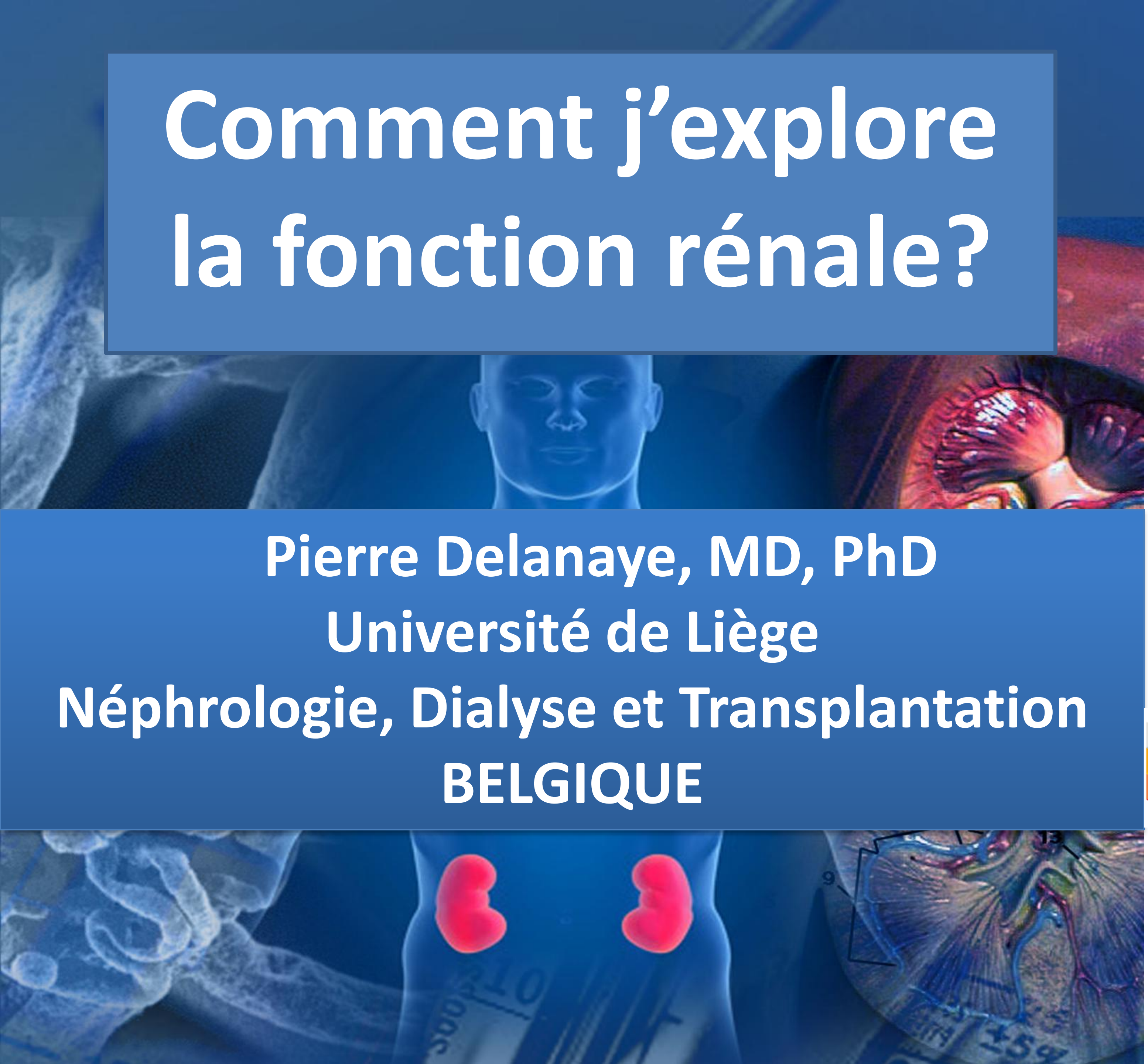

# Comment j'explore la fonction rénale?


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Pediatric Nephrology (2025) 40:3347–3357
https://doi.org/10.1007/s00467-025-06724-2

REVIEW

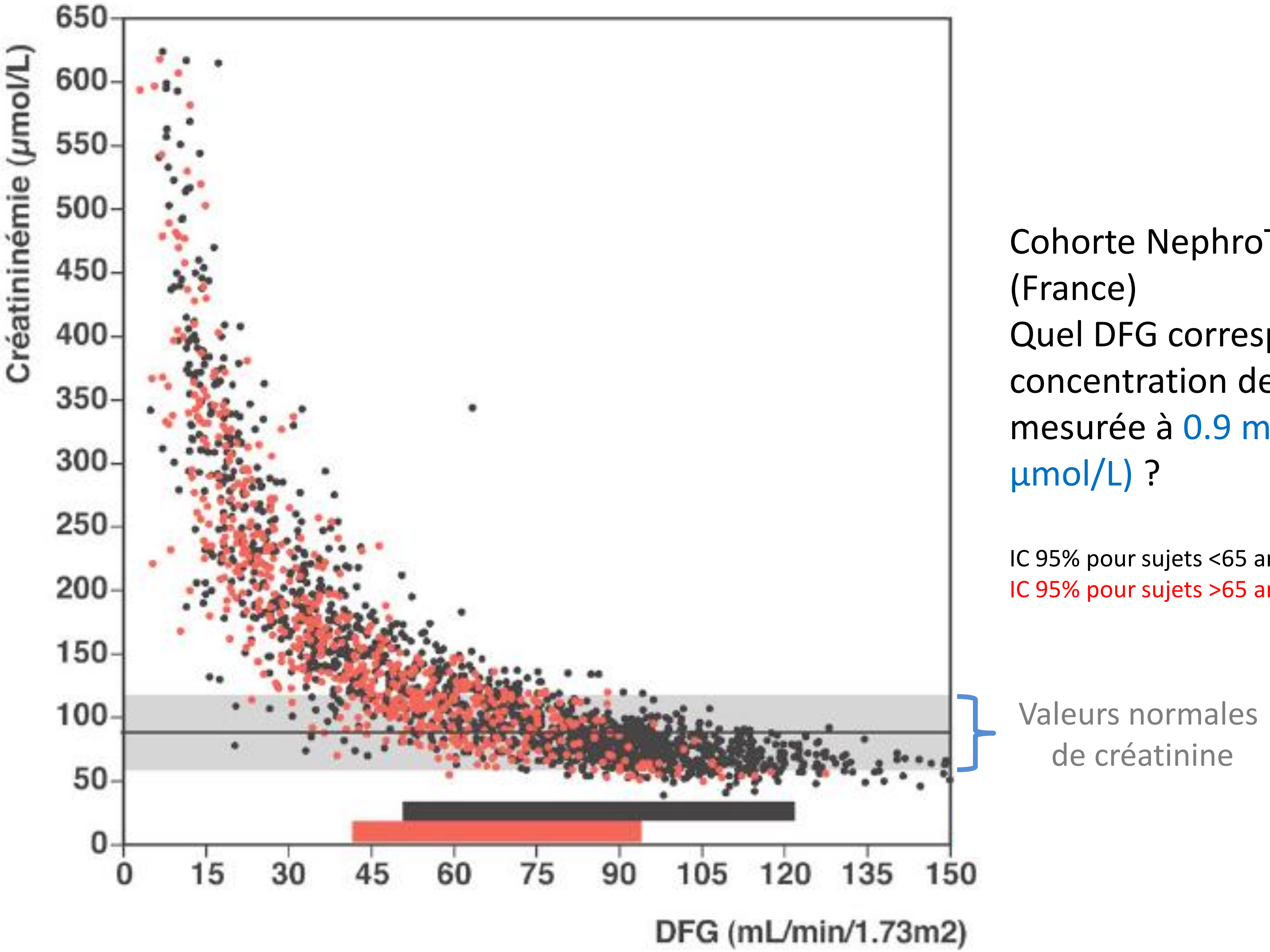
# Measuring and estimating the GFR in children: state of the art in 2025

Hans Pottel[1] · George J. Schwartz[2]

Received: 11 October 2024 / Revised: 9 February 2025 / Accepted: 10 February 2025 / Published online: 11 March 2025

Le DFG est le paramètre le plus utilisé pour estimer la fonction globale du rein

- Le DFG est estimé avec des biomarqueurs
- La créatinine est une des analyses les plus prescrites
- Le plus important est probablement d'en connaitre les limites…




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

Avec la permission de Marc Froissart

# Autres Limites

## *Analytiques*

- Méthodes de Jaffe
- Méthodes enzymatiques
- Ces deux méthodes donnent des résultats différents
- Pseudochromogènes: glucose, fructose, ascorbate, protéines, urate, acetoacetate, acétone, pyruvate => faux +
- Bilirubines: faux –
- CALIBRATION

## *Physiologiques: Sécrétion tubulaire*

- 10 à 40%
- Augmente quand le DFG diminue
- Difficile à prédire à l'échelle individuelle

## *Physiologiques: Masse musculaire*

- Production (relativement) constante mais production musculaire => créatinine sérique dépend de la masse musculaire, pas seulement du DFG (âge? sexe/genre? race/population?)
- Production extra-rénale

*Perrone RD, Clin Chem, 1992, 38, p1933*
*Delanaye P, Nephron, 2017, 136, p302*

# Créatinine: à la poubelle?

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

# Créatinine: à la poubelle?

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

# 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 »

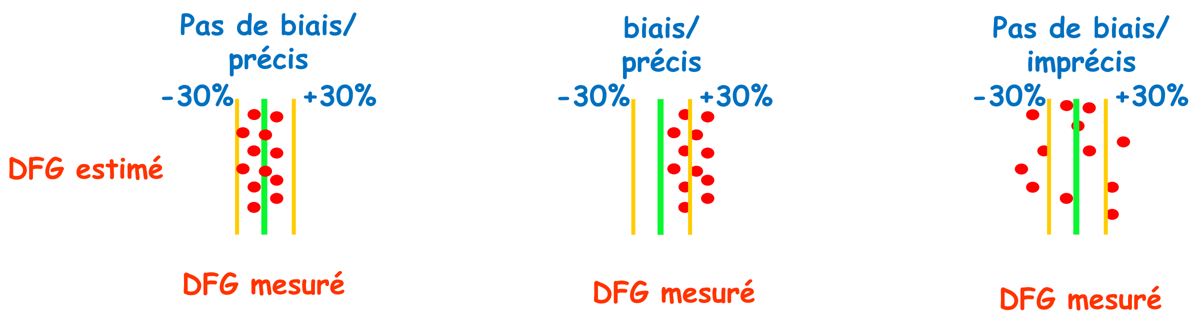
50 to 70 % pour les autres

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*

# 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*

# Quelles équations?

- ~~Cockcroft~~
- Schwartz – Schwartz updated - CKiDU25
- EKFC

Clinica Chimica Acta 396 (2008) 49–55

Contents lists available at ScienceDirect

Clinica Chimica Acta

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

# Establishing age/sex related serum creatinine reference intervals from hospital laboratory data based on different statistical methods

Hans Pottel [a,*], Nicolas Vrydags [b], Boris Mahieu [b], Emmanuel Vandewynckele [b], Kathleen Croes [b], Frank Martens [b]

[a] Interdisciplinary Research Center, Katholieke Universiteit Leuven Campus Kortrijk, Kortrijk, Belgium
[b] Department of Clinical Chemistry, AZ Groeninge Hospital, Kortrijk, Belgium

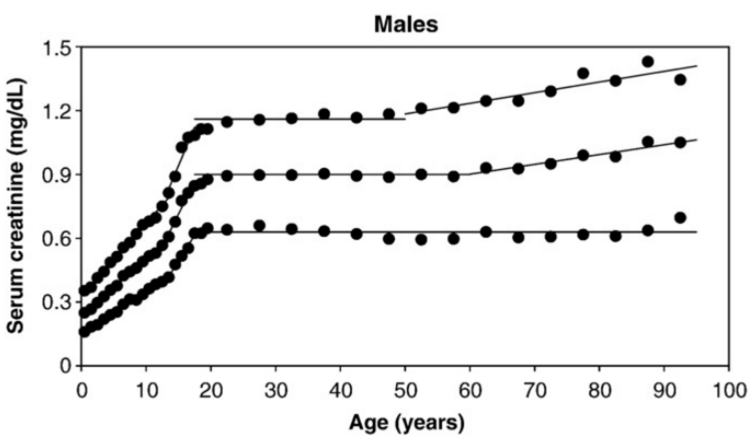



**Fig. 3.** Age dependency of Scr (mg/dL) for males for lower limit, mean and upper limit.

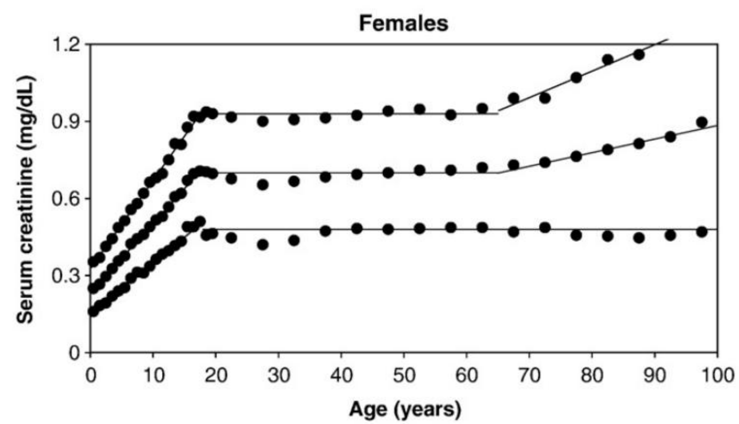



**Fig. 4.** Age dependency of Scr (mg/dL) for females for lower limit, mean and upper limit.

**Fig. 2.** GFR values (MAG3 series), corrected for body surface area. The 10th, 25th, 50th, 75th and 90th percentiles are represented. **a** Values up to 2 years of age. **b** Values up to 15 years. After 2 years of age, the GFR remains constant

*Original article*

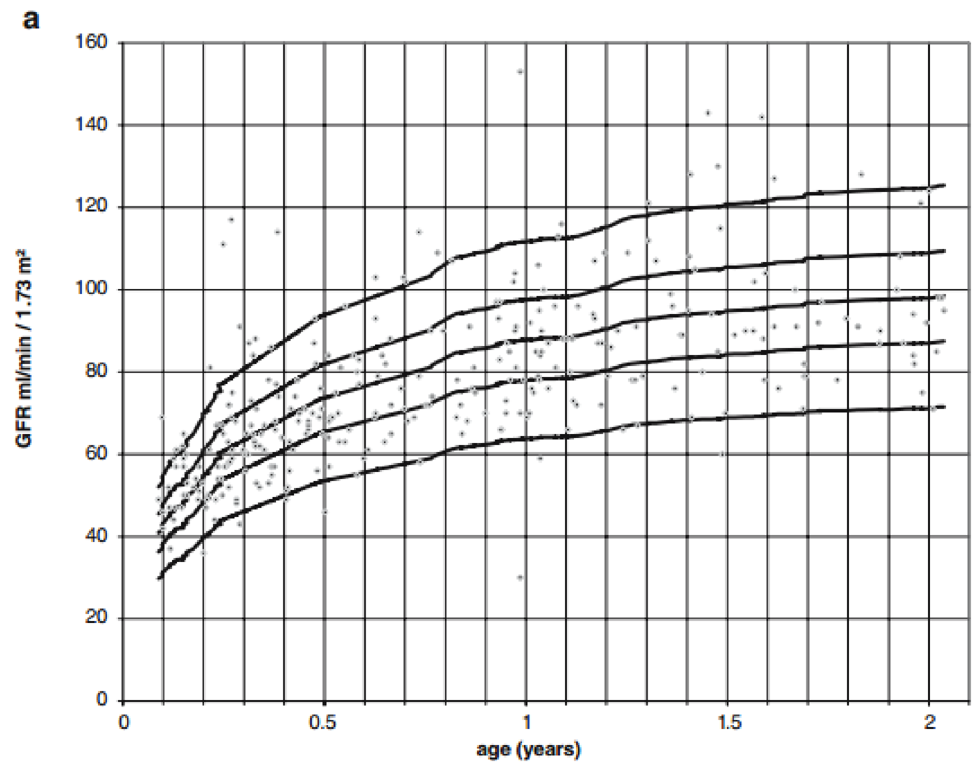
## Revisiting normal $^{51}$Cr-ethylenediaminetetraacetic acid clearance values in children

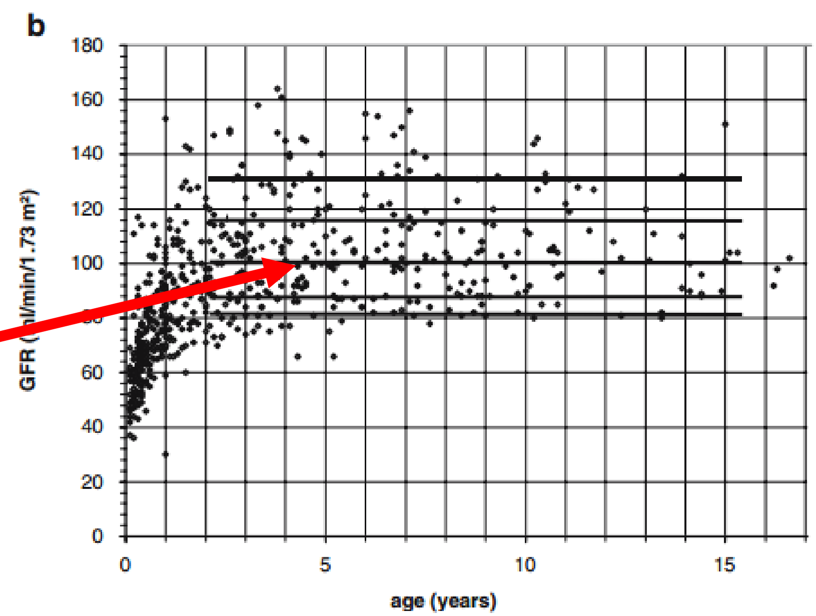
A. Piepsz[1], M. Tondeur[1], H. Ham[2]

[1] CHU St Pierre, Department of Radioisotopes, 322, Rue Haute, 1000 Brussels, Belgium
[2] UZ Ghent, Department of Nuclear Medicine, Ghent, Belgium

Received: 16 April 2006 / Accepted: 23 May 2006 / Published online: 25 July 2006


**Eur J Nucl Med Mol Imaging (2006) 33:1477–1482**
DOI 10.1007/s00259-006-0179-2




104 mL/min/1.73m²

# A Simple Estimate of Glomerular Filtration Rate in Children Derived From Body Length and Plasma Creatinine

G. J. Schwartz, M.D., G. B. Haycock, M.B., C. M. Edelmann, Jr., M.D., *and* Adrian Spitzer, M.D.

*From the Division of Nephrology, Department of Pediatrics, Albert Einstein College of Medicine and Rose F. Kennedy Center, New York, New York*

*Pediatrics* 1976;58;259

- Développée chez 186 enfants (6 mois à 20 ans) (régression, r=0,893)
- GFR ~ clairance de créatinine
- Créatinine mesurée par « Technicon autoanalyzer »
- Validée chez 146 enfants avec clairance de créatinine (r=0,935)
- Validée chez 77 enfants avec clairance d’inuline

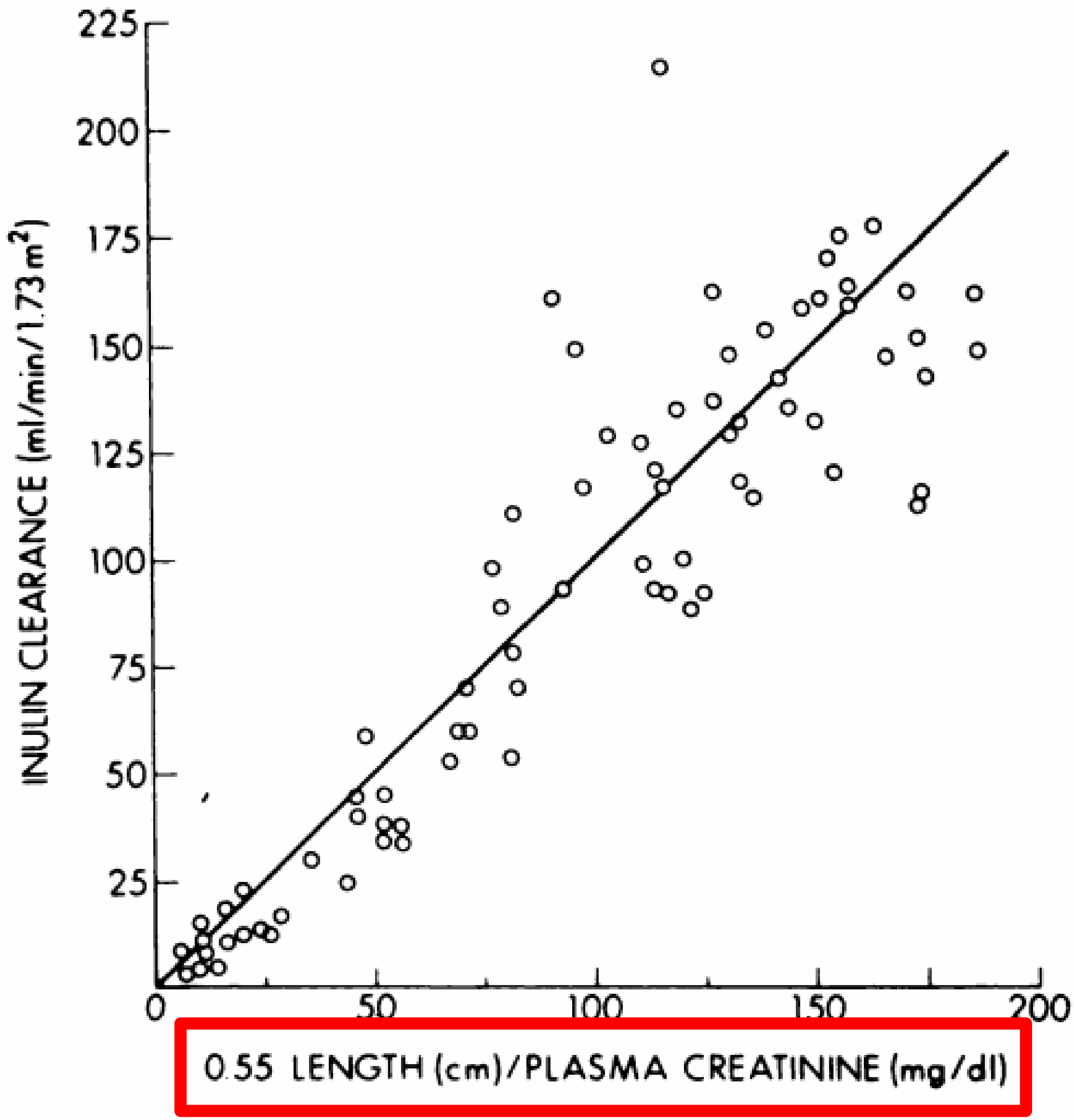



FIG. 4. Relationship between Cin and GFR as predicted by the formula 0.55 L/Pcr (No. = 77; $r$ = .905). The line of identity is superimposed.

› J Pediatr. 1984 Jun;104(6):849-54. doi: 10.1016/s0022-3476(84)80479-5.

# A simple estimate of glomerular filtration rate in full-term infants during the first year of life

K=0,45

› J Pediatr. 1985 Mar;106(3):522-6. doi: 10.1016/s0022-3476(85)80697-1.

# A simple estimate of glomerular filtration rate in adolescent boys

G J Schwartz, B Gauthier

K=0,70 à partir de 13 ans chez garçon
K reste à 0,55 chez fille

# CRÉATININE MESURÉE PAR JAFFE (SPECIAL) (ET NON STANDARDISÉE)

CLINICAL EPIDEMIOLOGY www.jasn.org

# New Equations to Estimate GFR in Children with CKD

George J. Schwartz,* Alvaro Muñoz,† Michael F. Schneider,† Robert H. Mak,‡ Frederick Kaskel,§ Bradley A. Warady,‖ and Susan L. Furth†¶

*Department of Pediatrics, University of Rochester School of Medicine, Rochester, and §Department of Pediatrics, Albert Einstein College of Medicine, Bronx, New York; †Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health and ¶Department of Pediatrics, Johns Hopkins School of Medicine, Baltimore, Maryland; ‡Department of Pediatrics, Children's Hospital of San Diego, San Diego, California; ‖Department of Pediatrics, Children's Mercy Hospital, Kansas City, Missouri

J Am Soc Nephrol **20:** 629–637, 2009

- Chronic Kidney Disease in Children (CKiD)
- N=349, 61% garçons
- DFG=clairance plasmatique iohexol
- Créatinine enzymatique (Siemens, Advia)
- 1 à 16 ans (médiane: 10,8 ans)
- DFG médian: 41 ml/min/1.73m² (15-75 mL/min/1.73m²)

$$eGFR = 41.3[height/Scr],$$

Table 3. Precision, goodness of fit, and agreement of eGFR derived from coefficients of indicated regression model; $n = 349$ children of the CKiD study[a]

| Model | eGFR= a [height/Scr]$^b$ [1.8/Cystatin C]$^c$ [30/BUN]$^d$ [$e^{male}$] [height/1.4]$^f$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *a* | *b* | *c* | *d* | *e* | *f* | RMSE | $R^2$ (%) | % of eGFR within 30% of iGFR | % of eGFR within 10% of iGFR |
| None | 41.0 ± 0.8 | 0 | 0 | 0 | 1 | 0 | 0.351 | 0.0 | 52.2 | 20.3 |
| Updated Schwartz | 41.3 ± 0.5 | 1 | 0 | 0 | 1 | 0 | 0.223 | 59.6 | 79.4 | 37.0 |

$$eGFR = 41.3[height/Scr],$$

Table 3. Precision, goodness of fit, and agreement of eGFR derived from coefficients of indicated regression model; $n = 349$ children of the CKiD study[a]

| Model | eGFR= a [height/Scr]$^b$ [1.8/Cystatin C]$^c$ [30/BUN]$^d$ [$e^{male}$] [height/1.4]$^f$ | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | a | b | c | d | e | f | RMSE | $R^2$ (%) | % of eGFR within 30% of iGFR | % of eGFR within 10% of iGFR |
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| % of eGFR within 30% of iGFR |
|---|
| 52.2 |
| 79.4 |

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| Updated Schwartz | 41.3 ± 0.5 | 1 | 0 | 0 | 1 | 0 | 0.223 | 59.6 | 79.4 | 37.0 |
| IA | 41.6 ± 0.4 | 0.599 ± 0.038 | 0.317 ± 0.044 | 0 | 1 | 0 | 0.194 | 69.4 | 84.0 | 38.4 |
| IB | 40.7 ± 0.4 | 0.640 ± 0.035 | 0 | 0.202 ± 0.030 | 1 | 0 | 0.196 | 69.1 | 83.7 | 38.4 |
| IC | 40.9 ± 0.5 | 0 | 0.569 ± 0.045 | 0.313 ± 0.032 | 1 | 0 | 0.226 | 58.6 | 78.2 | 35.0 |
| II | 41.1 ± 0.4 | 0.510 ± 0.039 | 0.272 ± 0.043 | 0.171 ± 0.029 | 1 | 0 | 0.185 | 72.3 | 86.3 | 38.7 |
| III | 39.1 ± 0.6 | 0.516 ± 0.037 | 0.294 ± 0.041 | 0.169 ± 0.027 | 1.099 ± 0.021 | 0.188 ± 0.048 | 0.176 | 75.2 | 87.7 | 45.6 |

[a]eGFR and iGFR, ml/min per 1.73m$^2$; height, m; Scr, mg/dl; cystatin C, mg/L; BUN, mg/dl. Entries for a through f are regression coefficient ± SE. RMSE, root mean square error.

Taille chez MRC = ?

K unique donc pas valable chez ado plus vieux et jeune enfant

Updated “bedside” equation

# Age- and sex-dependent clinical equations to estimate glomerular filtration rates in children and young adults with chronic kidney disease

Check for updates

see commentary on page 808

Christopher B. Pierce[1], Alvaro Muñoz[1], Derek K. Ng[1], Bradley A. Warady[2], Susan L. Furth[3] and George J. Schwartz[4]

*[1]Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland, USA; [2]Division of Pediatric Nephrology, Children's Mercy Kansas City, Kansas City, Missouri, USA; [3]Department of Pediatrics, Perelman School of Medicine at the University of Pennsylvania, and Division of Nephrology, Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, USA; and [4]Department of Pediatrics, Pediatric Nephrology, University of Rochester Medical Center, Rochester, New York, USA*

*Kidney International* (2021) **99,** 948–956;

- Chronic Kidney Disease in Children (CKiD)
- N=928 (2655 résultats) (37% filles)
- DFG=clairance plasmatique iohexol
- Créatinine et cystatine C standardisées
- 1 à 25 ans (médiane: 13 ans)
- DFG médian: 41 à 49 ml/min/1.73m²

**Table 2 | Sex-specific values of *K* in constant and age-dependent models for *height/sCr* and *1/cysC* glomerular filtration rate estimating equations**

| | *K* for height / sCr | | | |
|---|---|---|---|---|
| | Male (N = 387; 1093 pv)[a] | | Female (N = 231; 671 pv)[a] | |
| Age, yr | Constant | Age dependent | Constant | Age dependent |
| 1–12 | 41.8 | $39.0 \times 1.008^{(age-12)}$ | 37.6 | $36.1 \times 1.008^{(age-12)}$ |
| 12–15 | | $39.0 \times 1.045^{(age-12)}$ | | $36.1 \times 1.023^{(age-12)}$ |
| 15–18 | | | | |
| 18–25 | | 50.8 | | 41.4 |

CysC, cystatin-C; pv, person-visits; sCr, serum creatinine.
[a]The number of participants and pv in the model training data set. CysC was missing for 81 pv in the training data.
Height is measured in meters; sCr, mg/dl; and cysC, mg/L.

| eGFR equation | Arithmetic bias, eGFR – mGFR (95% CI)[a] Aged <18 yr | Arithmetic bias, eGFR – mGFR (95% CI)[a] Aged ≥18 yr | p10: eGFR within 10% of mGFR Aged <18 yr | p10: eGFR within 10% of mGFR Aged ≥18 yr | p30: eGFR within 30% of mGFR Aged <18 yr | p30: eGFR within 30% of mGFR Aged ≥18 yr |
|---|---|---|---|---|---|---|
| Plasma/sCr-based equations | | | | | | |
| CKiD U25 age and sex dependent | 0.0 (–0.9 to 1.0) | 0.7 (–1.6 to 3.0) | 36.4 | 44.9 | 86.2 | 90.7 |
| CKiD "bedside" | 2.3 (1.1 to 3.5) | –5.4 (–7.7 to –3.1) | 34.6 | 33.6 | 77.2 | 86.0 |

CKiD U25 equation

| eGFR equation | Arithmetic bias, eGFR – mGFR (95% CI)[a] | | p10: eGFR within 10% of mGFR | | p30: eGFR within 30% of mGFR | | Test RMSE[b] | |
|---|---|---|---|---|---|---|---|---|
| | Aged <18 yr | Aged ≥18 yr | Aged <18 yr | Aged ≥18 yr | Aged <18 yr | Aged ≥18 yr | Aged <18 yr | Aged ≥18 yr |
| Plasma/sCr-based equations | | | | | | | | |
| CKiD U25 age and sex dependent | 0.0 (–0.9 to 1.0) | 0.7 (–1.6 to 3.0) | 36.4 | 44.9 | 86.2 | 90.7 | 9.9 | 9.6 |
| Full age spectrum (FAS) | | | | | | | | |
| Q(age) | 3.8 (2.7 to 4.9) | 5.9 (3.4 to 8.3) | 36.9 | 36.4 | 77.8 | 77.6 | 12.1 | 11.6 |
| Q(height) | 2.2 (1.1 to 3.2) | 0.5 (–2.1 to 3.2) | 38.0 | 43.0 | 82.1 | 87.9 | 10.6 | 11.0 |

CKiD U25 equation

# What else?

# L'équation 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) | $GFR = 141 \times (Scr/0.9)^{-1.209} \times (0.993)^{Age}$ |

# KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease

VOLUME 3 | ISSUE 1 | JANUARY 2013

http://www.kidney-international.org

*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”
- 7 + 6 cohortes
- « Caucasiens »

# 1-18 ans

- Développement: n=2056
- Validation interne: n=695
- Validation externe: n=1254

TOTAL: 4,005

*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.

**Figure 1.** The new EKFC equation.

| Age | SCr/Q | Equation |
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| 2–40 y | <1 | $107.3 \times (SCr/Q)^{-0.322}$ |
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| | ≥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:**

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**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.

Pierre Delanaye*, François Gaillard, Jessica van der Weijden, Geir Mjøen, Ingela Ferhman-Ekholm, Laurence Dubourg, Natalie Ebert, Elke Schaeffner, Torbjörn Åkerfeldt, Karolien Goffin, Lionel Couzi, Cyril Garrouste, Lionel Rostaing, Marie Courbebaisse, Christophe Legendre, Maryvonne Hourmant, Nassim Kamar, Etienne Cavalier, Laurent Weekers, Antoine Bouquegneau, Martin H. de Borst, Christophe Mariat, Hans Pottel and Marco van Londen

# Age-adapted percentiles of measured glomerular filtration in healthy individuals: extrapolation to living kidney donors over 65 years

Avant 40 ans: DFG mesuré = 107 mL/min/1.73m²
…et cela semble assez universel

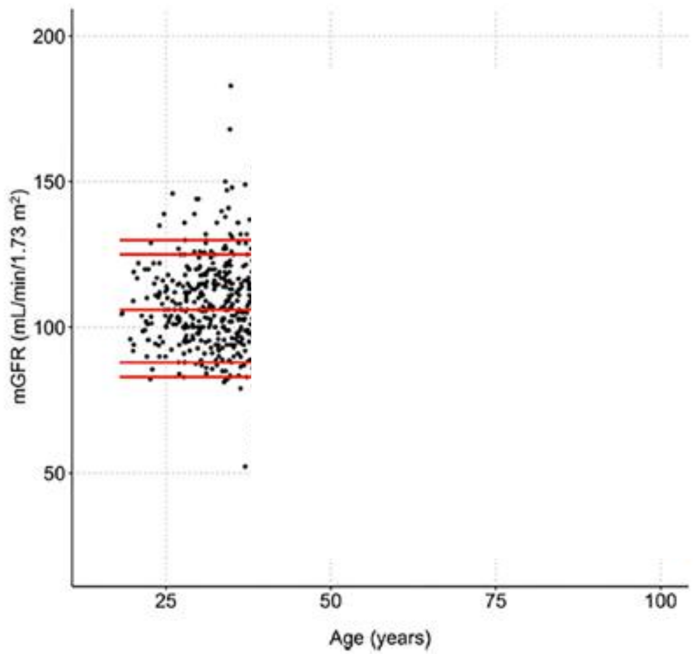



**Figure 3:** mGFR according to age in the development (dark dots) and external validation cohort (n=329) (gray dots). Red lines are percentiles 5, 10, 50, 90 and 95, calculated from kidney donors younger than 65 years and extrapolated for ages >65 years.

DE GRUYTER Clin Chem Lab Med 2022; 60(3): 401–407

Pierre Delanaye*, François Gaillard, Jessica van der Weijden, Geir Mjøen, Ingela Ferhman-Ekholm, Laurence Dubourg, Natalie Ebert, Elke Schaeffner, Torbjörn Åkerfeldt, Karolien Goffin, Lionel Couzi, Cyril Garrouste, Lionel Rostaing, Marie Courbebaisse, Christophe Legendre, Maryvonne Hourmant, Nassim Kamar, Etienne Cavalier, Laurent Weekers, Antoine Bouquegneau, Martin H. de Borst, Christophe Mariat, Hans Pottel and Marco van Londen

# Age-adapted percentiles of measured glomerular filtration in healthy individuals: extrapolation to living kidney donors over 65 years

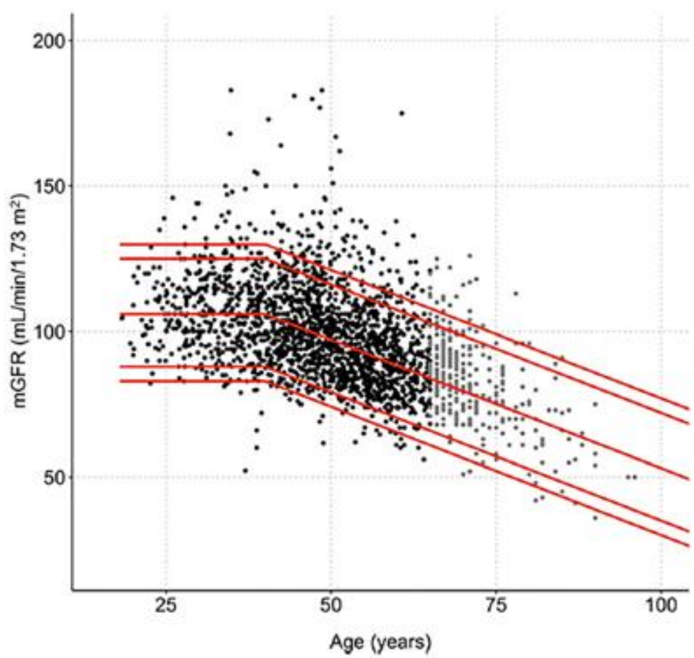
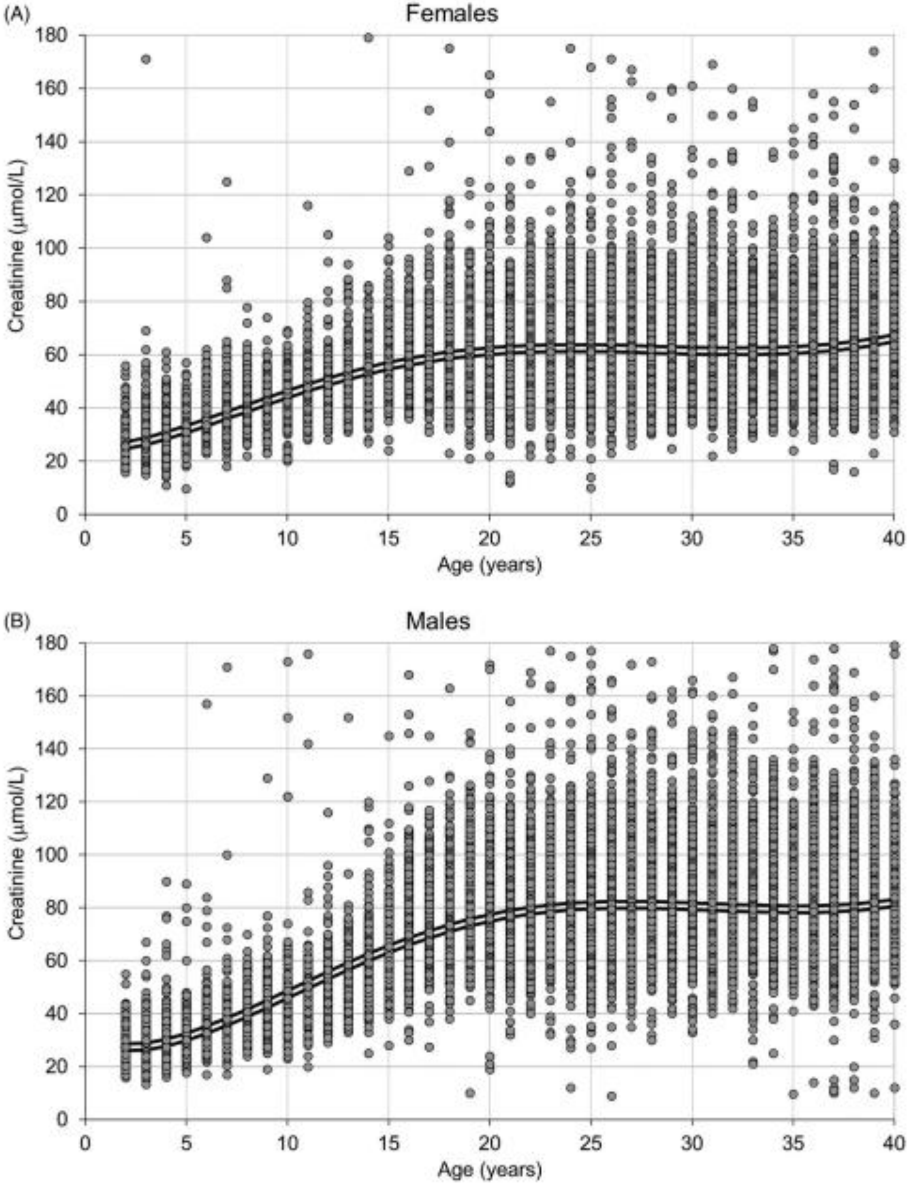



**Figure 3:** mGFR according to age in the development (dark dots) and external validation cohort (n=329) (gray dots). Red lines are percentiles 5, 10, 50, 90 and 95, calculated from kidney donors younger than 65 years and extrapolated for ages >65 years.




N=83,257 de 3 labos (Suède, Belgique)

62 µmol/L= 0,70 mg/dL

80 µmol/L= 0,90 mg/dL

*Bjork J, Scand J Clin Lab Invest, 2020, 80, p456*

*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.

***Figure 1.*** The new EKFC equation.

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

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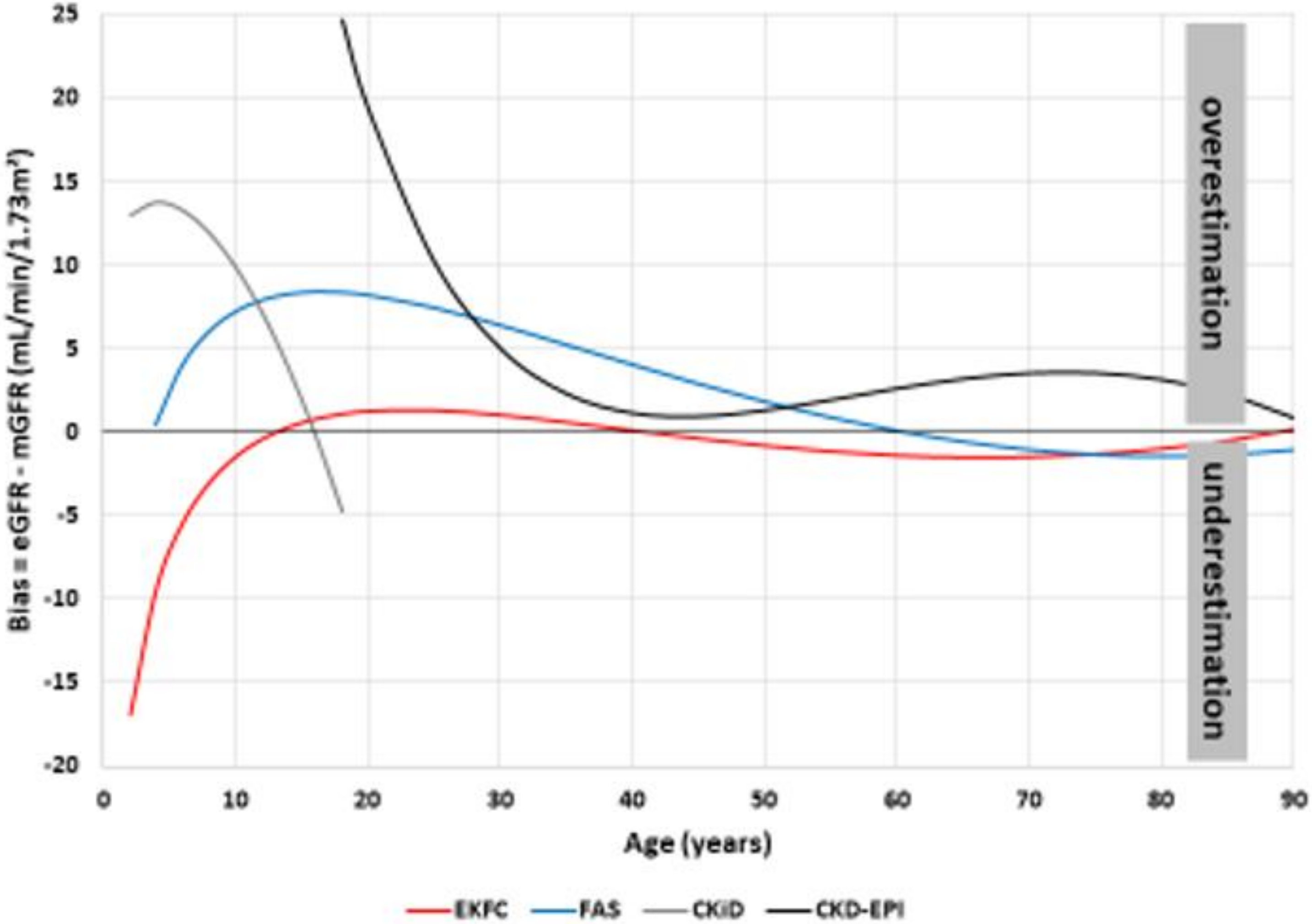


Bias = eGFR - mGFR (mL/min/1.73m²)
25
20
15
10
5
0
-5
-10
-15
-20
0
10
20
30
40
50
60
70
80
90
Age (years)
overestimation
underestimation
EKFC
FAS
CKiD
CKD-EPI

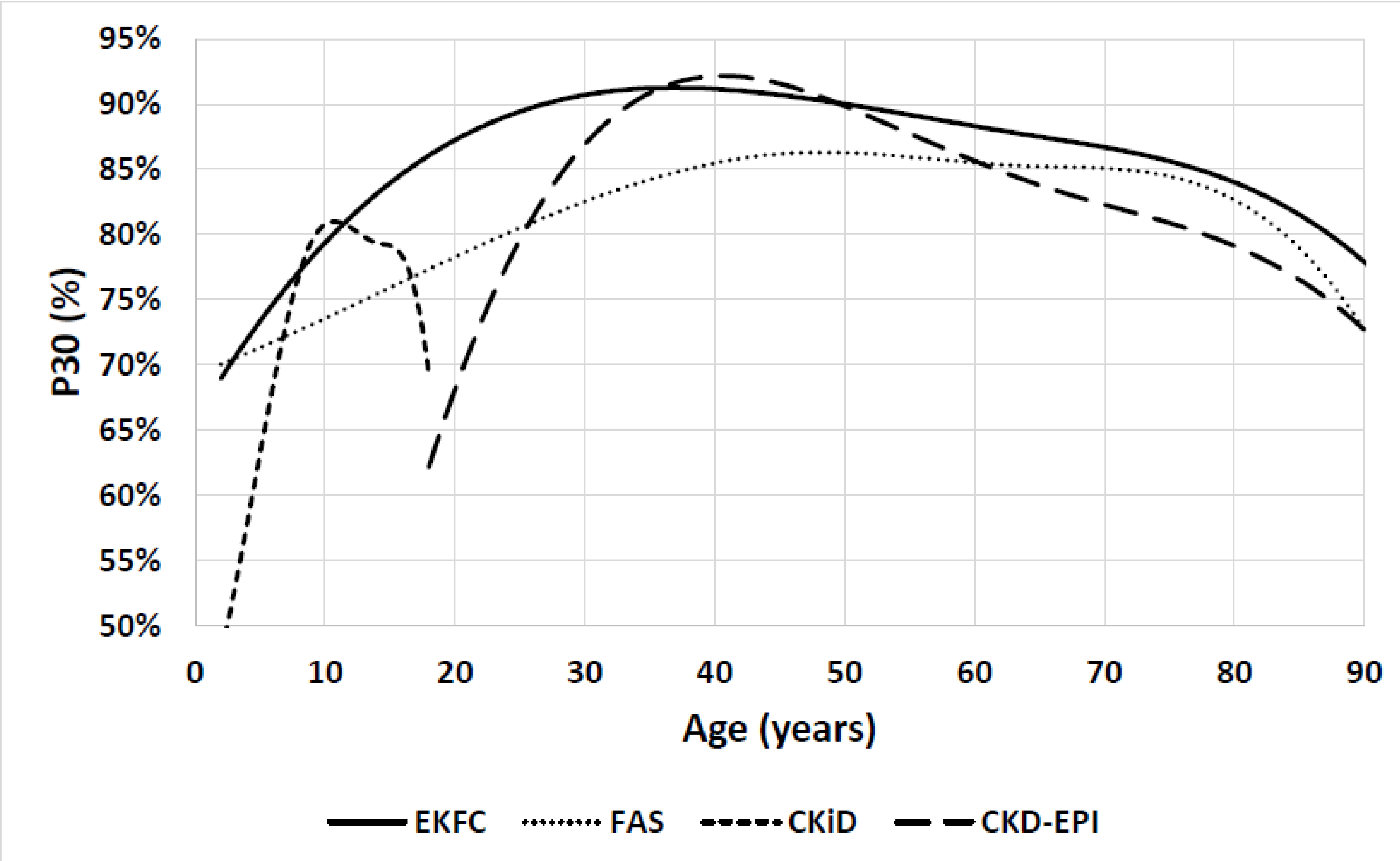



Figure S8. P30-accuracy against age for the EKFC, FAS, CKiD and CKD-EPI equation in the external validation dataset. P30 (%) was graphically presented across the age spectrum using cubic splines with two free knots and using 3rd degree polynomials.

*Table 1.* Performance Statistics for the EKFC, FAS, CKiD, and CKD-EPI Equations in the External Validation Data Set*

| Age Group | Equation | | |
|---|---|---|---|
| | EKFC | FAS | CKiD |
| **Children (2 to <18 y)** | | | |
| Median bias (95% CI), *mL/min/1.73 m²* | | | |
| All (*n* = 1254) | -1.2 (-2.7 to 0.0) | 6.7 (4.8 to 8.1) | 6.2 (4.6 to 7.7) |
| eGFR <75 mL/min/1.73 m² (*n* = 324) | -5.7 (-7.0 to -3.9) | -0.8 (-2.6 to 0.8) | -1.8 (-2.9 to -0.1) |
| eGFR ≥75 mL/min/1.73 m² (*n* = 930) | 1.1 (-0.4 to 3.0) | 10.8 (9.0 to 13.1) | 11.2 (9.2 to 13.4) |
| Imprecision, SD (P25–P75) | | | |
| All (*n* = 1254) | 27.8 (-14.9 to 11.0) | 70.6 (-7.4 to 22.8) | 56.6 (-7.7 to 23.6) |
| eGFR <75 mL/min/1.73 m² (*n* = 324) | 20.3 (-18.1 to 2.3) | 20.0 (-12.2 to 7.6) | 18.2 (-10.2 to 7.2) |
| eGFR ≥75 mL/min/1.73 m² (*n* = 930) | 29.6 (-14.4 to 14.3) | 80.1 (-5.3 to 29.1) | 63.7 (-6.5 to 30.9) |
| Accuracy P30 (95% CI), % | | | |
| All (*n* = 1254) | 79.7 (77.4 to 81.9) | 74.2 (71.7 to 76.6) | 73.2 (70.8 to 75.7) |
| eGFR <75 mL/min/1.73 m² (*n* = 324) | 73.8 (68.9 to 78.6) | 77.8 (73.2 to 82.3) | 80.2 (75.9 to 84.6) |
| eGFR ≥75 mL/min/1.73 m² (*n* = 930) | 81.7 (79.2 to 84.2) | 72.9 (70.0 to 75.8) | 70.8 (67.8 to 73.7) |

| | |
|---|---|
| EKFC-Height | $107.3 \times (Scr/Q)^{-0.322}$ [ $\times\ 0.990^{(Age-40)}$ if age > 40 years] for $Scr/Q < 1$<br>$107.3 \times (Scr/Q)^{-1.132}$ [ $\times\ 0.990^{(Age-40)}$ if age > 40 years] for $Scr/Q \geq 1$ (Scr in mg/dL or µmol/L)<br>$Q = 3.94 - 13.4 \times Ht + 17.6 \times Ht^2 - 9.84 \times Ht^3 + 2.04 \times Ht^4$ (Ht in m, Q in mg/dL >> or multiply Q by 88.4 to convert to µmol/L)<br>Q = 0.90 mg/dL (80 µmol/L) when Ht > 1.81 m |

**Table S6a. Median bias (eGFR – mGFR) (in mL/min/1.73m²) in age subgroups of the external validation dataset. Results have grey background when |bias| ≥ 10 mL/min/1.73m².**

| Age | N | EKFC | EKFC-Ht | KDIGO |
|---|---|---|---|---|
| **[02-04]** | 134 | -10.9 | -7.4 | 13.2 |
| **[04-06]** | 122 | -7.1 | -1.9 | 16.0 |
| **[06-08]** | 133 | -6.9 | -3.8 | 10.9 |
| **[08-10]** | 75 | -4.4 | -2.0 | 11.5 |
| **[10-12]** | 121 | -2.6 | -5.8 | 8.8 |
| **[12-14]** | 196 | 1.5 | -1.5 | 5.6 |
| **[14-16]** | 215 | 1.8 | 1.1 | 3.3 |
| **[16-18]** | 258 | 2.0 | 2.8 | -2.1 |
| | | | 0.7 | |

## Table S7a. P30-values (%) in age subgroups. P30-values < 75% are shaded in grey.

| Age range | N | EKFC | EKFC-Ht | KDIGO |
|---|---|---|---|---|
| **[02-04]** | 134 | 63.4% | 69.4% | 52.2% |
| **[04-06]** | 122 | 72.1% | 77.9% | 60.7% |
| **[06-08]** | 133 | 81.2% | 82.7% | 70.7% |
| **[08-10]** | 75 | 90.7% | 90.7% | 84.0% |
| **[10-12]** | 121 | 84.3% | 85.1% | 78.5% |
| **[12-14]** | 196 | 87.8% | 87.8% | 81.1% |
| **[14-16]** | 215 | 80.0% | 85.1% | 78.1% |
| **[16-18]** | 258 | 79.1% | 79.8% | 75.6% |

# The Modified CKiD Study Estimated GFR Equations for Children and Young Adults Under 25 Years of Age: Performance in a European Multicenter Cohort

*Ulf Nyman, MD, PhD, Jonas Björk, PhD, Ulla Berg, MD, PhD, Arend Bökenkamp, MD, PhD, Laurence Dubourg, MD, PhD, Karolien Goffin, MD, PhD, Anders Grubb, MD, PhD, Magnus Hansson, MD, PhD, Anders Larsson, MD, PhD, Karin Littmann, MD, PhD, Kajsa Åsling-Monemi, MD, PhD, Hans Pottel, PhD, and Pierre Delanaye, MD, PhD*

*AJKD* Vol 80 | Iss 6 | December 2022

**Table 1.** Patient Characteristics of the Cohorts

| | Children With Creatinine and Cystatin C Measured (N = 2,293) | Young Adults (N = 1,816) | |
|---|---|---|---|
| | | With Creatinine Measured (n = 1,816) | With Cystatin C Measured (n = 348) |
| Age, y | 11.9 (2.3-17.8) | 20.0 (18.0-24.6) | 18.9 (18.0-24.1) |
| Female sex | 949 (41%) | 846 (47%) | 144 (41%) |
| Body mass index, kg/m$^2$ | 18 (14-29) | 21 (16-31) | 22 (15-35) |
| Body surface area, m$^2$ | 1.29 (0.54-2.05) | 1.68 (1.29-2.14) | 1.73 (1.33-2.36) |
| Plasma/serum creatinine, μmol/L | 52 (19-155) | 75 (41-191) | 78 (38-196) |
| Plasma/serum cystatin, mg/L | 0.96 (0.61-2.72) | – | 0.96 (0.62-2.39) |
| mGFR, mL/min/1.73 m$^2$ | 97 (28-169) | 92 (31-141) | 91 (30-134) |
| mGFR <75 mL/min/1.73 m$^2$ | 503 (22%) | 543 (30%) | 95 (27%) |

Children defined as aged 2.0-17.9 years; young adults as 18.0-24.9 years. Continuous variables given as median (2.5 and 97.5 percentiles).

## Table 2. Bias, Precision, and Accuracy of eGFR Equations in Children and Young Adults

| | Creatinine Equations | | | |
|---|---|---|---|---|
| | CKiDU25 | CKD-EPI40 | EKFC | LMR18 |
| **Children (n = 2,293 for creatinine equations** | | | | |
| Bias, median | 1.3 (0.6; 2.2) | −5.3 (−6.1; −4.5) | −1.6 (−2.4; −0.4) | −4.5 (−5.3; −3.7) |
| Precision, IQR | 23.6 | 23.9 | 23.4 | 23.0 |
| Accuracy, $P_{30}$ | 83.8 (82.3; 85.3) | 83.9 (82.4; 85.4) | 85.2 (83.8; 86.7) | 86.3 (84.9; 87.8) |
| $P_{30}$ difference | Reference | 0.1 (−1.4; 1.6) | 1.4 (0.1; 2.7) | 2.5 (1.1; 3.8) |
| **Young adults (n = 1,816 for creatinine equations** | | | | |
| Bias, median | 2.1 (1.3; 2.9) | −1.7 (−2.8; −1.1) | 2.5 (1.8; 3.1) | −2.6 (−3.5; −1.5) |
| Precision, IQR | 22.3 | 21.8 | 21.3 | 21.5 |
| Accuracy, $P_{30}$ | 82.8 (81.0; 84.5) | 85.4 (83.7; 87.0) | 84.0 (82.3; 85.7) | 86.1 (84.5; 87.7) |
| $P_{30}$ difference | Reference | 2.6 (1.2; 4.0) | 1.3 (−0.2; 2.7) | 3.4 (1.9; 4.8) |

# TAILLE !!!!

***Stratified for eGFR of creatinine-based equation***

| eGFR intervals | Stratified for eGFR (CKiDU25) | | Stratified for eGFR (EKFC) | |
|---|---|---|---|---|
| | CKiDU25cr | EKFC | EKFC | CKiDU25cr |
| *<75 mL/min/1.73 m$^2$* | *n=1012* | | *n=953* | |
| Bias, median | 0.9 (0.1; 1.7) | 1.6 (0.5; 2.3) | 0.4 (-0.4; 1.6) | 0.9 (0.0; 1.6) |
| Precision, IQR | 15.9 | 16.4 | 15.8 | 15.5 |
| Accuracy, $P_{30}$ | 82.1 (79.8; 84.5) | 77.7 (75.1; 80.2) | 78.5 (75.9; 81.1) | 81.7 (79.3; 84.2) |
| -difference | Reference | -4.5 (-6.4; -2.5) | Reference | 3.2 (1.5; 5.0) |
| *≥75 mL/min/1.73 m$^2$* | *n=3097* | | *n=3156* | |
| Bias, median | 2.1 (1.3; 2.9) | 0.0 (-0.8; 0.9) | 0.6 (-0.2; 1.3) | 2.1 (1.3; 2.9) |
| Precision, IQR | 26.5 | 25.4 | 25.2 | 26.5 |
| Accuracy, $P_{30}$ | 83.8 (82.5; 85.1) | 87.0 (85.8; 88.2) | 86.6 (85.4; 87.8) | 83.8 (82.6; 85.1) |
| -difference | Reference | 3.2 (2.1; 4.4) | Reference | -2.7 (-3.9; -1.6) |

Bias (median error eGFR-mGFR) and precision (interquartile range eGFR-mGFR, IQR), and accuracy expressed in percentage of GFR estimates within ±30 % of mGFR ($P_{30}$). Differences in $P_{30}$ were hence evaluated statistically using 95% confidence intervals for paired proportions. CKiDU25 = Chronic Kidney Disease in Children equation for individuals under 25 years [6] and EKFC = European Kidney Function Consortium equation [1].

clinical investigation www.kidney-international.org

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

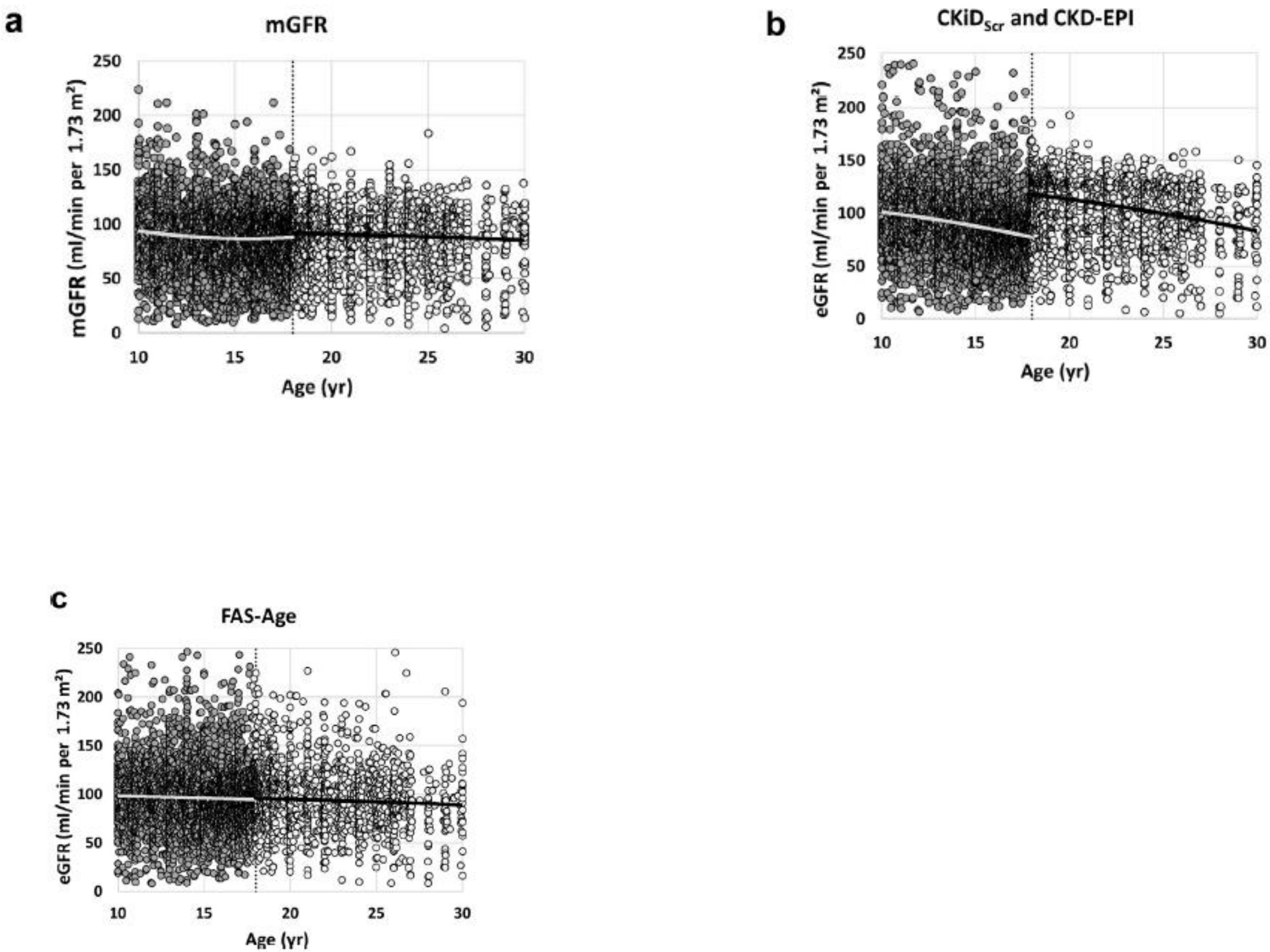
Check for updates

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

*Kidney International* (2019) **95,** 1234–1243;

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


a
mGFR
mGFR (ml/min per 1.73 m²)
250
200
150
100
50
0
10
15
20
25
30
Age (yr)
b
CKiD$_{Scr}$ and CKD-EPI
eGFR (ml/min per 1.73 m²)
250
200
150
100
50
0
10
15
20
25
30
Age (yr)
c
FAS-Age
eGFR (ml/min per 1.73 m²)
250
200
150
100
50
0
10
15
20
25
30
Age (yr)

# 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
- Meilleur que Schwartz/Ckid dans les valeurs normales de DFG, moins bonne dans les valeurs basses
- Attention chez jeune enfant

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

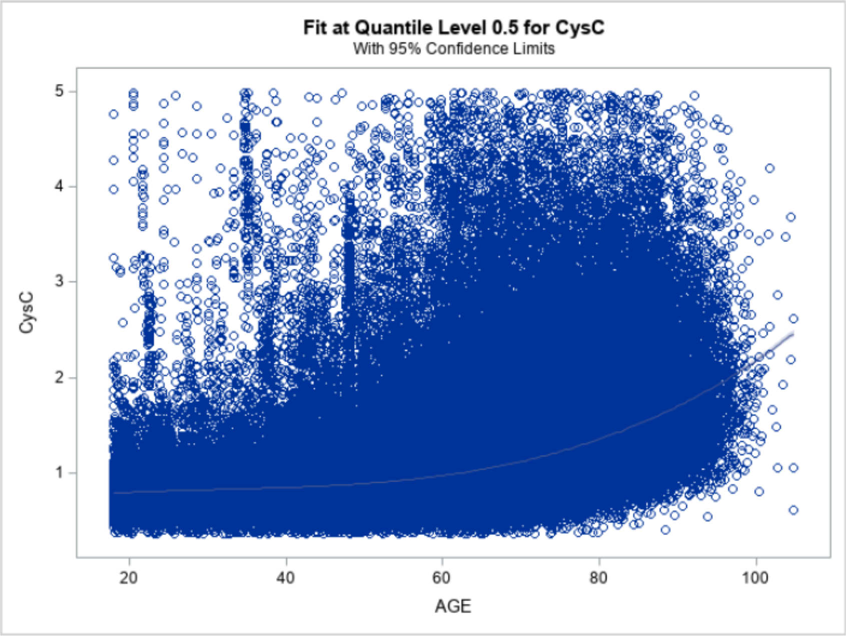
ABSTRACT

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.

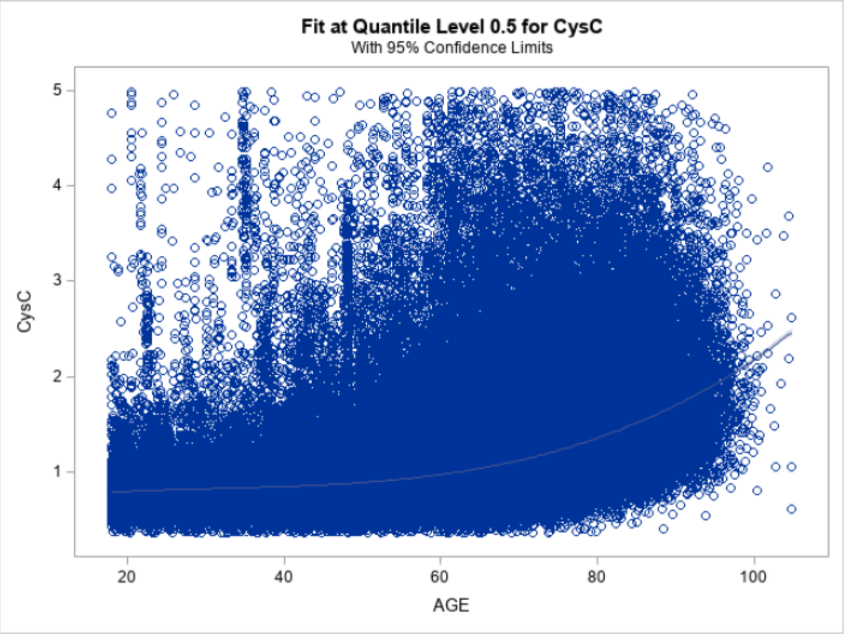



♀ Q' = 0.79 mg/L jusqu'à 50 ans,
Q' = 0.79 + 0.005 x (Age – 50)
♂ Q' = 0.86 mg/L jusqu'à 50 ans
Q' = 0.86 + 0.005 x (Age – 50)

# 1er étape: cystatine C et sexe

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

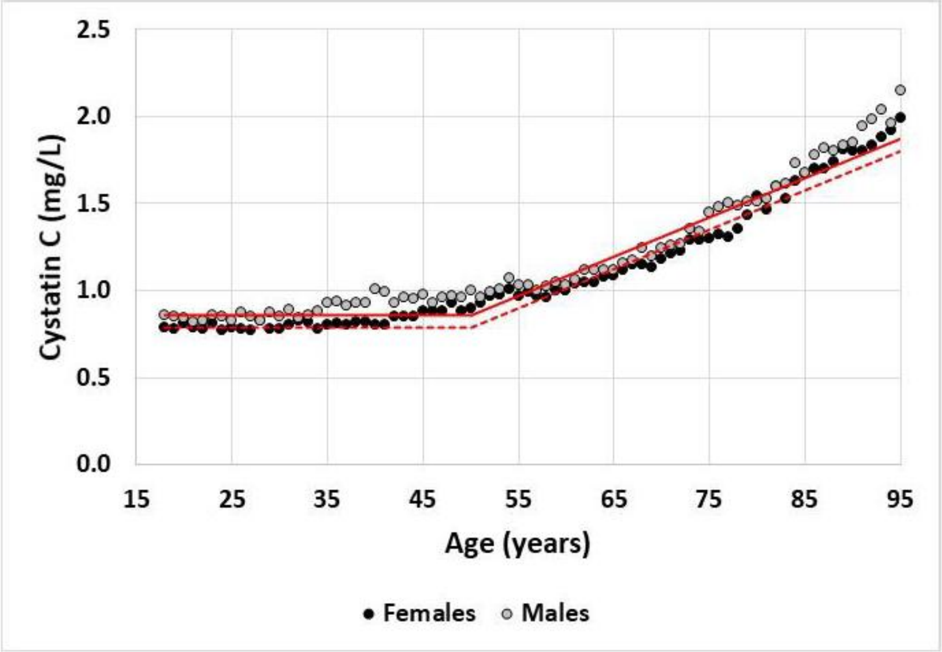
**Figure S3**. Cystatin C versus age and the median quantile line for the 227,643 included subjects.




♀ 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/m²) | mGFR (mL/min/1.73m²) | 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 |

# $4^{ème}$ 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.

Adultes
DFGm, creatinine et cystatine C calibrées
N=12,832

11 cohortes
Européens blancs: n=7,727
Européens blancs de Paris: n=2,646
US blancs: n=1,093
Européens noirs de Paris: n=858
Africains noirs: n=508

**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 $m^2$† | 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 $m^2$‡ | 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 $m^2$§ | 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) |


| | |
|---|---|
| 7.40 (7.02 to 7.76) | 0.58 (0.32 to 0.86) |
| 16.3 (0.0 to 16.3) | 14.5 (−6.5 to 8.0) |
| 16.3 (15.9 to 16.6) | 13.1 (12.8 to 13.4) |
| 34.7 (33.6 to 35.8) | 43.3 (42.2 to 44.4) |
| 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) |


| Cystatin C–Based Equations | |
|---|---|
| CKD-EPI eGFRcys | EKFC eGFRcys without Sex |
| | |
| 0.28 (−0.02 to 0.64) | 0.00 (−0.37 to 0.27) |
| 19.1 (−7.9 to 11.2) | 14.4 (−7.9 to 6.5) |
| 15.8 (15.5 to 16.1) | 13.5 (12.9 to 14.1) |
| 32.0 (31.0 to 33.0) | 41.7 (40.6 to 42.8) |
| 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 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) |

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ORIGINAL ARTICLE

# Extending the cystatin C based EKFC-equation to children – validation results from Europe

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**Table 1** Patient characteristics of the validation dataset $n = 2{,}293$

| | |
|---|---|
| Age (years) | 11.9 (2.3–17.8) |
| Females, number (%) | 949 (41) |
| Body mass index | 18 (14–29) |
| Body surface area (m$^2$) | 1.29 (0.54–2.05) |
| Plasma/serum creatinine (µmol/L; mg/dL) | 52 (19–155); 0.59 (0.21–1.75) |
| Plasma/serum cystatin C (mg/L) | 0.96 (0.61–2.72) |
| Measured GFR (mL/min/1.73 m$^2$) | 97 (28–169) |
| Number below 75 mL/min/1.73 m$^2$ (%) | 503 (22) |

Continuous variables are presented as median (2.5$^{th}$–97.5$^{th}$ Percentiles)

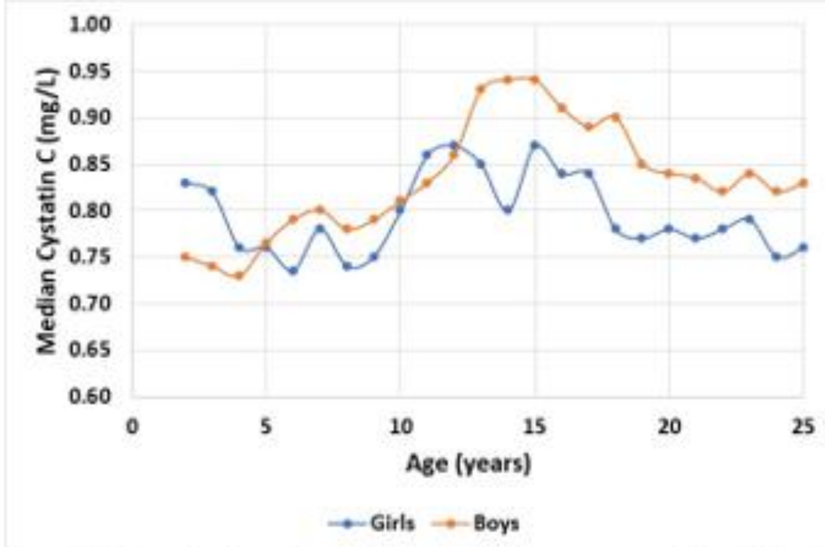


Figure S3. Zooming in on the median cystatin C versus age relationship in children, adolescents and young adults

Garçons: 0,83 mg/L
Filles: 0,81 mg/L

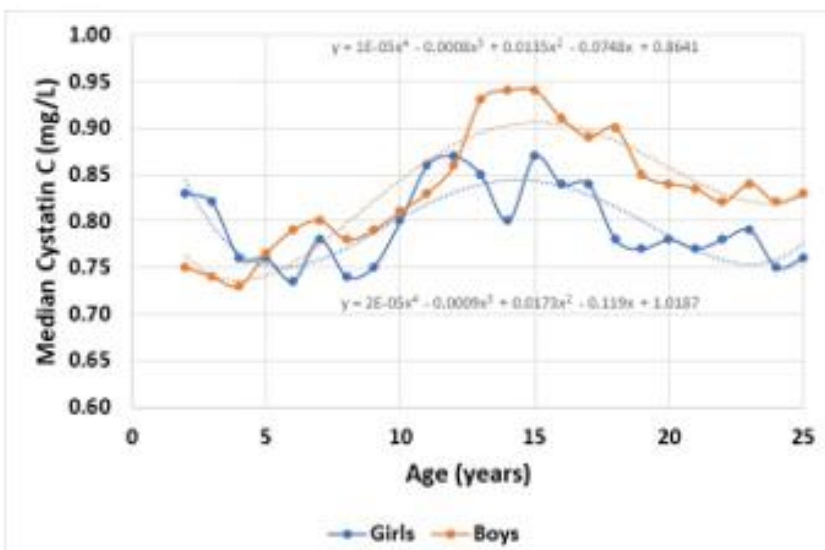


Figure S4. Q-values modelled as 4[th] degree polynomials

**Table 3** Performance characteristics (bias = median of eGFR–mGFR; IQR = interquartile range; P10 and P30 = % of patients with eGFR within 10% or 30% of mGFR) of EKFC-equations ($CKiD_{crea}$ is used as a benchmark) in = 2,293 children (2 – 18 years)

| Statistic | $CKiD_{Crea}$ | $EKFC_{Crea}$ | $EKFC_{CysC}$ | $EKFC_{CysC\text{-}u}$ | $EKFC_{Mean}$ | $EKFC_{Mean\text{-}u}$ |
|---|---|---|---|---|---|---|
| Bias (mL/min/1.73 $m^2$) | +6.21 [5.1; 7.5] | –1.6 [–2.4; –0.4] | –7.6 [–8.4; –6.5] | –7.6 [–8.6; –6.8] | –4.0 [–4.5; –3.1] | –4.0 [–4.6; –3.2] |
| IQR [Q1–Q3] (mL/min/1.73 $m^2$) | 27.5 [–6.5; 21.1] | 23.4 [–13.9; 9.5] | 23.5 [–19.8; +3.6] | 24.1 [–21.2; +2.9] | 20.4 [–15.5; +5.0] | 20.8 [–15.0; +6.3] |
| P10 (%) | 32.9 [31.0; 34.9] | 39.9 [37.9; 41.9] | 36.9 [34.9; 38.9] | 35.6 [33.6; 37.6] | 44.4 [42.4; 46.4] | 44.3 [42.3; 46.3] |
| P30 (%) | 78.0 [76.3; 79.7] | 85.2 [83.8; 86.7] | 85.8 [84.4; 87.3] | 85.0 [83.6; 86.5] | 90.4 [89.2; 91.6] | 89.9 [88.7; 91.1] |

u = Q-values modelled as 4$^{th}$ degree polynomials based on the Uppsala data

**Table S4** Performance characteristics (bias = mean of eGFR – mGFR; IQR = interquartile range; P10/P30 = % of patients with eGFR within 10/30% of mGFR) of cystatin C based equations in = 2,293 children (2 – 18 years)

**Cystatin C equations**

| | **CKiDU25** | **CAPA** | **CKD-EPI** | **FAS** | **EKFC** | **EKFC-u** |
|---|---|---|---|---|---|---|
| Bias | -12.8 [-13.8; -11.3] | -0.6 [-1.7; +0.3] | -2.5 [-3.3; -1.3] | -4.2 [-4.8; -3.4] | -7.6 [-8.4; -6.5] | -7.6 [-8.6; -6.8] |
| IQR [Q1-Q3] | 24.2 [-25.9; -1.7] | 26.9 [-13.1; +13.8] | 24.5 [-14.0; +10.5] | 23.9 [-17.2; +6.8] | 23.5 [-19.8; +3.6] | 24.1 [-21.2; +2.9] |
| P10 | 29.7 [27.9; 31.6] | 34.6 [32.6; 36.5] | 37.4 [35.4; 39.4] | 37.9 [35.9; 39.9] | 36.9 [34.9; 38.9] | 35.6 [33.6; 37.6] |
| P30 | 82.6 [81.0; 84.1] | 82.0 [80.4; 83.6] | 84.3 [82.9; 85.8] | 85.9 [84.5; 87.3] | 85.8 [84.4; 87.3] | 85.0 [83.6; 86.5] |

EKFC-u = EKFC-equation with $Q_{cysC}$ obtained from the 4th degree polynomials fitted on the data from Uppsala

**Table S5**. Performance characteristics (bias = mean of eGFR – mGFR; IQR = interquartile range; P10/P30 = % of patients with eGFR within 10/30% of mGFR) of the arithmetic mean of the EKFC equations in = 2,293 children (2 – 18 years)

**$EKFC_{Mean}$**

| | **EKFC** | **EKFC-u** |
|---|---|---|
| Bias | -4.0 [-4.5; -3.1] | -4.0 [-4.6; -3.2] |
| IQR [Q1-Q3] | 20.4 [-15.5; +5.0] | 20.8 [-15.0; +6.3] |
| P10 | 44.4 [42.4; 46.4] | 44.3 [42.3; 46.3] |
| P30 | 90.4 [89.2; 91.6] | 89.9 [88.7; 91.1] |

# Age- and sex-dependent clinical equations to estimate glomerular filtration rates in children and young adults with chronic kidney disease

Check for updates

see commentary on page 808

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*Kidney International* (2021) **99,** 948–956;

- Chronic Kidney Disease in Children (CKiD)
- N=928 (2655 résultats) (37% filles)
- DFG=clairance plasmatique iohexol
- Créatinine et cystatine C standardisées
- 1 à 25 ans (médiane: 13 ans)
- DFG médian: 41 à 49 ml/min/1.73m²

**Table 2 | Sex-specific values of *K* in constant and age-dependent models for *height/sCr* and *1/cysC* glomerular filtration rate estimating equations**

| | *K* for height / sCr | | | | *K* for 1 / cysC | | | |
|---|---|---|---|---|---|---|---|---|
| | Male (N = 387; 1093 pv)[a] | | Female (N = 231; 671 pv)[a] | | Male (N = 387; 1039 pv)[a] | | Female (N = 231; 644 pv)[a] | |
| Age, yr | Constant | Age dependent | Constant | Age dependent | Constant | Age dependent | Constant | Age dependent |
| 1–12 | 41.8 | $39.0 \times 1.008^{(age-12)}$ | 37.6 | $36.1 \times 1.008^{(age-12)}$ | 81.9 | $87.2 \times 1.011^{(age-15)}$ | 74.9 | $79.9 \times 1.004^{(age-12)}$ |
| 12–15 | | $39.0 \times 1.045^{(age-12)}$ | | $36.1 \times 1.023^{(age-12)}$ | | | | $79.9 \times 0.974^{(age-12)}$ |
| 15–18 | | | | | | $87.2 \times 0.960^{(age-15)}$ | | |
| 18–25 | 50.8 | | 41.4 | | 77.1 | | 68.3 | |

CysC, cystatin-C; pv, person-visits; sCr, serum creatinine.

| eGFR equation | Arithmetic bias, eGFR − mGFR (95% CI)[a] | | p10: eGFR within 10% of mGFR | | p30: eGFR within 30% of mGFR | | Test RMSE[b] | |
|---|---|---|---|---|---|---|---|---|
| | Aged <18 yr | Aged ≥18 yr | Aged <18 yr | Aged ≥18 yr | Aged <18 yr | Aged ≥18 yr | Aged <18 yr | Aged ≥18 yr |
| Plasma/sCr-based equations | | | | | | | | |
| CKiD U25 age and sex dependent | 0.0 (−0.9 to 1.0) | 0.7 (−1.6 to 3.0) | 36.4 | 44.9 | 86.2 | 90.7 | 9.9 | 9.6 |
| CKiD "bedside" | 2.3 (1.1 to 3.5) | −5.4 (−7.7 to −3.1) | 34.6 | 33.6 | 77.2 | 86.0 | 12.0 | 11.7 |
| Full age spectrum (FAS) | | | | | | | | |
| Q(age) | 3.8 (2.7 to 4.9) | 5.9 (3.4 to 8.3) | 36.9 | 36.4 | 77.8 | 77.6 | 12.1 | 11.6 |
| Q(height) | 2.2 (1.1 to 3.2) | 0.5 (−2.1 to 3.2) | 38.0 | 43.0 | 82.1 | 87.9 | 10.6 | 11.0 |
| Lund-Malmö revised for sCr, including those aged <18 yr (LMR18) | −2.3 (−3.5 to −1.2) | −3.8 (−5.9 to −1.6) | 29.8 | 36.4 | 81.3 | 88.8 | 11.6 | 10.1 |
| Schwartz-Lyon | −2.0 (−3.0 to −0.9) | −7.4 (−9.8 to −5.1) | 36.6 | 30.8 | 85.6 | 83.2 | 10.4 | 12.7 |
| Flanders metadata (FM) | 0.3 (−0.8 to 1.4) | −4.2 (−6.5 to −1.8) | 40.2 | 35.5 | 83.7 | 89.7 | 10.8 | 11.0 |
| Gao quadratic (GQ) | 2.9 (1.7 to 4.1) | −2.1 (−4.3 to 0.1) | 28.7 | 40.2 | 69.6 | 89.7 | 12.4 | 9.8 |
| IFCC cysC-based equations | | | | | | | | |
| CKiD U25, age and sex dependent | −0.8 (−1.7 to 0.1) | −0.9 (−3.1 to 1.3) | 39.3 | 45.7 | 86.6 | 85.7 | 10.5 | 10.8 |
| Full age spectrum (FAS) | 4.1 (3.2 to 5.1) | 8.7 (6.6 to 10.8) | 36.9 | 22.9 | 79.8 | 71.4 | 11.8 | 13.9 |
| Caucasian, Asian, pediatric and adult (CAPA) | 2.2 (1.0 to 3.3) | 3.0 (0.6 to 5.3) | 30.9 | 32.4 | 76.4 | 81.0 | 13.5 | 12.1 |
| Berg | 1.4 (0.4 to 2.4) | 7.1 (4.5 to 9.8) | 35.4 | 27.6 | 82.2 | 76.2 | 12.5 | 15.0 |
| Non-IFCC cysC-based equations | | | | | | | | |
| CKiD 2012[c] | 1.9 (1.0 to 2.9) | 5.8 (3.7 to 7.8) | 38.3 | 27.6 | 82.0 | 75.2 | 10.9 | 11.9 |

# Cystatine C

- La cystatine 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 $EKFC_{crea}$ et $EKFC_{CC}$
- Les équations EKFC sont un peu meilleures que les équations CKD-EPI correspondantes => alternative valable en Europe et en Afrique
- Les équations basées sur la cystatine C ne sont pas meilleures que les équations basées sur la créatinine
- Les équations combinées sont meilleures (exactitude +5-10%)
- Standardisation
- Plus cher
- Comment gérer les résultats différents entre créatinine et cystatine C?

https://ekfccalculator.pages.dev/

# KDIGO 2024 CLINICAL PRACTICE GUIDELINE FOR THE EVALUATION AND MANAGEMENT OF CHRONIC KIDNEY DISEASE

## 1.2.4 Selection of GFR estimating equations

**Recommendation 1.2.4.1: We recommend using a validated GFR estimating equation to derive GFR from serum filtration markers (eGFR) rather than relying on the serum filtration markers alone (*1D*).**

Practice Point 1.2.4.1: Use the same equation within geographical regions (as defined locally [e.g., continent, country, and region] and as large as possible). Within such regions, equations may differ for adults and children.

Practice Point 1.2.4.2: Use of race in the computation of eGFR should be avoided.

***<u>Special considerations</u>***

*Pediatric considerations*

Practice Point 1.2.4.3: Estimate GFR in children using validated equations that have been developed or validated in comparable populations.

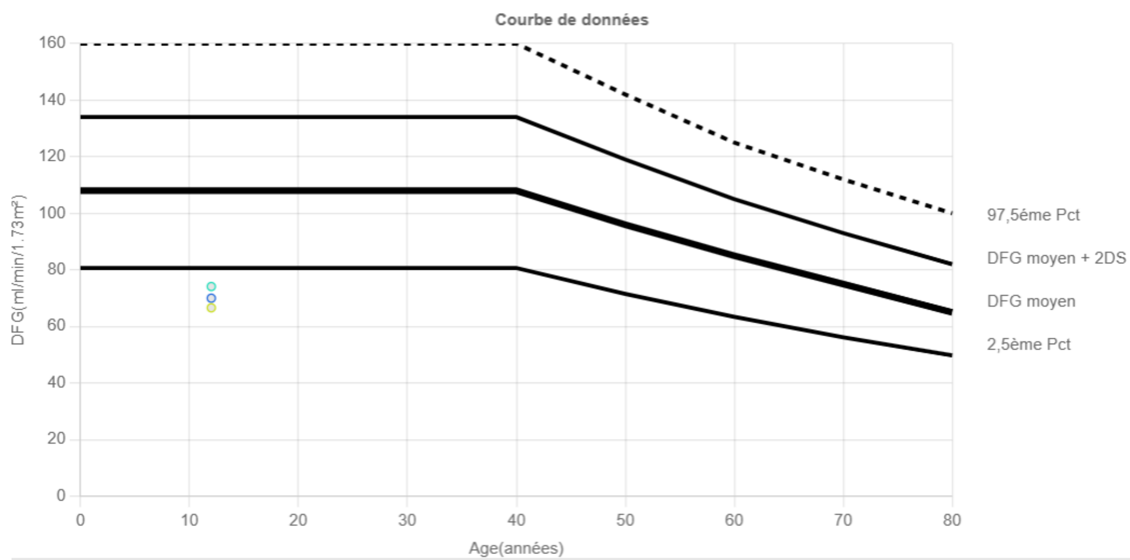
**Table 14 | Validated GFR estimating equations**

| Marker | Equation name and year | Age | Variables | Development populations |
|---|---|---|---|---|
| Creatinine | CKD-EPI 2009[238] | ≥18; modification CKD-EPI 40 for pediatric available | Developed using A, S, R but reported not using the Black race coefficient, A, S, R (NB) | 8254 Black and NB individuals from 10 studies in the United States and Europe[a] |
| | CKiD U25 2021[239] | 1–25 | A, S, height | 928 children with CKD in the United States and Canada |
| | CKD-EPI 2021[147] | ≥18 | A, S | 8254 Black and NB individuals from 10 studies in the United States and Europe[a] |
| | EKFC 2021[240] | 2–100 | A, S, European Black and NB specific Q-value; separate Q-values for Africa vs. Europe | mGFR vs. SCr (11,251 participants in 7 studies in Europe and 1 study from the United States)<br>Normal GFR from 5482 participants in 12 studies of kidney donor candidates (100% Caucasian)<br>European NB Q from 83,157 laboratory samples (age 2–40 years) in 3 European hospital clinical laboratories; European Black Q-value (N = 90 living kidney donors from Paris); African Black Q-value (N = 470 healthy individuals from République Démocratique de Congo); All Q-values developed in cohorts independent for EKFC development and validation |
| Cystatin C | CKD-EPI 2012[148] | ≥18 | A, S | 5352 Black and NB individuals from 13 studies in the United States and Europe |
| | EKFC 2023[91] | 18–100 | A | mGFR vs. SCys (assumed to be the same as mGFR vs. SCr)<br>Normal GFR (same as for the SCr equation)<br>Q from laboratory samples from 227,643 (42% female) laboratory samples from Uppsala University Hospital, Sweden |

# Calculateurs DFG (dont EKFC)

**Résultats**

| | | |
|---|---|---|
| EKFC créatinine | 82 | ml/min/1.73m² |
| EKFC créatinine taille | 67 | ml/min/1.73m² |
| CKiD | 74 | ml/min/1.73m² |
| CKiDU25 | 70 | ml/min/1.73m² |



# 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)*

# Ne pas sur-interpreter un DFG estimé…

Toutes les équations restent des estimations

OK au niveau populationnel

Manque de précision au niveau individuel

| 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) |

REVIEWS

# The applicability of eGFR equations to different populations

*Pierre Delanaye and Christophe Mariat*

→ RETOUR à une mesure du DFG

***Delanaye P, Nature Rev Nephrol, 2013, 9, p513***
***Ebert N, Clin Kidney J, 2021, 14, p1861***
***Agarwal R, Nephrol Dial Transplant, 2019, 34, p2001***
***Shafi T, Ann Intern Med, 2022, 175, p1073***

**Practice Point 1.2.2.2: Where more accurate ascertainment of GFR will impact treatment decisions, measure GFR using plasma or urinary clearance of an exogenous filtration marker (Table 9).**

Clairance plasmatique d'iohexol

Pas si difficile

Pas si cher

ARTICLE IN PRESS

www.kidney-international.org review

# Iohexol plasma clearance measurement protocol standardization for adults: a consensus paper of the European Kidney Function Consortium

OPEN

Natalie Ebert[1,25], Elke Schaeffner[1,25], Jesse C. Seegmiller[2], Marco van Londen[3], Arend Bökenkamp[4], Etienne Cavalier[5], Pierre Delanaye[6,7], Laurence Derain-Dubourg[8], Bjørn O. Eriksen[9], Olafur S. Indridason[10], Runolfur Palsson[10,11], Tariq Shafi[12], Anders Christensson[13], Sebastjan Bevc[14,15], Fabiola Carrara[16], Marie Courbebaisse[17], R. Neil Dalton[18], Markus van der Giet[19], Toralf Melsom[9], Shona Methven[20], Gunnar Nordin[21], Hans Pottel[22], Andrew D. Rule[23], Matias Trillini[16] and Christine A. White[24]; and the European Federation of Clinical Chemistry and Laboratory Medicine Task Group on Chronic Kidney Disease (EFLM TG-CKD)

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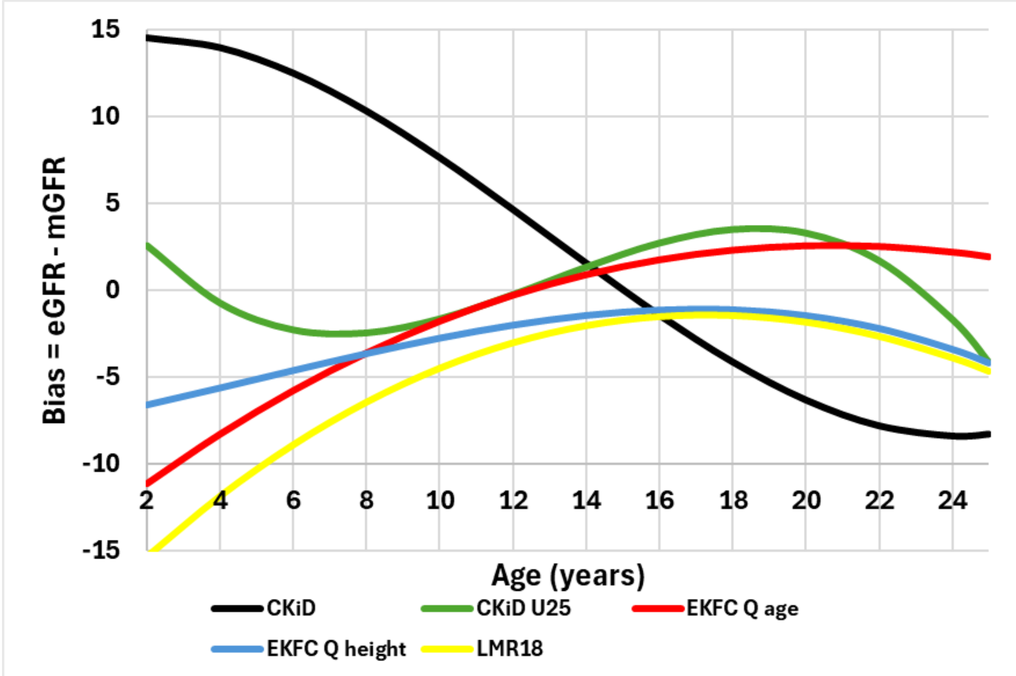
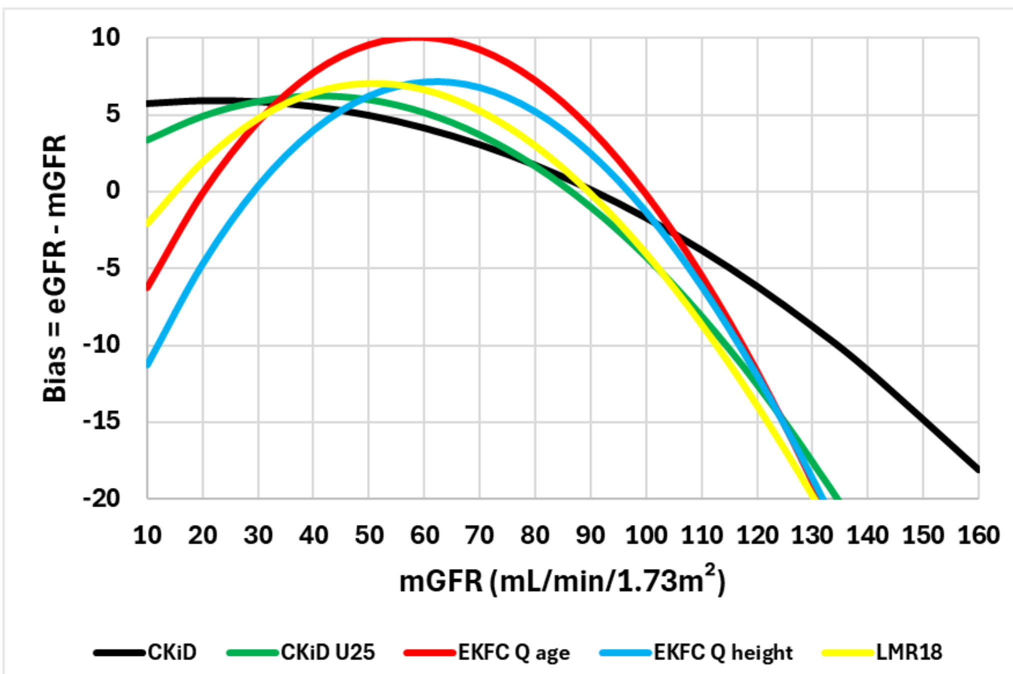
Etienne Cavalier, Liège

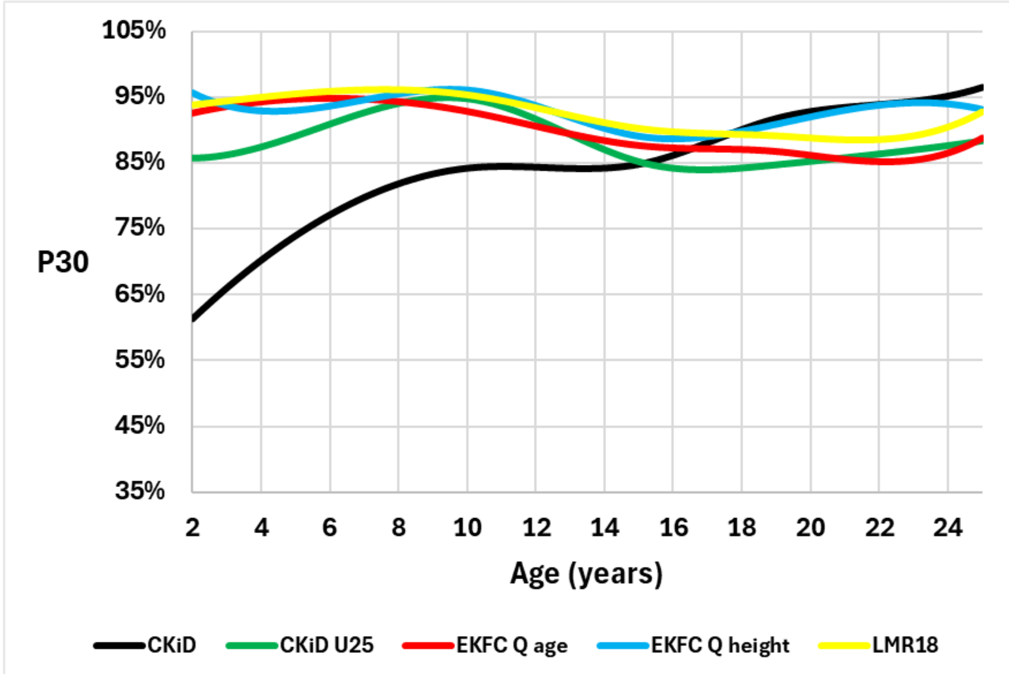
Eric Yayo, Abidjan

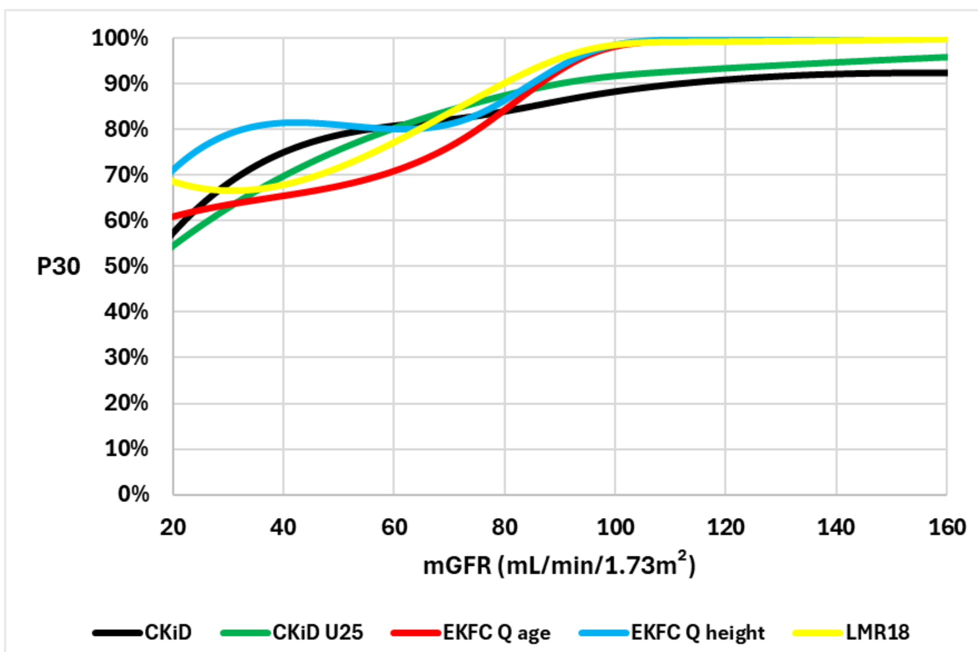
Andrew Rule, Rochester

# Merci


15
10
5
0
-5
-10
-15
Bias = eGFR - mGFR
2
4
6
8
10
12
14
16
18
20
22
24
Age (years)
CKiD
CKiD U25
EKFC Q age
EKFC Q height
LMR18


10
5
0
-5
-10
-15
-20
Bias = eGFR - mGFR
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
mGFR (mL/min/1.73m²)
CKiD
CKiD U25
EKFC Q age
EKFC Q height
LMR18


P30
105%
95%
85%
75%
65%
55%
45%
35%
2
4
6
8
10
12
14
16
18
20
22
24
Age (years)
CKiD
CKiD U25
EKFC Q age
EKFC Q height
LMR18


P30
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
20
40
60
80
100
120
140
160
mGFR (mL/min/1.73m2)
CKiD
CKiD U25
EKFC Q age
EKFC Q height
LMR18

## 3359 garçons (1-25 ans)

| | CKiD | CKiD U25 | EKFC Q age | EKFC Q height |
|---|---|---|---|---|
| Bias | -2,45 [-3,08; -1,73] | 2,79 [2,15; 3,33] | -0,13 [-0,72; 0,46] | -3,29 [-3,90; -2,73] |
| IQR | 27,3 [-15,8; 11,5] | 22,5 [-8,0; 14,5] | 22,6 [-12,2; 10,3] | 22,5 [-14,8; 7,7] |
| P20 | 62,3 [60,6; 63,9] | 67,9 [66,3; 69,5] | 69,6 [68,1; 71,2] | 68,2 [66,6; 69,8] |
| P30 | 80,8 [79,5; 82,2] | 83,1 [81,8; 84,3] | 84,6 [83,4; 85,8] | 85,4 [84,2; 86,6] |

## 2599 filles (1-25 ans)

| | CKiD | CKiD U25 | EKFC Q age | EKFC Q height |
|---|---|---|---|---|
| Bias | 4,91 [4,14; 5,78] | -1,71 [-2,38; -0,64] | 0,29 [-0,41; 1,08] | -1,43 [-2,17; -0,79] |
| IQR | 25,3 [-6,7; 18,6] | 23,1 [-12,9; 10,2] | 23,0 [-11,0; 11,9] | 22,9 [-12,7; 10,2] |
| P20 | 63,8 [61,9; 65,6] | 69,1 [67,4; 70,9] | 70,1 [68,4; 71,9] | 69,0 [67,2; 70,8] |
| P30 | 80,7 [79,2; 82,2] | 86,0 [84,7; 87,3] | 85,5 [84,1; 86,8] | 87,0 [85,7; 88,3] |