Performance of the Chronic Kidney Disease Epidemiology Collaboration Equation to Estimate Glomerular Filtration Rate in Diabetic Patients

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OBJECTIVE—The best method to estimate glomerular filtration rate (GFR) in diabetic patients is still largely debated. We compared the performance of creatinine-based formulas in a European diabetic population.

RESEARCH DESIGN AND METHODS—We compared the performance of Cockcroft and Gault, simplified Modification of Diet in Renal Disease (MDRD), and Chronic Kidney Disease Epidemiology (CKD-EPI) Collaboration equations in 246 diabetic patients by calculating the mean bias and the interquartile range (IQR) of the bias, 10% (P10) and 30% (P30) accuracies, and Bland-Altman plots. GFR was measured by inulin clearance.

RESULTS—For the whole population, the IQR was slightly lower for CKD-EPI, but the mean bias was lower and P10 and P30 were higher for MDRD. Similar results were observed in specific subgroups, including patients with mild renal insufficiency, obese patients, or type 2 diabetic patients.

CONCLUSIONS—In our population, the CKD-EPI formula does not exhibit better performance than the simplified MDRD formula for estimating GFR.

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Using a creatinine-based formula is the most common way to evaluate the glomerular filtration rate (GFR) in clinical practice. However, it can lead to an inaccurate evaluation, especially in patients with normal renal function (1). A new GFR formula, the Chronic Kidney Disease Epidemiology (CKD-EPI) Collaboration equation, has recently been developed and has exhibited better performance than the other creatinine-based formulas in the general population (2). Therefore, we compared the performance of the CKD-EPI equation to Cockcroft and Gault (CG) and simplified Modification of Diet in Renal Disease (MDRD) equations in a population of diabetic patients.

RESEARCH DESIGN AND METHODS—The study included 246 nondialyzed diabetic adult patients (59% men, 95.1% white, 85.8% type 2 diabetic patients). Mean age was 62.5 ± 13.0 years, and mean BMI was 28.8 ± 5.0 kg/m^2 (39% of patients had a BMI >30 kg/m^2). Mean plasma creatinine (PCr) was 137 ± 69 μmol/L, and 60.6% of the patients had measured GFR (mGFR) <60 mL/min/1.73 m^2.

GFR was measured by inulin clearance (Inutest, Fresenius Kabi, Graz, Austria) using a continuous infusion of inulin after a loading dose and urine collections. The clearance value was calculated by the standard (urinary inulin × urine flow)/plasma inulin (UV/P) formula, and was normalized to 1.73 m^2 of body surface area (BSA), calculated according to the Du Bois formula (3). PCr was assayed with a kinetic colorimetric-compensated Jaffe technique (Roche Modular, Meylan, France).

The following equations were used to determine estimated GFR (eGFR):

CG = 1.73/BSA × [(140 − age {years}) × body weight (kg) × k/PCr (μmol/L)] (4).

MDRD = 186.3 × [(PCr in μmol/L)/88.5)]$^{-1.154}$ × age in years$^{-0.203}$ × 0.742 (if female) × 1.21 (if black) (5,6).

CKD-EPI = $k1$ × [(PCr/88.5)/$k2$)]$^{-k3}$ × 0.993$^{\text{age}}$, with

–$k1$ = 141, 143, 163, 166 for white male and female and black male and female, respectively;

–$k2$ = 0.7 or 0.9 for female and male, respectively;

–$k3$ = 1.209, 0.411, 0.329 for male with PCr >80 μmol/L, female with PCr >62 μmol/L, male with PCr ≤80 μmol/L, and female with PCr ≤62 μmol/L, respectively (2).

To assess the performance of formulas, the correlation coefficient (R^2), the mean absolute bias (eGFR − mGFR), the interquartile range of the bias (IQR), and 10% (P10) and 30% (P30) accuracies were calculated. Bland-Altman plots were used to show the agreement between mGFR and eGFR (7). P values < 0.05 were considered significant.

RESULTS—For the whole population of diabetic patients, mean mGFR was 55.4 ± 29 mL/min/1.73 m^2. Correlation between mGFR and eGFR was significant for the three formulas, with R^2 values of 0.728, 0.818, and 0.814 for CG, MDRD, and CKD-EPI, respectively. Mean absolute bias was 0.8 ± 15, −1.2 ± 12, and −12.7 ± 12 mL/min/1.73 m^2, and IQR was 16.4, 15.8, and 16 mL/min/1.73 m^2 for CG, MDRD, and CKD-EPI, respectively.

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Figure 1 shows the graphic representation of agreement for each formula according to the Bland-Altman method. P10 and P30 were, respectively, 25.6 and 72.8% for CG, 37.4 and 82.1% for MDRD, and 28 and 80.1% CKD-EPI.

The mean mGFR was 61.2 ± 31 and 54.4 ± 28 mL/min/1.73 m^2 in type 1 and 2 diabetic patients, respectively. In both groups of patients, MDRD exhibited the highest P10 (31.4 and 38.4%) and P30 (85.7 and 81.5%), respectively, compared with CG and CKD-EPI.

The mean mGFR was 36.4 ± 13 and 84.6 ± 21 mL/min/1.73 m^2 in patients with GFR <60 and >60 mL/min/1.73 m^2, respectively. MDRD exhibited the highest P10 (36.2 and 39.2%) and P30 (75.3 and 91.7%) in both groups compared with CG and CKD-EPI.

Finally, MDRD exhibited the highest accuracy in nonobese (BMI <30 kg/m^2, mGFR = 59.8 ± 29) and obese patients (mGFR = 48.5 ± 26), with P10 at 35.3 and 40.6% and P30 at 81.3 and 83.3%, respectively.

CONCLUSIONS—Our data showed that the CKD-EPI equation exhibited similar (or worse) performance than the simplified MDRD equation in our population of diabetic patients, as well as in specific subgroups according to the type of diabetes, GFR, or presence or not of obesity. We confirm that the CG formula is less accurate than the MDRD equation and should not be used to evaluate GFR in diabetic patients (8,9). Several authors have demonstrated better performance of CKD-EPI compared with MDRD in the general population and in diabetic patients (2,10). We are unable to confirm those results in our population of European diabetic patients. This discrepancy could be attributed to differences between American and European diabetic patients, including a greater proportion of black patients, a smaller proportion of type 1 diabetic patients, and higher BMIs in North America (11,12).

The use of a nonenzymatic assay of PCr and, therefore, the non–re-expressed MDRD formula, comparatively with the CKD-EPI study, could be another factor to explain the difference (2,13). However, values obtained with our compensated Jaffe method were very similar to those of an enzymatic method (14). In conclusion, our data suggest that the non–re-expressed simplified MDRD formula can be used in European diabetic patients to evaluate GFR because the CKD-EPI

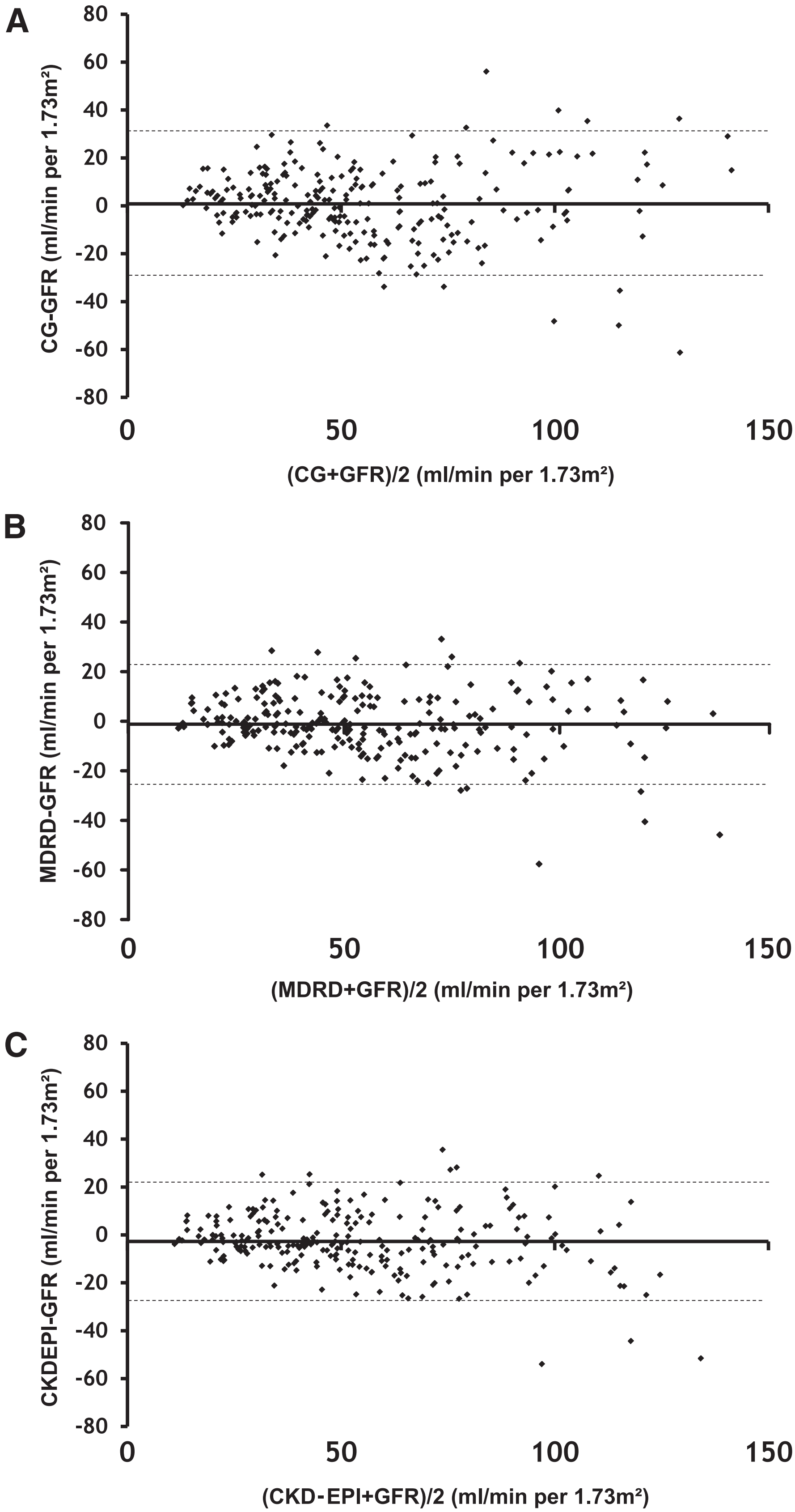

Figure 1—*Bland-Altman graph shows the agreement between GFR measured by inulin clearance and GFR estimated by normalized CG (A), simplified MDRD (B), and CKD-EPI (C) equations. The solid line shows the mean value and the dotted line shows the range of 95% of the values of the bias.*

equation does not seem to exhibit better performance and is less convenient to use in clinical practice. However, these results should be confirmed in larger studies.

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