Débit de filtration glomérulaire: pour qui? et comment?

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3 mars 2023, Société Marocaine de Néphrologie, Casablanca

Category	Disclosure Information
Employer	Nothing to disclose.
Ownership Interest	Nothing to disclose.
Consultancy	IDS; Nephrolytix; Alentis Therapeutics; ARK Bioscience;
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Honoraria	IDS; Fresenius Kabi; Fresenius Medical Care; Nephrolytix; Alentis Therapeutics; ARK Bioscience; AstraZeneca;
Patents or Royalties	Nothing to disclose.
Advisory or Leadership Role	Nothing to disclose.
Speakers Bureau	Nothing to disclose.
Other Interests or Relationships	Nothing to disclose.

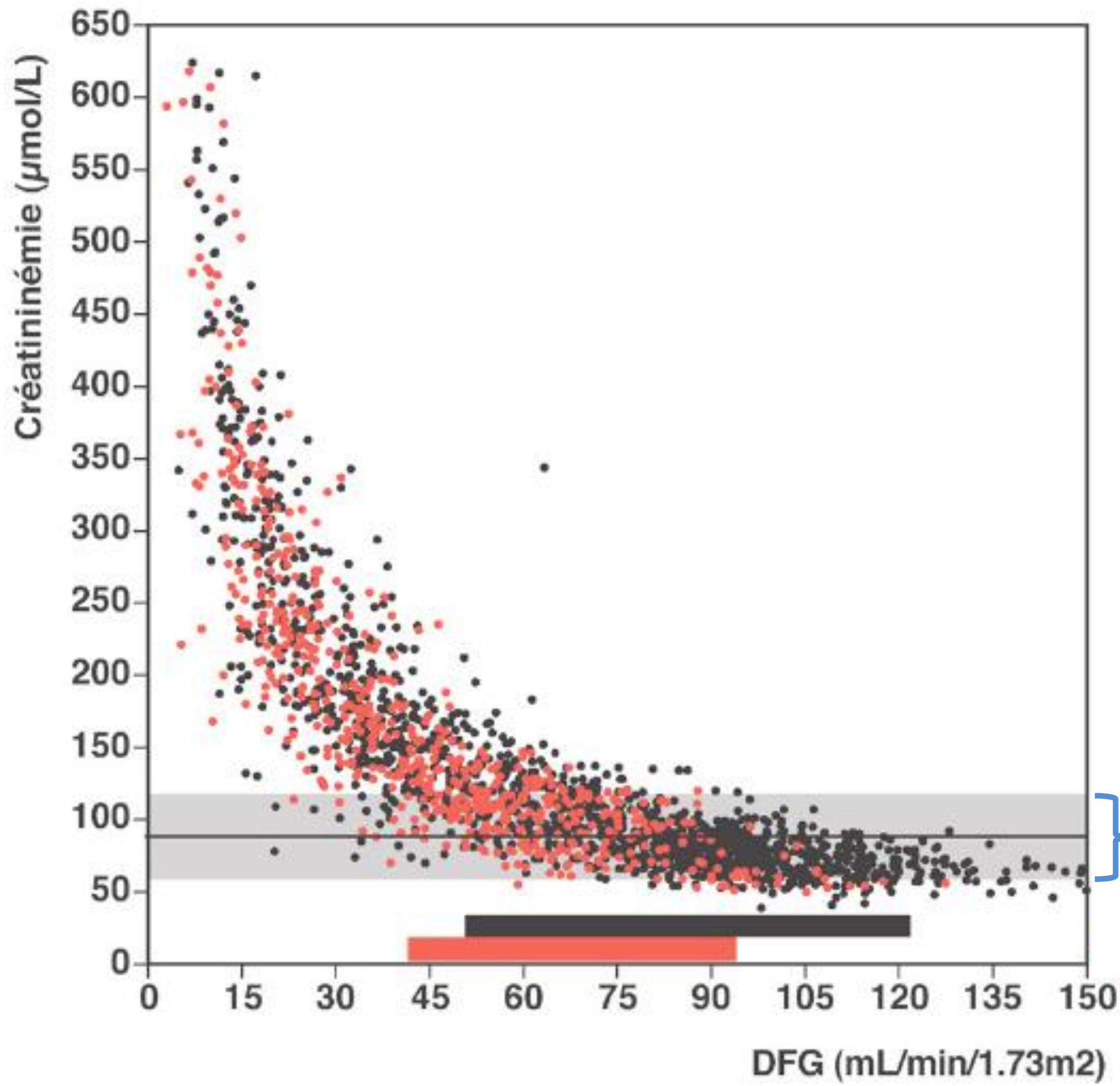
- Estimation du DFG
- Mesure du DFG

- Estimation du DFG
- Mesure du DFG

Créatinine sérique

- Une des analyses les plus prescrites
- …mais important d'en connaitre les limitations
- Limitations physiologiques
- Limitations analytiques
- Limitations "mathématiques"

Perrone RD, Clin Chem, 1992, 38, 1933
Delanaye P, Ann Biol Clin (Paris), 2010, 68, 531



Cohorte NephroTest (France)
Quel DFG correspond à une concentration de créatinine mesurée à 0.9 mg/dL (80 µmol/L) ?

IC 95% pour sujets <65 ans
IC 95% pour sujets >65 ans

Valeurs normales de créatinine

Avec la permission de Marc Froissart

Créatinine: « limitations mathématiques »

- Relation hyperbolique entre créatinine et DFG!!!

Pour un patient donné,

si la créatinine augmente de 0.6 à 1.2 mg/dl
=> diminution du DFG de 50%

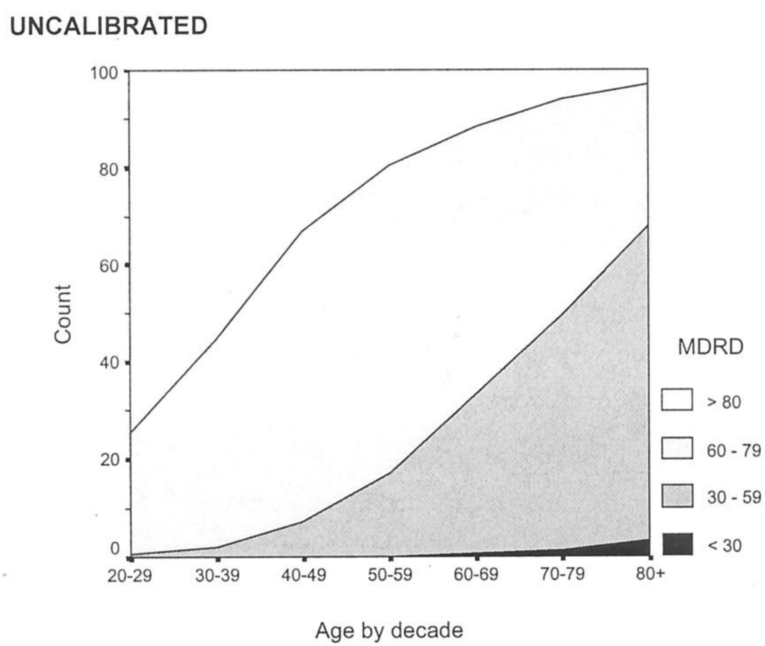
si la créatinine augmente de 2.0 à 3.0 mg/dl
=> diminution du DFG de 25%

Mesure de la créatinine sérique
Limitations analytiques

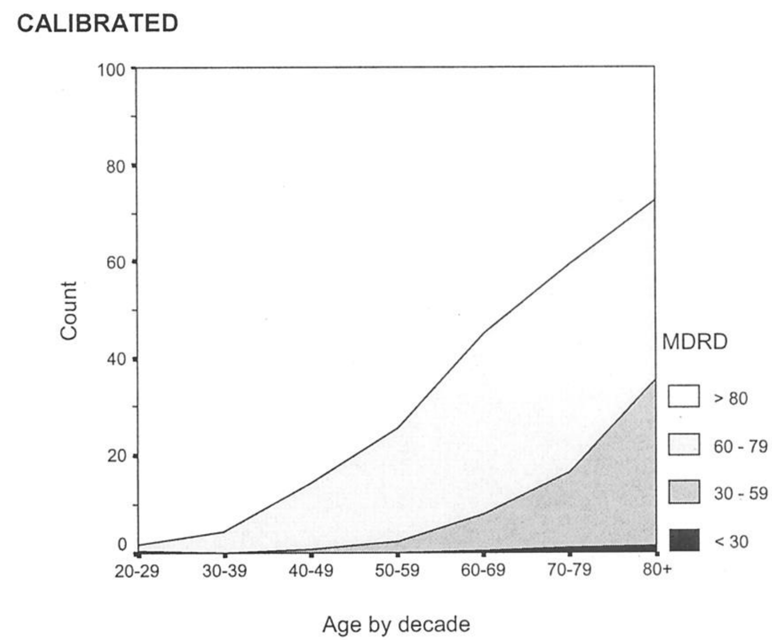
- Méthodes de Jaffe
- Méthodes enzymatiques
- Différentes méthodes mais aussi différents « assays »
- Interférences

Perrone RD, Clin Chem, 1992, 38, 1933
Delanaye P, Ann Biol Clin (Paris), 2010, 68, 531

Mesure de la créatinine sérique
Limitations analytiques



N	3037	2827	2138	1422	1670	1241	916	Total 13251
≥ 80	74.6%	55.2%	33.0%	19.5%	11.7%	6.1%	2.8%	41.8%
60-79	24.8%	42.7%	59.7%	63.3%	54.9%	44.2%	29.4%	45.4%
30-59	0.6%	2.0%	7.2%	17.2%	32.7%	48.5%	64.6%	12.5%
< 30	<0.1%	<0.1%	<0.1%	<0.1%	0.7%	1.2%	3.2%	0.3%



3037	2827	2138	1422	1670	1241	916	Total 13251
98.3%	95.7%	85.7%	74.4%	55.1%	40.7%	27.5%	82.1%
1.5%	4.2%	13.5%	23.3%	36.9%	42.7%	37.0%	14.5%
0.2%	<0.1%	0.8%	2.4%	7.6%	15.7%	34.3%	3.2%
<0.1%	<0.1%	<0.1%	<0.1%	0.5%	0.9%	1.2%	0.2%

Coresh, J. et al. J Am Soc Nephrol 2002;13:2811-2816

Beaucoup de progrès ces dernières années…

Clinica Chimica Acta 412 (2011) 2070–2075

Contents lists available at ScienceDirect

Clinica Chimica Acta

journal homepage: www.elsevier.com/locate/clinchim

A multicentric evaluation of IDMS-traceable creatinine enzymatic assays

Laurence Piéroni [a], Pierre Delanaye [b,*], Anne Boutten [c], Anne-Sophie Bargnoux [d], Eric Rozet [e], Vincent Delatour [f], Marie-Christine Carlier [g], Anne-Marie Hanser [h], Etienne Cavalier [i], Marc Froissart [j], and Jean-Paul Cristol [d]
On behalf of the Société Française de Biologie Clinique [1]

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[b] Nephrology–Dialysis–Transplantation, University of Liège, CHU Sart Tilman, Liège, Belgium
[c] Biochimie, CHU Bichat, APHP, Paris, France
[d] Biochimie, CHU Lapeyronie, Montpellier, France
[e] Analytical Chemistry Laboratory, CIRM, University of Liège, Liège, Belgium
[f] Laboratoire National de Métrologie et d'Essais, Paris, France
[g] Biochimie, Hôpitaux de Lyon Sud, Lyon, France
[h] Biochimie, Hospices civils, Colmar, France
[i] Clinical Chemistry, University of Liège, CHU Sart Tilman, Liège, Belgium
[j] Physiologie Rénale, Hôpital Européen Georges Pompidou, APHP, Paris, France

Limitations physiologiques

- Sécrétion tubulaire de créatinine

10 to 40%

Sécrétion augmente alors que DFG diminue

Non prédictible à l'échelon individuel

- Production extra-rénale

Perrone RD, Clin Chem, 1992, 38, 1933
Delanaye P, Ann Biol Clin (Paris), 2010, 68, 531

Limitations physiologiques

- Production (relativement) constante d'origine musculaire => la concentration de créatinine dépend de la masse musculaire, pas seulement du DFG
  - genre
  - âge
  - Ethnicité ?
  - Masse musculaire

Perrone RD, Clin Chem, 1992, 38, 1933
Delanaye P, Ann Biol Clin (Paris), 2010, 68, 531

Créatinine et médicaments

- Inhibiteurs de la sécrétion tubulaire

  cimétidine, triméthoprime, dolutegravir

- Fibrates
- Interactions « à hautes concentrations »

  acétylcystéine, dobutamine, lidocaine, ascorbate

Perrone RD, Clin Chem, 1992, 38, 1933
Delanaye P, Ann Biol Clin (Paris), 2010, 68, 531
Delanaye P, Nephron Clin Pract, 2011, 119, c187

Créatinine: à la poubelle?

- Bon marché! (0.04€ /Jaffe)
- Bonne spécificité
- Bon CV analytique
- Préférence pour les méthodes enzymatiques

Clairance de créatinine

- N'est recommandée par aucun guidelines
- Sécrétion tubulaire
- Manque de précision:

erreurs dans la collecte

22 à 27% chez les patients « entrainés »
50 to 70 % pour les autres

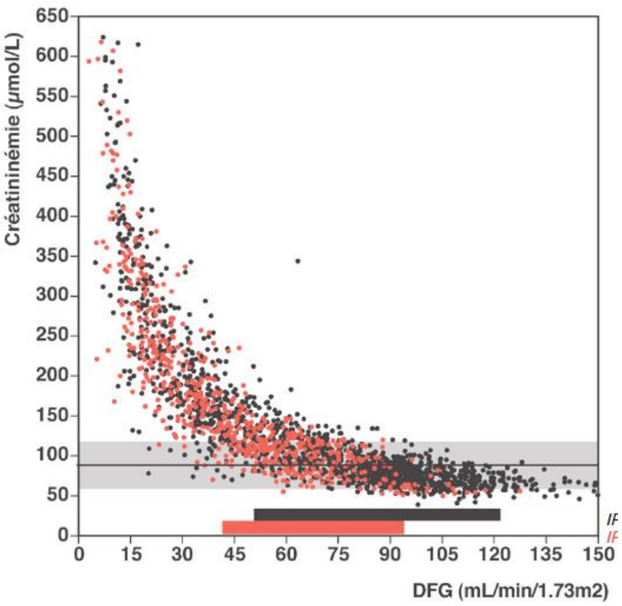
importante variabilité intra-individuelle de l'excrétion urinaire de créatinine

KDIGO, Kidney Int, 2012, 3
Perrone RD, Clin Chem, 1992, 38, 1933
Delanaye P, Ann Biol Clin (Paris), 2010, 68, 531

Equations basées sur la créatinine

But des équations:

- Conceptualiser la relation hyperbolique
- Adapter la créatinine pour l'âge, le genre, l'ethnicité
- Diminuer l'IC (?)

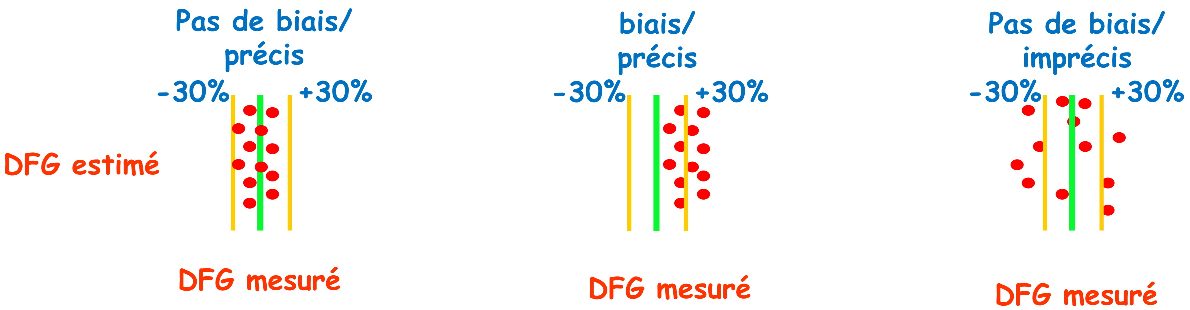


Quelles équations?

- Cockcroft
- MDRD
- CKD-EPI
- EKFC

Statistiques

- Corrélation: une condition “*sine qua non”* mais insuffisante!
- Biais: différence moyenne entre 2 valeurs = erreur systématique
- Précision: SD autour de ce biais = erreur aléatoire
- Exactitude 30% = % du DFG estimée dans ± 30% du DFG mesuré



Bland JM, Altman DG, Lancet, 1986, 8476, 307
Delanaye P, Nephrol Dial Transplant, 2013, 28, 1396

Table 1. MDRD study equations and Cockcroft equation commonly used for GFR estimation

Cockcroft and Gault

$$\text{GFR (ml/min)} = \frac{(140 - \text{age}) \times \text{weight (kg)}}{7.2 \times \text{SCr (mg/dl)}} \times 0.85 \text{ if woman}$$

Cockcroft DW, Nephron, 1976, 16, p31
Levey AS, Ann Intern Med, 1999, 130, p461

Received: 24 June 2021 | Revised: 4 October 2021 | Accepted: 19 October 2021
DOI: 10.1111/bcp.15132

ORIGINAL ARTICLE

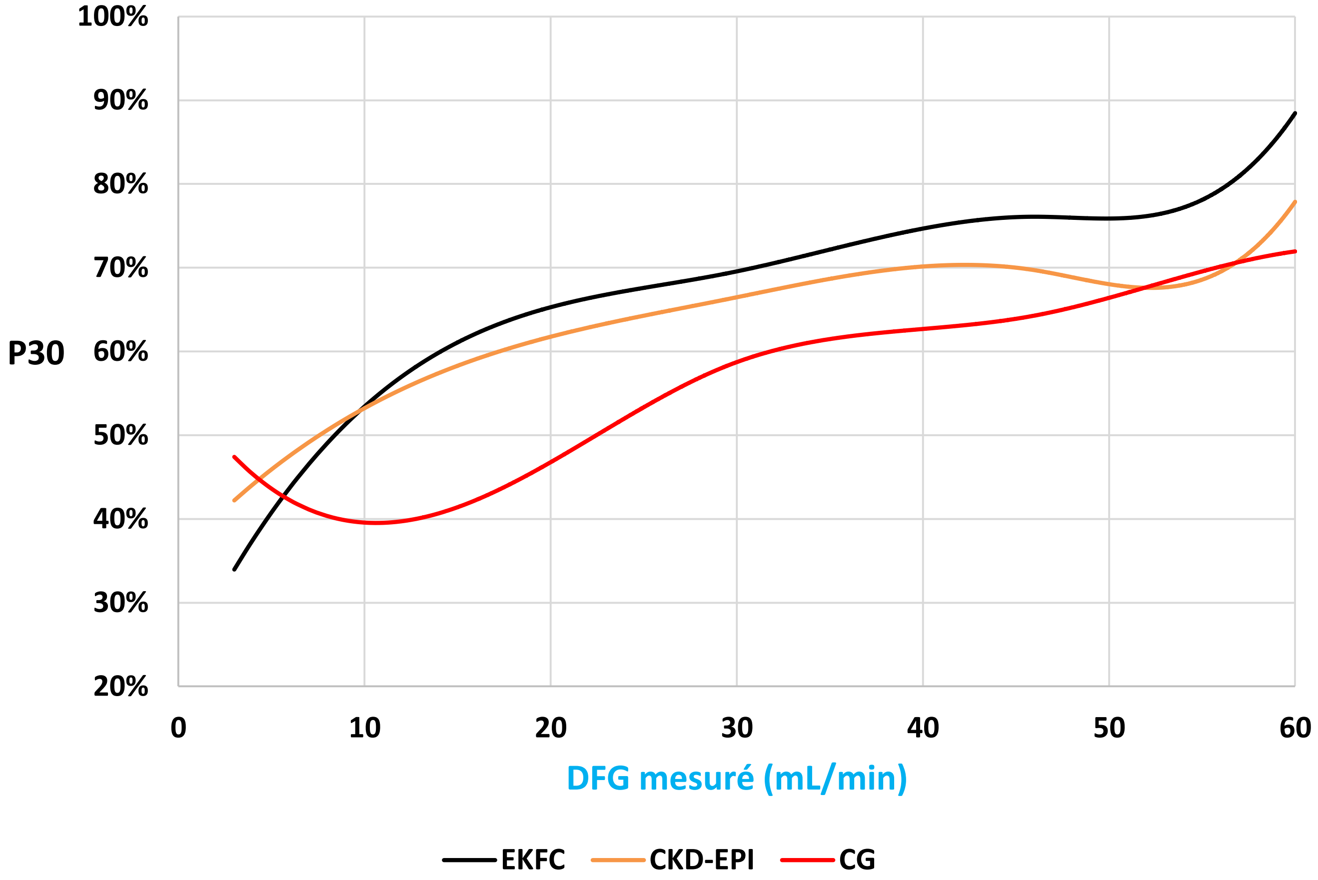
BJCP BRITISH PHARMACOLOGICAL SOCIETY

Performance of creatinine-based equations to estimate glomerular filtration rate with a methodology adapted to the context of drug dosage adjustment

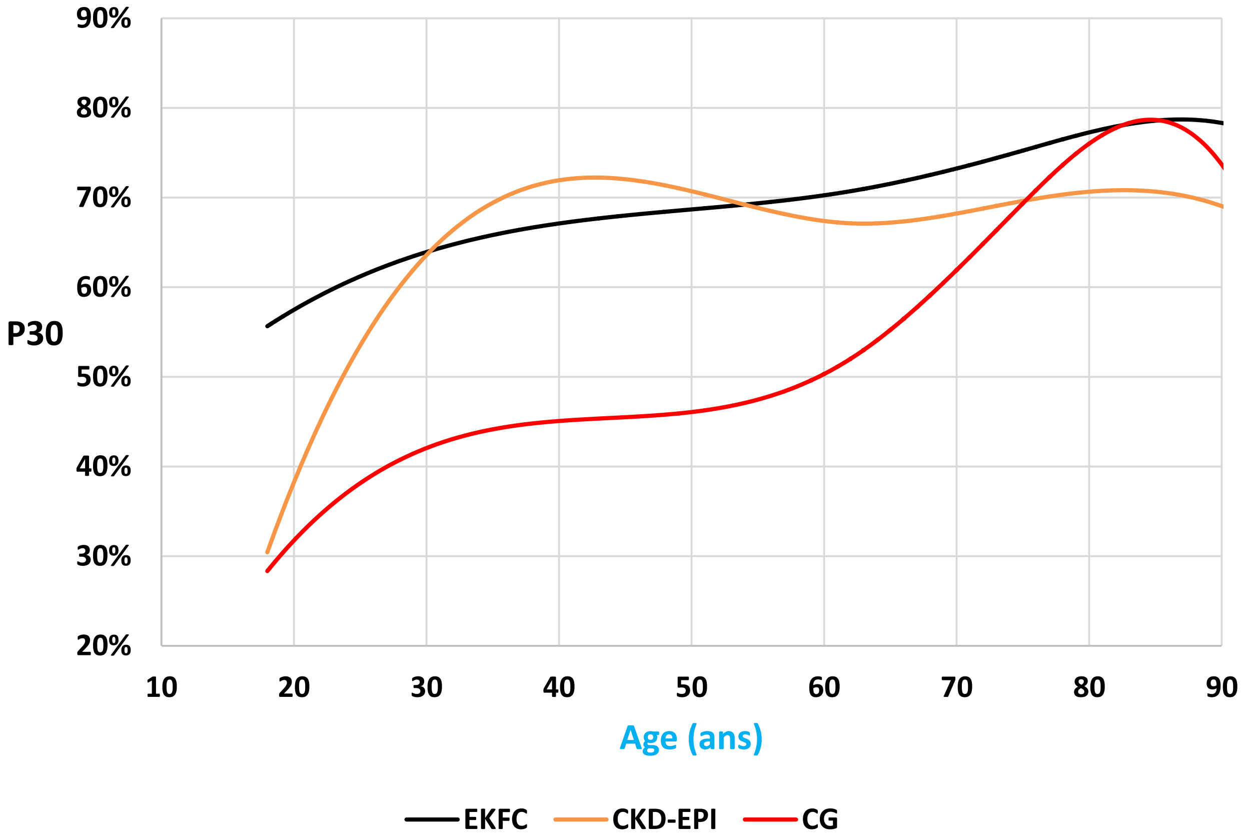
Pierre Delanaye[1,2] | Jonas Björk[3,4] | Marie Courbebaisse[5] | Lionel Couzi[6] | Natalie Ebert[7] | Björn O. Eriksen[8] | R. Neil Dalton[9] | Laurence Dubourg[10] | Francois Gaillard[11] | Cyril Garrouste[12] | Anders Grubb[13] | Lola Jacquemont[14] | Magnus Hansson[15] | Nassim Kamar[16] | Edmund J. Lamb[17] | Christophe Legendre[18] | Karin Littmann[19] | Christophe Mariat[20] | Toralf Melsom[8] | Lionel Rostaing[21] | Andrew D. Rule[22] | Elke Schaeffner[7] | Per-Ola Sundin[23] | Ulla B. Berg[24] | Kajsa Åsling-Monemi[24] | Luciano Selistre[25] | Anna Åkesson[3,4] | Anders Larsson[26] | Arend Bökenkamp[27] | Hans Pottel[28] | Ulf Nyman[29]

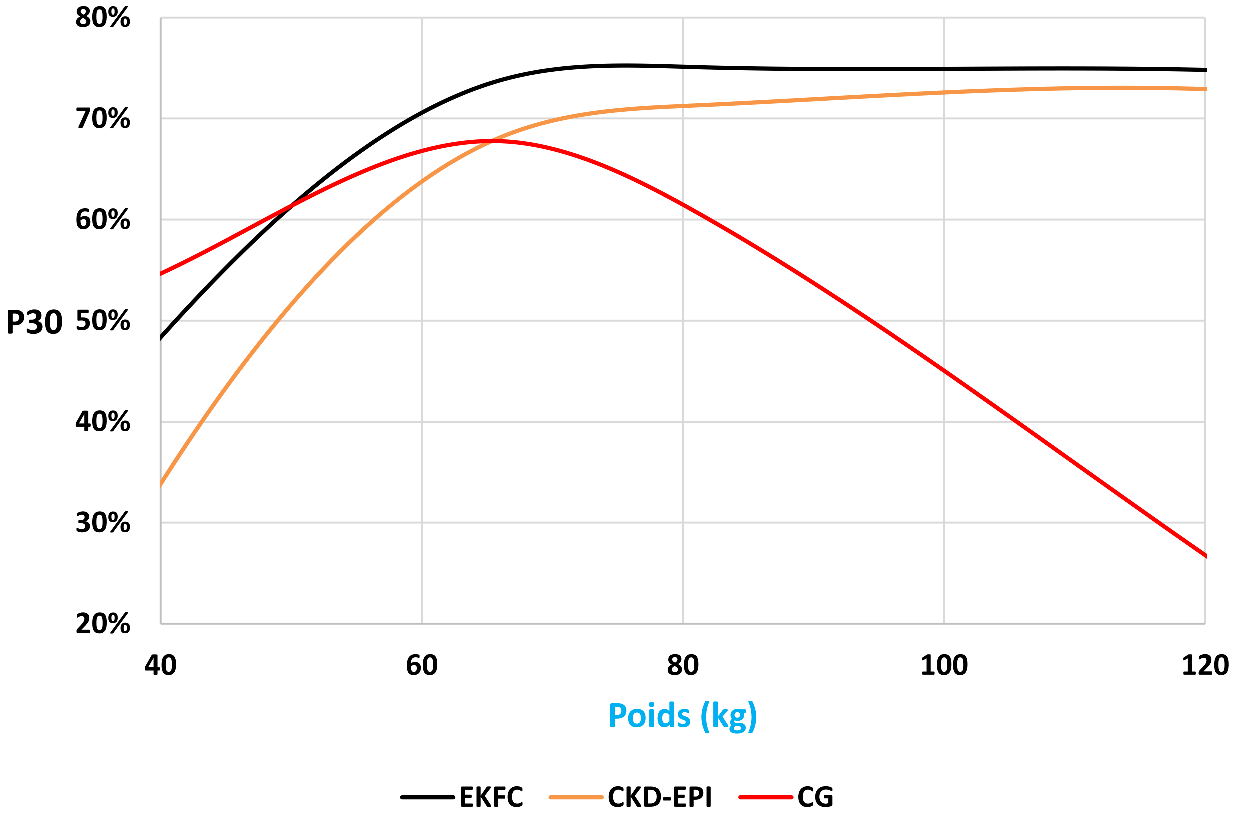
Br J Clin Pharmacol. 2022;88:2118–2127.

- 14,804 participants (adultes)
- Cockcroft, CKD-EPI et EKFC
- De-indexé
- Focus sur DFG< 60 mL/min (n=4328)

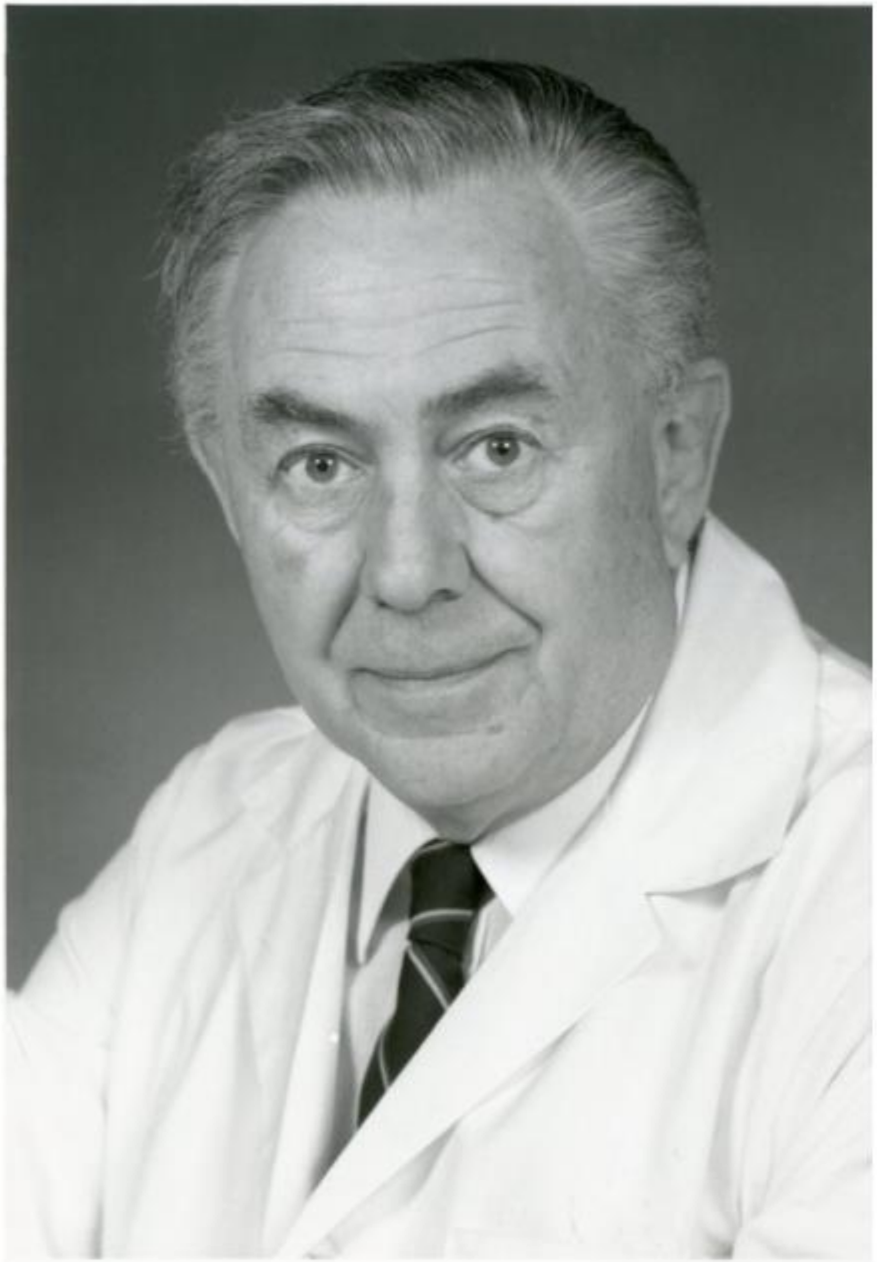


100%
90%
80%
70%
P30
60%
50%
40%
30%
20%
0
10
20
30
40
50
60
DFG mesuré (mL/min)
EKFC
CKD-EPI
CG


P30
90%
80%
70%
60%
50%
40%
30%
20%
10
20
30
40
50
60
70
80
90
Age (ans)
EKFC
CKD-EPI
CG


80%
70%
60%
P30
50%
40%
30%
20%
40
60
80
100
120
Poids (kg)
EKFC
CKD-EPI
CG

Dr. Do



, MD, FRCPC

Profe

Medicine

Equation CKD-EPI

ARTICLE | Annals of Internal Medicine

A New Equation to Estimate Glomerular Filtration Rate

Andrew S. Levey, MD; Lesley A. Stevens, MD, MS; Christopher H. Schmid, PhD; Yaping (Lucy) Zhang, MS; Alejandro F. Castro III, MPH; Harold I. Feldman, MD, MSCE; John W. Kusek, PhD; Paul Eggers, PhD; Frederick Van Lente, PhD; Tom Greene, PhD; and Josef Coresh, MD, PhD, MHS, for the CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration)*

Ann Intern Med. 2009;150:604-612.

Table 2. The CKD-EPI Equation for Estimating GFR on the Natural Scale*

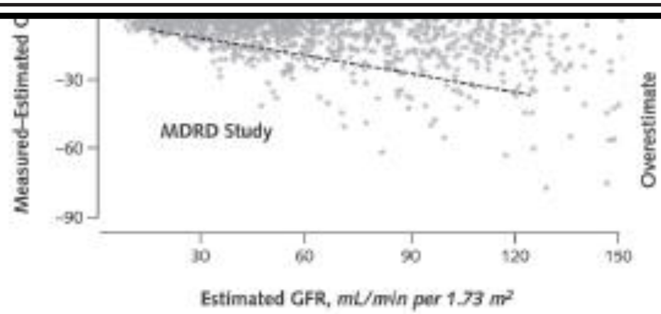
Race and Sex	Serum Creatinine Level, *µmol/L (mg/dL)*	Equation
Black		
Female	≤62 (≤0.7)	$GFR = 166 \times (Scr/0.7)^{-0.329} \times (0.993)^{Age}$
	>62 (>0.7)	$GFR = 166 \times (Scr/0.7)^{-1.209} \times (0.993)^{Age}$
Male	≤80 (≤0.9)	$GFR = 163 \times (Scr/0.9)^{-0.411} \times (0.993)^{Age}$
	>80 (>0.9)	$GFR = 163 \times (Scr/0.9)^{-1.209} \times (0.993)^{Age}$
White or other		
Female	≤62 (≤0.7)	$GFR = 144 \times (Scr/0.7)^{-0.329} \times (0.993)^{Age}$
	>62 (>0.7)	$GFR = 144 \times (Scr/0.7)^{-1.209} \times (0.993)^{Age}$
Male	≤80 (≤0.9)	$GFR = 141 \times (Scr/0.9)^{-0.411} \times (0.993)^{Age}$
	>80 (>0.9)	$GFR = 141 \times (Scr/0.9)^{-1.209} \times (0.993)^{Age}$

- CKD-EPI
- “Development dataset”: n=5504
- “Internal validation”: n=2750
- “External validation”: n=3896
- Créatinine calibrée
- DFG médian = 68 mL/min/1.73 m^2

Figure. Performance of the CKD-EPI and MDRD Study equations in estimating measured GFR in the external validation data set.

Table 3. Comparison of the CKD-EPI and MDRD Study Equations in Estimating Measured GFR in the Validation Data Set*

Variable and Equation	All Patients	Patients With Estimated GFR <60 mL/min per 1.73 m²	Patients With Estimated GFR ≥60 mL/min per 1.73 m²
Median difference (95% CI), *mL/min per 1.73 m²*†			
CKD-EPI	2.5 (2.1–2.9)	2.1 (1.7–2.4)	3.5 (2.6–4.5)
MDRD Study	5.5 (5.0–5.9)	3.4 (2.9–4.0)	10.6 (9.8–11.3)
Interquartile range for differences (95% CI), *mL/min per 1.73 m²*‡			
CKD-EPI	16.6 (15.9–17.3)	11.3 (10.7–12.1)	24.2 (22.8–25.3)
MDRD Study	18.3 (17.4–19.3)	12.9 (12.0–13.6)	25.7 (24.4–27.1)
P_{30} (95% CI), %§			
CKD-EPI	84.1 (83.0–85.3)	79.9 (78.1–81.7)	88.3 (86.9–89.7)
MDRD Study	80.6 (79.5–82.0)	77.2 (75.5–79.0)	84.7 (83.0–86.3)
Root mean square error (95% CI)			
CKD-EPI	0.250 (0.241–0.259)	0.284 (0.270–0.298)	0.213 (0.203–0.223)
MDRD Study	0.274 (0.265–0.283)	0.294 (0.280–0.308)	0.248 (0.238–0.258)



KDIGO®

KIDNEY DISEASE · IMPROVING GLOBAL OUTCOMES

MDRD – CKD-EPI: What else?

- Equation Bis
- Equation Lund-Malmö
- Equation EKFC
- Autre biomarqueurs: cystatine C

Schaeffner, Ann intern Med, 2012, 157, 471
Bjork, Scand J Urol Nephrol, 2012, 46, 212
Pottel H, Nephrol Dial Transplant, 2016
Seronie-Vivien, CCLM, 2008

Annals of Internal Medicine | ORIGINAL RESEARCH

Two Novel Equations to Estimate Kidney Function in Persons Aged 70 Years or Older

Elke S. Schaeffner, MD, MS*; Natalie Ebert, MD, MPH*; Pierre Delanaye, MD, PhD; Ulrich Frei, MD; Jens Gaedeke, MD; Olga Jakob; Martin K. Kuhlmann, MD; Mirjam Schuchardt, PhD; Markus Tölle, MD; Reinhard Ziebig, PhD; Markus van der Giet, MD; and Peter Martus, PhD

BIS1:

$$3736 \times \text{creatinine}^{-0.87} \times \text{age}^{-0.95} \times 0.82 \text{ (si femme)}$$

- n=610, iohexol, créatinine enzymatique calibrée
- DFG moyen = 52 mL/min/1,73 m²

Ann Intern Med. 2012;157:471-481

Ulf Nyman*, Anders Grubb, Anders Larsson, Lars-Olof Hansson, Mats Flodin, Gunnar Nordin, Veronica Lindström and Jonas Björk

The revised Lund-Malmö GFR estimating equation outperforms MDRD and CKD-EPI across GFR, age and BMI intervals in a large Swedish population

Clin Chem Lab Med 2014, 52(6), 815-824

Revised Lund-Malmö Study equation (LM Revised) [34]

$e^{X-0.0158\times Age+0.438\times \ln(Age)}$

Female	pCr<150 µmol/L:	$X=2.50+0.0121\times(150-pCr)$
Female	pCr≥150 µmol/L:	$X=2.50-0.926\times\ln(pCr/150)$
Male	pCr<180 µmol/L:	$X=2.56+0.00968\times(180-pCr)$
Male	pCr≥180 µmol/L:	$X=2.56-0.926\times\ln(pCr/180)$

- Lund-Malmö
- n=3495 (chez 2847 sujets), iohexol, créatinine calibrée
- DFG moyen = 60 mL/min/1,73 m²

Ann Intern Med. 2021;174:183-191. doi:10.7326/M20-4366

Annals of Internal Medicine

ORIGINAL RESEARCH

Development and Validation of a Modified Full Age Spectrum Creatinine-Based Equation to Estimate Glomerular Filtration Rate

A Cross-sectional Analysis of Pooled Data

Hans Pottel, PhD*; Jonas Björk, PhD*; Marie Courbebaisse, MD, PhD; Lionel Couzi, MD, PhD; Natalie Ebert, MD, MPH; Björn O. Eriksen, MD, PhD; R. Neil Dalton, PhD; Laurence Dubourg, MD, PhD; François Gaillard, MD, PhD; Cyril Garrouste, MD; Anders Grubb, MD, PhD; Lola Jacquemont, MD, PhD; Magnus Hansson, MD, PhD; Nassim Kamar, MD, PhD; Edmund J. Lamb, PhD; Christophe Legendre, MD; Karin Littmann, MD; Christophe Mariat, MD, PhD; Toralf Melsom, MD, PhD; Lionel Rostaing, MD, PhD; Andrew D. Rule, MD; Elke Schaeffner, MD, PhD, MSc; Per-Ola Sundin, MD, PhD; Stephen Turner, MD, PhD; Arend Bökenkamp, MD; Ulla Berg, MD, PhD; Kajsa Åsling-Monemi, MD, PhD; Luciano Selistre, MD, PhD; Anna Åkesson, BSc; Anders Larsson, MD, PhD; Ulf Nyman, MD, PhD†; and Pierre Delanaye, MD, PhD†

- Sujets avec DFG mesuré et créatinine standardisée
- n=11,251 “développement et validation interne”
- n=8,378 “validation externe”
- n=1,254 âge entre 2 et 18 ans
- 7 + 6 cohortes
- « Caucasiens »

Figure 1. The new EKFC equation.

Age	SCr/Q	Equation
2–40 y	<1	$107.3 \times (SCr/Q)^{-0.322}$
	≥1	$107.3 \times (SCr/Q)^{-1.132}$
>40 y	<1	$107.3 \times (SCr/Q)^{-0.322} \times 0.990^{(Age-40)}$
	≥1	$107.3 \times (SCr/Q)^{-1.132} \times 0.990^{(Age-40)}$

Q Values

For ages 2–25 y:

Males:

$$\ln(Q) = 3.200 + 0.259 \times Age - 0.543 \times \ln(Age) - 0.00763 \times Age^2 + 0.0000790 \times Age^3$$

Females:

$$\ln(Q) = 3.080 + 0.177 \times Age - 0.223 \times \ln(Age) - 0.00596 \times Age^2 + 0.0000686 \times Age^3$$

For ages >25 y:

Males:

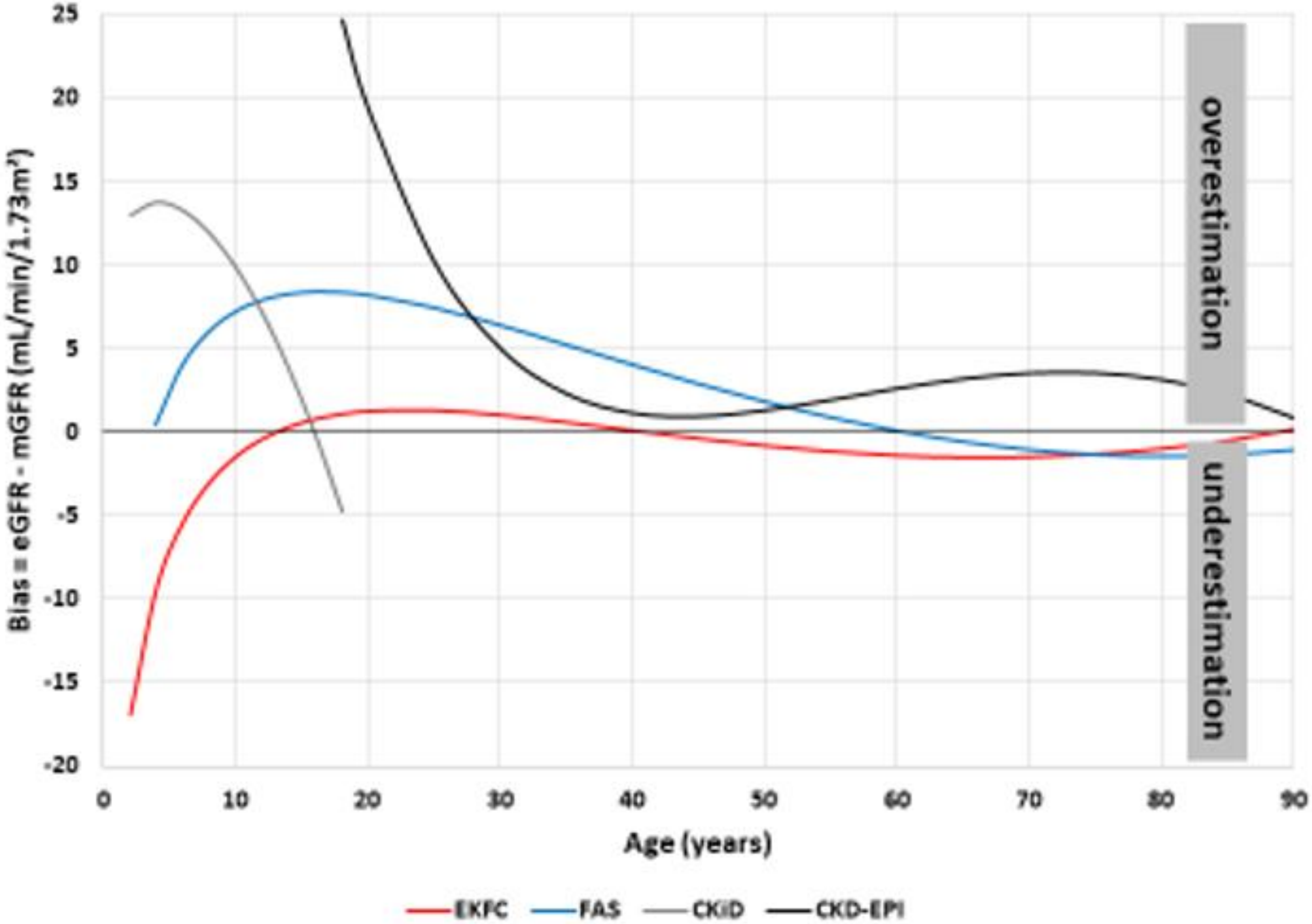
Q = 80 µmol/L (0.90 mg/dL)

Females:

Q = 62 µmol/L (0.70 mg/dL)

SCr and Q in µmol/L (to convert to mg/dL, divide by 88.4)

Q values (in µmol/L or mg/dL) correspond to the median SCr values for the age- and sex-specific populations. EKFC = European Kidney Function Consortium; SCr = serum creatinine.



25
20
15
10
5
0
-5
-10
-15
-20
Bias = eGFR - mGFR (mL/min/1.73m²)
overestimation
underestimation
0
10
20
30
40
50
60
70
80
90
Age (years)
EKFC
FAS
CKiD
CKD-EPI

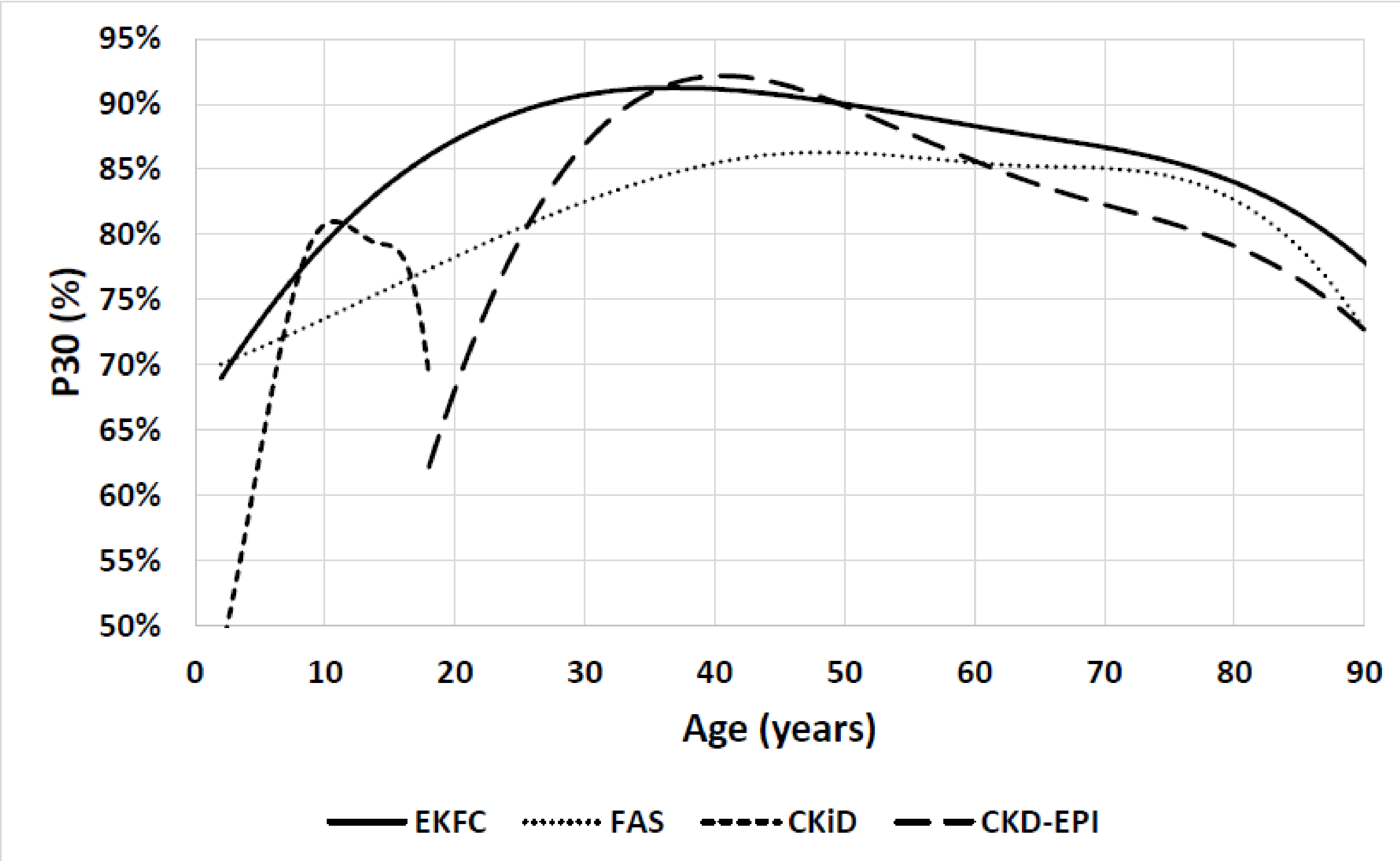


Figure S8. P30-accuracy against age for the EKFC, FAS, CKiD and CKD-EPI equation in the external validation dataset. P30 (%) was graphically presented across the age spectrum using cubic splines with two free knots and using 3rd degree polynomials.

Avantages de EKFC

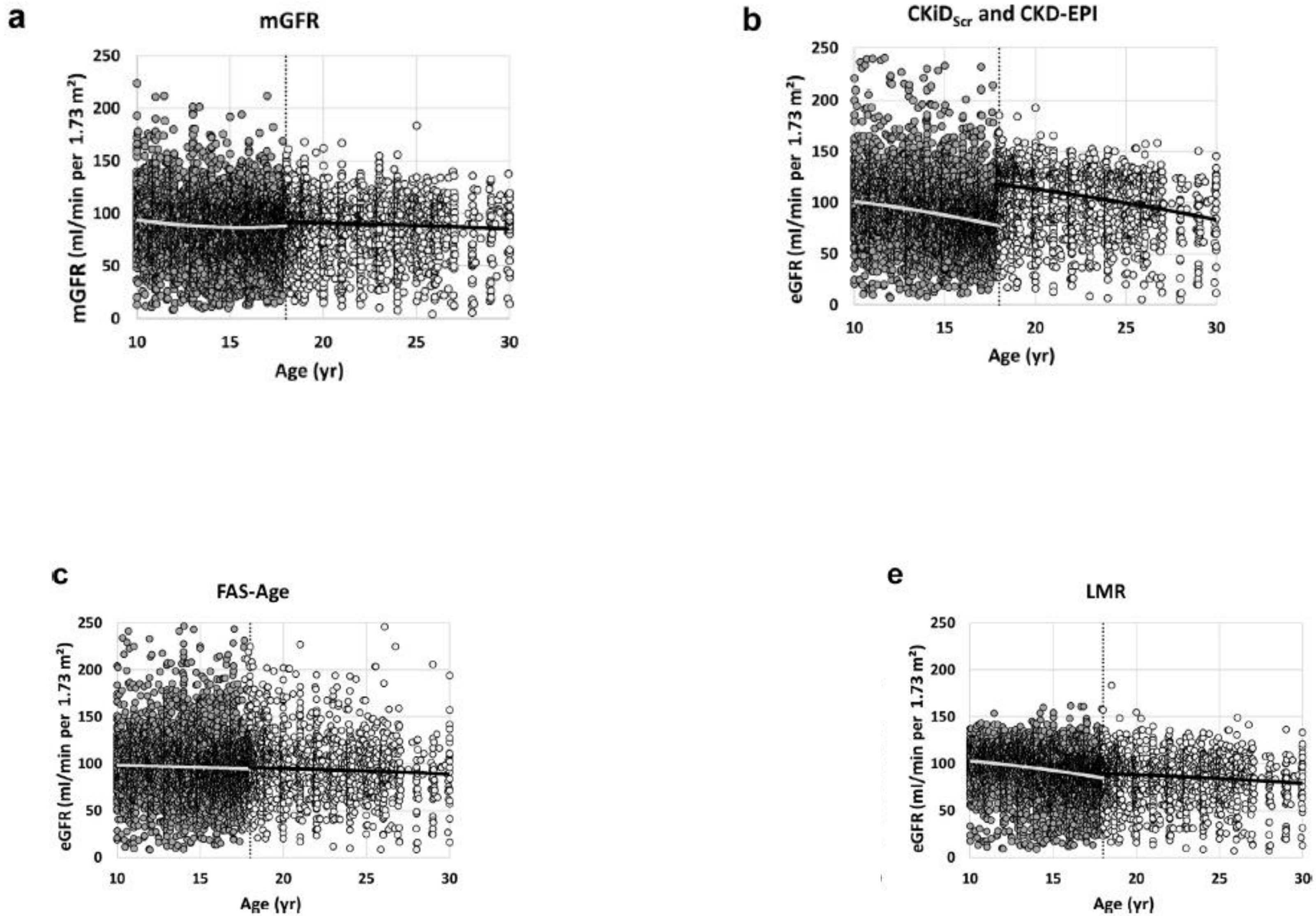
- Meilleures performances (pas plus cher)
- Plus « physiologique »: correction au niveau de la créatinine (sexe, « race »), âge mieux conceptualisé, « Q » spécifique pour des populations spécifiques
- Valide à tout âge (et pas de « jump » à 18 ans)
- Enfant: pas besoin de la taille
- Même formule (« concept ») pour la cystatine C (et les autres biomarqueurs)

Estimating glomerular filtration rate at the transition from pediatric to adult care

Hans Pottel[1,13], Jonas Björk[2,3,13], Arend Bökenkamp[4,13], Ulla Berg[5], Kajsa Åsling-Monemi[5], Luciano Selistre[6], Laurence Dubourg[7,13], Magnus Hansson[8], Karin Littmann[8], Ian Jones[9], Per Sjöström[9], Ulf Nyman[10,12,13] and Pierre Delanaye[11,12,13]

[1]*Department of Public Health and Primary Care, Katholieke Universiteit Leuven Campus Kulak Kortrijk, Kortrijk, Belgium;* [2]*Division of Occupational and Environmental Medicine, Lund University, Lund, Sweden;* [3]*Clinical Studies Sweden, Forum South, Skåne University Hospital, Lund, Sweden;* [4]*Emma Children's Hospital, Amsterdam University Medical Center, Vrije Universiteit Amsterdam, Amsterdam, the Netherlands;* [5]*Department of Clinical Science, Intervention, and Technology, Division of Pediatrics, Karolinska Institutet, Karolinska University Hospital Huddinge, Stockholm, Sweden;* [6]*Mestrado em Ciências da Saúde—Universidade Caxias do Sul Foundation, Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, Brazil;* [7]*Exploration Fonctionnelle Rénale, Groupement Hospitalier Edouard Herriot, Hospices Civils de Lyon, Lyon, France;* [8]*Department of Laboratory Medicine, Division of Clinical Chemistry, Karolinska Institutet, Karolinska University Hospital Huddinge, Stockholm, Sweden;* [9]*Department of Laboratory Medicine, Örebro University Hospital, Örebro, Sweden;* [10]*Department of Translational Medicine, Division of Medical Radiology, Lund University, Malmö, Sweden; and* [11]*Nephrology-Dialysis-Transplantation, University of Liège, Centre Hospitalier Universitaire du Sart Tilman, Liège, Belgium*

- 5764 enfants, adolescents et jeunes adultes
- Résultats en «médiane»


a
mGFR
mGFR (ml/min per 1.73 m²)
Age (yr)
b
CKiD_Scr and CKD-EPI
eGFR (ml/min per 1.73 m²)
Age (yr)
c
FAS-Age
eGFR (ml/min per 1.73 m²)
Age (yr)
e
LMR
eGFR (ml/min per 1.73 m²)
Age (yr)

Débat sur le facteur racial aux Etats-Unis

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

New Creatinine- and Cystatin C–Based Equations to Estimate GFR without Race

L.A. Inker, N.D. Eneanya, J. Coresh, H. Tighiouart, D. Wang, Y. Sang, D.C. Crews, A. Doria, M.M. Estrella, M. Froissart, M.E. Grams, T. Greene, A. Grubb, V. Gudnason, O.M. Gutiérrez, R. Kalil, A.B. Karger, M. Mauer, G. Navis, R.G. Nelson, E.D. Poggio, R. Rodby, P. Rossing, A.D. Rule, E. Selvin, J.C. Seegmiller, M.G. Shlipak, V.E. Torres, W. Yang, S.H. Ballew, S.J. Couture, N.R. Powe, and A.S. Levey, for the Chronic Kidney Disease Epidemiology Collaboration*

N Engl J Med. 2021 Nov 4;385(19):1737-1749.

Table 3. Accuracy of Current and New Approaches for GFR Estimation as Compared with Measured GFR in the Validation Data Set.

Filtration Marker and Equation*	Black Participants	Non-Black Participants	Difference between Black Participants and Non-Black Participants (95% CI)†
	Bias: Median Difference between Measured GFR and eGFR (95% CI)‡		
		milliliters per minute per 1.73 square meters	
Creatinine			
eGFRcr(ASR), current	−3.7 (−5.4 to −1.8)	−0.5 (−0.9 to 0.0)	−3.2 (−5.0 to −1.3)
eGFRcr(ASR-NB), new	7.1 (5.9 to 8.8)	−0.5 (−0.9 to 0.0)	7.6 (6.1 to 9.0)
eGFRcr(AS), new	3.6 (1.8 to 5.5)	−3.9 (−4.4 to −3.4)	7.6 (5.6 to 9.5)
Creatinine			
eGFRcr(ASR), current	85.1 (82.2 to 87.9)	89.5 (88.5 to 90.4)	−4.4 (−7.6 to −1.2)
eGFRcr(ASR-NB), new	86.4 (83.4 to 89.1)	89.5 (88.5 to 90.4)	−3.1 (−6.2 to 0)
eGFRcr(AS), new	87.2 (84.5 to 90.0)	86.5 (85.4 to 87.6)	0.7 (−2.4 to 3.8)

Facteur ethnique CKD/EPI - MDRD

NON

RESEARCH LETTER

Performance of GFR Estimating Equations in African Europeans: Basis for a Lower Race-Ethnicity Factor Than in African Americans

Flamant M et al Am J Kidney Dis, 2013, 62, p179

PLOS | ONE

RESEARCH ARTICLE

Performance of glomerular filtration rate estimation equations in Congolese healthy adults: The inopportunity of the ethnic correction

Justine B. Bukabau[1] *, Ernest K. Sumaili[1], Etienne Cavalier[2], Hans Pottel[3], Bejos Kifakiou[1], Aliocha Nkodila[1], Jean Robert R. Makulo[1], Vieux M. Mokoli[1], Chantal V. Zinga[1], Augustin L. Longo[1], Yannick M. Engole[1], Yannick M. Nlandu[1], François B. Lepira[1], Nazaire M. Nseka[1], Jean Marie Krzesinski[4], Pierre Delanaye[4]

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Hindawi
International Journal of Nephrology
Volume 2020, Article ID 2141038, 9 pages
https://doi.org/10.1155/2020/2141038

Hindawi

Research Article

No Race-Ethnicity Adjustment in CKD-EPI Equations Is Required for Estimating Glomerular Filtration Rate in the Brazilian Population

Amanda D. Rocha,[1] Suzane Garcia,[2] Andressa B. Santos,[3] José C. C. Eduardo,[3] Claudio T. Mesquita,[2,4] Jocemir R. Lugon,[1,3] and Jorge P. Strogoff-de-Matos[1,3]

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Yayo ES, Nephrol Ther, 2016 , 12 , 454
Flamant M, Am J Kdiney Dis, 2013, 62, 179
Bukabau JB, Plos One, 2018, 13, e0193384

ARTICLE IN PRESS

www.kidney-international.org clinical investigation

Performance of creatinine- or cystatin C–based equations to estimate glomerular filtration rate in sub-Saharan African populations

Justine B. Bukabau[1,7], Eric Yayo[2,7], Appolinaire Gnionsahé[3], Dagui Monnet[2], Hans Pottel[4], Etienne Cavalier[5], Aliocha Nkodila[1], Jean Robert R. Makulo[1], Vieux M. Mokoli[1], François B. Lepira[1], Nazaire M. Nseka[1], Jean-Marie Krzesinski[6], Ernest K. Sumaili[1,7] and Pierre Delanaye[6,7]

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- N=494
- Iohexol
- Créatinine calibrée

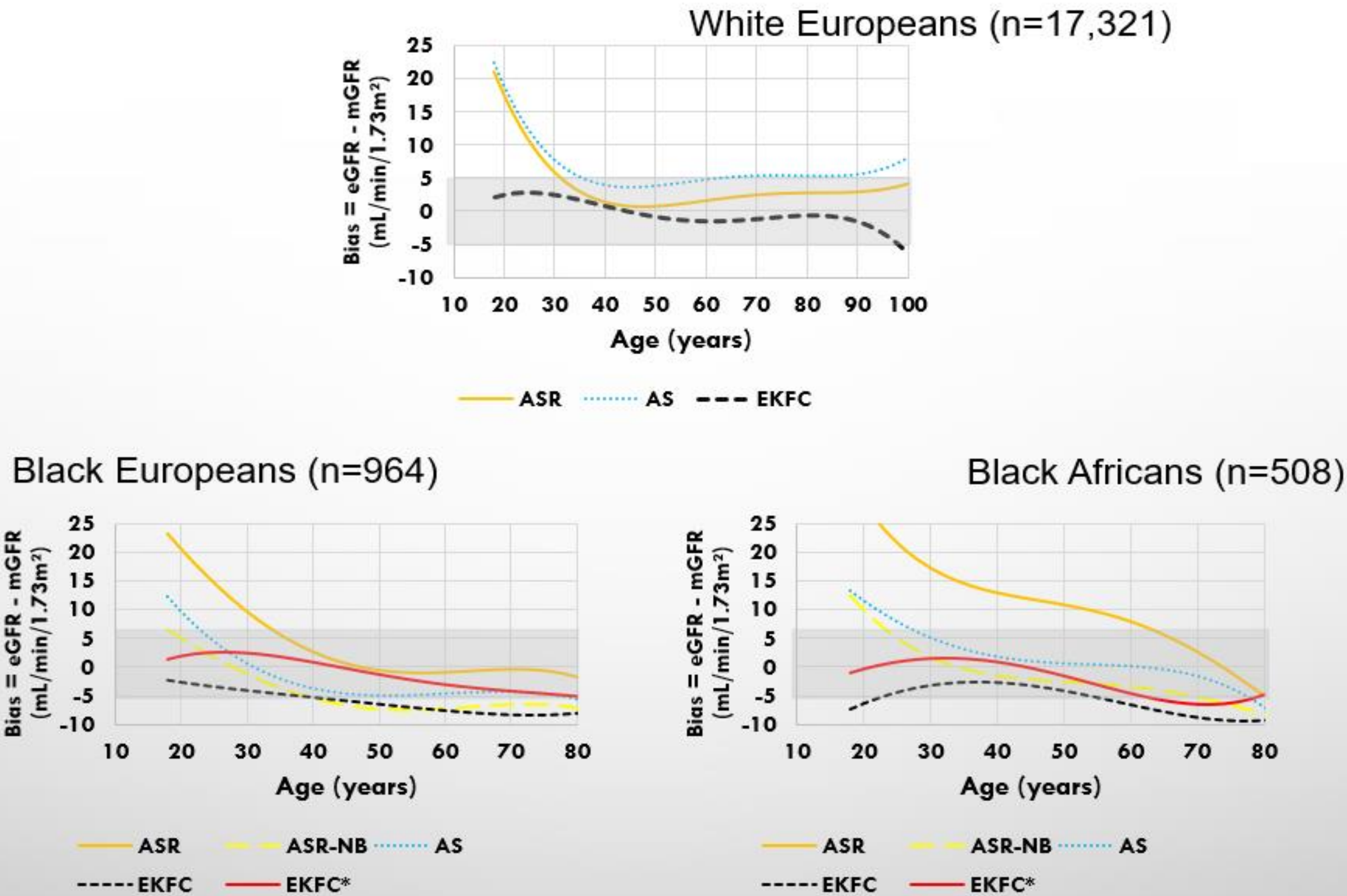
Nephrology Dialysis Transplantation (2022) 0: 1–13
https://doi.org/10.1093/ndt/gfac241
Advance Access publication date 24 August 2022

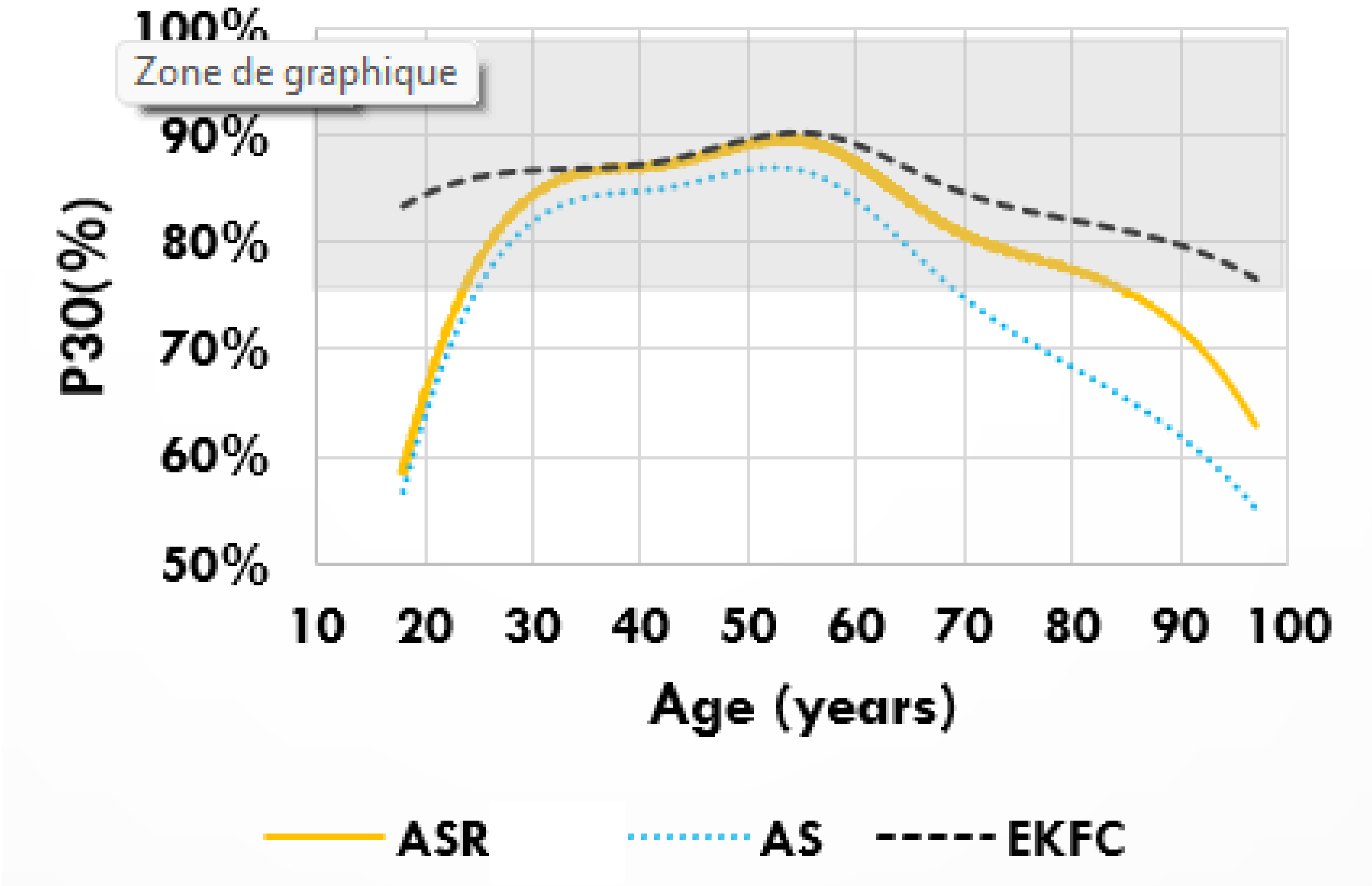
Performance of creatinine-based equations to estimate glomerular filtration rate in White and Black populations in Europe, Brazil and Africa

Pierre Delanaye[1,2,*], Emmanuelle Vidal-Petiot[3,*], Jonas Björk[4,5], Natalie Ebert[6], Björn O. Eriksen[7], Laurence Dubourg[8], Anders Grubb[9], Magnus Hansson[10], Karin Littmann[11], Christophe Mariat[12], Toralf Melsom[7], Elke Schaeffner[6], Per-Ola Sundin[13], Arend Bökenkamp[14], Ulla B. Berg[15], Kajsa Åsling-Monemi[15], Anna Åkesson[4,5], Anders Larsson[16], Etienne Cavalier[17], R. Neil Dalton[18], Marie Courbebaisse[19], Lionel Couzi[20], Francois Gaillard[21], Cyril Garrouste[22], Lola Jacquemont[23], Nassim Kamar[24], Christophe Legendre[25], Lionel Rostaing[26], Thomas Stehlé[27,28], Jean-Philippe Haymann[29], Luciano da Silva Selistre[30], Jorge P. Strogoff-de-Matos[31], Justine B. Bukabau[32], Ernest K. Sumaili[32], Eric Yayo[33], Dagui Monnet[33], Ulf Nyman[34], Hans Pottel[35,†] and Martin Flamant[36,†]

Méthodes

- Sujets de plus de 18 ans, DFG mesuré, créatinine sérique “IDMS traceable”
- EKFC consortium: 11 cohortes d’Europe (n=17,321)
- Données de Paris (n=4,429, parmi lesquels 964 européens noirs)
- Données d’Afrique (RDC et Côte d’Ivoire, n=508)


White Europeans (n=17,321)
Bias = eGFR - mGFR (mL/min/1.73m²)
Age (years)
ASR
AS
EKFC
Black Europeans (n=964)
Bias = eGFR - mGFR (mL/min/1.73m²)
Age (years)
ASR
ASR-NB
AS
EKFC
EKFC*
Black Africans (n=508)
Bias = eGFR - mGFR (mL/min/1.73m²)
Age (years)
ASR
ASR-NB
AS
EKFC
EKFC*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P30(%)
10
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60
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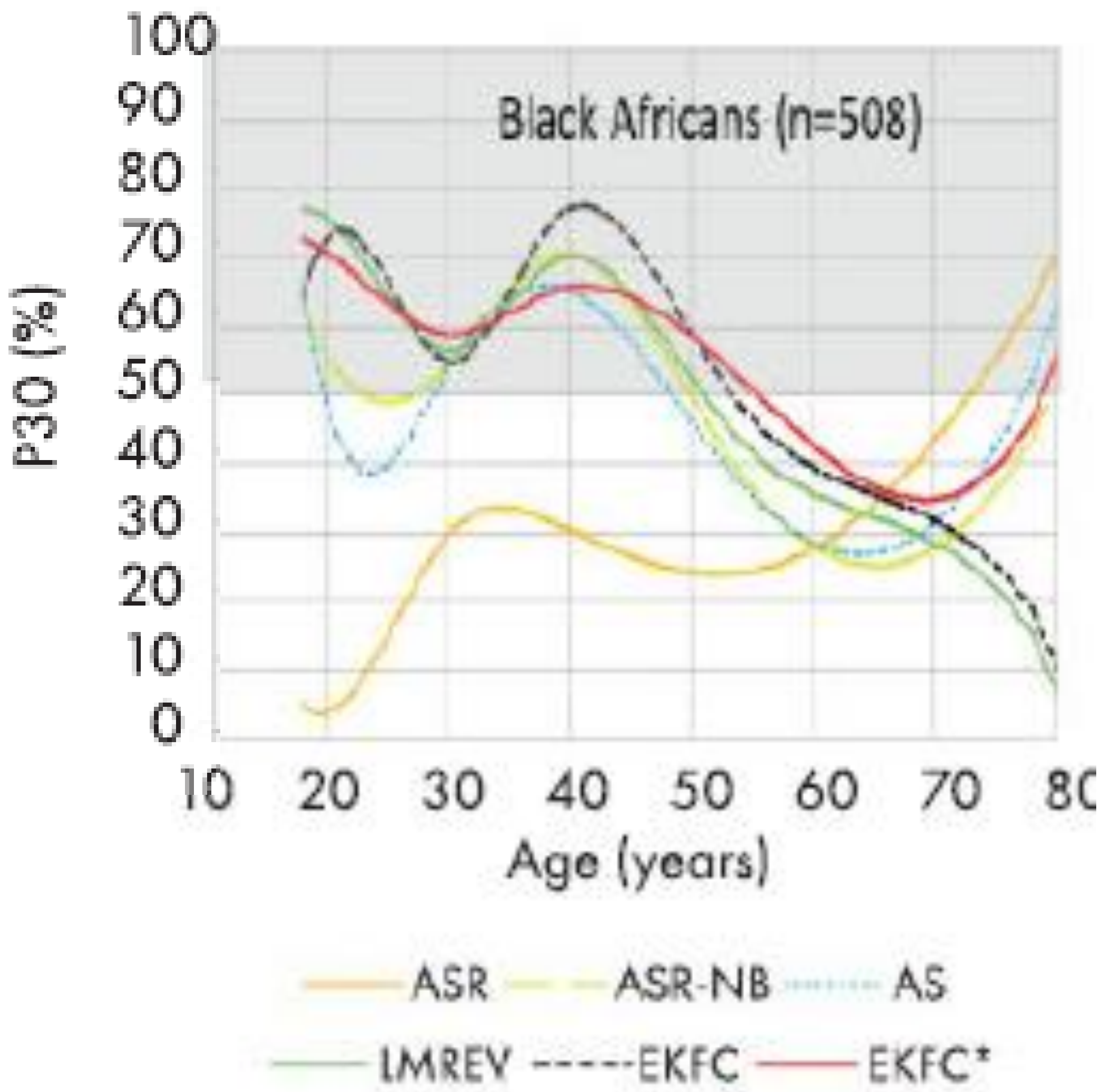
80
90
100
Age (years)
ASR
AS
EKFC


Black Africans (n=508)
P30 (%)
100
90
80
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
80
Age (years)
ASR
ASR-NB
AS
LMREV
EKFC
EKFC*

Americentrism in estimation of glomerular filtration rate equations

Check for updates

Pierre Delanaye[1,2], Hans Pottel[3] and Richard J. Glassock[4]
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KEYWORDS: glomerular filtration rate; race; serum creatinine

Clin Chem Lab Med 2023; 61(1): 44–47 DE GRUYTER

EFLM Paper

Pierre Delanaye, Elke Schaeffner, Mario Cozzolino, Michel Langlois, Mario Plebani, Tomris Ozben and Etienne Cavalier*, on behalf of the Board members of the EFLM Task Group Chronic Kidney Diseases

The new, race-free, Chronic Kidney Disease Epidemiology Consortium (CKD-EPI) equation to estimate glomerular filtration rate: is it applicable in Europe? A position statement by the European Federation of Clinical Chemistry and Laboratory Medicine (EFLM)

Nephrol Dial Transplant (2023) 38: 1–6
https://doi.org/10.1093/ndt/gfac254
Advance Access publication date 7 September 2022

What should European nephrology do with the new CKD-EPI equation?

Ron T. Gansevoort[1], Hans-Joachim Anders[2], Mario Cozzolino[3], Danilo Fliser[4], Denis Fouque[5], Alberto Ortiz[6,7], Maria José Soler[8] and Christoph Wanner[9]

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Cystatine C

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Estimating Glomerular Filtration Rate from Serum Creatinine and Cystatin C

Lesley A. Inker, M.D., Christopher H. Schmid, Ph.D., Hocine Tighiouart, M.S., John H. Eckfeldt, M.D., Ph.D., Harold I. Feldman, M.D., Tom Greene, Ph.D., John W. Kusek, Ph.D., Jane Manzi, Ph.D., Frederick Van Lente, Ph.D., Yaping Lucy Zhang, M.S., Josef Coresh, M.D., Ph.D., and Andrew S. Levey, M.D., for the CKD-EPI Investigators*

N Engl J Med 2012;367:20-9.

Table 1. Characteristics of Study Participants, According to Data Set.*

Characteristic	Development and Internal Validation (N = 5352)	External Validation (N = 1119)	P Value
Age — yr	47±15	50±17	<0.001
Age group — no. (%)			
<40 yr	2008 (38)	357 (32)	<0.001
40–65 yr	2625 (49)	530 (47)	
>65 yr	719 (13)	232 (21)	
Male sex — no. (%)	3107 (58)	663 (59)	0.46
Black race — no. (%)†	2123 (40)	30 (3)	<0.001
Diabetes — no. (%)	1726 (32)	594 (53)	<0.001
Body-mass index‡			
Mean	28±6	25±4	<0.001
<20 — no. (%)	214 (4)	81 (7)	<0.001
20–24 — no. (%)	1585 (30)	503 (45)	
25–30 — no. (%)	1881 (35)	386 (35)	
>30 — no. (%)	1671 (31)	149 (13)	
Mean weight — kg	83±20	74±15	<0.001
Mean height — cm	171±10	170±9	0.017
Mean body-surface area — m^2	1.94±0.24	1.85±0.21	<0.001
Mean serum cystatin C — ml/liter	1.4±0.7	1.5±0.8	0.01
Mean serum creatinine — mg/dl§	1.6±0.9	1.6±1.1	0.15
Mean measured GFR — ml/min/1.73 m^2 of body-surface area	68±39	70±41	0.13
Measured GFR — no. (%)			
<15 ml/min/1.73 m^2	160 (3)	51 (5)	<0.001
15–29 ml/min/1.73 m^2	785 (15)	166 (15)	
30–59 ml/min/1.73 m^2	1765 (33)	316 (28)	
60–89 ml/min/1.73 m^2	1105 (21)	215 (19)	
90–119 ml/min/1.73 m^2	862 (16)	199 (18)	
>120 ml/min/1.73 m^2	675 (13)	172 (15)	

Table 2. Creatinine Equation (CKD-EPI 2009), Cystatin C Equation (CKD-EPI 2012), and Creatinine–Cystatin C Equation (CKD-EPI 2012) for Estimating GFR, Expressed for Specified Sex, Serum Creatinine Level, and Serum Cystatin C Level.*

Basis of Equation and Sex	Serum Creatinine†	Serum Cystatin C	Equation for Estimating GFR
	mg/dl	*mg/liter*	
CKD-EPI creatinine equation‡			
Female	≤ 0.7		$144 \times (Scr/0.7)^{-0.329} \times 0.993^{Age}$ [$\times$ 1.159 if black]
Female	>0.7		$144 \times (Scr/0.7)^{-1.209} \times 0.993^{Age}$ [$\times$ 1.159 if black]
Male	≤ 0.9		$141 \times (Scr/0.9)^{-0.411} \times 0.993^{Age}$ [$\times$ 1.159 if black]
Male	>0.9		$141 \times (Scr/0.9)^{-1.209} \times 0.993^{Age}$ [$\times$ 1.159 if black]
CKD-EPI cystatin C equation§			
Female or male		≤ 0.8	$133 \times (Scys/0.8)^{-0.499} \times 0.996^{Age}$ [$\times$ 0.932 if female]
Female or male		>0.8	$133 \times (Scys/0.8)^{-1.328} \times 0.996^{Age}$ [$\times$ 0.932 if female]
CKD-EPI creatinine–cystatin C equation¶			
Female	≤ 0.7	≤ 0.8	$130 \times (Scr/0.7)^{-0.248} \times (Scys/0.8)^{-0.375} \times 0.995^{Age}$ [$\times$ 1.08 if black]
		>0.8	$130 \times (Scr/0.7)^{-0.248} \times (Scys/0.8)^{-0.711} \times 0.995^{Age}$ [$\times$ 1.08 if black]
Female	>0.7	≤ 0.8	$130 \times (Scr/0.7)^{-0.601} \times (Scys/0.8)^{-0.375} \times 0.995^{Age}$ [$\times$ 1.08 if black]
		>0.8	$130 \times (Scr/0.7)^{-0.601} \times (Scys/0.8)^{-0.711} \times 0.995^{Age}$ [$\times$ 1.08 if black]
Male	≤ 0.9	≤ 0.8	$135 \times (Scr/0.9)^{-0.207} \times (Scys/0.8)^{-0.375} \times 0.995^{Age}$ [$\times$ 1.08 if black]
		>0.8	$135 \times (Scr/0.9)^{-0.207} \times (Scys/0.8)^{-0.711} \times 0.995^{Age}$ [$\times$ 1.08 if black]
Male	>0.9	≤ 0.8	$135 \times (Scr/0.9)^{-0.601} \times (Scys/0.8)^{-0.375} \times 0.995^{Age}$ [$\times$ 1.08 if black]
		>0.8	$135 \times (Scr/0.9)^{-0.601} \times (Scys/0.8)^{-0.711} \times 0.995^{Age}$ [$\times$ 1.08 if black]

Table 3. Use of the CKD-EPI Creatinine Equation (2009), CKD-EPI Cystatin C Equation (2012), and CKD-EPI Creatinine–Cystatin C Equations (2012) in the External-Validation Data Set Comprising 1119 Participants.*

Variable	Estimated GFR			
	Overall	<60	60–89	≥90
	ml/min/1.73 m² of body-surface area			
Bias — median difference (95% CI)				
Creatinine equation	3.7 (2.8 to 4.6)	1.8 (1.1 to 2.5)	6.6 (3.5 to 9.2)	11.1 (8.0 to 12.5)
Cystatin C equation	3.4 (2.3 to 4.4)	0.4 (−0.5 to 1.4)	6.0 (4.6 to 8.5)	8.5 (6.5 to 11.2)
Creatinine–cystatin C equation	3.9 (3.2 to 4.5)	1.3 (0.5 to 1.8)	6.9 (5.0 to 8.9)	10.6 (9.5 to 12.7)
Average of creatinine and cystatin C†	3.5 (2.8 to 4.1)	0.4 (−0.3 to 0.8)	6.5 (4.6 to 8.4)	11.9 (9.9 to 13.9)
Precision — IQR of the difference (95% CI)				
Creatinine equation	15.4 (14.3 to 16.5)	10.0 (8.9 to 11.0)	19.6 (17.3 to 23.2)	25.0 (21.6 to 28.1)
Cystatin C equation	16.4 (14.8 to 17.8)	11.0 (10.0 to 12.4)	19.6 (16.1 to 23.1)	22.6 (18.8 to 26.3)
Creatinine–cystatin C equation	13.4 (12.3 to 14.5)	8.1 (7.3 to 9.1)	15.9 (13.9 to 18.1)	18.8 (16.8 to 22.5)
Average of creatinine and cystatin C equations†	13.9 (12.9 to 14.7)	7.9 (7.1 to 9.0)	15.8 (13.9 to 17.7)	18.6 (16.1 to 22.2)
Accuracy — % (95% CI)‡				
$1 - P_{30}$				
Creatinine equation	12.8 (10.9 to 14.7)	16.6 (13.6 to 19.7)	10.2 (6.4 to 14.2)	7.8 (5.1 to 11.0)
Cystatin C equation	14.1 (12.2 to 16.2)	21.4 (18.2 to 24.9)	12.7 (8.5 to 17.4)	2.2 (0.6 to 3.9)
Creatinine–cystatin C equation	8.5 (7.0 to 10.2)	13.3 (10.7 to 16.1)	5.3 (2.7 to 8.2)	2.3 (0.9 to 4.2)
Average of creatinine and cystatin C equations†	8.2 (6.7 to 9.9)	12.1 (9.5 to 14.8)	6.4 (3.6 to 9.7)	2.9 (1.3 to 4.9)
$1 - P_{20}$				
Creatinine equation	32.9 (30.1 to 35.7)	37.2 (33.1 to 41.2)	31.1 (25.1 to 37.4)	26.5 (21.7 to 31.4)
Cystatin C equation	33.0 (30.3 to 35.7)	42.1 (38.2 to 46.1)	29.3 (23.6 to 35.4)	19.4 (15.4 to 23.7)
Creatinine–cystatin C equation	22.8 (20.4 to 25.2)	28.6 (25.1 to 32.4)	17.8 (13.3 to 22.9)	16.2 (12.4 to 20.5)
Average of creatinine and cystatin C equations†	23.7 (21.3 to 26.1)	29.1 (25.7 to 32.8)	17.6 (13.2 to 22.4)	18.8 (14.6 to 23.2)

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Cystatin C–Based Equation to Estimate GFR without the Inclusion of Race and Sex

H. Pottel, J. Björk, A.D. Rule, N. Ebert, B.O. Eriksen, L. Dubourg, E. Vidal-Petiot, A. Grubb, M. Hansson, E.J. Lamb, K. Littmann, C. Mariat, T. Melsom, E. Schaeffner, P.-O. Sundin, A. Åkesson, A. Larsson, E. Cavalier, J.B. Bukabau, E.K. Sumaili, E. Yayo, D. Monnet, M. Flamant, U. Nyman, and P. Delanaye

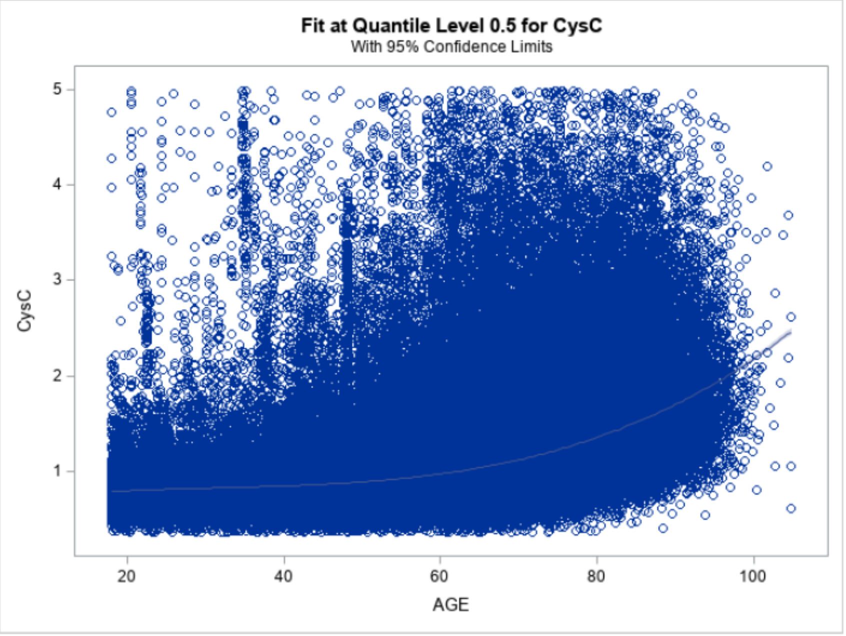
ABSTRACT

N Engl J Med 2023;388:333-43.

1er étape: cystatine C et âge

Données de labo de Suède
N=227,643
♀ 95,469
♂ 132,174

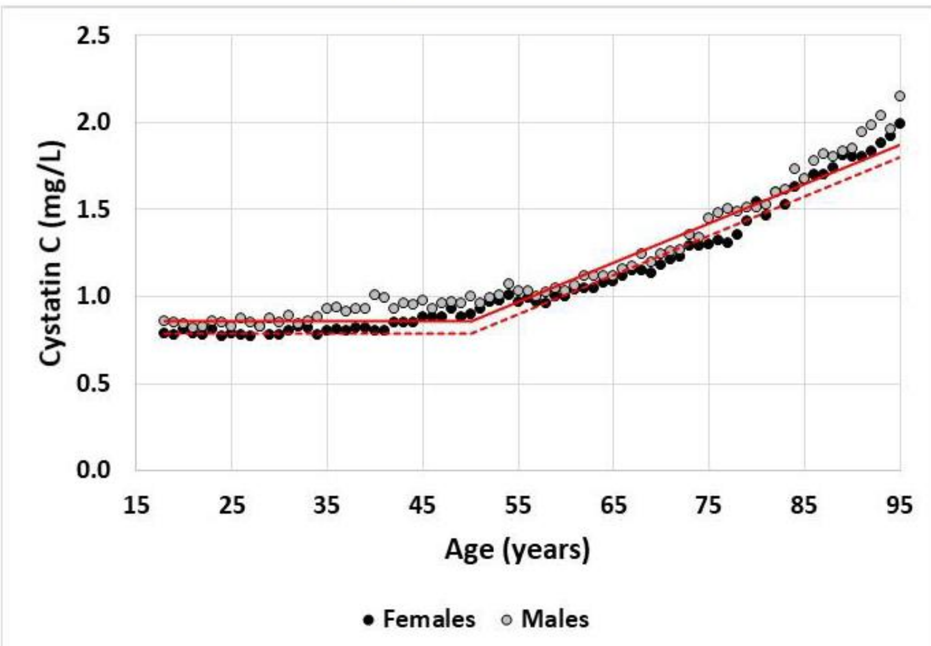
Figure S3. Cystatin C versus age and the median quantile line for the 227,643 included subjects.



♀ Q' = 0.79 mg/L jusqu'à 50 ans,
Q' = 0.79 + 0.005 x (Age – 50)
♂ Q' = 0.86 mg/L jusqu'à 50 ans
Q' = 0.86 + 0.005 x (Age – 50)

2ème étape: cystatine C et sexe

Figure S4. Median plasma cystatin C in one-year intervals against age for men and women. A mathematical model to define Q'-values is proposed (red solid line): for adults Q' = 0.79 mg/L (women, dashed line) and 0.86 mg/L (men, solid line) until 50 years and a linear increasing model thereafter.



Q' = 0.83 mg/L jusqu'à 50 ans

Q' = 0.83 + 0.005 x (Age – 50)

3ème étape: Cystatine C et “race”

- Données du même centre en France
- Même DFG de référence (Cr-EDTA)
- Même dosage de créatinine et de cystatine C

Table S3. Patient characteristics of the entire cohorts used for the matching analysis (mean ± SD)

Ethnicity/Sex	N	Age (years)	BMI (kg/m^2)	mGFR ($mL/min/1.73m^2$)	SCr (mg/dL)	CysC (mg/L)
White Men	1296 (57%)	53.0 ± 14.6	26.2 ± 4.9	61.8 ± 26.0	1.52 ± 0.73	1.52 ± 0.68
Black Men	436 (63%)	50.7 ± 13.1	26.3 ± 4.5	62.0 ± 22.1	1.73 ± 0.81	1.41 ± 0.61
White Women	966 (43%)	52.5 ± 15.2	25.8 ± 6.2	62.8 ± 26.8	1.16 ± 0.61	1.38 ± 0.73
Black Women	261 (37%)	51.9 ± 15.2	27.4 ± 5.8	59.1 ± 25.6	1.40 ± 0.79	1.46 ± 0.76

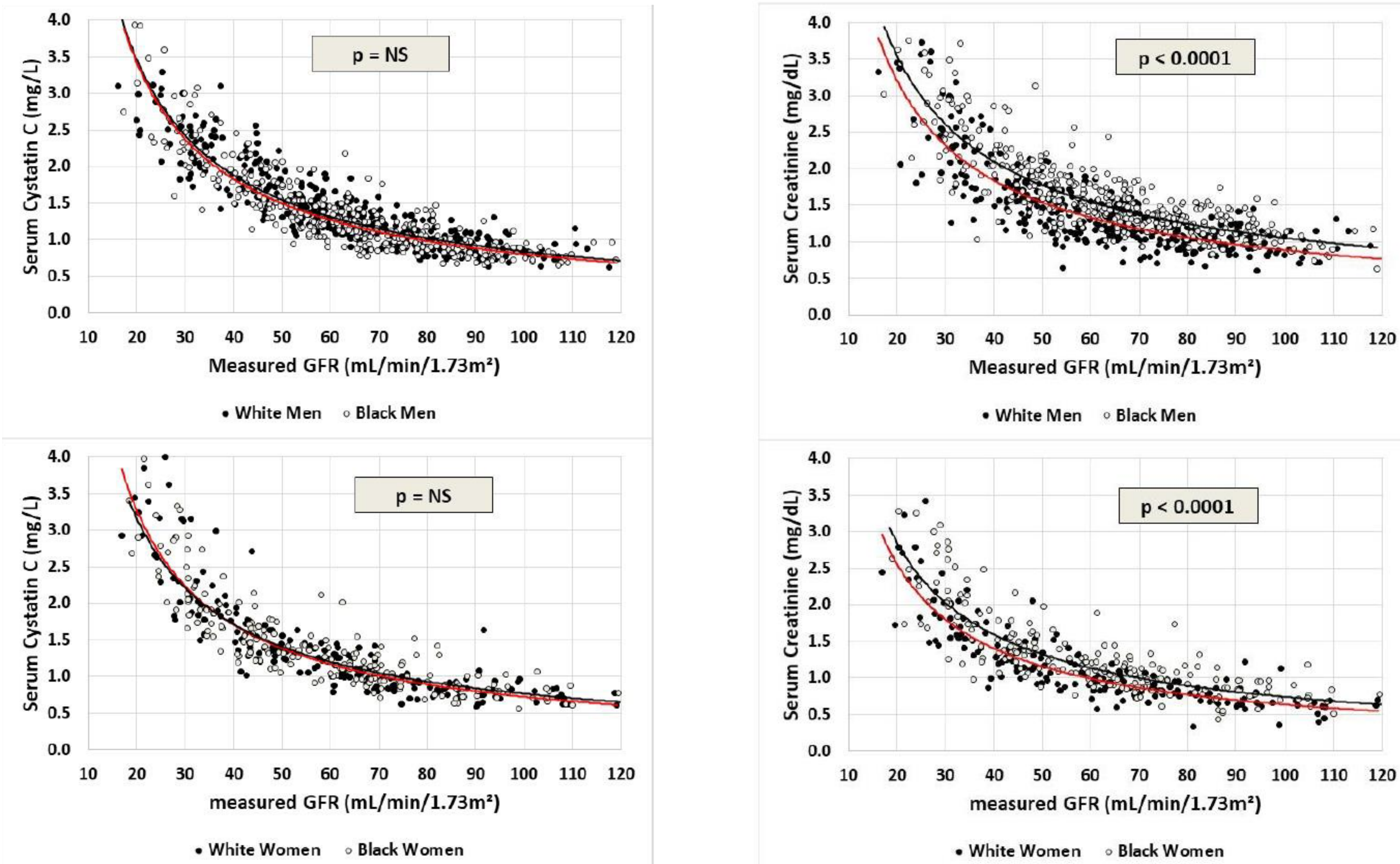
3ème étape: Cystatin C et “race”

Analyse matchée 1:1

- Pour le sexe
- IMC (±2,5 kg/m²)
- DFG mesuré (±3 mL/min/1.73m²)
- âge (± 3 ans)

Table S4. Demographic and renal characteristics of the matched White and Black subjects (mean ± SD)

Sex	N	Age (years)	BMI (kg/m²)	mGFR (mL/min/1.73m²)	SCr (mg/dL)	CysC (mg/L)
White Men	377	51.1 ± 12.2	25.7 ± 3.4	63.8 ± 21.0	1.43 ± 0.62	1.41 ± 0.56
Black Men	377	50.8 ± 12.3	25.8 ± 3.5	63.6 ± 21.0	1.65 ± 0.64	1.37 ± 0.59
White Women	200	53.4 ± 11.9	26.1 ± 4.6	59.7 ± 23.2	1.16 ± 0.53	1.40 ± 0.69
Black Women	200	53.3 ± 11.9	26.2 ± 4.6	59.8 ± 23.1	1.33 ± 0.61	1.41 ± 0.64


p = NS
Serum Cystatin C (mg/L)
Measured GFR (mL/min/1.73m²)
• White Men ∘ Black Men
p < 0.0001
Serum Creatinine (mg/dL)
Measured GFR (mL/min/1.73m²)
• White Men ∘ Black Men
p = NS
Serum Cystatin C (mg/L)
measured GFR (mL/min/1.73m²)
• White Women ∘ Black Women
p < 0.0001
Serum Creatinine (mg/dL)
measured GFR (mL/min/1.73m²)
• White Women ∘ Black Women

4ème étape: Validation de la nouvelle équation

$$\text{EKFC} - \text{eGFR} = 107.3/[\text{Biomarker}/\text{Q}]^{\alpha} \times [0.990^{(\text{Age}-40)} \text{ if age} > 40 \text{ years}],$$

with $\alpha = 0.322$ when biomarker/Q is less than 1 and $\alpha = 1.132$ when biomarker/Q is 1 or more.

Table S1: Patient and method characteristics of the different validation cohorts

Name	Country	Cohort	n	Method mGFR	Age median [IQR]	mGFR median [IQR]	Crea/Q median [IQR]	CysC/Q' median [IQR]	% men
EKFC (White)			**7,727**		**62.0 [53.0 – 73.9]**	**70.8 [43.4 – 90.6]**	**1.13 [0.94 – 1.65]**	**1.28 [0.97 – 2.02]**	**53.4**
Berlin	Germany	BIS-study [1]	657	PC / iohexol	77.0 [73.6 – 82.5]	57.9 [43.4 – 70.0]	1.18 [1.00 – 1.52]	1.33 [1.12 – 1.72]	58.3
Kent#	UK	GFR in old adults study [2]	394	PC / 51Cr-EDTA	80.0 [77.0 – 83.0]	53.4 [35.3 – 67.8]	1.34 [1.08 – 2.02]	1.44 [1.19 – 2.26]	48.0
Lund#	Sweden	CAPA-study [3]	2,847	PC / iohexol	63.0 [50.0 – 72.0]	56.4 [31.2 – 81.6]	1.34 [1.01 – 2.15]	1.75 [1.27 – 2.72]	51.5
Lyon	France	Referrals*	914	PC/RC inulin/iohexol	51.6 [37.9 – 62.5]	79.6 [55.6 – 99.0]	1.10 [0.92 – 1.45]	1.13 [0.94 – 1.59]	54.9
Saint-Etienne	France	HIV-study [4]	203	RC / inulin	48.0 [42.0 – 56.0]	95.9 [80.3 – 107.7]	0.97 [0.87 – 1.09]	1.04 [0.92 – 1.16]	81.8
Stockholm	Sweden	Referrals*	577	PC / iohexol	75.0 [72.0 – 79.0]	42.2 [24.7 – 62.9]	1.65 [1.18 – 2.44]	1.99 [1.43 – 3.00]	52.5
Tromsö	Norway	RENIS-T6 study [5]	1,627	PC / iohexol	58.7 [54.7 – 61.4]	91.5 [82.9 – 101.2]	0.94 [0.85 – 1.04]	0.87 [0.79 – 0.97]	49.2
Örebro	Sweden	Referrals*	508	PC / iohexol	58.1 [43.2 – 68.4]	71.5 [41.5 – 93.0]	1.31 [1.02 – 1.74]	1.29 [0.98 – 2.04]	61.8
USA (White)#	Rochester, Minnesota	GENOA / ECAC study [6]	**1,093**	**RC / iothalamate**	**66.1 [59.1 – 71.2]**	**80.0 [66.0 – 93.0]**	**1.04 [0.92 – 1.17]**	**0.96 [0.84 – 1.09]**	**43.4**
Africa (Black)#			**508**		**39.0 [30.0 – 53.0]**	**86.8 [71.7 – 99.2]**	**1.16 [1.02 – 1.41]**	**1.07 [0.95 – 1.28]**	**53.3**
	Côte d'Ivoire	eGFR-study [7]	285	PC / iohexol	34.0 [27.0 – 43.0]	89.1 [73.9 – 100.8]	1.18 [1.04 – 1.48]	1.05 [0.93 – 1.32]	57.9
	Congo	eGFR-study [8]	223	PC / iohexol	49.0 [37.5 – 60.0]	84.4 [65.2 – 97.3]	1.13 [1.01 – 1.35]	1.13 [0.99 – 1.22]	47.5
Paris (White and Black)#			**3,504**		**53.4 [42.0 – 63.0]**	**63.2 [44.3 – 84.5]**	**1.42 [1.12 – 1.90]**	**1.48 [1.11 – 2.07]**	**57.4**
	Paris White	Referrals*	2,646	PC / ^{51}Cr EDTA	54.2 [42.3 – 64.0]	62.7 [43.8 – 85.3]	1.42 [1.09 – 1.90]	1.49 [1.11 – 2.11]	56.1
	Paris Black	Referrals*	858	PC / ^{51}Cr EDTA	51.2 [41.0 – 60.4]	64.3 [45.9 – 81.7]	1.46 [1.19 – 1.94]	1.45 [1.12 – 1.96]	61.3

mGFR= measured glomerular filtration rate, IQR= interquartile range, PC= plasma clearance (only blood samples are required), RC= renal clearance (both blood and urine samples are required). Crea/Q = scaled creatinine, CysC/Q' = scaled cystatin C (both scaled markers equal '1' for the average healthy subject); Referrals*: subjects referred for measured GFR; # = Cohorts are true "external" validation cohorts

Comparateur = équations CKD-EPI

- = 2009 and **<u>2021</u>**

  = CKD-EPI équation cystatine C 2012

  = CKD-EPI equation combinée

Q creatinine

EKFC	Q female/male
European cohort White	0.70/0.90
European cohort Black	0.74/1.02
African cohort	0.72/0.96

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*

Variable	Serum Creatinine–Based Equations		
	CKD-EPI eGFRcr(ASR)	CKD-EPI eGFRcr(AS)	EKFC eGFRcr
EKFC cohort, 7727 White patients			
Median bias (95% CI) — ml/min/1.73 m²†	3.96 (3.67 to 4.32)	7.40 (7.02 to 7.76)	0.58 (0.32 to 0.86)
IQR of estimated GFR– measured GFR— ml/min/1.73 m²‡	15.5 (−3.0 to 12.5)	16.3 (0.0 to 16.3)	14.5 (−6.5 to 8.0)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	14.8 (14.4 to 15.2)	16.3 (15.9 to 16.6)	13.1 (12.8 to 13.4)
P_{10} — % (95% CI)¶	40.3 (39.2 to 41.4)	34.7 (33.6 to 35.8)	43.3 (42.2 to 44.4)
P_{30} — % (95% CI)‖	81.6 (80.8 to 82.5)	75.7 (74.8 to 76.7)	85.8 (85.0 to 86.5)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*		
Variable	Cystatin C–Based Equations	
	CKD-EPI eGFRcys	EKFC eGFRcys without Sex
EKFC cohort, 7727 White patients		
Median bias (95% CI) — ml/min/1.73 m²†	0.28 (−0.02 to 0.64)	0.00 (−0.37 to 0.27)
IQR of estimated GFR− measured GFR— ml/min/1.73 m²‡	19.1 (−7.9 to 11.2)	14.4 (−7.9 to 6.5)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	15.8 (15.5 to 16.1)	13.5 (12.9 to 14.1)
P_{10} — % (95% CI)¶	32.0 (31.0 to 33.0)	41.7 (40.6 to 42.8)
P_{30} — % (95% CI)‖	80.8 (79.9 to 81.7)	86.2 (85.4 to 87.0)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*					
Variable	Serum Creatinine–Based Equations			Cystatin C–Based Equations	
	CKD-EPI eGFRcr(ASR)	CKD-EPI eGFRcr(AS)	EKFC eGFRcr	CKD-EPI eGFRcys	EKFC eGFRcys without Sex
EKFC cohort, 7727 White patients					
Median bias (95% CI) — ml/min/1.73 m²†	3.96 (3.67 to 4.32)	7.40 (7.02 to 7.76)	0.58 (0.32 to 0.86)	0.28 (−0.02 to 0.64)	0.00 (−0.37 to 0.27)
IQR of estimated GFR− measured GFR— ml/min/1.73 m²‡	15.5 (−3.0 to 12.5)	16.3 (0.0 to 16.3)	14.5 (−6.5 to 8.0)	19.1 (−7.9 to 11.2)	14.4 (−7.9 to 6.5)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	14.8 (14.4 to 15.2)	16.3 (15.9 to 16.6)	13.1 (12.8 to 13.4)	15.8 (15.5 to 16.1)	13.5 (12.9 to 14.1)
P_{10} — % (95% CI)¶	40.3 (39.2 to 41.4)	34.7 (33.6 to 35.8)	43.3 (42.2 to 44.4)	32.0 (31.0 to 33.0)	41.7 (40.6 to 42.8)
P_{30} — % (95% CI)‖	81.6 (80.8 to 82.5)	75.7 (74.8 to 76.7)	85.8 (85.0 to 86.5)	80.8 (79.9 to 81.7)	86.2 (85.4 to 87.0)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*

Variable	Serum Creatinine–Based Equations		
	CKD-EPI eGFRcr(ASR)	CKD-EPI eGFRcr(AS)	EKFC eGFRcr
Paris cohort, 2646 White patients			
Median bias (95% CI) — ml/min/1.73 m²†	0.30 (−0.21 to 0.78)	3.22 (2.69 to 3.86)	−1.24 (−1.75 to −0.74)
IQR of estimated GFR − measured GFR — ml/min/1.73 m²‡	15.2 (−6.8 to 8.4)	15.9 (−4.1 to 11.7)	14.6 (−8.3 to 6.3)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	14.2 (13.6 to 14.8)	14.8 (14.2 to 15.4)	13.6 (13.0 to 14.1)
P_{10} — % (95% CI)¶	39.5 (37.7 to 41.4)	38.2 (36.4 to 40.1)	40.9 (39.0 to 42.7)
P_{30} — % (95% CI)‖	84.5 (83.1 to 85.8)	82.5 (81.1 to 84.0)	86.5 (85.2 to 87.7)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*		
Variable	Cystatin C–Based Equations	
	CKD-EPI eGFRcys	EKFC eGFRcys without Sex
Paris cohort, 2646 White patients		
Median bias (95% CI) — ml/min/1.73 m^2†	−2.85 (−3.35 to −2.21)	−0.79 (−1.26 to −0.31)
IQR of estimated GFR − measured GFR — ml/min/1.73 m^2‡	16.4 (−10.3 to 6.1)	15.3 (−8.5 to 6.7)
Root-mean-square error (95% CI) — ml/min/1.73 m^2§	14.5 (13.9 to 15.1)	13.5 (12.9 to 14.1)
P_{10} — % (95% CI)¶	34.2 (32.4 to 36.0)	38.2 (36.4 to 40.1)
P_{30} — % (95% CI)‖	82.7 (81.3 to 84.2)	87.6 (86.3 to 88.9)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*

Variable	Serum Creatinine–Based Equations			Cystatin C–Based Equations	
	CKD-EPI eGFRcr(ASR)	CKD-EPI eGFRcr(AS)	EKFC eGFRcr	CKD-EPI eGFRcys	EKFC eGFRcys without Sex
Paris cohort, 2646 White patients					
Median bias (95% CI) — ml/min/1.73 m^2†	0.30 (−0.21 to 0.78)	3.22 (2.69 to 3.86)	−1.24 (−1.75 to −0.74)	−2.85 (−3.35 to −2.21)	−0.79 (−1.26 to −0.31)
IQR of estimated GFR − measured GFR — ml/min/1.73 m^2‡	15.2 (−6.8 to 8.4)	15.9 (−4.1 to 11.7)	14.6 (−8.3 to 6.3)	16.4 (−10.3 to 6.1)	15.3 (−8.5 to 6.7)
Root-mean-square error (95% CI) — ml/min/1.73 m^2§	14.2 (13.6 to 14.8)	14.8 (14.2 to 15.4)	13.6 (13.0 to 14.1)	14.5 (13.9 to 15.1)	13.5 (12.9 to 14.1)
P_{10} — % (95% CI)¶	39.5 (37.7 to 41.4)	38.2 (36.4 to 40.1)	40.9 (39.0 to 42.7)	34.2 (32.4 to 36.0)	38.2 (36.4 to 40.1)
P_{30} — % (95% CI)‖	84.5 (83.1 to 85.8)	82.5 (81.1 to 84.0)	86.5 (85.2 to 87.7)	82.7 (81.3 to 84.2)	87.6 (86.3 to 88.9)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*

Variable	Serum Creatinine–Based Equations		
	CKD-EPI eGFRcr(ASR)	CKD-EPI eGFRcr(AS)	EKFC eGFRcr
U.S. cohort, 1093 White patients			
Median bias (95% CI) — ml/min/1.73 m²†	2.83 (1.65 to 3.64)	7.11 (6.15 to 7.97)	−2.69 (−3.68 to −1.79)
IQR of estimated GFR− measured GFR— ml/min/1.73 m²‡	18.8 (−6.6 to 12.2)	18.7 (−2.2 to 16.5)	18.5 (−11.9 to 6.6)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	16.2 (15.0 to 17.4)	17.5 (16.4 to 18.6)	16.2 (14.9 to 17.4)
P_{10} — % (95% CI)¶	41.9 (39.0 to 44.8)	39.4 (36.5 to 42.3)	41.4 (38.5 to 44.4)
P_{30} — % (95% CI)‖	86.0 (83.9 to 88.1)	81.0 (78.6 to 83.3)	89.3 (87.5 to 91.1)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*

Variable	Cystatin C–Based Equations	
	CKD-EPI eGFRcys	EKFC eGFRcys without Sex
U.S. cohort, 1093 White patients		
Median bias (95% CI) — ml/min/1.73 m^2†	12.1 (11.1 to 13.3)	4.26 (3.33 to 5.08)
IQR of estimated GFR– measured GFR— ml/min/1.73 m^2‡	21.5 (1.5 to 23.0)	18.3 (−5.3 to 13.0)
Root-mean-square error (95% CI) — ml/min/1.73 m^2§	21.3 (20.3 to 22.2)	16.8 (15.7 to 17.9)
P_{10} — % (95% CI)¶	29.4 (26.7 to 32.1)	41.5 (38.6 to 44.5)
P_{30} — % (95% CI)‖	72.9 (70.3 to 75.6)	83.9 (81.7 to 86.1)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*

Variable	Serum Creatinine–Based Equations			Cystatin C–Based Equations	
	CKD-EPI eGFRcr(ASR)	CKD-EPI eGFRcr(AS)	EKFC eGFRcr	CKD-EPI eGFRcys	EKFC eGFRcys without Sex
U.S. cohort, 1093 White patients					
Median bias (95% CI) — ml/min/1.73 m^2†	2.83 (1.65 to 3.64)	7.11 (6.15 to 7.97)	−2.69 (−3.68 to −1.79)	12.1 (11.1 to 13.3)	4.26 (3.33 to 5.08)
IQR of estimated GFR− measured GFR— ml/min/1.73 m^2‡	18.8 (−6.6 to 12.2)	18.7 (−2.2 to 16.5)	18.5 (−11.9 to 6.6)	21.5 (1.5 to 23.0)	18.3 (−5.3 to 13.0)
Root-mean-square error (95% CI) — ml/min/1.73 m^2§	16.2 (15.0 to 17.4)	17.5 (16.4 to 18.6)	16.2 (14.9 to 17.4)	21.3 (20.3 to 22.2)	16.8 (15.7 to 17.9)
P_{10} — % (95% CI)¶	41.9 (39.0 to 44.8)	39.4 (36.5 to 42.3)	41.4 (38.5 to 44.4)	29.4 (26.7 to 32.1)	41.5 (38.6 to 44.5)
P_{30} — % (95% CI)‖	86.0 (83.9 to 88.1)	81.0 (78.6 to 83.3)	89.3 (87.5 to 91.1)	72.9 (70.3 to 75.6)	83.9 (81.7 to 86.1)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*

Variable	Serum Creatinine–Based Equations		
	CKD-EPI eGFRcr(ASR)	CKD-EPI eGFRcr (AS)	EKFC eGFRcr
Paris cohort, 858 Black patients			
Median bias (95% CI) — ml/min/1.73 m²†	0.24 (−0.64 to 0.81)	−5.09 (−5.68 to −4.14)	−2.58 (−3.49 to −1.71)
IQR of estimated GFR− measured GFR— ml/min/1.73 m²‡	19.3 (−12.7 to 4.1)	16.8 (−12.7 to 4.1)	14.9 (−9.9 to 5.1)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	16.0 (14.7 to 17.2)	14.9 (13.5 to 16.1)	13.9 (12.4 to 15.2)
P_{10} — % (95% CI)¶	35.4 (32.2 to 38.6)	33.0 (29.8 to 36.1)	37.5 (34.3 to 40.8)
P_{30} — % (95% CI)‖	79.8 (77.1 to 82.5)	82.3 (79.7 to 84.8)	85.5 (83.2 to 87.9)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*		
Variable	Cystatin C–Based Equations	
	CKD-EPI eGFRcys	EKFC eGFRcys without Sex
Paris cohort, 858 Black patients		
Median bias (95% CI) — ml/min/1.73 m²†	−0.62 (−1.71 to 0.28)	1.40 (0.38 to 2.23)
IQR of estimated GFR− measured GFR— ml/min/1.73 m²‡	17.9 (−8.1 to 9.8)	14.3 (−5.6 to 8.8)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	15.4 (14.0 to 16.6)	13.5 (12.1 to 14.7)
P_{10} — % (95% CI)¶	36.2 (33.0 to 39.5)	41.0 (37.7 to 44.3)
P_{30} — % (95% CI)‖	81.5 (78.9 to 84.1)	87.4 (85.2 to 89.6)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*					
Variable	Serum Creatinine–Based Equations			Cystatin C–Based Equations	
	CKD-EPI eGFRcr(ASR)	CKD-EPI eGFRcr(AS)	EKFC eGFRcr	CKD-EPI eGFRcys	EKFC eGFRcys without Sex
Paris cohort, 858 Black patients					
Median bias (95% CI) — ml/min/1.73 m²†	0.24 (−0.64 to 0.81)	−5.09 (−5.68 to −4.14)	−2.58 (−3.49 to −1.71)	−0.62 (−1.71 to 0.28)	1.40 (0.38 to 2.23)
IQR of estimated GFR− measured GFR— ml/min/1.73 m²‡	19.3 (−12.7 to 4.1)	16.8 (−12.7 to 4.1)	14.9 (−9.9 to 5.1)	17.9 (−8.1 to 9.8)	14.3 (−5.6 to 8.8)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	16.0 (14.7 to 17.2)	14.9 (13.5 to 16.1)	13.9 (12.4 to 15.2)	15.4 (14.0 to 16.6)	13.5 (12.1 to 14.7)
P_{10} — % (95% CI)¶	35.4 (32.2 to 38.6)	33.0 (29.8 to 36.1)	37.5 (34.3 to 40.8)	36.2 (33.0 to 39.5)	41.0 (37.7 to 44.3)
P_{30} — % (95% CI)‖	79.8 (77.1 to 82.5)	82.3 (79.7 to 84.8)	85.5 (83.2 to 87.9)	81.5 (78.9 to 84.1)	87.4 (85.2 to 89.6)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*

Variable	Serum Creatinine–Based Equations		
	CKD-EPI eGFRcr(ASR)	CKD-EPI eGFRcr(AS)	EKFC eGFRcr
African cohort, 508 Black patients			
Median bias (95% CI) — ml/min/1.73 m²†	12.2 (10.7 to 15.0)	2.48 (0.72 to 4.15)	−1.45 (−2.82 to 0.62)
IQR of estimated GFR − measured GFR — ml/min/1.73 m²‡	30.0 (−3.2 to 26.8)	23.3 (−9.0 to 14.3)	20.4 (−10.6 to 9.9)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	24.5 (22.7 to 26.1)	18.1 (16.6 to 19.4)	16.4 (15.0 to 17.8)
P_{10} — % (95% CI)¶	19.5 (16.0 to 22.9)	34.4 (30.3 to 38.6)	38.0 (33.8 to 42.2)
P_{30} — % (95% CI)‖	63.6 (59.4 to 67.8)	74.4 (70.6 to 78.2)	78.9 (75.4 to 82.5)

Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*

Variable	Cystatin C–Based Equations	
	CKD-EPI eGFRcys	EKFC eGFRcys without Sex
African cohort, 508 Black patients		
Median bias (95% CI) — ml/min/1.73 m^2†	2.82 (1.43 to 4.48)	1.74 (0.28 to 3.25)
IQR of estimated GFR − measured GFR — ml/min/1.73 m^2‡	23.7 (−7.7 to 16.0)	19.5 (−7.4 to 12.1)
Root-mean-square error (95% CI) — ml/min/1.73 m^2§	18.5 (17.1 to 19.8)	16.0 (14.7 to 17.2)
P_{10} — % (95% CI)¶	33.1 (29.0 to 37.2)	40.6 (36.3 to 44.8)
P_{30} — % (95% CI)‖	77.4 (73.7 to 81.0)	83.5 (80.2 to 86.7)

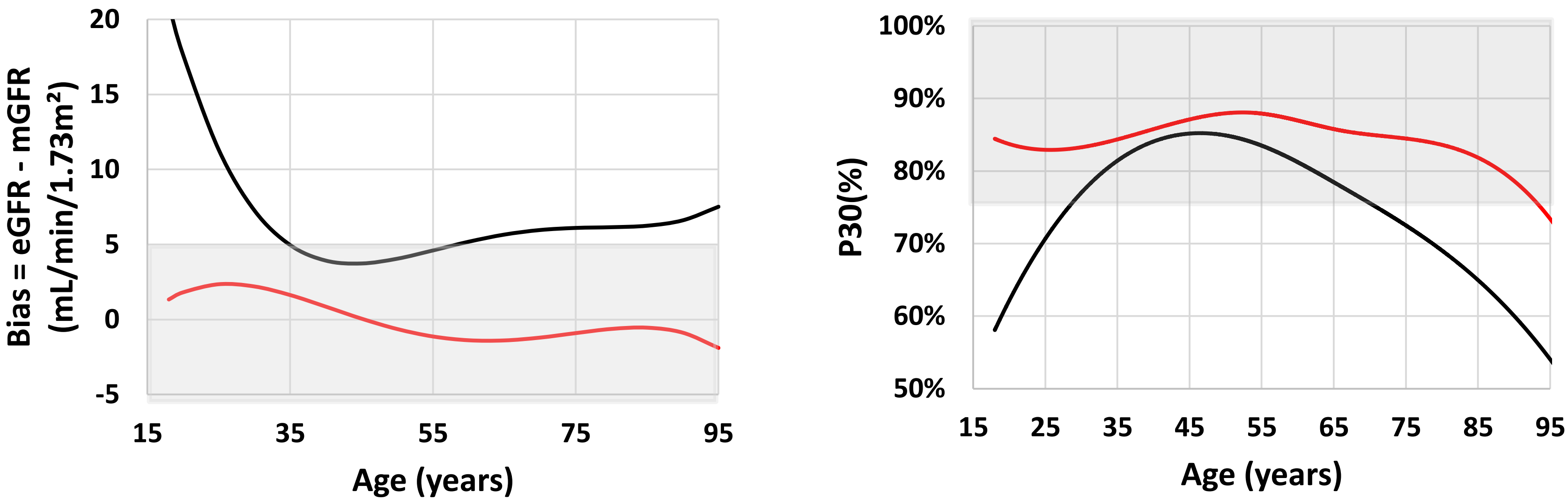
Table 1. Performance of Single Biomarker (Serum Creatinine or Cystatin C)–Based Equations to Estimate the Glomerular Filtration Rate.*

Variable	Serum Creatinine–Based Equations			Cystatin C–Based Equations	
	CKD-EPI eGFRcr(ASR)	CKD-EPI eGFRcr(AS)	EKFC eGFRcr	CKD-EPI eGFRcys	EKFC eGFRcys without Sex
African cohort, 508 Black patients					
Median bias (95% CI) — ml/min/1.73 m^2†	12.2 (10.7 to 15.0)	2.48 (0.72 to 4.15)	−1.45 (−2.82 to 0.62)	2.82 (1.43 to 4.48)	1.74 (0.28 to 3.25)
IQR of estimated GFR − measured GFR — ml/min/1.73 m^2‡	30.0 (−3.2 to 26.8)	23.3 (−9.0 to 14.3)	20.4 (−10.6 to 9.9)	23.7 (−7.7 to 16.0)	19.5 (−7.4 to 12.1)
Root-mean-square error (95% CI) — ml/min/1.73 m^2§	24.5 (22.7 to 26.1)	18.1 (16.6 to 19.4)	16.4 (15.0 to 17.8)	18.5 (17.1 to 19.8)	16.0 (14.7 to 17.2)
P_{10} — % (95% CI)¶	19.5 (16.0 to 22.9)	34.4 (30.3 to 38.6)	38.0 (33.8 to 42.2)	33.1 (29.0 to 37.2)	40.6 (36.3 to 44.8)
P_{30} — % (95% CI)‖	63.6 (59.4 to 67.8)	74.4 (70.6 to 78.2)	78.9 (75.4 to 82.5)	77.4 (73.7 to 81.0)	83.5 (80.2 to 86.7)

Table 2. Performance of Combined Serum Creatinine– and Cystatin C–Based Equations to Estimate GFR.*

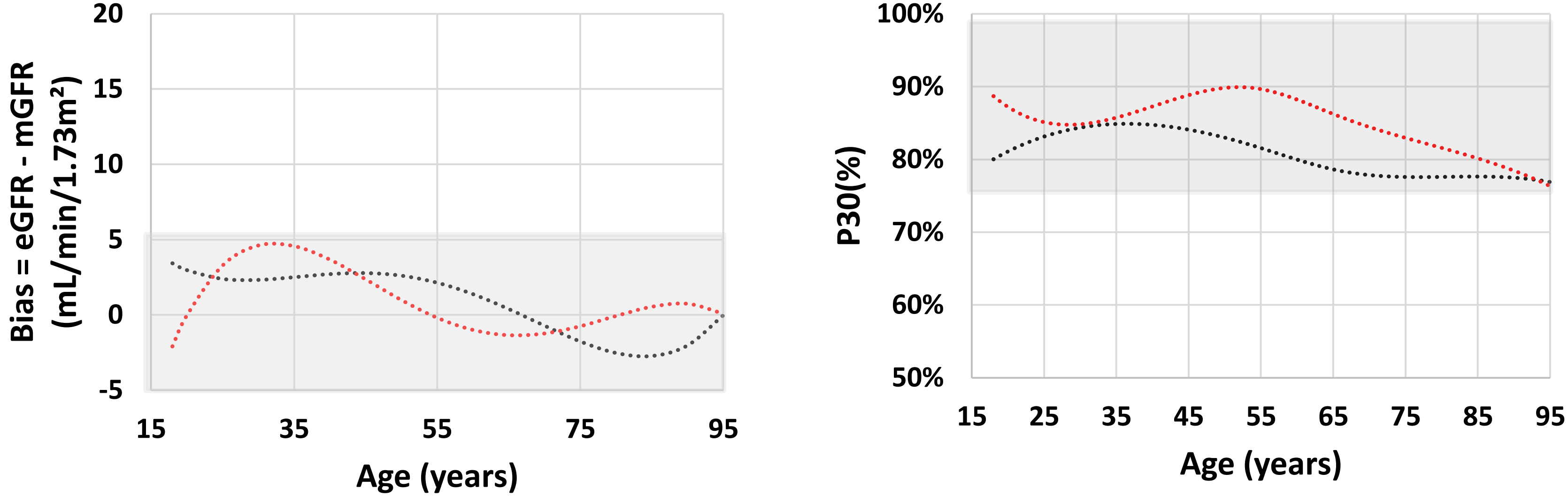
Variable	CKD-EPI eGFRcr-cys(ASR)	CKD-EPI eGFRcr-cys(AS)	EKFC eGFRcr-cys without Sex
EKFC cohort, 7727 White patients			
Median bias (95% CI) — ml/min/1.73 m²†	2.50 (2.17 to 2.76)	5.04 (4.69 to 5.36)	0.37 (0.14 to 0.66)
IQR of estimated GFR – measured GFR — ml/min/1.73 m²‡	14.8 (−3.6 to 11.2)	16.7 (−1.8 to 14.9)	12.0 (−5.9 to 6.1)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	13.1 (12.8 to 13.4)	14.7 (14.4 to 15.0)	11.3 (11.0 to 11.6)
P_{10} — % (95% CI)¶	41.5 (40.4 to 42.6)	37.2 (36.2 to 38.3)	48.9 (47.8 to 50.0)
P_{30} — % (95% CI)‖	88.3 (87.6 to 89.0)	84.2 (83.4 to 85.0)	90.4 (89.8 to 91.1)
Paris cohort, 2646 White patients			
Median bias (95% CI) — ml/min/1.73 m²†	−1.35 (−1.82 to −0.97)	0.64 (0.16 to 1.15)	−0.65 (−1.06 to −0.23)
IQR of estimated GFR – measured GFR — ml/min/1.73 m²‡	13.4 (−7.5 to 5.8)	14.1 (−5.8 to 8.3)	12.4 (−6.8 to 5.6)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	12.1 (11.6 to 12.7)	12.6 (12.0 to 13.1)	11.8 (11.2 to 12.4)
P_{10} — % (95% CI)¶	43.9 (42.0 to 45.8)	42.3 (40.4 to 44.1)	45.8 (43.9 to 47.7)
P_{30} — % (95% CI)‖	89.7 (88.5 to 90.8)	89.2 (88.0 to 90.4)	92.1 (91.1 to 93.1)
U.S. cohort, 1093 White patients			
Median bias (95% CI) — ml/min/1.73 m²†	9.23 (8.45 to 10.10)	13.9 (13.1 to 14.9)	0.97 (0.01 to 2.12)
IQR of estimated GFR – measured GFR — ml/min/1.73 m²‡	18.4 (0.5 to 18.8)	18.1 (5.1 to 23.3)	17.4 (−8.2 to 9.2)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	18.1 (17.1 to 19.1)	21.0 (20.1 to 22.0)	15.5 (14.3 to 16.7)
P_{10} — % (95% CI)¶	37.1 (34.3 to 40.0)	28.1 (25.4 to 30.8)	45.7 (42.7 to 48.6)
P_{30} — % (95% CI)‖	79.5 (77.1 to 81.9)	72.1 (69.4 to 74.8)	88.7 (86.9 to 90.6)
Paris cohort, 858 Black patients			
Median bias (95% CI) — ml/min/1.73 m²†	−0.37 (−1.06 to 0.57)	−2.08 (−2.71 to −1.32)	−0.65 (−1.23 to 0.11)
IQR of estimated GFR – measured GFR — ml/min/1.73 m²‡	15.2 (−6.4 to 8.8)	14.0 (−7.9 to 6.1)	12.4 (−6.2 to 6.2)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	13.3 (11.9 to 14.6)	12.6 (11.2 to 13.9)	11.6 (10.0 to 13.0)
P_{10} — % (95% CI)¶	38.7 (35.4 to 42.0)	38.9 (35.7 to 42.2)	48.3 (44.9 to 51.6)
P_{30} — % (95% CI)‖	87.9 (85.7 to 90.1)	89.0 (87.0 to 91.1)	92.0 (90.1 to 93.8)
African cohort, 508 Black patients			
Median bias (95% CI) — ml/min/1.73 m²†	8.55 (6.87 to 10.30)	4.08 (2.37 to 5.78)	0.42 (−1.03 to 1.51)
IQR of estimated GFR – measured GFR — ml/min/1.73 m²‡	24.7 (−4.5 to 20.1)	22.0 (−7.4 to 14.7)	17.1 (−7.2 to 10.0)
Root-mean-square error (95% CI) — ml/min/1.73 m²§	19.7 (18.2 to 21.1)	17.2 (15.8 to 18.5)	14.7 (13.3 to 16.0)
P_{10} — % (95% CI)¶	28.7 (24.8 to 32.7)	34.3 (30.1 to 38.4)	43.5 (39.2 to 47.8)
P_{30} — % (95% CI)‖	75.0 (71.2 to 78.8)	77.6 (73.9 to 81.2)	84.3 (81.1 to 87.4)

SCr-based eGFR: CKD-EPI$_{Crea}$ (AS) (black) versus EKFC$_{Crea}$ (red)



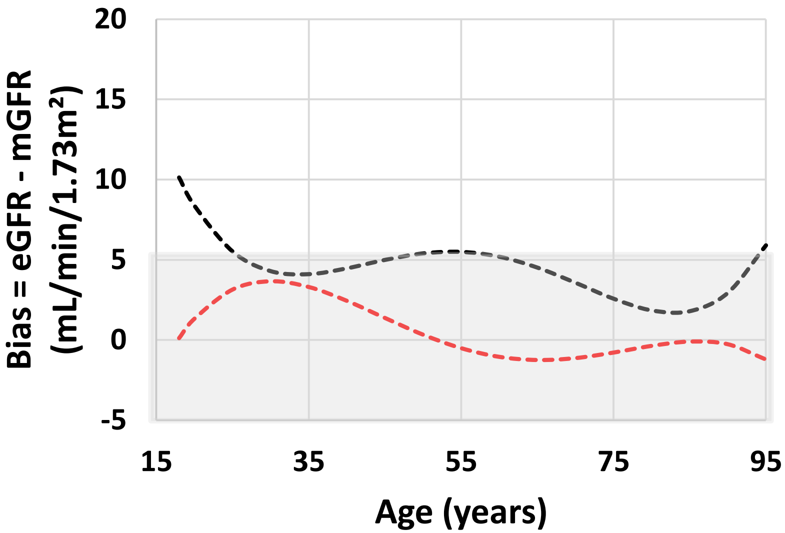
N=12,832

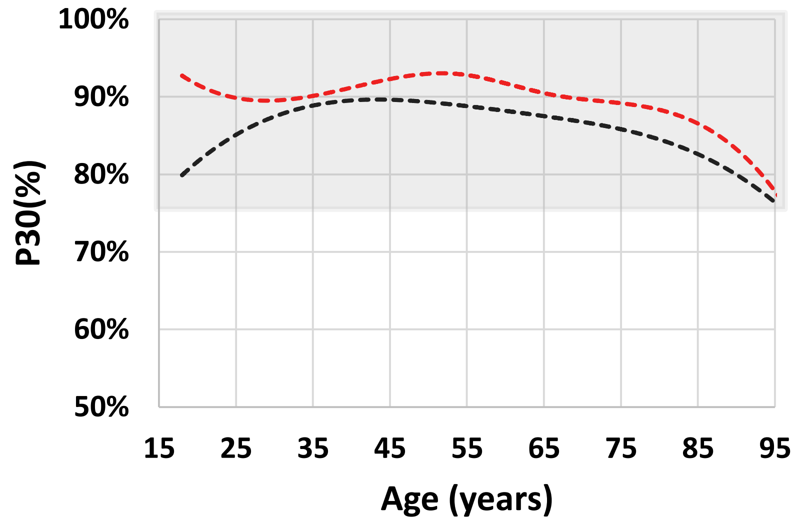
CysC-based eGFR: CKD-EPI$_{CysC}$ (black) versus EKFC$_{CysC}$ (red)



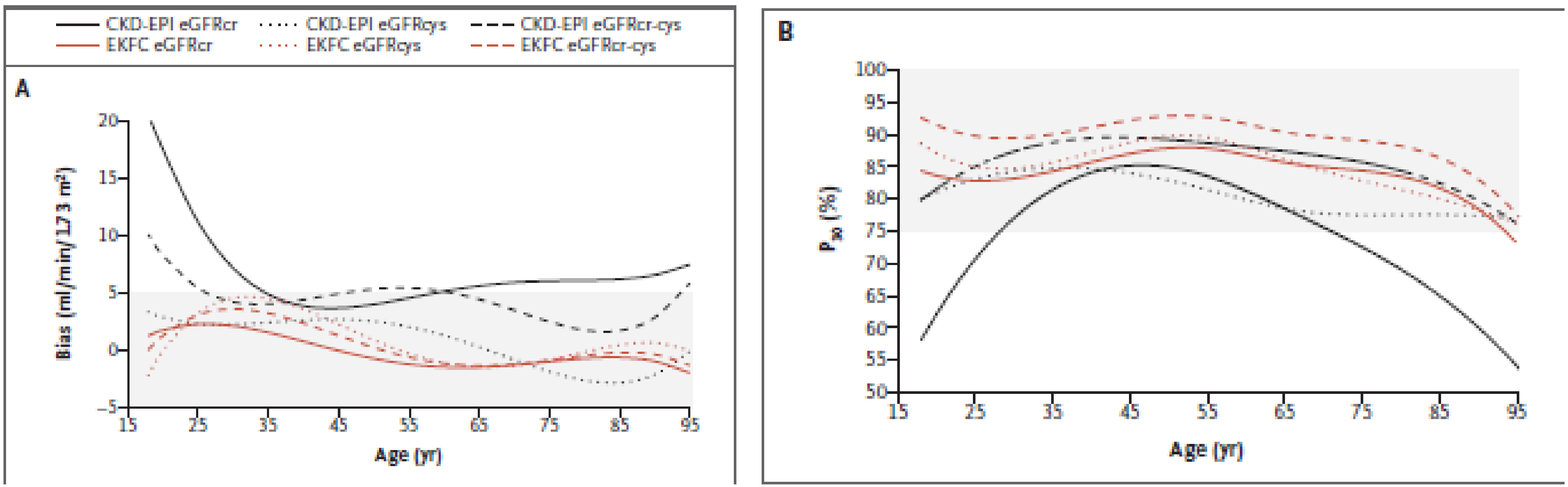
N=12,832

SCr/CysC-based eGFR: CKD-EPI$_{Crea+CysC}$ (AS) (black) versus EKFC$_{Crea+CysC}$ (red)





N=12,832



CKD-EPI eGFRcr
CKD-EPI eGFRcys
CKD-EPI eGFRcr-cys
EKFC eGFRcr
EKFC eGFRcys
EKFC eGFRcr-cys
A
Bias (ml/min/1.73 m²)
Age (yr)
B
P30 (%)
Age (yr)

N=12,832

Table S9.4a. P30-accuracy (% of subjects with eGFR within 30% of mGFR) for mGFR < 60 mL/min/1.73m^2

P30 [95%CI]	Men			Women		
	age 18-40	age 40-65	age ≥ 65	age 18-40	age 40-65	age ≥ 65
N	223	1008	1556	184	741	1197
EKFC-eGFR$_{Cr}$	69.5 [63.4; 75.6]	70.6 [67.8; 73.5]	77.2 [75.1; 79.3]	65.2 [58.3; 72.2]	72.2 [69.0; 75.4]	76.4 [74.0; 78.8]
CKD-EPI-eGFR$_{Cr}$ (AS)	62.8 [56.4; 69.2]	66.4 [63.4; 69.3]	63.2 [60.8; 65.6]	56.5 [49.3; 63.8]	66.7 [63.3; 70.1]	62.4 [59.7; 65.2]
EKFC-eGFR$_{Cys}$ (S)	77.1 [71.6; 82.7]	80.3 [77.8; 82.7]	78.9 [76.8; 80.9]	69.0 [62.3; 75.8]	76.1 [73.0; 79.2]	76.7 [74.3; 79.1]
EKFC-eGFR$_{Cys}$	80.7 [75.5; 85.9]	81.9 [79.6; 84.3]	80.5 [78.5; 82.4]	65.2 [58.3; 72.2]	74.9 [71.8; 78.0]	75.5 [73.1; 78.0]
CKD-EPI-eGFR$_{Cys}$	80.7 [75.5; 85.9]	78.8 [76.2; 81.3]	77.3 [75.2; 79.4]	72.8 [66.3; 79.3]	74.0 [70.8; 77.1]	71.6 [69.0; 74.2]
EKFC-eGFR$_{Cr+Cys}$(S)	78.0 [72.6; 83.5]	81.2 [78.7; 83.6]	84.4 [82.6; 86.2]	74.5 [68.1; 80.8]	80.2 [77.3; 83.0]	82.7 [80.6; 84.9]
EKFC-eGFR$_{Cr+Cys}$	79.8 [74.5; 85.1]	82.5 [80.2; 84.9]	85.3 [83.5; 87.0]	70.1 [63.4; 76.8]	79.6 [76.7; 82.5]	81.5 [79.2; 83.7]
CKD-EPI-eGFR$_{Cr+Cys}$(AS)	85.2 [80.5; 89.9]	83.3 [81.0; 85.6]	81.0 [79.1; 83.0]	75.0 [68.7; 71.3]	79.9 [77.0; 82.8]	78.1 [75.8; 80.5]

Table S9.4b. P30-accuracy (% of subjects with eGFR within 30% of mGFR) for mGFR ≥ 60 mL/min/1.73m^2

P30 [95%CI]	Men			Women		
	age 18-40	age 40-65	age ≥ 65	age 18-40	age 40-65	age ≥ 65
N	782	2452	858	640	2243	948
EKFC-eGFR$_{Cr}$	89.5 [87.4; 91.7]	93.3 [92.3; 94.3]	94.1 [92.5; 95.6]	89.2 [86.8; 91.6]	94.6 [93.7; 95.5]	95.0 [93.7; 96.4]
CKD-EPI-eGFR$_{Cr}$ (AS)	80.6 [77.8; 83.3]	89.4 [88.1; 90.6]	86.8 [84.6; 89.1]	79.8 [76.7; 83.0]	88.5 [87.2; 89.8]	84.8 [82.5; 87.1]
EKFC-eGFR$_{Cys}$ (S)	89.0 [86.8;91.2]	92.4 [91.3; 93.4]	91.3 [89.4; 93.2]	90.6 [88.4; 92.9]	92.5 [91.4; 93.6]	90.5 [88.6; 92.4]
EKFC-eGFR$_{Cys}$	91.0 [89.0; 93.1]	91.7 [90.6; 92.8]	90.2 [88.2; 92.2]	88.0 [85.4; 90.5]	91.9 [90.8; 93.1]	92.0 [90.3; 93.7]
CKD-EPI-eGFR$_{Cys}$	84.9 [82.4; 87.4]	83.5 [92.1; 85.0]	83.8 [81.3; 86.3]	85.2 [82.4; 87.9]	82.7 [81.1; 84.2]	81.9 [79.4; 84.3]
EKFC-eGFR$_{Cr+Cys}$(S)	94.5 [92.9; 96.1]	95.4 [94.6; 96.2]	95.8 [94.5; 97.1]	94.4 [92.6; 96.2]	97.0 [96.3; 97.7]	96.6 [95.5; 97.8]
EKFC-eGFR$_{Cr+Cys}$	94.8 [93.2; 96.3]	95.7 [94.9; 96.5]	95.5 [94.1; 96.9]	93.1 [91.2; 95.1]	96.3 [95.5; 97.1]	96.9 [85.8; 98.0]
CKD-EPI-eGFR$_{Cr+Cys}$(AS)	89.6 [87.5; 91.8]	88.9 [87.7; 90.2]	87.1 [84.8; 89.3]	87.0 [84.4; 89.6]	83.3 [81.8; 84.9]	84.7 [82.4; 87.0]

Cystatine C

- La cystatin C permet une estimation du DFG sans les variables “âge” ni “sexe”
- L’équation EKFC est mathématiquement la même pour la créatinine et le cystatine C, seul Q change
- Continuum entre enfants et adultes pour $EKFC_{crea}$ (analyse en cours pour $EKFC_{CC}$)
- Les équations basées sur la cystatine C ne sont pas meilleures que les équations basées sur la créatinine
- Les équations EKFC sont un peu meilleures que les équations CKD-EPI correspondantes => alternative valable en Europe et en Afrique
- Les équations combinées sont meilleures (exactitude +5-10%)
- Standardisation
- Plus cher

> Un expert, c'est une opinion. Deux experts, c'est la contradiction. Trois experts, c'est la confusion.

Anonyme [redacted]

Limitations des formules = créatinine

Populations spécifiques:
Les équations ne sont pas magiques!!
Gardons notre sens clinique!!

Anorexie nerveuse (Delanaye P, Clin Nephrol, 2009, 71, 482)

Cirrhose (Skluzacek PA, Am J Kidney Dis, 2003, 42, 1169)

USI (Delanaye P, BMC Nephrology, 2014, 15, 9)

Hospitalisés (Poggio ED, Am J Kidney Dis, 2005, 46, 242)

Greffés cœur (Delanaye P, Clin Transplant, 2006, 20, 596)

Greffés rein (Masson I, Transplantation, 2013, 95, 1211)

Obèse (Bouquegneau A, NDT, 2013, 28, iv122)

Nephrol Dial Transplant (2019) 34: 287–294
doi: 10.1093/ndt/gfy086
Advance Access publication 11 May 2018

Chronic kidney disease staging with cystatin C or creatinine-based formulas: flipping the coin

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Table 2. Classification of patients in CKD stages by a representative group of nine creatinine and/or cystatin C–based formulas

Creatinine

Cockcroft-Gault

Stage	GFR	N	True positive	False positive	Missing
1	178	242	142 (80%)	100 *(41%)*[a]	36 (20%)
2	252	254	136 (54%)	118 *(46%)*	116 (46%)
3	251	248	151 (60%)	97 *(39%)*	100 (40%)
4	176	124	99 (56%)	25 *(20%)*	77 (44%)
5	25	14	6 (24%)	8 *(57%)*	19 (76%)

aMDRD

Stage	GFR	N	True positive	False positive	Missing
1	178	175	115 (65%)	60 *(34%)*	63 (35%)
2	252	259	145 (58%)	114 *(44%)*	107 (42%)
3	251	257	166 (66%)	91 *(35%)*	85 (34%)
4	176	157	121 (69%)	36 *(23%)*	55 (31%)
5	25	34	13 (52%)	21 *(62%)*	12 (48%)

CKD-EPI

Stage	GFR	N	True positive	False positive	Missing
1	178	222	136 (76%)	86 *(39%)*	42 (24%)
2	252	241	138 (55%)	103 *(43%)*	114 (45%)
3	251	226	155 (62%)	71 *(31%)*	96 (38%)
4	176	156	121 (69%)	35 *(22%)*	55 (31%)
5	25	37	13 (52%)	24 *(65%)*	12 (48%)

Cystatin-C

Le Bricon

Stage	GFR	N	True positive	False positive	Missing
1	178	259	162 (91%)	97 *(37%)*	16 (9%)
2	252	243	148 (59%)	95 *(39%)*	104 (41%)
3	251	329	170 (68%)	159 *(48%)*	81 (32%)
4	176	50	32 (1[illegible]	[illegible]	[illegible]
5	25	1	1 (4[illegible]	[illegible]	[illegible]

MCQ

Stage	GFR	N	True positive	False positive	Missing
1	178	146	114 (64%)	32 *(22%)*	64 (36%)
2	252	205	127 (50%)	78 *(38%)*	125 (50%)
3	251	274	166 (66%)	108 *(39%)*	85 (34%)
4	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

CKD-EPI

Stage	GFR	N	True positive	False positive	Missing
1	178	229	155 (87%)	74 *(32%)*	23 (13%)
2	252	182	128 (51%)	54 *(30%)*	124 (49%)
3	251	246	177 (71%)	69 *(28%)*	74 (29%)
4	[illegible]	[illegible]	[illegible]	[illegible]2 *(27%)*	36 (20%)
5	[illegible]	[illegible]	[illegible]	[illegible]9 *(58%)*	11 (44%)

Creatinine + Cystatin-C

[illegible]

Stage	GFR	N	True positive	False positive	Missing
1	178	288	168 (9[illegible]	[illegible]	[illegible]
2	252	207	127 (5[illegible]	[illegible]	[illegible]
3	251	227	172 (6[illegible]	[illegible]	[illegible]
4	176	149	130 (7[illegible]	[illegible]	[illegible]
5	25	11	8 (3[illegible]	[illegible]	[illegible]

[illegible]PI

Stage	GFR	N	True positive	False positive	Missing
1	[illegible]	[illegible]	[illegible]	[illegible]5 *(29%)*	20 (11%)
2	[illegible]	[illegible]	[illegible]	[illegible]0 *(28%)*	98 (39%)
3	[illegible]	[illegible]	[illegible]	[illegible]3 *(23%)*	78 (31%)
4	[illegible]	[illegible]	[illegible]	[illegible]2 *(24%)*	40 (23%)
5	[illegible]	[illegible]	[illegible]	[illegible]2 *(54%)*	6 (24%)

Results. Misclassification was a constant for all 61 formulas evaluated and averaged 50% for creatinine-based and 35% for cystatin C–based equations. Most of the cases were misclassified as one stage higher or lower. However, in 10% of the subjects, one stage was skipped and patients were classified two stages above or below their real stage. No clinically relevant improvement was observed with cystatin C–based formulas compared with those based on creatinine.

'True positives cases' represent the subjects that were corretly classified in each CKD stage by eGFR. 'False positives cases' represent the patients who were classified in one CKD stage based on eGFR when actually belonging to a different stage. 'Missing cases' represent the cases that were not classified in the corresponding CKD stage.

[a]The percentage of false positive cases refers to the number of cases defined in each CKD stage by mGFR (grey column). The percentage of true positive and missing cases refers to the number of cases defined in each CKD stage by eGFR.

Ne pas sur-interpreter un résultat…

Toutes les équations restent des estimations

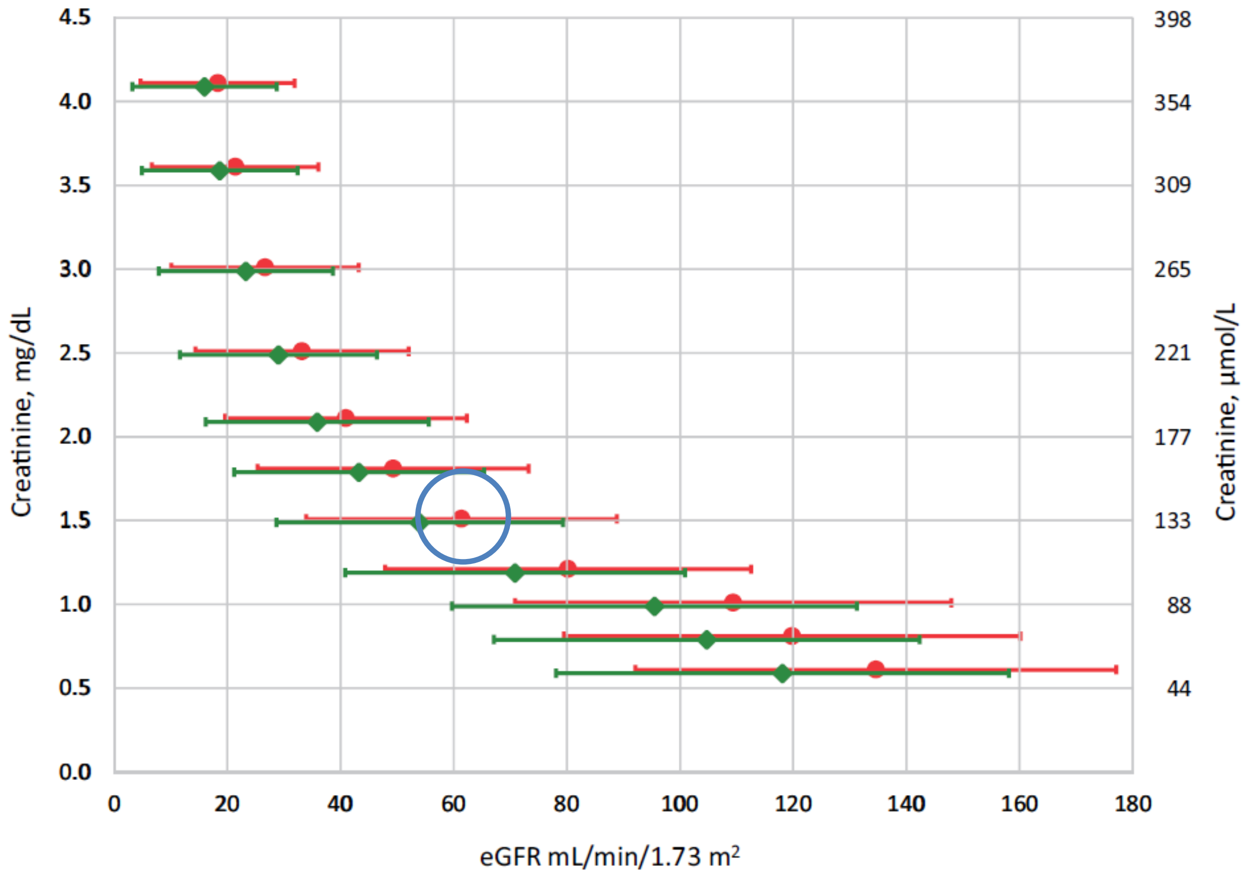


Fig. 1. Uncertainty of eGFR calculated using the CKD-EPI equations for African-Americans and non-African-Americans at various creatinine concentrations for a 50-year-old male. Circles (red, larger values) indicate African-American and diamonds (green, lower values) indicate non-African-American equations. Plot symbols are the eGFR values and error bars represent the 95% CI for each eGFR value.

eGFR = 60,25 ml/min/1.73m²

Miller WG, Clin Chem, 2021, p693 and p820

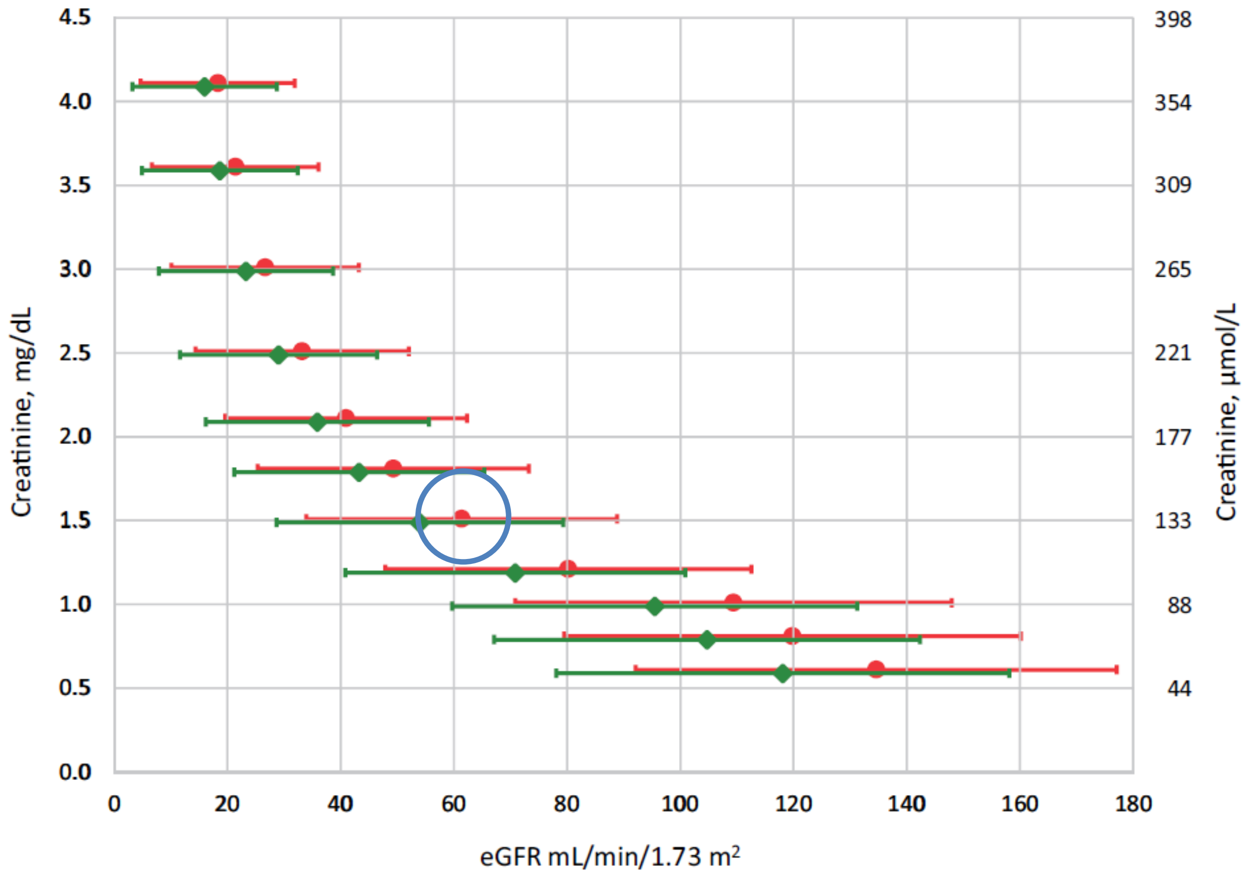


Fig. 1. Uncertainty of eGFR calculated using the CKD-EPI equations for African-Americans and non-African-Americans at various creatinine concentrations for a 50-year-old male. Circles (red, larger values) indicate African-American and diamonds (green, lower values) indicate non-African-American equations. Plot symbols are the eGFR values and error bars represent the 95% CI for each eGFR value.

eGFR ~~= 60,25 ml/min/1.73m²~~

= 60 ml/min/1.73m² (CI 95%: 33-87)

Miller WG, Clin Chem, 2021, p693 and p820

REVIEWS

The applicability of eGFR equations to different populations

Pierre Delanaye and Christophe Mariat

Delanaye P, Nature Rev Nephrol, 2013, 9, 513

Et si on mesurait le DFG…

- Estimation du DFG
- Mesure du DFG

Mesurer le DFG: Pourquoi?
Une question de précision!

- Décision d'initier la dialyse
- Individus sarcopéniques
- Gabarit extrême
- Cirrhose, USI, Hyperfiltration
- Donneur vivant

Agarwal R, Nephrol Dial Transplant, 2019, 34, p2001
Ebert N, Clin Kidney J, 2021, p1861

Impact of estimation versus direct measurement of predonation glomerular filtration rate on the eligibility of potential living kidney donors

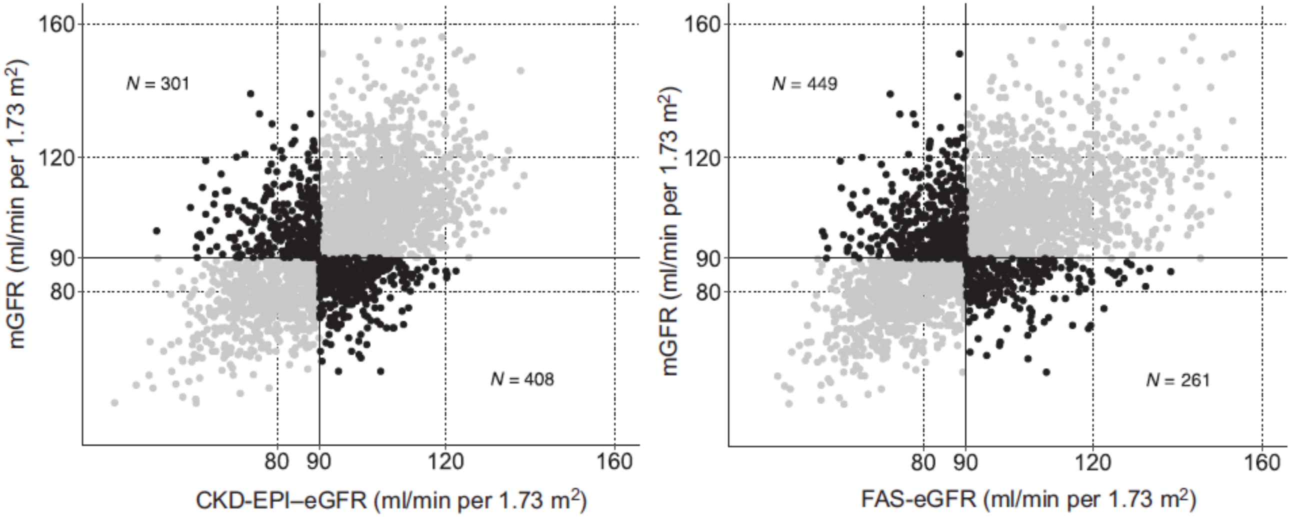
see commentary on page 738

Check for updates

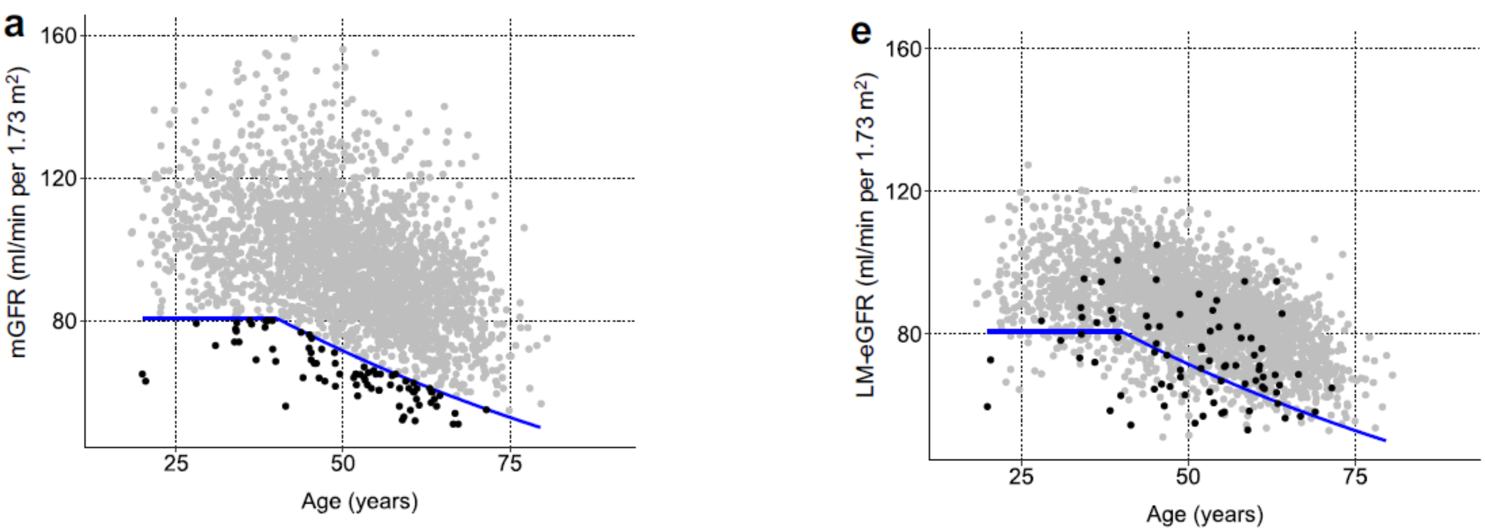
François Gaillard[1,2], Marie Courbebaisse[2,3], Nassim Kamar[4,5,18], Lionel Rostaing[6,18], Lola Jacquemont[7,8], Maryvonne Hourmant[7,8], Arnaud Del Bello[4], Lionel Couzi[9,10], Pierre Merville[9,10], Paolo Malvezzi[6], Benedicte Janbon[6], Bruno Moulin[11], Nicolas Maillard[12], Laurence Dubourg[13,14], Sandrine Lemoine[13], Cyril Garrouste[15], Hans Pottel[16], Christophe Legendre[1,2], Pierre Delanaye[17,19] and Christophe Mariat[12,19]

Kidney International (2019) **95,** 896–904;

- N=2,733 donneurs potentiels
- DFG mesuré, créatinine calibrée



N = 301
N = 408
mGFR (ml/min per 1.73 m2)
CKD-EPI–eGFR (ml/min per 1.73 m2)
160
120
90
80
80 90 120 160
N = 449
N = 261
mGFR (ml/min per 1.73 m2)
FAS-eGFR (ml/min per 1.73 m2)



a
mGFR (ml/min per 1.73 m2)
160
120
80
25 50 75
Age (years)
e
LM-eGFR (ml/min per 1.73 m2)
160
120
80
25 50 75
Age (years)

Mesurer le DFG: Pourquoi? Une question de précision!

- Décision d'initier la dialyse
- Individus sarcopéniques
- Gabarit extrême
- Cirrhose, USI, Hyperfiltration
- Donneur vivant
- Recherche Clinique, EMA

Agarwal R, Nephrol Dial Transplant, 2019, 34, p2001
Ebert N, Clin Kidney J, 2021, p1861

Mesurer le DFG: Pourquoi?
Une question de précision!

- Décision d'initier la dialyse
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- Donneur vivant
- Recherche Clinique, EMA
- Dosage d'un médicament potentiellement néphrotoxique (=>2)

Agarwal R, Nephrol Dial Transplant, 2019, 34, p2001
Ebert N, Clin Kidney J, 2021, p1861

Mesurer le DFG: Pourquoi? Une question de précision!

- Décision d’initier la dialyse
- Individus sarcopéniques
- Gabarit extrême
- Cirrhose, USI, Hyperfiltration
- Donneur vivant
- Recherche Clinique, EMA
- Dosage d’un médicament potentiellement néphrotoxique (=>2)
- Pas de preuve définitive…

Agarwal R, Nephrol Dial Transplant, 2019, 34, p2001
Ebert N, Clin Kidney J, 2021, p1861

Disponibles sur le marché…

Marqueurs	Forces	Limites
Inuline	"Gold standard" (ou historique)	Coûteux Dosage ni facile ni standardisé Impossible en clairance plasmatique
Iothalamate	Le plus populaire aux USA Isotopique ou "froide"	Sécrétion tubulaire Allergie Iode
Iohexol	Populaire en Europe Froide	Allergie Iode
EDTA	Facile à mesurer	Seulement isotopique Pas disponible aux USA…et plus en Europe!!
DTPA	Facile à mesurer	Seulement isotopique Liaison aux protéines

Stevens LA, J Am Soc Nephrol, 2009, 20, 2305
Cavalier E, Clin Chim Acta, 2008, 396, 80
Delanaye P, Clin Kidney J, 2016, 9, 700

AJKD
Original Investigation

Measuring GFR: A Systematic Review

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Table 1. Bias and Accuracy of Index Methods Compared to Reference Method When Measuring Glomerular Filtration Rate

	No. of Pts/ Studies	Median Bias[a] (95% CI)	Mean Bias (95 % CI)	P_{30} (95% CI)	P_{10} (95% CI)	Sufficient Accuracy	Scientific Evidence	Comments[b]
Criteria for sufficient precision		≤±5%	≤±10%	≥80%	≥50%			
Index method								
DTPA								
Renal clearance	126/5	−2 (−4 to 2)	−1 (−6 to 5)	87 (81 to 93)	53 (45 to 62)	Yes	⊕⊕○○	Inconsistency, −1; imprecision, −1
Plasma clearance	89/2	20 (18 to 35)	13 (5 to 22)	56 (47 to 68)	19 (13 to 29)	No	⊕⊕○○	Study limitations −1; imprecision −1
^{51}Cr-EDTA								
Renal clearance	198/9	−5 (−7 to −3)	−2 (−8 to 4)	95 (92 to 98)	56 (50 to 64)	Yes	⊕⊕⊕○	Imprecision, −1
Plasma clearance	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Iohexol								
Renal clearance	47/2	−7 (−10 to 0)	−7 (−16 to 2)	100[c]	53 (41 to 70)	Yes	⊕⊕○○	Imprecision, −2
Plasma clearance	172/5	3 (0 to 6)	2 (−4 to 9)	86 (81 to 91)	50 (43 to 58)	Yes	⊕⊕⊕○	Imprecision, −1
[illegible]								
Renal clearance	548/13	−1 (−2 to 0)	6 (1 to 11)	97 (95 to 98)	66 (62 to 70)	Yes	⊕⊕⊕⊕	
Plasma clearance	61/1	9 (0 to 15)	11 (−6 to 29)	82 (73 to 92)	33 (23 to 47)	—	⊕○○○	Study limitations, −1; imprecision, −2
Inulin								
Plasma clearance	39/2	2 (−3 to 6)	1 (−9 to 11)	100[c]	72 (59 to 87)	Yes	⊕⊕○○	Imprecision, −1; indirectness, −1

Note: Modified with permission of the Swedish Council on Health Technology Assessment.[3] Accuracy and bias expressed as percentage. Renal inulin clearance served as reference method. Mean bias, P_{10}, and P_{30} were estimated using generalized linear mixed models based on normal distribution (mean bias) or Poisson distribution (P_{10}, P_{30}; log-transformed outcome and robust variance estimation), with a random intercept for each study and a fixed effect for each index method ("unadjusted model results"; see Statistical Methods section). All analyses were weighed with respect to number of participants in each study. Estimates were obtained as marginal means.

Abbreviations and definitions: ⊕⊕⊕⊕, strong evidence; ⊕⊕⊕○, moderately strong evidence; ⊕⊕○○, limited evidence; ⊕○○○, insufficient evidence; ^{51}Cr-EDTA, chromium 51–labeled ethylenediaminetetraacetic acid; DTPA, diethylenetriaminepentaacetic acid; CI, confidence interval; Imprecision, N < 100 in meta-analysis (−1), P_{30} lower 95% CI ≤ 80%, P_{10} lower 95% CI ≤ 50%, or median bias 95% CI ≥ ±5% (−1); Inconsistency, inconsistency in study outcomes that cannot be explained by differences in study design (−1); Indirectness, limited generalizability (−1); P_{10}, percentage of measurements by index method that differed no more than 10% from reference method; P_{30}, percentage of measurements by index method that differed no more than 30% from reference method; pts, patients; Study limitations, risk of bias due to shortcomings in individual studies (−1).

[a]Median bias was calculated directly (using the weights) for each index method together with nonparametric CIs.

[b]Strength of scientific evidence.

[c]The generalized linear mixed model does not yield valid estimates of confidence limits when estimated proportion (eg, P_{30}) is 100%.

Soveri I, Am J Kidney Dis, 2014, 64, 411

Comment mesurer le DFG?

Table 4. Available procedures to perform iohexol clearance

Methodology	Indication in clinical practice	Indication in clinical research	Bibliographic examples where the procedure is described into details
Urinary clearance	Increased extracellular volume (oedema, ascites, intensive care units, etc.)	Basic (physiologic) studies Specific populations (cirrhotic, intensive care, nephrotic syndrome, oedema, etc.)	[36, 77, 125, 170]
Plasma clearance			
Multiple samples (first or fast, second or slow exponential curves and calculation of area under the curve)	High GFR values ('hyperfiltrating') subjects	Development of equations to estimate GFR Studies in hyperfiltrating patients	[52, 93, 171]
Multiple samples only for second and slow component (2 h after injection, 4 samples over 5 or 6 h, 1 sample/h) + BM correction	High precision determination (see text)	Development of equations to estimate GFR Clinical research with GFR as main endpoint	[126, 172]
Idem + late sample (8 h or 24 h)	Pre-dialysis subjects	Research in pre-dialysis subjects	[52, 77]
Simplified two or three sample method (2 samples: first at 2 or 3 h and second at 4 or 5 h) + BM correction	CKD or healthy population	Development of equations to estimate GFR Clinical research with GFR as a secondary endpoint	[69, 116]
Simplified single-sample method + Jacobsson correction [110]	CKD or healthy population	Development of equations to estimate GFR Clinical research with GFR as a secondary endpoint Epidemiological research	[14, 173]

Suggestions (expert opinion-based) according to the clinical or experimental context.
GFR, glomerular filtration rate; CKD, chronic kidney disease; BM, Brochner-Mortensen correction [116].

Delanaye P, Clin Kidney J, 2016, 9, 700

EKFC

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Single- versus multiple-sample method to measure glomerular filtration rate

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**These authors equally contributed as last senior author.

Original Investigation
AJKD

Comparability of Plasma Iohexol Clearance Across Population-Based Cohorts

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Rationale & Objective: Glomerular filtration rate (GFR) estimation based on creatinine or cystatin C level is currently the standard method for assessing GFR in epidemiologic research and clinical trials despite several important and well-known limitations. Plasma iohexol clearance has been proposed as an inexpensive method for measuring GFR that could replace estimated GFR in many research projects. However, lack of standardization for iohexol assays and the use of different protocols such as single- and multiple-sample methods could potentially hamper comparisons across studies. We compared iohexol assays and GFR measurement protocols in 3 population-based European cohorts.

Study Design: Cross-sectional investigation.

Setting & Participants: Participants in the Age

Results: Frozen samples from the 3 studies were obtained and iohexol concentrations were remeasured in the laboratory at the University Hospital of North Norway. Lin's concordance correlation coefficient ρ was >0.96 and C_b (accuracy) was >0.99 for remeasured versus original serum iohexol concentrations in all 3 cohorts, and Passing-Bablok regression did not find differences between measurements, except for a slope of 1.025 (95% CI, 1.006-1.046) for the log-transformed AGES-Kidney measurements. The multiple-sample iohexol clearance measurements in AGES-Kidney and BIS were compared with single-sample GFRs derived from the same iohexol measurements. Mean bias for multiple-sample relative to single-sample GFRs in AGES-Kidney and BIS were −0.25 and −0.15 mL/min, and 99% and 97% of

Complete author and article information provided before references.

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CLINICAL RESEARCH

Comparison of Plasma Clearance With Early-Compartment Correction Equations and Urinary Clearance in High GFR Ranges

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RESEARCH LETTERS

Comparison of Early-Compartment Correction Equations for GFR Measurements

Check for updates

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AJKD

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RESEARCH LETTER

Concordance
Iohexol Plasma Clearance

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BMC Nephrology
RESEARCH Open Access

Iohexol plasma clearance for measuring glomerular filtration rate: effect of different ways to calculate the area under the curve

Check for updates

Hans Pottel[1*], Elke Schaeffner[2], Natalie Ebert[2], Markus van der Giet[3] and Pierre Delanaye[4,5]

KI REPORTS
KIReports.org
RESEARCH LETTER

Iohexol Plasma Clearance: Impact of Weighing the Syringe

Check for updates

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Choix du marqueur

- Seules les méthodes froides sont facilement implantables partout dans le monde
- Iohexol est disponible partout
- Très stable (labo central et/ou de “référence”)
- EQUAS (Equalis, Sweden) est disponible
- Cr-EDTA, inuline, iothalamate pas ou plus disponibles…

Iohexol au CHU de Liège

- Iohexol (clairance plasmatique), 5 mL bolus
- 5 heures
- Echantillons à 2, 3, 4 et 5 heures (+long si DFG très bas)
- Bröchner-Mortensen
- 50 à 100 euros

Conclusions DFG mesuré

- Mesurer le DFG n'est pas si difficile
- Iohexol est la meilleure balance entre physiologie et faisabilité
- Iohexol est sans danger
- Iohexol est la seule chance pour une mesure du DFG standardisée dans le monde entier
- En Europe, l'iohexol va s'imposer par manque de combattants

Conclusions

- Limitations de la créatinine
- Plusieurs formules
- Avantages de la formule EKFC
- Cystatine C
- Mesure du DFG est possible (iohexol)

Merci de votre attention

Merci de votre attention