

Contribution of B2M and BTP to Performance of Race-Free CKD-EPI Equations:
Comparison of Performance of CKD-EPI 2020 B2M and BTP Equations to 2021
Creatinine and Creatinine-Cystatin C Equations

A CKD-EPI Technical Report

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Introduction

Background and rationale

The most accurate estimated glomerular filtration rate (eGFR) available are those based on the combination of creatinine and cystatin C (eGFRcr-cys). However, eGFRcr-cys can lead to large errors in some individuals. The percentages of estimates within 30% of mGFR can exceed 90% in ambulatory patients in US and Europe, but are lower in the other populations. Other than methodologic differences in measurement of GFR and serum creatinine and cystatin C, the main source of error is population differences in the non-GFR determinants of serum creatinine and cystatin C. In principle, use of a panel of endogenous filtration markers can improve accuracy of eGFR by reducing errors due to the non-GFR determinants of creatinine and cystatin C, motivating the search for additional filtration markers.

We previously demonstrated that CKD-EPI 2020 4-marker panel equation (eGFRcr-cys-B2M-BTP) did not require use of race, and was more accurate than 2009 eGFRcr equation and as accurate as, but not more accurate than, 2012 eGFRcr-cys equation (Table 1).¹ The 2009 and 2012 equations included race, and are no longer recommended in US. The CKD-EPI 2021 eGFRcr and eGFRcr-cys equations, which do not include race, are recommended instead, but are less accurate than 2009 and 2012 equations.² Thus, there is a need to evaluate whether adding B2M and BTP to creatinine and cystatin C in a 4-marker panel equation is more accurate than the 2021 eGFRcr-cys equation.

We also previously demonstrated that the 4-marker panel equation (eGFRcr-cys-B2M-BTP) was more accurate than a 3-marker panel not including creatinine (eGFRcys-B2M-BTP), but did not evaluate 3-marker panels including creatinine and B2M or BTP (eGFRcr-cys-B2M or eGFRcr-cys-BTP). Thus, there is also a need to evaluate whether the either B2M or BTP to creatinine in a 3-marker panel is more accurate than the 2021 eGFRcr-cys equation.

Despite recommendations to increase utilization of cystatin C for GFR estimation, implementation of cystatin C has been slow. B2M and cystatin C are highly correlated and B2M assays may be more available than cystatin C assays. Thus, there is also a need to evaluate whether adding B2M or BTP to creatinine in a 2-marker panel without cystatin C is as accurate as 2021 eGFRcr-cys equation in a diverse population.

Research questions

What is the value of adding B2M and BTP to race-free CKD-EPI 2021 eGFRcr and eGFRcr-cys equations in a diverse population?

1. Is the CKD-EPI 2020 equation using B2M and BTP (4-marker equations) more accurate than the 2021 eGFRcr-cys equation?
2. Are CKD-EPI 2020 equations using B2M or BTP (3-marker equations) more accurate than the 2021 eGFRcr-cys equation?
3. Are combinations of B2M or BTP with creatinine (2-marker equations – average of 2020 and 2021 equations) as accurate as the 2021 eGFRcr-cys equation?

Methods

Study population. Participants in the 2020 validation dataset.¹ Subgroups were defined using race communities (Black people vs non-Black), eGFR (<30, 30-<45, 45-<60, 60-<90, ≥ 90 mL/min/1.73 m²), age (<40, 40-65, >65 y), sex (male, female), body mass index (<20, 20-<25, 25-<30, ≥ 30 kg/m²). Race was ascertained by the investigators or study participants at the time of data collection in each study.

Estimated GFR (eGFR)

We calibrated serum creatinine assays to, or measured serum creatinine with, the Roche enzymatic method (Roche-Hitachi Modular P instrument with Roche Creatininase Plus assay; Hoffman-La Roche Ltd), traceable to National Institute Standardized Technology creatinine standard reference material. We calibrated serum cystatin C assays to or measured serum cystatin C on a Siemens Dade Behring Nephelometer traceable to the International Federation for Clinical Chemists Working Group for the Standardization of Serum Cystatin C and the Institute for Reference Materials and Measurements—certified reference materials. B2M was measured on a Siemens Prospec from 2011 to 2013, a Roche Modular P from 2013 to 2015, and a Roche COBAS from 2015 to 2019. BTP was measured on a Siemens ProSpec from 2013 to 2019. Stability of the assays over time was evaluated using pooled quality-control material and calibration panels.¹

Table 2 shows eGFR equations used in this analysis. The reference equation for all comparisons was the 2021 eGFRcr-cys equation. Comparator equations using B2M or BTP included the following: 2-marker equations (average of 2021 eGFRcr and 2020 eGFRB2M and average of 2021 eGFRcr and 2020 eGFRBTP); 3-marker equations (2020 eGFRcr-cys-B2M and 2020 eGFRcr-cys-BTP); and the 4-marker equation (2020 eGFRcr-cys-B2M-BTP). We also reported the 2021 eGFRcr equation.

Measured GFR (mGFR).

GFR was measured either as plasma clearance of iothexol (5 studies) or urinary clearance of iothalamate (2 studies). As reported previously,¹ we calibrated mGFR using plasma clearance of iothexol to urinary clearance of iothalamate, the method used in the development datasets for eGFRcr and eGFRcr-cys equations, because iothalamate is cleared by glomerular filtration and tubular secretion. Based on a systematic comparison of all methods, we assumed urinary clearance of iothalamate was 5% higher than plasma clearance of iothexol and calibrated mGFR by increasing mGFR in studies that used plasma clearance of iothexol by 5%. We also reported equation performance without calibrating mGFR to urinary clearance of iothalamate.

Metrics for Equation Performance and Statistics

We assessed bias as the median of the difference between mGFR and eGFR (mGFR minus eGFR, so a positive value is an underestimate of mGFR, and a negative value is an overestimate of mGFR). We assessed precision as the interquartile range for the differences between mGFR and eGFR, and accuracy as root mean square error (RMSE) of the regression of eGFR vs. mGFR on the logarithmic scale and as the percentage of eGFRs within 30% of mGFR (P30). We assessed concordance as agreement between eGFR and mGFR categories. Confidence intervals were calculated by bootstrap methods (2,000 bootstraps). Accuracy metrics incorporate bias and precision, and P30 specifically reflects large errors, which are clinically relevant. We compared each metric to the 2021 cr-cys equations by inspection of 95% confidence intervals (absolute value for median bias). Non-overlapping confidence intervals for the comparator equations are highlighted.

Results

Study Population

The demographic and clinical characteristics of the study population overall and by study is shown in Table 3. A total of 2,245 participants were included, mean age (SD) was 52.8(12.8) years, 29% were female, 24% were Black, 35% had diabetes, mean (SD) BMI was 27.5(5.4) kg/m². Mean (SD) reported non-calibrated and calibrated mGFR were 79.9(26.1) and 83.2(27.4) ml/min/1.73 m², respectively.

Evaluation using mGFR Calibration

Evaluation in the total population (Table 4) showed that eGFRcr-cys had better performance (higher P30) than eGFRcr, as expected. The 4-marker panel and 3-marker panels did not have better performance than eGFRcr-cys [larger bias (underestimation of mGFR) and similar IQR, P30, RMSE and concordance as eGFRcr-cys]. The 2-marker panels had worse performance than eGFRcr-cys [larger bias (underestimation of mGFR) and either similar or worse IQR, P30, RMSE and concordance as eGFRcr-cys]. Evaluation in subgroups showed generally consistent results by sex (Table 5), race (Table 6), age (Table 7), eGFR (Table 8), BMI (Table 9), and diabetes (Table 10) as the total group.

Evaluation not using mGFR calibration

Evaluation in the total population not using mGFR calibration (Table 11) showed that eGFRcr-cys had similar performance as in the analysis using mGFR calibration, but equations with BTP and B2M had lesser bias than in the analysis using mGFR calibration. Using calibrated mGFR, eGFRcr-cys had better performance (higher P30) than eGFRcr, as expected. The 4-marker panel and 3-marker panel showed variable improvement compared to eGFRcr-cys. The 4-marker panel had smaller bias and smaller IQR, but similar P30, RMSE and concordance as eGFRcr-cys. The 3-panel marker including BTP had smaller bias, smaller IQR and RMSE, higher P30 and similar concordance as eGFRcr-cys. The 3-panel marker including B2M had similar values for all metrics as eGFRcr-cys. The 2-marker panels showed similar performance to eGFRcr-cys (similar values for all metrics as eGFRcr-cys, except higher RMSE for cr-B2M). Evaluation in subgroups showed generally consistent results by sex (Table 12), race (Table 13), age (Table 14), eGFR (Table 15), BMI (Table 16), and diabetes (Table 17) as the total group.

Discussion

Our analysis does not confirm hypotheses that 2020 4-marker panel or 3-marker panels are more accurate than 2021 eGFRcr-cys equation (the former result is similar to previously reported result using 2012 eGFRcr-cys equation as the reference equation). Furthermore, our analysis does not confirm hypothesis that average of 2021 eGFRcr and 2020 eGFRB2M equations or average of 2021 eGFRcr and 2020 eGFRBTP equations are as accurate as 2021 eGFRcr-cys equation (not previously published). Results were generally consistent among subgroups.

Analysis using non-calibrated mGFR shows lesser bias for panels using B2M and BTP. The 2020 4-marker panel and 3-marker panel with B2M were not more accurate than 2021 eGFRcr-cys equation, but the 2020 3-marker panel with BTP was more accurate than 2021 eGFRcr-cys. Both 2-panel markers were as accurate as eGFRcr-cys. Results were generally consistent among subgroups.

Overall, our results do not add to support for implementation of B2M and BTP as a confirmatory test either in addition to creatinine and cystatin C or as a substitute for cystatin C in study populations similar to our

validation database. Previous studies showed variation in performance of CKD-EPI 4-marker panel and 3-marker panel equations to eGFRcr-cys.^{1,3-7} This is the only study to date that compares performance of race-free CKD-EPI 2020 B2M and BTP equations to race-free CKD-EPI 2021 creatinine and cystatin C equations. Lesser improvement of 4-marker and 3-marker panel equations seen in this study may be due to characteristics of studies in our validation dataset (research studies without serious acute and chronic comorbid illness) and minimal bias and high P30 of eGFRcr-cys. This may also be the explanation why B2M and BTP were not able to substitute for cystatin C in this study. We suggest further studies in populations in which eGFRcr-cys performs less well could be of value (for example, clinical populations with acute and chronic comorbid illness and greater variation in non-GFR determinants of creatinine and cystatin C).

As discussed previously,¹ limitations of these analyses include the following: 1) a lack of representation from geographically diverse populations; 2) a lower mean GFR in the development population than in the development population for the 2021 equations and the external validation population, suggesting that regression to the mean is a likely explanation for the underestimation of mGFR in the validation population of the present study; 3) possible variation in measurement methods for endogenous filtration markers over time; and measurement error and in mGFR and uncertainty about the calibration of mGFR methods.

In conclusion, eGFR equations using B2M and/or BTP in addition to creatinine and cystatin C were not more accurate than eGFRcr-cys in ambulatory adults without serious acute or chronic comorbid illness. Also, eGFR equations using B2M or BTP in addition to creatinine were not as accurate as eGFRcr-cys in this population.

Tables and Figures

Table 1. CKD-EPI Equations used in Analysis and their Demographic Variables and Filtration Markers

Equation	Panels using B2M or BTP with Creatinine	Filtration Markers	Demographic Variables	Comment
2021 eGFRcr-cys ² (Reference equation for this analysis)		Creatinine and Cystatin C	Age, Sex	More accurate than 2021 eGFRcr. Recommended as confirmatory test for GFR evaluation in the US (less accurate than 2012 eGFRcr-cys, which includes age, sex and race).
2021 eGFRcr ²		Creatinine	Age, Sex	Recommended as first-test for GFR evaluation in the US (less accurate than 2009 eGFRcr, which includes age, sex and race).
2020/2021 eGFRcr-B2M ^{1,2}	2-marker	Creatinine and B2M	Age, Sex	New combination of equations. Not previously evaluated.
2021/2021 eGFRcr- BTP ^{1,2}	2-marker	Creatinine and BTP	Age, Sex	New combination of equations. Not previously evaluated.
2020 eGFRcr-cys-BTP ¹	3-marker	Creatinine, Cystatin C and BTP	Age, Sex	Not previously evaluated.
2020 eGFRcr-cys-B2M ¹	3-marker	Creatinine, Cystatin C and B2M	Age, Sex	Not previously evaluated.
2020 eGFRcr-cys-B2M-BTP ¹	4-marker	Creatinine, Cystatin C, B2M and BTP	Age, Sex	More accurate than 2009 eGFRcr equation (which includes age, sex and race). As accurate, but not more accurate than 2012 eGFRcr-cys (which includes age, sex, and race). More accurate than 2020 eGFRcys-B2M-BTP (which does not include race).

Table 2. CKD-EPI Equations used in Analysis and Statistical Formulas

Equation	Panels using B2M or BTP with Creatinine	Equations
2021 eGFR _{cr} -cys ² (Reference equation for this analysis)		eGFR= 135 × min(Scr/k, 1) ^α × max(Scr/k, 1) ^{-0.601} × min(Scys/0.8, 1) ^{-0.375} × max(Scys/0.8, 1) ^{-0.711} × 0.995 ^{Age} [× 0.969 if female] [× 1.08 if Black] Where Scr is serum creatinine, Scys is serum cystatin C, κ is 0.7 for females and 0.9 for males, α is -0.248 for females and -0.207 for males, min indicates the minimum of Scr/κ or 1, and max indicates the maximum of Scr/κ or 1
2021 eGFR _{cr} ²		eGFR= 141 × min(Scr/k, 1) ^α × max(Scr/k, 1) ^{-1.209} × 0.993 ^{Age} [× 1.018 if female] [× 1.159 if Black] Where Scr is serum creatinine, κ is 0.7 for females and 0.9 for males, α is -0.329 for females and -0.411 for males, min is the minimum of Scr/κ or 1, and max is the maximum of Scr/κ or 1
2020/2021 eGFR _{cr} -B2M ^{1,2}	2-marker	eGFR= (2021 eGFR _{cr} +2020 eGFR _{B2M})/2 Where eGFR _{cr} is the 2021 CKD-EPI model described in the first row, eGFR _{B2M} is the 2020 CKD-EPI model described in row number four
2021/2021 eGFR _{cr} -BTP ^{1,2}	2-marker	eGFR= (2021 eGFR _{cr} + eGFR _{BTP})/2 Where eGFR _{cr} is the 2021 CKD-EPI model described in the first row, eGFR _{BTP} is the 2020 CKD-EPI model described in row number five
2020 eGFR _{cr} -cys-BTP ¹	3-marker	eGFR=126 X min(Scr/k,1) ^α X max(Scr/k,1) ^{-0.491} X min(Scys/0.8,1) ^{-0.595} X max(Scys/0.8,1) ^{-0.505} X min(SBTP/0.6,1) ^{-0.005} X max(SBTP/0.6,1) ^{-0.200} X 0.996 ^{age} [X 0.933 if female] Where Scr is serum creatinine, Scys is serum cystatin C, SB2M is serum B2M, SBTP is serum BTP, B2M is Beta 2-Microglobulin, BTP is Beta-Trace Protein, k is 0.7 for females and 0.9 males, α is -0.242 for females and -0.307 for males, min indicates the minimum of Scr/k or 1, max indicates the maximum of Scr/k or 1
2020 eGFR _{cr} -cys-B2M ¹	3-marker	eGFR=136 X min(Scr/k,1) ^α X max(Scr/k,1) ^{-0.507} X min(Scys/0.8,1) ^{-0.435} X max(Scys/0.8,1) ^{-0.508} X B2M ^{-0.165} X 0.996 ^{age} [X 0.944 if female] Where Scr is serum creatinine, Scys is serum cystatin C, SB2M is serum B2M, SBTP is serum BTP, B2M is Beta 2-Microglobulin, BTP is Beta-Trace Protein, k is 0.7 for females and 0.9 males, α is -0.193 for females and -0.234 for males, min indicates the minimum of Scr/k or 1, max indicates the maximum of Scr/k or 1
2020 eGFR _{cr} -cys-B2M-BTP ¹	4-marker	eGFR =131 × min(Scr/k,1) ^α × max(Scr/k,1) ^{-0.471} × min(Scys/0.8,1) ^{-0.519} × max(Scys/0.8,1) ^{-0.423} × SB2M ^{-0.103} × min(SBTP/0.6,1) ^{-0.004} × max(SBTP/0.6,1) ^{-0.177} × 0.996 ^{age} [× 0.937 if female] Where Scr is serum creatinine, Scys is serum cystatin C, SBTP is serum β-trace protein, SB2M is serum β2-microglobulin, max is maximum of the 2 listed terms, min is minimum of the 2 listed term, k is 0.7 for women and 0.9 for men, α is -0.243 for women and -0.295 for men

Table 3. Characteristics of Total Study Population

Characteristics	Total	Groningen	HIV	MACS	PERL	CCFP	MESA	ALTOLD
N	2245 (100)	320 (14)	198 (9)	660 (29)	487 (22)	153 (7)	293 (13)	134 (6)
Female	652 (29.0)	146 (45.6)	55 (27.8)	0 (0.0)	162 (33.3)	63 (41.2)	140 (47.8)	86 (64.2)
Black people	539 (24.0)	3 (0.9)	102 (51.5)	224 (33.9)	57 (11.7)	12 (7.8)	138 (47.1)	3 (2.2)
Age, years	52.8 (12.8)	49.0 (13.4)	47.8 (8.3)	52.4 (8.7)	51.4 (11.0)	47.8(13.3)	70.7 (8.6)	43.5 (11.4)
<40	331 (14.7)	84 (26.3)	26 (13.1)	40 (6.1)	86 (17.7)	43 (28.1)	0 (0.0)	52 (38.8)
40-65	1570 (69.9)	205 (64.1)	167 (84.3)	573 (86.8)	358 (73.5)	96 (62.8)	92 (31.4)	79 (59.0)
>65	344 (15.3)	31 (9.7)	5 (2.5)	47 (7.1)	43 (8.8)	14 (9.2)	201 (68.6)	3 (2.2)
BMI, kg/m ²	27.5 (5.4)	26.0 (4.3)	26.6 (5.8)	26.4 (4.7)	29.4 (6.0)	27.1 (5.6)	29.7 (5.4)	26.9 (4.3)
<20	82 (3.7)	18 (5.6)	15 (7.6)	24 (3.6)	11 (2.3)	10 (6.5)	3 (1.0)	1 (0.8)
20-<25	692 (30.9)	119 (37.2)	64 (32.3)	259 (39.2)	105 (21.8)	50 (32.7)	47 (16.0)	48 (35.8)
25-30	884 (39.5)	128 (40.0)	84 (42.4)	269 (40.8)	166 (34.4)	53 (34.6)	123 (42.0)	55 (41.0)
>30	582 (26.0)	55 (17.2)	35 (17.7)	108 (16.4)	200 (41.5)	40 (26.1)	120 (41.0)	30 (22.4)
Diabetes	731 (34.7)	35 (10.9)	15 (7.6)	100 (19.2)	487 (100.0)	21 (13.7)	73 (24.9)	0 (0.0)
Reported mGFR, ml/min/1.73m ²	79.9 (26.1)	60.6 (26.0)	87.2 (25.5)	96.0 (21.3)	68.1 (17.0)	79.2(35.6)	72.5 (18.8)	96.5 (14.5)
Calibrated mGFR, ml/min/1.73m ²	83.2 (27.4)	60.6 (26.0)	91.5 (26.7)	100.8 (22.3)	71.5 (17.9)	79.2(35.6)	76.2 (19.8)	101.4(15.3)
Creatinine, mg/dL	1.1 (0.5)	1.4 (0.6)	1.2 (0.4)	1.0 (0.3)	1.1 (0.3)	1.2 (0.9)	0.9 (0.3)	0.8 (0.1)
Cystatin C, mg/L	1.2 (0.5)	1.8 (0.7)	1.1 (0.4)	1.0 (0.3)	1.1 (0.3)	1.2 (0.7)	1.0 (0.3)	0.8 (0.1)
B2M, mg/L	2.6 (1.5)	3.5 (2.0)	2.8 (1.5)	2.3 (1.0)	2.5 (0.8)	3.0 (3.0)	2.2 (1.0)	1.7 (0.2)
BTP, mg/L	0.8 (0.4)	0.9 (0.4)	0.6 (0.2)	0.6 (0.2)	0.9 (0.3)	1.0 (0.9)	0.6 (0.3)	0.6 (0.1)
Abbreviations: MACS, Multicenter Aids Cohort Study; PERL, Preventing Early Rental Loss in Diabetes; CCF, Cleveland Clinic Foundation; MESA, Multi-Ethnic Study of Atherosclerosis; ALTOLD, Assessing Long Term Outcome of Living Kidney Donors; mGFR, measured glomerular filtration rate; B2M, Beta2-Microglobulin; BTP, Beta-Trace Protein;								
Note: Values for categorical variables are given as number (percentage), for continuous variables, mean (standard deviation)								

Table 4. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations in Total Study Population with mGFR calibration

CKD-EPI Equation (N = 2245)	Panels using B2M or BTP with Creatinine	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
CKD-EPI 2021 eGFRcr-cys*		1.8 (1.2, 2.4)	18.7 (17.7, 19.9)	90.0 (88.8, 91.2)	0.199 (0.191, 0.207)	66.7 (64.8, 68.6)
CKD-EPI 2021 eGFRcr		0.8 (0.1, 1.3)	19.6 (18.5, 20.8)	86.7 (85.4, 88.1)	0.206 (0.199, 0.212)	63.4 (61.5, 65.4)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	2-marker	4.1 (3.4, 4.7)	19.8 (19.0, 21.3)	85.9 (84.5, 87.3)	0.241 (0.227, 0.255)	61.0 (58.9, 62.9)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	2-marker	4.8 (4.0, 5.8)	18.8 (17.8, 19.7)	88.7 (87.4, 90.1)	0.225 (0.212, 0.238)	64.5 (62.5, 66.4)
CKD-EPI 2020 eGFRcr-cys-BTP	3-marker	3.4 (2.9, 4.1)	16.6 (15.7, 17.7)	92.1 (91.0, 93.2)	0.189 (0.182, 0.197)	68.2 (66.3, 70.2)
CKD-EPI 2020 eGFRcr-cys-B2M	3-marker	3.6 (3.0, 4.1)	17.9 (17.0, 18.9)	90.0 (88.7, 91.2)	0.202 (0.194, 0.210)	65.6 (63.7, 67.6)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	4-marker	3.6 (3.1, 4.0)	16.9 (15.9, 18.0)	91.4 (90.2, 92.5)	0.197 (0.188, 0.205)	67.7 (65.8, 69.7)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * Indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 5. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by sex groups with mGFR calibration

CKD-EPI Equation	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
Female (N = 652)					
CKD-EPI 2021 eGFRcr-cys*	-1.3 (-2.5, -0.2)	17.0 (15.2, 18.5)	87.4 (84.7, 90.1)	0.198 (0.185, 0.210)	65.5 (61.8, 69.0)
CKD-EPI 2021 eGFRcr	-3.2 (-4.6, -1.4)	18.6 (17.2, 20.4)	82.7 (79.8, 85.7)	0.209 (0.197, 0.221)	59.5 (55.7, 63.2)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	-1.2 (-2.2, -0.4)	16.4 (14.6, 18.8)	86.5 (83.9, 89.3)	0.236 (0.206, 0.267)	64.3 (60.4, 67.9)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	0.2 (-1.0, 1.3)	17.7 (16.1, 19.1)	88.8 (86.3, 91.1)	0.228 (0.202, 0.256)	63.8 (60.1, 67.5)
CKD-EPI 2020 eGFRcr-cys-BTP	1.4 (0.5, 2.6)	15.4 (14.1, 16.7)	91.6 (89.4, 93.9)	0.186 (0.173, 0.199)	66.9 (63.3, 70.6)
CKD-EPI 2020 eGFRcr-cys-B2M	1.8 (0.9, 2.5)	16.2 (14.8, 17.7)	90.6 (88.3, 92.8)	0.193 (0.180, 0.206)	66.1 (62.6, 69.8)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	1.4 (0.2, 2.7)	15.6 (14.3, 16.9)	91.4 (89.3, 93.6)	0.194 (0.179, 0.209)	67.5 (63.8, 71.2)
Male (N = 1593)					
CKD-EPI 2021 eGFRcr-cys*	3.4 (2.5, 4.4)	19.4 (18.3, 20.6)	91.0 (89.6, 92.3)	0.199 (0.190, 0.209)	67.2 (64.8, 69.4)
CKD-EPI 2021 eGFRcr	2.2 (1.3, 2.7)	19.8 (18.6, 21.4)	88.4 (86.9, 90.0)	0.204 (0.196, 0.212)	65.0 (62.7, 67.4)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	6.5 (5.6, 7.6)	21.1 (19.7, 22.5)	85.7 (84.0, 87.4)	0.243 (0.229, 0.257)	59.6 (57.3, 62.1)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	6.8 (5.9, 7.6)	18.7 (17.5, 19.9)	88.7 (87.1, 90.3)	0.223 (0.210, 0.237)	64.8 (62.5, 67.2)
CKD-EPI 2020 eGFRcr-cys-BTP	4.2 (3.5, 4.8)	17.8 (16.4, 18.6)	92.3 (91.0, 93.7)	0.191 (0.182, 0.200)	68.7 (66.4, 71.1)
CKD-EPI 2020 eGFRcr-cys-B2M	4.5 (3.9, 5.4)	19.2 (17.9, 20.4)	89.7 (88.1, 91.1)	0.205 (0.197, 0.215)	65.4 (63.0, 67.8)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	4.3 (3.7, 5.0)	18.0 (16.7, 19.3)	91.3 (90.0, 92.8)	0.199 (0.189, 0.208)	67.8 (65.4, 70.1)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * Indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 6. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by race groups with mGFR calibration

CKD-EPI Equation	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
Black (N = 539)					
CKD-EPI 2021 eGFRcr-cys*	4.4 (2.8, 6.0)	21.0 (19.1, 22.8)	90.7 (88.3, 93.1)	0.202 (0.188, 0.216)	66.4 (62.5, 70.2)
CKD-EPI 2021 eGFRcr	6.8 (5.4, 8.9)	22.9 (19.5, 25.2)	85.9 (82.9, 88.9)	0.228 (0.214, 0.242)	59.6 (55.3, 63.6)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	9.9 (6.7, 12.2)	25.7 (22.3, 28.1)	80.0 (76.5, 83.3)	0.259 (0.242, 0.275)	53.4 (49.4, 57.5)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	7.9 (6.4, 9.6)	19.6 (17.7, 22.2)	90.2 (87.6, 92.8)	0.207 (0.193, 0.221)	60.9 (56.8, 64.9)
CKD-EPI 2020 eGFRcr-cys-BTP	6.0 (4.7, 7.3)	19.3 (17.1, 21.4)	92.4 (90.2, 94.4)	0.192 (0.181, 0.204)	66.6 (62.5, 70.5)
CKD-EPI 2020 eGFRcr-cys-B2M	6.9 (5.0, 8.8)	21.1 (19.2, 24.5)	88.1 (85.4, 90.7)	0.217 (0.204, 0.231)	62.7 (58.7, 66.8)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	6.1 (4.4, 7.8)	20.7 (18.2, 22.9)	90.9 (88.5, 93.1)	0.202 (0.189, 0.214)	65.9 (62.0, 69.7)
non-Black (N = 1706)					
CKD-EPI 2021 eGFRcr-cys*	1.2 (0.7, 1.9)	18.1 (16.9, 19.2)	89.7 (88.2, 91.1)	0.198 (0.189, 0.208)	66.8 (64.6, 68.9)
CKD-EPI 2021 eGFRcr	-0.8 (-1.5, -0.2)	18.3 (17.3, 19.7)	87.0 (85.3, 88.5)	0.198 (0.190, 0.206)	64.6 (62.3, 66.8)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	3.0 (2.1, 3.7)	18.3 (17.2, 19.6)	87.8 (86.2, 89.4)	0.235 (0.218, 0.253)	63.4 (61.0, 65.7)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	3.7 (2.7, 4.4)	18.5 (17.3, 19.8)	88.3 (86.8, 89.8)	0.230 (0.214, 0.248)	65.7 (63.5, 67.9)
CKD-EPI 2020 eGFRcr-cys-BTP	2.8 (2.0, 3.4)	16.0 (15.2, 16.9)	92.0 (90.7, 93.3)	0.188 (0.179, 0.198)	68.7 (66.5, 70.8)
CKD-EPI 2020 eGFRcr-cys-B2M	2.8 (2.1, 3.5)	16.9 (16.1, 17.9)	90.6 (89.2, 91.9)	0.197 (0.188, 0.206)	66.5 (64.3, 68.7)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	3.0 (2.3, 3.6)	16.0 (15.2, 16.9)	91.5 (90.2, 92.8)	0.196 (0.186, 0.206)	68.3 (66.1, 70.5)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * Indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 7. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by age groups with mGFR calibration

CKD-EPI Equation	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
Age<40 (N = 331)					
CKD-EPI 2021 eGFRcr-cys*	1.3 (-0.4, 4.2)	19.3 (16.4, 22.0)	91.5 (88.2, 94.3)	0.188 (0.172, 0.206)	74.6 (69.8, 79.5)
CKD-EPI 2021 eGFRcr	0.5 (-1.5, 2.0)	18.7 (16.0, 21.6)	87.3 (83.7, 90.9)	0.198 (0.180, 0.214)	72.2 (67.4, 77.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	4.8 (3.7, 6.4)	18.6 (16.3, 22.4)	86.4 (82.8, 90.0)	0.229 (0.201, 0.262)	67.4 (62.2, 72.2)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	6.9 (5.2, 8.7)	20.4 (18.6, 23.1)	87.6 (84.0, 90.9)	0.231 (0.204, 0.260)	68.0 (63.1, 73.1)
CKD-EPI 2020 eGFRcr-cys-BTP	4.3 (2.9, 5.7)	15.7 (13.8, 20.0)	91.8 (88.8, 94.6)	0.186 (0.168, 0.203)	72.5 (67.7, 77.3)
CKD-EPI 2020 eGFRcr-cys-B2M	3.6 (1.9, 5.7)	17.6 (15.8, 20.1)	90.6 (87.6, 93.7)	0.194 (0.177, 0.211)	71.9 (67.1, 76.9)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	4.4 (3.4, 5.7)	16.8 (14.5, 20.3)	91.8 (88.8, 94.7)	0.196 (0.177, 0.216)	70.7 (66.2, 75.5)
Age 40-65 (N = 1570)					
CKD-EPI 2021 eGFRcr-cys*	2.8 (2.1, 3.8)	20.0 (18.8, 21.3)	89.2 (87.7, 90.8)	0.207 (0.198, 0.217)	65.4 (63.0, 67.7)
CKD-EPI 2021 eGFRcr	1.8 (1.0, 2.5)	20.6 (18.9, 22.0)	86.9 (85.4, 88.6)	0.210 (0.201, 0.217)	62.0 (59.7, 64.3)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	5.4 (4.5, 6.4)	21.4 (20.2, 22.9)	84.6 (82.9, 86.4)	0.248 (0.232, 0.265)	58.7 (56.3, 61.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	6.1 (5.0, 6.9)	18.6 (17.7, 20.0)	88.7 (87.1, 90.2)	0.226 (0.210, 0.242)	63.4 (61.0, 65.7)
CKD-EPI 2020 eGFRcr-cys-BTP	4.3 (3.8, 5.0)	17.6 (16.2, 18.6)	91.7 (90.3, 93.0)	0.196 (0.188, 0.206)	66.7 (64.4, 69.1)
CKD-EPI 2020 eGFRcr-cys-B2M	4.5 (3.9, 5.4)	19.1 (17.9, 20.5)	88.9 (87.3, 90.4)	0.212 (0.203, 0.221)	63.6 (61.3, 66.1)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	4.4 (3.8, 5.0)	17.9 (16.7, 19.3)	90.6 (89.2, 92.1)	0.204 (0.194, 0.214)	66.6 (64.5, 68.9)
Age>65 (N = 344)					
CKD-EPI 2021 eGFRcr-cys*	-1.5 (-2.8, -0.2)	14.8 (12.9, 16.5)	91.9 (89.0, 94.5)	0.168 (0.154, 0.183)	65.1 (59.9, 70.1)
CKD-EPI 2021 eGFRcr	-3.0 (-4.8, -1.2)	16.9 (15.1, 18.0)	85.2 (81.4, 88.7)	0.194 (0.178, 0.211)	61.0 (55.8, 66.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	-2.2 (-3.6, -1.1)	14.6 (12.8, 16.2)	91.3 (88.4, 94.2)	0.216 (0.175, 0.261)	65.4 (60.2, 70.3)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	-0.3 (-1.6, 0.9)	14.1 (12.6, 16.7)	90.1 (86.8, 93.2)	0.214 (0.177, 0.255)	66.6 (61.6, 71.5)
CKD-EPI 2020 eGFRcr-cys-BTP	-0.4 (-1.8, 0.5)	12.9 (11.0, 14.7)	94.2 (91.6, 96.5)	0.158 (0.143, 0.174)	70.9 (66.0, 75.9)
CKD-EPI 2020 eGFRcr-cys-B2M	-0.4 (-1.8, 0.9)	12.9 (11.4, 14.9)	94.2 (91.6, 96.5)	0.160 (0.144, 0.176)	68.6 (63.7, 73.5)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	-0.8 (-2.1, 0.4)	12.9 (11.3, 14.7)	94.2 (91.6, 96.5)	0.165 (0.147, 0.183)	69.8 (64.8, 74.7)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * Indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 8. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by eGFR groups with mGFR calibration

CKD-EPI Equation	N	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
eGFR <30						
CKD-EPI 2021 eGFRcr-cys*	80	4.2 (2.4, 6.5)	12.7 (7.8, 15.6)	63.8 (53.8, 75.0)	0.353 (0.300, 0.410)	51.3 (40.0, 62.5)
CKD-EPI 2021 eGFRcr	47	1.1 (0.1, 3.3)	7.4 (4.2, 10.0)	80.9 (68.1, 91.5)	0.278 (0.219, 0.333)	66.0 (51.1, 78.7)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	32	2.1 (0.2, 5.0)	9.0 (4.9, 17.1)	68.8 (53.1, 84.4)	0.302 (0.235, 0.365)	59.4 (40.6, 75.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	18	1.2 (-2.4, 2.6)	5.1 (2.8, 9.8)	88.9 (72.2, 100.0)	0.201 (0.123, 0.274)	72.2 (50.0, 88.9)
CKD-EPI 2020 eGFRcr-cys-BTP	55	0.2 (-1.7, 3.2)	11.9 (7.7, 15.4)	58.2 (45.5, 70.9)	0.338 (0.281, 0.395)	56.4 (43.6, 69.1)
CKD-EPI 2020 eGFRcr-cys-B2M	66	1.7 (-1.0, 4.3)	14.0 (7.9, 18.0)	59.1 (47.0, 71.2)	0.367 (0.308, 0.424)	51.5 (39.4, 63.6)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	52	0.6 (-1.3, 3.2)	11.2 (6.7, 16.8)	59.6 (46.2, 73.1)	0.389 (0.313, 0.459)	53.8 (40.4, 67.3)
eGFR 30-<45						
CKD-EPI 2021 eGFRcr-cys*	194	7.8 (6.2, 9.6)	12.4 (10.7, 14.4)	78.9 (73.2, 84.5)	0.288 (0.257, 0.319)	39.2 (32.5, 46.4)
CKD-EPI 2021 eGFRcr	141	2.9 (1.3, 5.5)	11.3 (9.3, 14.1)	83.7 (77.3, 89.4)	0.240 (0.210, 0.269)	48.2 (40.4, 56.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	128	3.5 (1.2, 5.0)	14.4 (11.6, 17.5)	77.3 (70.3, 84.4)	0.339 (0.273, 0.413)	43.8 (35.2, 51.6)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	127	0.8 (-1.3, 2.9)	14.7 (10.8, 16.8)	77.2 (70.1, 84.3)	0.344 (0.269, 0.418)	47.2 (37.8, 55.9)
CKD-EPI 2020 eGFRcr-cys-BTP	184	5.5 (4.1, 6.4)	11.4 (9.7, 13.4)	83.2 (77.7, 88.6)	0.261 (0.229, 0.294)	44.6 (37.5, 51.6)
CKD-EPI 2020 eGFRcr-cys-B2M	182	5.6 (4.1, 7.9)	12.0 (10.3, 14.3)	81.9 (75.8, 87.4)	0.270 (0.238, 0.301)	41.8 (35.2, 48.9)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	175	5.0 (3.6, 6.4)	12.2 (10.6, 13.7)	82.3 (76.6, 87.4)	0.270 (0.236, 0.306)	45.1 (37.7, 52.6)
eGFR 45-<60						
CKD-EPI 2021 eGFRcr-cys*	262	4.8 (3.0, 6.1)	13.6 (11.7, 16.4)	88.2 (84.0, 92.0)	0.214 (0.192, 0.237)	48.1 (42.4, 54.6)
CKD-EPI 2021 eGFRcr	263	2.9 (1.6, 5.2)	17.7 (13.8, 19.8)	82.5 (77.9, 87.5)	0.228 (0.208, 0.247)	44.5 (38.8, 51.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	326	0.5 (-0.5, 3.2)	15.5 (13.1, 18.3)	80.4 (76.1, 84.4)	0.280 (0.237, 0.327)	47.5 (42.0, 53.2)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	309	0.0 (-1.2, 1.9)	14.7 (12.9, 16.6)	83.8 (79.9, 87.7)	0.294 (0.242, 0.344)	49.5 (44.0, 55.3)
CKD-EPI 2020 eGFRcr-cys-BTP	303	3.3 (2.0, 4.4)	12.6 (10.7, 14.1)	90.8 (87.1, 94.1)	0.202 (0.181, 0.222)	49.8 (44.2, 55.4)
CKD-EPI 2020 eGFRcr-cys-B2M	307	4.0 (2.7, 4.7)	13.2 (11.5, 15.3)	86.3 (82.4, 89.9)	0.218 (0.198, 0.239)	46.3 (40.7, 51.8)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	309	3.4 (2.0, 4.4)	13.2 (11.0, 14.7)	88.7 (85.1, 92.2)	0.215 (0.193, 0.237)	50.5 (45.3, 56.0)
eGFR 60-<90						
CKD-EPI 2021 eGFRcr-cys*	774	2.2 (1.3, 3.2)	18.1 (16.2, 19.9)	92.4 (90.4, 94.1)	0.178 (0.168, 0.188)	67.3 (64.1, 70.7)
CKD-EPI 2021 eGFRcr	847	1.0 (0.0, 2.3)	21.4 (19.5, 23.7)	85.0 (82.8, 87.4)	0.215 (0.205, 0.227)	59.4 (56.1, 62.6)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	1121	4.8 (4.0, 5.8)	22.2 (20.4, 24.1)	85.5 (83.4, 87.4)	0.244 (0.226, 0.263)	55.1 (52.3, 58.1)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	1164	3.9 (3.1, 5.2)	17.9 (16.7, 19.5)	89.4 (87.6, 91.2)	0.203 (0.191, 0.216)	57.9 (54.9, 60.7)
CKD-EPI 2020 eGFRcr-cys-BTP	908	3.8 (3.0, 4.6)	17.0 (15.6, 18.5)	94.4 (92.8, 95.8)	0.175 (0.165, 0.184)	65.9 (62.7, 68.8)
CKD-EPI 2020 eGFRcr-cys-B2M	917	3.9 (3.1, 5.1)	19.2 (17.5, 21.1)	91.7 (89.9, 93.5)	0.191 (0.181, 0.201)	63.0 (59.9, 66.1)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	932	4.0 (3.1, 4.7)	17.4 (15.7, 19.1)	93.5 (91.7, 95.0)	0.183 (0.173, 0.193)	64.7 (61.6, 67.9)
eGFR ≥90						
CKD-EPI 2021 eGFRcr-cys*	935	-2.5 (-3.9, -1.0)	21.5 (19.5, 23.8)	93.0 (91.3, 94.5)	0.168 (0.159, 0.177)	78.4 (75.7, 81.0)
CKD-EPI 2021 eGFRcr	947	-1.2 (-2.0, 0.2)	22.1 (20.5, 23.7)	90.2 (88.2, 92.0)	0.178 (0.169, 0.188)	74.3 (71.5, 77.2)

Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	638	4.7 (3.3, 6.3)	21.4 (19.4, 23.2)	92.2 (90.1, 94.2)	0.178 (0.167, 0.190)	81.7 (78.7, 84.5)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	627	11.3 (9.1, 12.8)	20.2 (18.4, 22.1)	92.2 (90.1, 94.1)	0.191 (0.180, 0.202)	87.6 (84.7, 90.0)
CKD-EPI 2020 eGFRcr-cys-BTP	795	2.3 (1.4, 3.8)	21.3 (18.7, 22.8)	94.3 (92.7, 95.7)	0.165 (0.155, 0.176)	84.2 (81.4, 86.5)
CKD-EPI 2020 eGFRcr-cys-B2M	773	2.0 (0.6, 3.3)	20.5 (19.0, 23.4)	93.9 (92.2, 95.5)	0.166 (0.156, 0.176)	83.2 (80.5, 85.8)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	777	3.0 (1.9, 4.0)	20.7 (18.7, 22.4)	94.1 (92.4, 95.6)	0.164 (0.155, 0.175)	84.2 (81.6, 86.6)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 9. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by BMI groups with mGFR calibration

CKD-EPI Equation	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
BMI <20 (N = 82)					
CKD-EPI 2021 eGFRcr-cys*	2.6 (-0.1, 5.5)	21.5 (14.2, 26.0)	90.2 (82.9, 96.3)	0.213 (0.172, 0.253)	61.0 (50.0, 70.7)
CKD-EPI 2021 eGFRcr	-2.8 (-5.6, 0.9)	20.4 (15.7, 26.5)	86.6 (79.3, 93.9)	0.216 (0.177, 0.254)	63.4 (53.7, 74.4)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	3.4 (0.8, 6.6)	20.6 (15.4, 30.5)	85.4 (76.8, 92.7)	0.339 (0.207, 0.450)	65.9 (54.9, 75.6)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	3.3 (-0.5, 6.1)	19.1 (13.5, 25.0)	85.4 (76.8, 92.7)	0.333 (0.200, 0.443)	69.5 (59.8, 79.3)
CKD-EPI 2020 eGFRcr-cys-BTP	3.3 (1.7, 4.8)	17.2 (12.5, 23.6)	89.0 (81.7, 95.1)	0.238 (0.177, 0.295)	62.2 (51.8, 72.0)
CKD-EPI 2020 eGFRcr-cys-B2M	3.6 (1.5, 7.9)	19.0 (12.7, 25.9)	90.2 (84.1, 96.3)	0.237 (0.180, 0.292)	63.4 (52.4, 73.2)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	4.1 (0.8, 5.9)	17.4 (12.2, 23.3)	90.2 (84.1, 96.3)	0.252 (0.182, 0.316)	63.4 (52.4, 73.2)
BMI 20-<25 (N = 692)					
CKD-EPI 2021 eGFRcr-cys*	2.6 (1.4, 4.1)	19.4 (17.5, 21.1)	88.6 (86.1, 90.9)	0.211 (0.197, 0.226)	67.5 (63.9, 71.0)
CKD-EPI 2021 eGFRcr	1.9 (0.8, 2.8)	19.8 (17.6, 21.9)	87.1 (84.5, 89.5)	0.207 (0.195, 0.220)	65.3 (61.7, 68.8)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	6.1 (4.7, 7.6)	19.8 (17.9, 22.2)	84.8 (82.2, 87.4)	0.261 (0.233, 0.290)	60.3 (56.8, 63.9)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	6.9 (5.9, 8.2)	18.9 (17.4, 21.3)	89.3 (87.0, 91.5)	0.235 (0.210, 0.262)	65.5 (62.0, 69.1)
CKD-EPI 2020 eGFRcr-cys-BTP	4.1 (3.1, 5.3)	16.2 (14.5, 18.6)	91.0 (88.9, 93.1)	0.199 (0.186, 0.213)	68.9 (65.3, 72.4)
CKD-EPI 2020 eGFRcr-cys-B2M	4.6 (3.7, 5.8)	17.9 (16.4, 20.0)	88.4 (86.0, 90.8)	0.216 (0.202, 0.230)	66.0 (62.4, 69.5)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	4.4 (3.4, 5.7)	17.0 (14.9, 19.5)	89.6 (87.3, 91.8)	0.209 (0.195, 0.224)	69.1 (65.5, 72.5)
BMI 25-<30 (N = 878)					
CKD-EPI 2021 eGFRcr-cys*	1.9 (1.0, 3.3)	18.9 (17.5, 20.4)	91.0 (89.0, 92.9)	0.193 (0.181, 0.206)	67.4 (64.4, 70.6)
CKD-EPI 2021 eGFRcr	1.3 (0.7, 2.7)	18.7 (16.9, 20.7)	89.1 (87.0, 91.1)	0.194 (0.185, 0.204)	65.0 (61.8, 68.1)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	4.8 (3.5, 5.9)	20.5 (18.6, 22.5)	86.6 (84.3, 88.7)	0.230 (0.213, 0.248)	60.5 (57.2, 63.7)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	5.4 (4.2, 6.7)	18.9 (17.5, 20.6)	89.2 (87.1, 91.2)	0.218 (0.201, 0.238)	63.4 (60.3, 66.7)
CKD-EPI 2020 eGFRcr-cys-BTP	4.1 (3.0, 4.8)	17.3 (15.9, 18.9)	92.6 (90.8, 94.3)	0.184 (0.174, 0.195)	67.9 (64.7, 70.9)
CKD-EPI 2020 eGFRcr-cys-B2M	4.0 (2.9, 5.1)	18.0 (16.8, 19.9)	90.7 (88.6, 92.6)	0.197 (0.185, 0.209)	65.3 (62.1, 68.5)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	4.0 (3.0, 4.9)	17.4 (15.9, 18.9)	91.8 (89.9, 93.7)	0.192 (0.180, 0.205)	66.5 (63.7, 69.7)
BMI ≥30 (N = 588)					
CKD-EPI 2021 eGFRcr-cys*	0.8 (-0.4, 1.6)	17.4 (15.4, 19.2)	90.1 (87.6, 92.5)	0.191 (0.178, 0.204)	65.5 (61.4, 69.3)
CKD-EPI 2021 eGFRcr	-1.5 (-3.0, 0.0)	20.2 (18.1, 22.7)	83.0 (79.9, 85.9)	0.218 (0.205, 0.232)	58.8 (55.1, 62.6)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	0.8 (-0.3, 2.6)	19.0 (16.9, 20.7)	86.2 (83.3, 88.8)	0.214 (0.199, 0.230)	61.9 (57.8, 65.8)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	2.1 (0.6, 3.4)	18.6 (16.1, 20.5)	87.9 (85.2, 90.3)	0.202 (0.188, 0.217)	64.3 (60.0, 68.0)
CKD-EPI 2020 eGFRcr-cys-BTP	2.3 (1.2, 3.3)	15.7 (14.0, 17.4)	93.0 (90.8, 94.9)	0.176 (0.164, 0.189)	68.5 (64.6, 72.1)
CKD-EPI 2020 eGFRcr-cys-B2M	1.8 (0.8, 2.8)	16.3 (15.0, 18.3)	90.8 (88.4, 93.0)	0.187 (0.174, 0.200)	65.8 (61.7, 69.4)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	2.4 (1.4, 3.2)	15.8 (14.0, 17.4)	93.0 (90.8, 94.9)	0.180 (0.168, 0.193)	68.4 (64.5, 71.9)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 10. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by diabetes groups with mGFR calibration

CKD-EPI Equation	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
Diabetes (N = 731)					
CKD-EPI 2021 eGFRcr-cys*	-0.4 (-1.7, 0.3)	15.9 (14.5, 17.5)	89.9 (87.7, 92.1)	0.183 (0.173, 0.193)	65.4 (62.0, 68.7)
CKD-EPI 2021 eGFRcr	-2.4 (-3.5, -1.2)	18.0 (16.4, 19.2)	86.0 (83.4, 88.5)	0.200 (0.188, 0.211)	59.6 (56.1, 63.2)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	0.5 (-0.3, 1.7)	13.8 (12.5, 15.7)	90.0 (87.7, 92.1)	0.215 (0.186, 0.245)	64.4 (60.9, 68.1)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	3.0 (2.1, 3.9)	13.8 (12.8, 15.3)	92.2 (90.2, 94.1)	0.203 (0.177, 0.231)	66.8 (63.3, 70.2)
CKD-EPI 2020 eGFRcr-cys-BTP	2.0 (1.2, 3.0)	13.9 (12.4, 15.0)	94.5 (92.9, 96.2)	0.169 (0.157, 0.181)	68.1 (64.6, 71.4)
CKD-EPI 2020 eGFRcr-cys-B2M	0.7 (-0.2, 1.5)	14.4 (13.3, 15.7)	91.9 (90.0, 93.8)	0.176 (0.164, 0.188)	67.0 (63.6, 70.5)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	2.1 (1.0, 3.0)	13.9 (12.5, 15.0)	94.4 (92.7, 96.0)	0.173 (0.159, 0.187)	68.1 (64.6, 71.4)
non-Diabetes (N = 1374)					
CKD-EPI 2021 eGFRcr-cys*	2.8 (1.8, 4.1)	19.7 (18.4, 21.1)	90.0 (88.3, 91.6)	0.208 (0.197, 0.219)	66.5 (64.0, 69.0)
CKD-EPI 2021 eGFRcr	1.9 (1.1, 2.7)	19.8 (18.2, 21.7)	86.7 (84.8, 88.4)	0.209 (0.201, 0.219)	64.6 (62.2, 67.1)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	5.2 (4.3, 6.3)	22.1 (20.4, 23.5)	84.1 (82.2, 86.1)	0.251 (0.236, 0.268)	59.9 (57.2, 62.4)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	5.2 (3.9, 6.3)	21.6 (20.0, 23.0)	87.0 (85.1, 88.6)	0.236 (0.221, 0.253)	62.6 (60.0, 65.2)
CKD-EPI 2020 eGFRcr-cys-BTP	4.0 (2.9, 4.6)	18.1 (16.8, 19.4)	90.8 (89.2, 92.3)	0.199 (0.189, 0.209)	67.4 (64.8, 69.8)
CKD-EPI 2020 eGFRcr-cys-B2M	4.6 (3.9, 5.7)	18.8 (17.8, 20.3)	89.2 (87.5, 90.9)	0.213 (0.202, 0.223)	64.7 (62.1, 67.2)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	4.0 (3.2, 4.9)	18.5 (17.1, 20.2)	89.7 (88.1, 91.3)	0.208 (0.198, 0.219)	67.0 (64.3, 69.4)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 11. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations in Total Study Population without mGFR calibration

CKD-EPI Equation (N = 2245)	Panels using B2M or BTP with Creatinine	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
CKD-EPI 2021 eGFRcr-cys*		-1.1 (-1.7, -0.4)	19.1 (18.1, 20.2)	89.0 (87.7, 90.2)	0.198 (0.190, 0.206)	64.8 (62.8, 66.8)
CKD-EPI 2021 eGFRcr		-2.3 (-2.9, -1.6)	18.9 (17.8, 20.1)	85.7 (84.5, 87.2)	0.206 (0.199, 0.212)	61.7 (59.7, 63.7)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	2-marker	1.0 (0.3, 1.5)	19.2 (18.1, 20.2)	86.6 (85.2, 88.0)	0.232 (0.218, 0.246)	61.6 (59.6, 63.7)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	2-marker	1.5 (0.9, 2.2)	17.1 (16.3, 18.2)	89.5 (88.2, 90.8)	0.215 (0.201, 0.229)	66.7 (64.8, 68.6)
CKD-EPI 2020 eGFRcr-cys-BTP	3-marker	0.4 (-0.1, 1.0)	16.9 (15.8, 17.6)	92.0 (90.9, 93.1)	0.183 (0.175, 0.190)	67.9 (66.0, 69.8)
CKD-EPI 2020 eGFRcr-cys-B2M	3-marker	0.7 (0.1, 1.3)	18.1 (17.0, 19.2)	90.6 (89.4, 91.9)	0.195 (0.187, 0.202)	64.7 (62.8, 66.8)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	4-marker	0.6 (-0.1, 1.0)	16.9 (16.1, 17.9)	91.2 (90.0, 92.4)	0.190 (0.182, 0.198)	67.3 (65.4, 69.3)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * Indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 12. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by sex groups without mGFR calibration

CKD-EPI Equation	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
Female (N = 652)					
CKD-EPI 2021 eGFRcr-cys*	-3.8 (-4.9, -3.1)	17.9 (16.3, 19.7)	82.8 (79.6, 85.7)	0.210 (0.198, 0.222)	62.0 (58.3, 65.6)
CKD-EPI 2021 eGFRcr	-5.3 (-7.2, -4.1)	18.8 (17.1, 20.6)	78.7 (75.6, 81.9)	0.221 (0.208, 0.233)	57.1 (53.4, 60.7)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	-3.9 (-4.9, -3.0)	16.6 (15.1, 18.5)	83.6 (80.8, 86.5)	0.242 (0.213, 0.273)	62.1 (58.4, 65.6)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	-2.5 (-3.7, -1.4)	16.8 (15.5, 18.4)	87.1 (84.6, 89.7)	0.230 (0.203, 0.257)	63.5 (59.8, 67.3)
CKD-EPI 2020 eGFRcr-cys-BTP	-1.2 (-2.1, 0.3)	15.1 (13.9, 16.8)	90.2 (87.9, 92.5)	0.190 (0.177, 0.203)	65.3 (61.8, 69.0)
CKD-EPI 2020 eGFRcr-cys-B2M	-1.1 (-1.9, 0.1)	16.5 (14.9, 18.6)	89.4 (87.0, 91.9)	0.198 (0.185, 0.211)	64.4 (60.9, 67.9)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	-1.0 (-2.0, -0.1)	15.6 (14.4, 17.1)	89.3 (87.0, 91.6)	0.197 (0.182, 0.212)	66.3 (62.6, 69.9)
Male (N = 1593)					
CKD-EPI 2021 eGFRcr-cys*	0.2 (-0.5, 1.3)	19.5 (18.4, 20.6)	91.5 (90.1, 92.7)	0.193 (0.184, 0.203)	65.9 (63.6, 68.3)
CKD-EPI 2021 eGFRcr	-1.3 (-2.1, -0.2)	19.4 (17.4, 20.9)	88.6 (87.1, 90.3)	0.199 (0.191, 0.207)	63.7 (61.3, 66.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	3.2 (2.2, 4.1)	19.6 (18.3, 20.9)	87.8 (86.3, 89.4)	0.227 (0.213, 0.242)	61.5 (59.1, 63.8)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	3.2 (2.3, 3.9)	17.2 (16.0, 18.2)	90.5 (89.1, 92.0)	0.208 (0.194, 0.223)	68.0 (65.7, 70.4)
CKD-EPI 2020 eGFRcr-cys-BTP	0.9 (0.3, 1.7)	16.9 (15.9, 18.1)	92.7 (91.4, 94.0)	0.180 (0.171, 0.189)	69.0 (66.7, 71.2)
CKD-EPI 2020 eGFRcr-cys-B2M	1.4 (0.7, 2.3)	19.0 (17.5, 19.8)	91.1 (89.7, 92.5)	0.194 (0.185, 0.203)	64.8 (62.5, 67.2)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	1.0 (0.5, 1.7)	17.6 (16.2, 18.7)	92.0 (90.6, 93.3)	0.187 (0.178, 0.197)	67.7 (65.5, 69.9)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * Indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 13. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by race groups without mGFR calibration

CKD-EPI Equation	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
Black (N = 539)					
CKD-EPI 2021 eGFRcr-cys*	0.5 (-0.7, 1.6)	20.3 (18.7, 22.1)	90.7 (88.1, 93.1)	0.191 (0.178, 0.203)	67.7 (63.6, 71.4)
CKD-EPI 2021 eGFRcr	3.1 (1.6, 5.0)	21.6 (18.5, 23.7)	87.4 (84.6, 90.2)	0.210 (0.196, 0.223)	62.2 (57.9, 66.4)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	6.1 (3.2, 7.6)	24.0 (21.5, 27.1)	83.7 (80.3, 86.6)	0.237 (0.222, 0.253)	57.3 (53.2, 61.4)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	3.9 (2.7, 5.5)	18.0 (16.3, 20.2)	91.5 (89.2, 93.9)	0.188 (0.175, 0.202)	66.0 (62.1, 70.1)
CKD-EPI 2020 eGFRcr-cys-BTP	2.1 (0.9, 3.3)	18.5 (16.7, 20.2)	92.8 (90.5, 94.8)	0.176 (0.166, 0.187)	69.0 (65.1, 72.7)
CKD-EPI 2020 eGFRcr-cys-B2M	2.9 (1.7, 4.8)	21.0 (18.7, 23.4)	90.7 (88.3, 93.1)	0.199 (0.187, 0.211)	64.6 (60.5, 68.5)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	2.0 (0.8, 3.5)	19.6 (17.9, 21.6)	92.0 (89.8, 94.2)	0.186 (0.174, 0.197)	67.5 (63.3, 71.2)
non-Black (N = 1706)					
CKD-EPI 2021 eGFRcr-cys*	-1.5 (-2.3, -0.9)	18.8 (17.8, 20.0)	88.4 (86.8, 89.9)	0.201 (0.192, 0.210)	63.8 (61.5, 66.1)
CKD-EPI 2021 eGFRcr	-3.7 (-4.6, -3.1)	18.3 (17.1, 19.5)	85.2 (83.6, 86.9)	0.204 (0.197, 0.212)	61.6 (59.4, 63.8)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	0.2 (-0.7, 0.8)	17.7 (16.7, 18.9)	87.5 (85.9, 89.1)	0.230 (0.213, 0.248)	63.0 (60.7, 65.4)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	0.6 (-0.2, 1.5)	16.8 (15.8, 17.8)	88.9 (87.3, 90.4)	0.222 (0.206, 0.240)	66.9 (64.7, 69.1)
CKD-EPI 2020 eGFRcr-cys-BTP	-0.1 (-0.7, 0.5)	16.2 (15.2, 17.2)	91.7 (90.4, 93.0)	0.185 (0.176, 0.194)	67.6 (65.4, 69.8)
CKD-EPI 2020 eGFRcr-cys-B2M	0.1 (-0.7, 0.7)	17.3 (16.3, 18.5)	90.6 (89.2, 92.0)	0.194 (0.184, 0.203)	64.8 (62.4, 66.9)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	-0.1 (-0.7, 0.8)	16.3 (15.4, 17.3)	90.9 (89.6, 92.3)	0.192 (0.182, 0.202)	67.2 (64.9, 69.4)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * Indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 14. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by age groups without mGFR calibration

CKD-EPI Equation	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
Age <40 (N = 331)					
CKD-EPI 2021 eGFRcr-cys*	-1.0 (-2.9, 0.3)	20.7 (17.6, 23.6)	90.9 (87.9, 94.0)	0.190 (0.174, 0.207)	71.0 (65.9, 76.1)
CKD-EPI 2021 eGFRcr	-2.7 (-3.9, -0.8)	18.8 (16.2, 21.6)	85.8 (82.2, 89.7)	0.199 (0.181, 0.216)	69.2 (64.0, 74.6)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	2.0 (0.5, 3.7)	18.8 (16.4, 22.1)	87.6 (84.0, 90.9)	0.221 (0.193, 0.255)	66.8 (61.6, 71.9)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	3.8 (1.4, 5.7)	18.7 (16.4, 21.1)	87.6 (84.0, 90.9)	0.220 (0.192, 0.251)	68.6 (63.4, 73.7)
CKD-EPI 2020 eGFRcr-cys-BTP	1.6 (0.4, 3.6)	16.5 (14.0, 18.8)	90.9 (87.9, 94.0)	0.181 (0.163, 0.198)	70.7 (65.9, 75.5)
CKD-EPI 2020 eGFRcr-cys-B2M	1.3 (0.1, 3.0)	19.3 (16.3, 21.3)	90.0 (87.0, 93.1)	0.191 (0.174, 0.207)	68.9 (63.7, 74.0)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	1.7 (0.4, 3.1)	16.6 (14.3, 19.6)	90.3 (87.3, 93.4)	0.191 (0.172, 0.211)	68.9 (64.0, 74.0)
Age 40-65 (N = 1570)					
CKD-EPI 2021 eGFRcr-cys*	-0.1 (-0.9, 0.6)	20.4 (19.1, 21.4)	88.9 (87.4, 90.5)	0.204 (0.195, 0.213)	63.8 (61.5, 66.2)
CKD-EPI 2021 eGFRcr	-1.4 (-2.2, -0.4)	19.7 (18.1, 21.3)	86.5 (84.9, 88.2)	0.207 (0.198, 0.214)	60.8 (58.3, 63.2)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	2.5 (1.4, 3.4)	20.4 (19.2, 21.9)	86.1 (84.5, 87.8)	0.235 (0.218, 0.252)	59.9 (57.5, 62.5)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	2.6 (1.7, 3.4)	17.3 (16.2, 18.5)	90.3 (88.9, 91.7)	0.213 (0.196, 0.230)	65.9 (63.6, 68.2)
CKD-EPI 2020 eGFRcr-cys-BTP	1.2 (0.4, 2.0)	17.3 (16.3, 18.5)	92.3 (91.0, 93.5)	0.187 (0.178, 0.196)	66.9 (64.7, 69.3)
CKD-EPI 2020 eGFRcr-cys-B2M	1.5 (0.8, 2.5)	19.1 (18.1, 20.2)	90.6 (89.0, 92.0)	0.202 (0.193, 0.211)	63.3 (61.1, 65.8)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	1.1 (0.6, 2.0)	17.8 (16.7, 19.0)	91.5 (90.1, 92.9)	0.194 (0.184, 0.204)	66.8 (64.6, 69.0)
Age >65 (N = 344)					
CKD-EPI 2021 eGFRcr-cys*	-4.6 (-6.0, -2.8)	15.2 (13.4, 16.8)	87.2 (83.4, 90.7)	0.178 (0.165, 0.193)	63.4 (58.1, 68.3)
CKD-EPI 2021 eGFRcr	-6.0 (-7.8, -4.1)	16.6 (14.7, 18.4)	82.3 (78.2, 86.2)	0.207 (0.191, 0.224)	59.0 (54.1, 64.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	-4.8 (-6.4, -3.9)	14.0 (12.7, 15.7)	87.8 (84.3, 91.0)	0.225 (0.185, 0.268)	64.5 (59.3, 69.5)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	-3.2 (-4.7, -2.2)	13.7 (12.1, 16.0)	87.5 (83.7, 90.7)	0.218 (0.182, 0.258)	68.3 (63.4, 73.3)
CKD-EPI 2020 eGFRcr-cys-BTP	-3.5 (-4.7, -2.0)	12.7 (11.1, 14.4)	91.6 (88.4, 94.5)	0.164 (0.150, 0.179)	69.8 (64.8, 74.7)
CKD-EPI 2020 eGFRcr-cys-B2M	-3.2 (-4.2, -1.9)	13.8 (12.0, 15.2)	91.6 (88.7, 94.5)	0.166 (0.151, 0.182)	67.2 (62.1, 72.4)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	-3.4 (-5.1, -2.3)	13.2 (11.4, 14.7)	90.7 (87.5, 93.6)	0.172 (0.155, 0.189)	68.0 (62.9, 73.0)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 15. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by eGFR groups without mGFR calibration

CKD-EPI Equation	N	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
eGFR <30						
CKD-EPI 2021 eGFRcr-cys*	80	3.8 (2.4, 6.2)	12.8 (7.9, 15.3)	65.0 (55.0, 75.0)	0.345 (0.292, 0.402)	51.3 (40.0, 62.5)
CKD-EPI 2021 eGFRcr	47	1.1 (-0.3, 2.8)	7.4 (4.2, 9.7)	83.0 (70.2, 93.6)	0.270 (0.213, 0.324)	68.1 (53.2, 80.9)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	32	2.1 (-0.1, 5.0)	9.0 (4.9, 15.9)	68.8 (53.1, 84.4)	0.286 (0.224, 0.343)	62.5 (46.9, 78.1)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	18	0.1 (-2.4, 2.6)	5.1 (2.8, 8.8)	94.4 (83.3, 100.0)	0.193 (0.120, 0.265)	77.8 (55.6, 94.4)
CKD-EPI 2020 eGFRcr-cys-BTP	55	0.2 (-1.7, 2.0)	11.5 (7.5, 15.4)	58.2 (45.5, 70.9)	0.332 (0.276, 0.390)	58.2 (45.5, 70.9)
CKD-EPI 2020 eGFRcr-cys-B2M	66	1.4 (-1.0, 4.1)	14.0 (8.3, 17.5)	62.1 (50.0, 74.2)	0.359 (0.299, 0.415)	51.5 (39.4, 63.6)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	52	0.6 (-1.5, 2.8)	11.0 (6.5, 16.4)	61.5 (48.1, 75.0)	0.382 (0.304, 0.451)	55.8 (42.3, 69.2)
eGFR 30-<45						
CKD-EPI 2021 eGFRcr-cys*	194	7.0 (5.2, 8.4)	12.4 (10.5, 14.2)	82.0 (76.8, 87.1)	0.276 (0.245, 0.308)	44.3 (37.1, 51.5)
CKD-EPI 2021 eGFRcr	141	2.2 (0.6, 4.1)	10.4 (8.4, 13.6)	85.1 (78.7, 90.8)	0.225 (0.197, 0.253)	51.8 (44.0, 59.6)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	128	2.4 (0.4, 4.2)	13.9 (11.1, 16.1)	77.3 (70.3, 84.4)	0.327 (0.259, 0.403)	48.4 (39.8, 57.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	127	-0.2 (-2.4, 1.5)	13.4 (10.2, 15.0)	78.7 (71.7, 85.8)	0.337 (0.261, 0.413)	55.1 (45.7, 63.8)
CKD-EPI 2020 eGFRcr-cys-BTP	184	4.1 (2.7, 5.6)	11.5 (9.6, 13.0)	85.3 (79.9, 90.2)	0.250 (0.218, 0.284)	50.5 (43.5, 57.6)
CKD-EPI 2020 eGFRcr-cys-B2M	182	4.8 (3.3, 7.1)	12.2 (10.4, 13.9)	84.1 (78.6, 89.3)	0.260 (0.228, 0.292)	47.3 (40.1, 54.4)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	175	3.9 (2.2, 5.3)	12.1 (10.5, 13.8)	82.9 (77.1, 88.0)	0.261 (0.225, 0.298)	50.9 (44.0, 58.3)
eGFR 45-<60						
CKD-EPI 2021 eGFRcr-cys*	262	3.2 (0.6, 4.6)	13.7 (11.7, 17.1)	89.7 (85.5, 93.1)	0.207 (0.186, 0.229)	49.2 (43.5, 55.7)
CKD-EPI 2021 eGFRcr	263	1.8 (0.0, 3.0)	16.8 (13.1, 19.3)	85.6 (81.4, 89.7)	0.218 (0.198, 0.235)	45.2 (39.2, 51.3)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	326	-0.8 (-2.1, 1.0)	14.8 (12.9, 17.4)	82.5 (78.2, 86.5)	0.275 (0.231, 0.322)	48.2 (42.3, 53.7)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	309	-1.6 (-2.9, 0.0)	13.9 (11.7, 15.5)	84.1 (79.9, 88.0)	0.290 (0.237, 0.341)	52.8 (47.2, 58.6)
CKD-EPI 2020 eGFRcr-cys-BTP	303	1.5 (0.5, 2.6)	12.3 (10.4, 14.4)	89.8 (86.1, 93.1)	0.194 (0.174, 0.215)	53.1 (47.2, 58.7)
CKD-EPI 2020 eGFRcr-cys-B2M	307	1.9 (1.1, 3.8)	13.5 (11.5, 16.1)	88.6 (85.0, 92.2)	0.209 (0.189, 0.230)	48.2 (42.3, 53.4)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	309	1.3 (0.3, 2.2)	12.5 (10.8, 14.6)	88.7 (85.1, 92.2)	0.207 (0.184, 0.229)	53.1 (47.6, 58.6)
eGFR 60-<90						
CKD-EPI 2021 eGFRcr-cys*	774	-1.1 (-1.8, 0.3)	17.8 (16.0, 19.6)	92.1 (90.2, 93.9)	0.174 (0.164, 0.184)	70.9 (67.6, 74.4)
CKD-EPI 2021 eGFRcr	847	-2.0 (-3.1, -1.2)	19.9 (17.9, 22.1)	82.9 (80.3, 85.4)	0.215 (0.205, 0.226)	63.2 (59.9, 66.4)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	1121	1.3 (0.6, 2.5)	21.0 (19.3, 22.8)	85.9 (83.9, 87.9)	0.233 (0.215, 0.253)	60.3 (57.4, 63.2)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	1164	0.7 (-0.4, 1.8)	16.9 (15.7, 18.3)	89.7 (88.0, 91.4)	0.195 (0.183, 0.208)	64.0 (61.3, 66.8)
CKD-EPI 2020 eGFRcr-cys-BTP	908	0.5 (-0.3, 1.4)	16.5 (15.0, 17.9)	94.7 (93.2, 96.0)	0.166 (0.157, 0.176)	70.7 (67.8, 73.6)
CKD-EPI 2020 eGFRcr-cys-B2M	917	0.7 (-0.4, 2.0)	18.8 (16.8, 20.4)	92.6 (90.8, 94.2)	0.180 (0.171, 0.190)	67.2 (64.0, 70.2)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	932	0.7 (-0.1, 1.3)	16.9 (15.3, 18.3)	93.6 (92.0, 95.1)	0.174 (0.164, 0.184)	69.3 (66.3, 72.2)
eGFR ≥90						
CKD-EPI 2021 eGFRcr-cys*	935	-6.9 (-8.0, -5.5)	21.0 (19.2, 22.9)	89.6 (87.6, 91.4)	0.177 (0.169, 0.186)	69.4 (66.5, 72.2)
CKD-EPI 2021 eGFRcr	947	-5.2 (-6.4, -4.3)	21.2 (19.3, 23.0)	88.6 (86.4, 90.6)	0.186 (0.176, 0.196)	66.2 (63.1, 69.2)

Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	638	0.1 (-1.2, 1.9)	20.5 (19.0, 22.6)	92.6 (90.4, 94.5)	0.170 (0.159, 0.180)	73.5 (70.1, 76.8)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	627	6.6 (5.0, 8.0)	19.1 (17.7, 21.4)	93.8 (91.9, 95.5)	0.170 (0.160, 0.180)	80.5 (77.4, 83.4)
CKD-EPI 2020 eGFRcr-cys-BTP	795	-2.2 (-3.4, -0.8)	20.4 (18.9, 22.1)	93.6 (91.8, 95.2)	0.163 (0.153, 0.173)	75.1 (72.0, 78.0)
CKD-EPI 2020 eGFRcr-cys-B2M	773	-2.5 (-4.0, -1.2)	21.0 (18.6, 23.0)	93.1 (91.3, 95.0)	0.166 (0.156, 0.176)	73.6 (70.5, 76.7)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	777	-1.6 (-2.7, -0.7)	20.1 (18.4, 22.0)	93.2 (91.4, 94.9)	0.162 (0.152, 0.172)	74.9 (71.9, 77.9)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 16. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by BMI groups without mGFR calibration

CKD-EPI Equation	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
BMI <20 (N = 82)					
CKD-EPI 2021 eGFRcr-cys*	0.4 (-3.3, 3.3)	20.4 (14.2, 27.1)	89.0 (81.7, 95.1)	0.211 (0.172, 0.249)	61.0 (50.0, 70.7)
CKD-EPI 2021 eGFRcr	-4.7 (-7.3, -0.9)	19.2 (13.4, 27.1)	84.1 (75.6, 91.5)	0.219 (0.180, 0.258)	61.0 (51.2, 72.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	0.4 (-2.2, 3.7)	21.2 (13.3, 29.8)	85.4 (78.0, 92.7)	0.330 (0.191, 0.443)	68.3 (58.5, 78.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	-1.0 (-3.2, 3.4)	17.2 (13.5, 22.8)	86.6 (79.3, 93.9)	0.328 (0.190, 0.439)	72.0 (62.2, 81.7)
CKD-EPI 2020 eGFRcr-cys-BTP	1.7 (-0.9, 4.4)	18.2 (12.8, 23.3)	89.0 (81.7, 95.1)	0.234 (0.173, 0.292)	67.1 (57.3, 76.8)
CKD-EPI 2020 eGFRcr-cys-B2M	1.5 (-1.1, 5.0)	20.5 (13.3, 25.4)	92.7 (86.6, 97.6)	0.229 (0.172, 0.285)	65.9 (56.1, 75.6)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	1.3 (-0.4, 4.6)	18.5 (12.7, 23.5)	91.5 (85.4, 96.3)	0.246 (0.175, 0.312)	68.3 (58.5, 78.0)
BMI 20-<25 (N = 692)					
CKD-EPI 2021 eGFRcr-cys*	-0.2 (-1.3, 1.0)	20.1 (18.0, 21.6)	88.3 (85.7, 90.6)	0.208 (0.194, 0.223)	65.6 (62.0, 69.1)
CKD-EPI 2021 eGFRcr	-0.8 (-2.2, 0.3)	18.9 (16.7, 21.0)	87.1 (84.4, 89.6)	0.204 (0.191, 0.216)	64.7 (61.1, 68.2)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	3.3 (1.7, 4.7)	19.0 (17.2, 20.8)	86.7 (84.1, 89.2)	0.249 (0.220, 0.279)	62.3 (58.7, 65.9)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	3.4 (2.2, 5.0)	17.8 (15.8, 19.6)	90.0 (87.7, 92.2)	0.223 (0.197, 0.251)	67.8 (64.3, 71.2)
CKD-EPI 2020 eGFRcr-cys-BTP	1.5 (0.5, 2.5)	17.0 (15.3, 18.4)	91.3 (89.2, 93.4)	0.192 (0.178, 0.205)	67.9 (64.4, 71.4)
CKD-EPI 2020 eGFRcr-cys-B2M	2.0 (0.9, 3.2)	19.0 (17.4, 20.5)	88.7 (86.3, 91.0)	0.207 (0.194, 0.221)	64.9 (61.4, 68.4)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	1.5 (0.6, 2.5)	17.4 (15.7, 19.1)	90.3 (88.0, 92.5)	0.201 (0.186, 0.216)	67.8 (64.3, 71.2)
BMI 25-<30 (N = 878)					
CKD-EPI 2021 eGFRcr-cys*	-0.9 (-1.8, 0.3)	18.9 (17.5, 20.4)	90.1 (88.1, 92.0)	0.192 (0.181, 0.205)	65.4 (62.3, 68.5)
CKD-EPI 2021 eGFRcr	-1.5 (-2.4, -0.2)	18.3 (16.3, 20.2)	88.5 (86.4, 90.4)	0.192 (0.183, 0.201)	62.9 (59.6, 65.8)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	1.4 (0.6, 3.0)	19.3 (17.7, 21.5)	87.6 (85.3, 89.7)	0.219 (0.202, 0.238)	60.6 (57.4, 63.8)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	2.0 (1.1, 3.2)	17.1 (15.7, 18.7)	90.3 (88.4, 92.3)	0.206 (0.188, 0.226)	65.5 (62.4, 68.7)
CKD-EPI 2020 eGFRcr-cys-BTP	0.5 (-0.4, 1.5)	17.1 (15.8, 18.1)	92.6 (90.7, 94.3)	0.177 (0.166, 0.189)	67.5 (64.4, 70.5)
CKD-EPI 2020 eGFRcr-cys-B2M	1.2 (0.2, 2.3)	18.1 (16.7, 19.4)	91.5 (89.5, 93.4)	0.189 (0.178, 0.201)	64.7 (61.6, 67.9)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	0.8 (-0.6, 1.5)	17.3 (15.9, 18.7)	91.5 (89.5, 93.4)	0.185 (0.173, 0.198)	66.2 (63.1, 69.4)
BMI ≥30 (N = 588)					
CKD-EPI 2021 eGFRcr-cys*	-2.3 (-3.7, -1.2)	17.5 (16.2, 19.7)	88.1 (85.4, 90.6)	0.192 (0.180, 0.205)	63.4 (59.4, 67.3)
CKD-EPI 2021 eGFRcr	-4.5 (-6.0, -3.3)	20.0 (18.0, 22.0)	80.4 (77.2, 83.7)	0.224 (0.212, 0.238)	56.8 (52.9, 60.5)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	-2.5 (-3.4, -0.8)	18.1 (16.0, 20.3)	85.2 (82.1, 87.9)	0.211 (0.196, 0.226)	61.6 (57.3, 65.1)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	-0.9 (-2.2, 0.1)	16.9 (15.3, 19.3)	88.1 (85.4, 90.6)	0.196 (0.182, 0.211)	66.3 (62.4, 69.8)
CKD-EPI 2020 eGFRcr-cys-BTP	-0.7 (-1.9, 0.1)	15.0 (13.6, 17.1)	92.3 (90.0, 94.4)	0.171 (0.160, 0.184)	68.5 (64.5, 71.9)
CKD-EPI 2020 eGFRcr-cys-B2M	-1.1 (-2.0, -0.4)	16.5 (14.6, 18.4)	91.5 (89.1, 93.5)	0.182 (0.171, 0.195)	64.3 (60.2, 67.9)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	-0.9 (-1.9, -0.2)	15.6 (13.5, 17.5)	91.8 (89.5, 93.9)	0.175 (0.164, 0.188)	68.0 (64.1, 71.4)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

Table 17. Performance of CKD-EPI creatinine, cystatin C, B2M and BTP equations by diabetes groups without mGFR calibration

CKD-EPI Equation	Bias (median)	Precision (IQR)	Accuracy (P ₃₀)	Accuracy (RMSE)	Concordance
Diabetes (N = 731)					
CKD-EPI 2021 eGFRcr-cys*	-3.8 (-5.0, -2.8)	16.4 (15.1, 18.1)	88.2 (85.9, 90.6)	0.190 (0.180, 0.200)	61.0 (57.5, 64.4)
CKD-EPI 2021 eGFRcr	-5.8 (-6.6, -4.4)	18.1 (16.5, 19.5)	82.4 (79.5, 85.0)	0.212 (0.201, 0.224)	56.0 (52.4, 59.5)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	-2.7 (-3.3, -2.0)	13.8 (12.3, 15.5)	88.4 (85.9, 90.6)	0.215 (0.187, 0.245)	63.1 (59.5, 66.6)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	-0.1 (-0.9, 0.9)	12.8 (12.0, 14.4)	92.1 (90.0, 94.0)	0.196 (0.169, 0.225)	68.7 (65.4, 72.1)
CKD-EPI 2020 eGFRcr-cys-BTP	-1.3 (-2.0, -0.4)	13.6 (12.5, 14.8)	93.2 (91.4, 94.8)	0.167 (0.155, 0.179)	67.2 (63.7, 70.6)
CKD-EPI 2020 eGFRcr-cys-B2M	-2.3 (-3.3, -1.5)	14.5 (13.4, 16.0)	91.4 (89.3, 93.3)	0.177 (0.166, 0.189)	64.2 (60.7, 67.6)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	-1.3 (-2.1, -0.5)	13.9 (12.6, 15.1)	92.6 (90.7, 94.5)	0.171 (0.158, 0.185)	66.6 (63.3, 70.0)
non-Diabetes (N = 1374)					
CKD-EPI 2021 eGFRcr-cys*	0.3 (-0.8, 1.4)	20.3 (19.0, 21.6)	88.7 (87.0, 90.4)	0.205 (0.195, 0.216)	65.7 (63.1, 68.3)
CKD-EPI 2021 eGFRcr	-0.8 (-1.6, 0.1)	19.4 (17.7, 21.0)	86.7 (84.8, 88.4)	0.205 (0.196, 0.214)	64.0 (61.6, 66.5)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR B2M	2.6 (1.3, 3.6)	20.7 (19.3, 22.1)	85.4 (83.5, 87.3)	0.240 (0.225, 0.258)	61.4 (58.9, 64.0)
Average CKD-EPI 2021 eGFRcr and 2020 eGFR BTP	2.0 (0.9, 2.9)	19.4 (18.0, 20.7)	87.7 (85.9, 89.4)	0.227 (0.211, 0.244)	65.1 (62.6, 67.7)
CKD-EPI 2020 eGFRcr-cys-BTP	1.3 (0.4, 2.2)	17.9 (16.8, 19.1)	91.0 (89.5, 92.6)	0.193 (0.183, 0.203)	67.6 (65.1, 70.2)
CKD-EPI 2020 eGFRcr-cys-B2M	2.2 (1.4, 3.0)	19.4 (18.1, 20.5)	89.9 (88.2, 91.4)	0.204 (0.194, 0.214)	64.8 (62.2, 67.4)
CKD-EPI 2020 eGFRcr-cys-B2M-BTP	1.1 (0.2, 1.9)	18.6 (17.5, 19.9)	90.1 (88.4, 91.6)	0.201 (0.191, 0.212)	67.0 (64.4, 69.6)

Units for Bias and IQR is mL/min/1.73m² and percent for concordance and P₃₀. A positive value for bias indicates eGFR underestimates mGFR, and a negative value indicates eGFR overestimates mGFR. Bias closer to zero is optimal. Lower IQR and RMSE are optimal. Higher P₃₀ and concordance are optimal. * indicates reference equation. Bold font indicates non-overlapping confidence intervals compared to reference equation (absolute values for bias). Red indicates better and green indicates worse performance compared to the reference equation.

Abbreviations: CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; B2M; Beta2-microglobulin; BTP, Beta-trace protein; eGFRcr, estimated glomerular filtration rate based on creatinine; eGFRcr-cys, estimated glomerular filtration rate based on creatinine and cystatin C; eGFR BTP; estimated glomerular filtration rate based on BTP; eGFR B2M; estimated glomerular filtration rate based on B2M; eGFRcr-cys-BTP, estimated glomerular filtration rate based on creatinine, cystatin and BTP; eGFRcr-cys-B2M, estimated glomerular filtration rate based on creatinine, cystatin and B2M; eGFRcr-cys-BTP-B2M, estimated glomerular filtration rate based on creatinine, cystatin, BTP and B2M.

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