and are called CKD-EPI creatinine 2021 and CKD-EPI creatinine cystatin C 2021 [16]. Goodson et al. [28] assessed 637 prospective living renal donors, evaluating how well the MDRD formulae and the CKD-EPI creatinine 2009 and 2021 formulas match the mGFR determined with iohexol. With a P30 value of 96.4% in Asian persons, the results demonstrated that the value determined using the CKD-EPI creatinine 2021 model was less biased and more accurate than those generated from earlier creatinine-based estimated GFR formulae. The CKD-EPI creatinine 2009, CKD-EPI creatinine 2021, CKD-EPI cystatin C 2012, CKD-EPI creatinine cystatin C 2012, and CKD-EPI creatinine cystatin C 2021 formulas were among the formulas evaluated in one study for their ability to estimate GFR before and three months following kidney donation in 486 Dutch live donors. The eGFR values obtained using the CKD-EPI creatinine 2021, CKD-EPI creatinine cystatin C 2012, and CKD-EPI creatinine cystatin C 2021 formulas showed the strongest connection with the mGFR measured before to and following kidney donation, according to the data. Prior to kidney donation, the accuracy (P30) was 97.5%, 98.9%, and 97.9%, respectively; following kidney donation, it was 96.6%, 96.6%, and 96.2% [18]. In comparison to the eGFR derived from the CKD-EPI formulas (CKD-EPI creatinine cystatin C 2012, CKD-EPI creatinine 2021, and CKD-EPI creatinine cystatin C 2021), the estimated GFR (eGFR) derived from these formulas showed superior correlation, accuracy, and bias. MDRD and Cockcroft–Gault formulae for living kidney donors. These algorithms work well for screening prospective kidney donors and performing an initial evaluation of their renal function.

Limitations

There are various limitations to our investigation. First of all, it was only carried out at one location, which would restrict the findings' applicability to other groups with distinct demographic traits. Furthermore, the study's retrospective design limits our capacity to account for potential confounders and raises the possibility of selection bias. Additionally, The findings are not as applicable to individuals with renal impairment because the sample was made up of potential kidney donors who were typically healthy and had normal kidney function.

CONCLUSIONS

For evaluating the renal function of possible living kidney donors, the CKD-EPI equations based on creatinine and cystatin C demonstrated the highest accuracy and consistency with the observed GFR, making them useful instruments. But as these formulas have the potential to either overstate or underestimate GFR, care must be taken when using them to assess renal function in prospective donors, particularly in clinical groupings specified by age, BMI, and gender. In order to increase the precision and dependability of donor selection procedures, new GFR estimate algorithms appropriate for these subgroups must be developed.

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Institutional Review Board Statement

The Can Tho University of Medicine and Pharmacy's Ethics Committee on Biological Research gave its approval for this study, which was carried out in compliance with the Declaration of Helsinki (No. 536/PCT-HĐĐĐ; 5 November 2021).

Informed Consent Statement

Every participant in the study gave their informed consent.

Data Availability Statement

Upon reasonable request, the relevant authors will provide the data supporting the study's conclusions.

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Conflicts of Interest

No conflicts of interest are disclosed by the writers.

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