CKD-EPI
¿por qué una nueva fórmula?

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EPI

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Sumario

- *Grupo CKD-EPI y sus ecuaciones*
- *Formulación CKD-EPI creatinina*
- *Ventajas de la nueva fórmula*
- *Limitaciones de la nueva fórmula*
- *Argumentos a favor y en contra de su uso*

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)*

Equations developed by the MDRD Study Group and CKD-EPI

Filtration Marker	eGFR	Research Group	Year of Publi-cation	Study Population Number of subjects (development, validation)	Assays	Equation	Advantages	References
Creatinine	eGFRcr	MDRD Study	1999	CKD 1628 (1628, 0)	Non-standardized	MDRD Study creatinine 1999	Recommended by NKF-KDOQI 2002	Levey et al. Ann Intern Med 1999; 130: 461-70;
		MDRD Study	2006	Same as above	Re-expressed for standardized assay	MDRD Study creatinine 2006	Appropriate for use with standardized assays	Levey et al. Ann Intern Med 2006; 145: 247-54
		CKD-EPI	2009	Diverse 12,150 (8254, 3896,)	Standardized	CKD-EPI creatinine 2009	Lesser bias at eGFR >60. Recommended by KDIGO 2013	Levey et al. Ann Int Med 2009; 150: 604-12
Cystatin C ± Creatinine	eGFRcys eGFRcr-cys	CKD-EPI	2008	CKD 3418 (2980, 438)	Non-standardized	CKD-EPI cystatin C 2008 CKD-EPI creatinine-cystatin C 2008	eGFRcr-cys more precise than eGFRcr or eGFR cys	Stevens et al. Am J Kidney Dis 2008; 51:395-406
		CKD-EPI	2011	Same as above	Re-expressed for standardized assay	CKD-EPI cystatin C 2011 CKD-EPI creatinine-cystatin C 2011	Appropriate for use with standardized assays	Inker et al. Am J Kidney Dis 2011; 58: 682-684
		CKD-EPI	2012	Diverse 6471 (5352, 1119)	Standardized	CKD-EPI cystatin C 2012 CKD-EPI creatinine-cystatin C 2012	Lesser bias at eGFR >60. Recommended by KDIGO 2013	Inker et al. N Engl J Med 2012; 367: 20-9

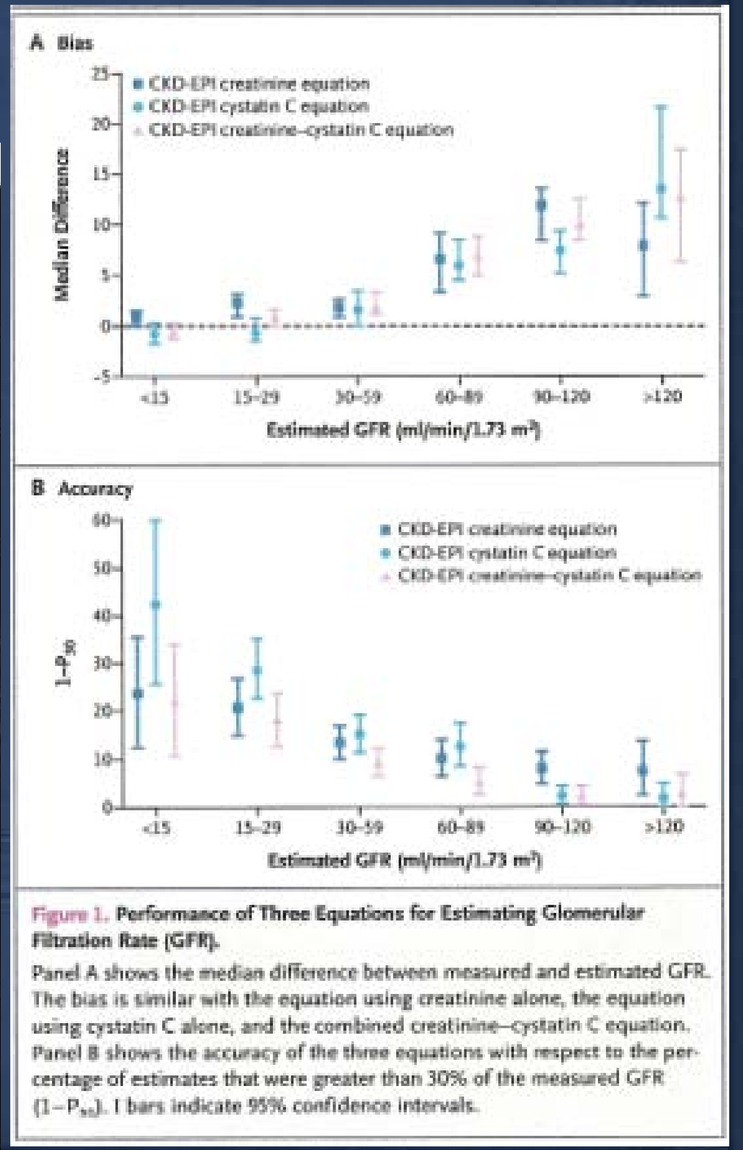

Figure 1. Performance of Three Equations for Estimating Glomerular Filtration Rate (GFR).

Panel A shows the median difference between measured and estimated GFR. The bias is similar with the equation using creatinine alone, the equation using cystatin C alone, and the combined creatinine–cystatin C equation. Panel B shows the accuracy of the three equations with respect to the percentage of estimates that were greater than 30% of the measured GFR ($1-P_{30}$). I bars indicate 95% confidence intervals.

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Context

The MDRD (Modification of Diet in Renal Disease) Study equation is commonly used to estimate glomerular filtration rate (GFR), but it is imprecise and underestimates GFR at higher values.

Contribution

These researchers pooled data from studies to develop and validate a new equation, the CKD-EPI (Chronic Kidney Disease Epidemiology Collaboration) equation, to predict GFR. The CKD-EPI equation was somewhat more precise and accurate than the MDRD Study equation, especially at higher GFRs. Using the new equation could decrease false-positive results—the mislabeling of people with high GFR as having poor kidney function.

Caution

The sample used to develop the CKD-EPI equation included few elderly and nonwhite persons. Evaluation of the equation in these populations is needed.

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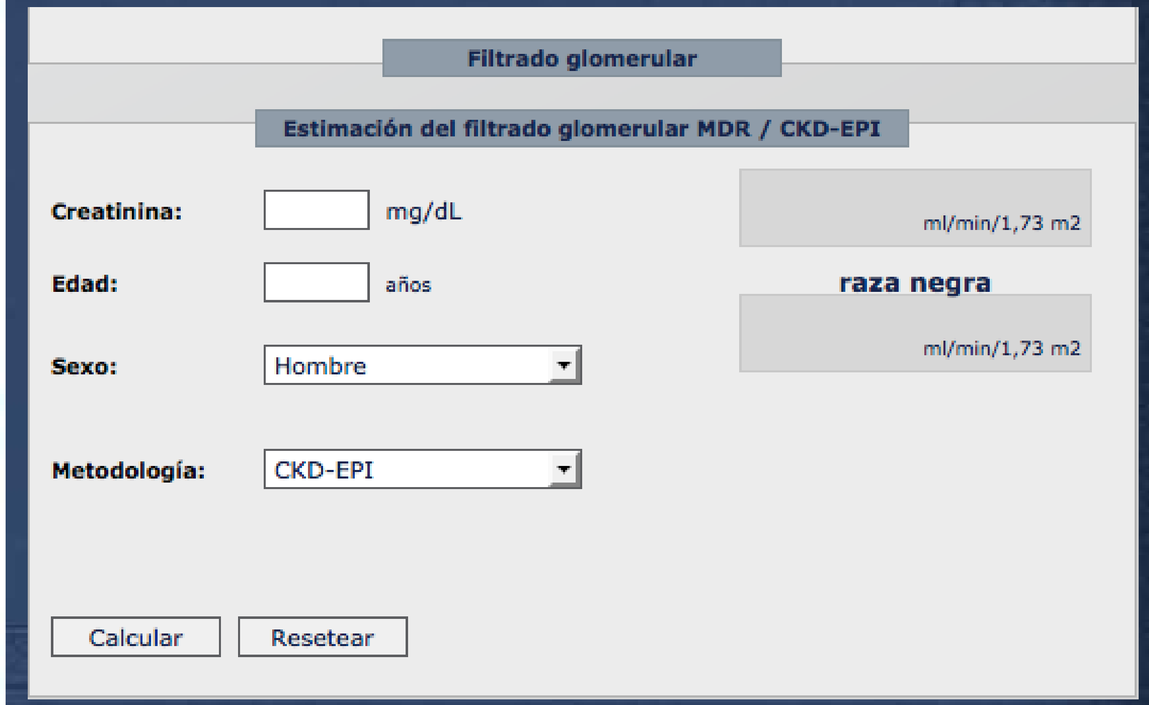
Formulación CKD-EPI creatinina

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 × (Scr/0.7)$^{-0.329}$ × (0.993)^{Age}
	>62 (>0.7)	GFR = 166 × (Scr/0.7)$^{-1.209}$ × (0.993)^{Age}
Male	≤80 (≤0.9)	GFR = 163 × (Scr/0.9)$^{-0.411}$ × (0.993)^{Age}
	>80 (>0.9)	GFR = 163 × (Scr/0.9)$^{-1.209}$ × (0.993)^{Age}
White or other		
Female	≤62 (≤0.7)	GFR = 144 × (Scr/0.7)$^{-0.329}$ × (0.993)^{Age}
	>62 (>0.7)	GFR = 144 × (Scr/0.7)$^{-1.209}$ × (0.993)^{Age}
Male	≤80 (≤0.9)	GFR = 141 × (Scr/0.9)$^{-0.411}$ × (0.993)^{Age}
	>80 (>0.9)	GFR = 141 × (Scr/0.9)$^{-1.209}$ × (0.993)^{Age}



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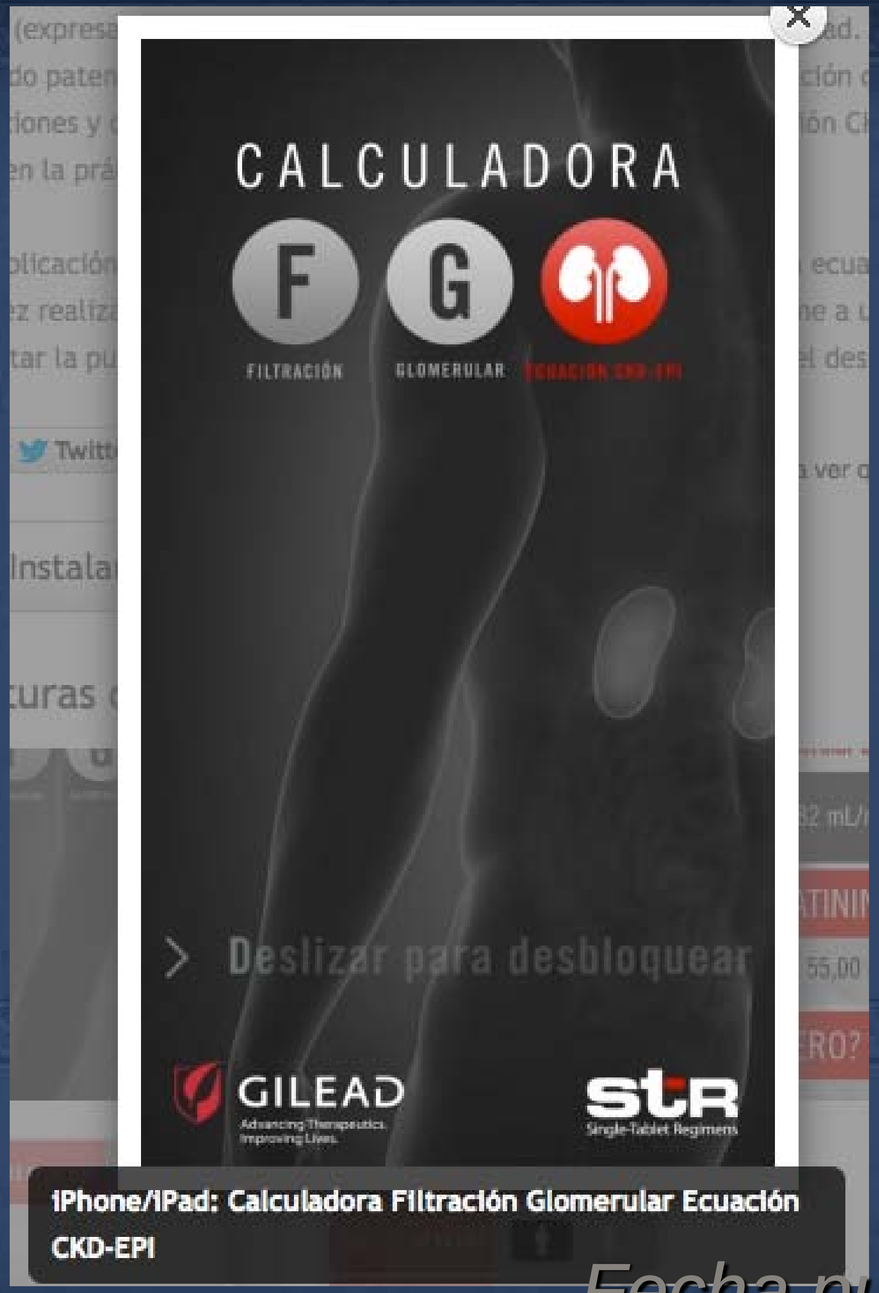

iPhone/iPad: Calculadora Filtración Glomerular Ecuación CKD-EPI

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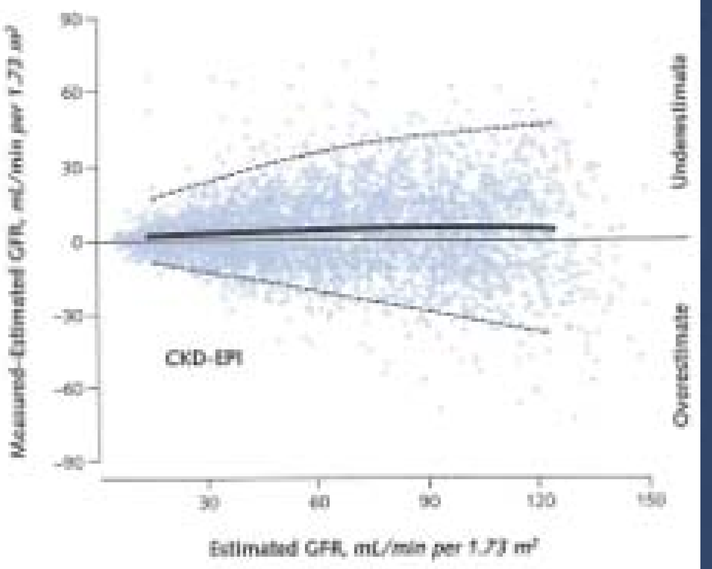
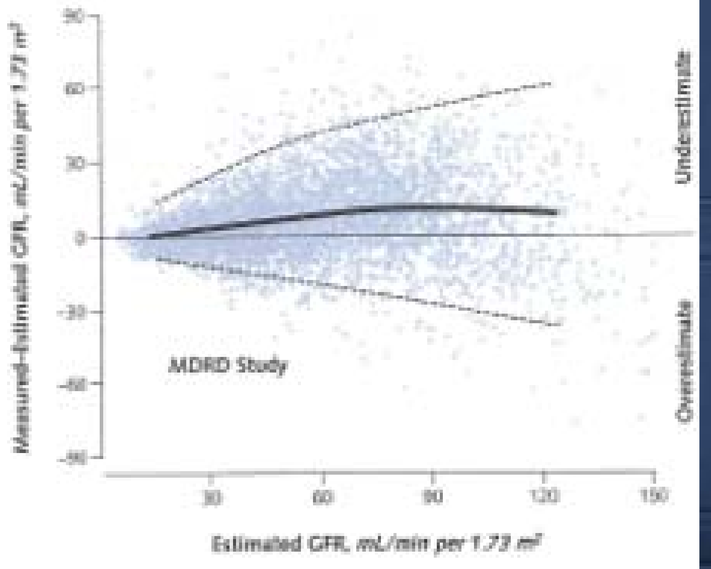
Figure. Performance of the CKD-EPI and MDRD Study equations in estimating measured GFR in the external validation data set.





ESTIMACIÓN DEL FILTRADO GLOMERULAR SEGÚN MDRD-4 IDMS Y CKD-EPI EN INDIVIDUOS DE EDAD IGUAL O SU...

ESTIMATION OF GLOMERULAR FILTRATION RATE BY MDRD-4 IDMS AND CKD-EPI IN INDIVIDUALS OF 60 YEARS ...

Betlem Salvador-González, Luisa M. Rodríguez-Latre, Roser Güell-Miró, Virtudes Álvarez-Funes, Héctor Sanz-Ródenas, Francisco J. Tovillas-Morán, MACAP Renal

Nefrologia 2013;33(4) | Doi. 10.3265/Nefrologia.pre2013.Apr.11929 | Aceptado el: 1 Abr. 2013

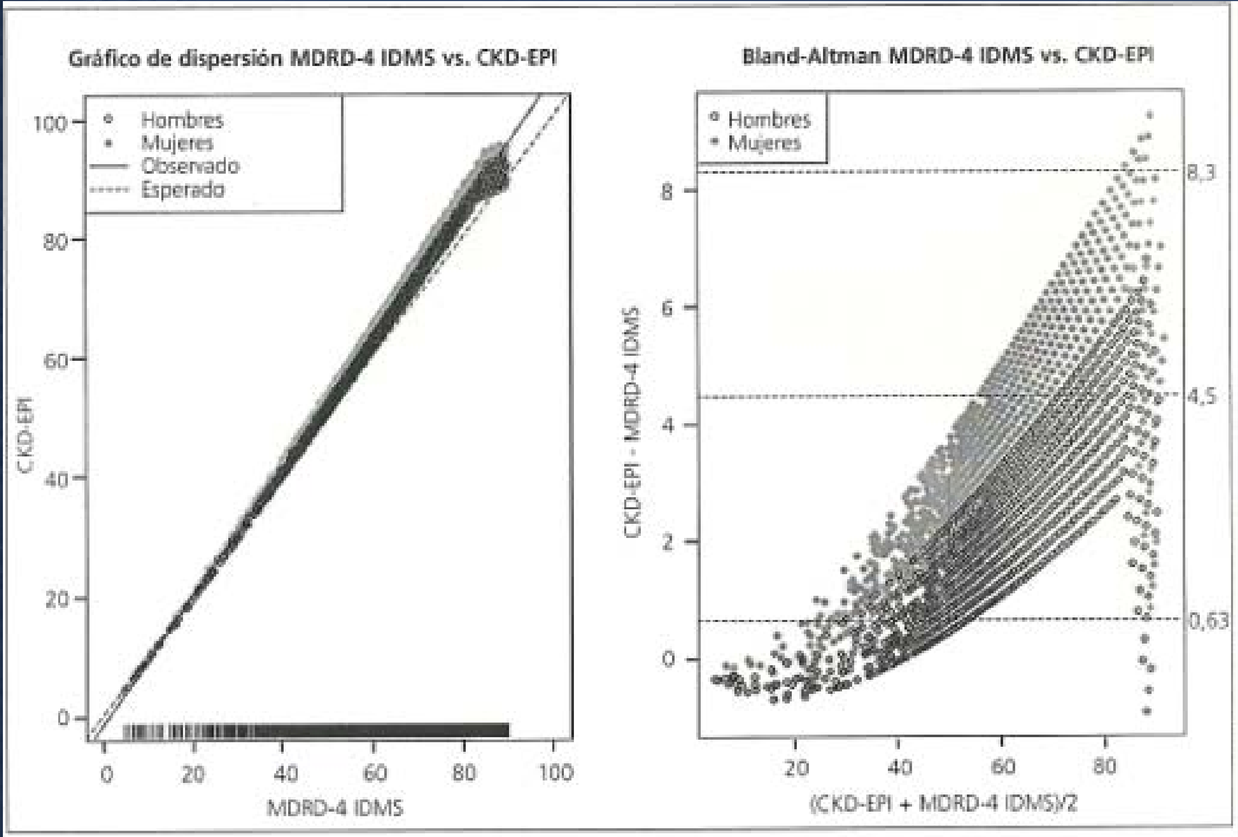


Figura 1. Relación entre la estimación del filtrado glomerular con MDRD-4 IDMS y CKD-EPI según sexo para individuos con valores de MDRD-4 IDMS < 90 y edad ≤ 70 años.
CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration; IDMS: espectrometría de masas con dilución isotópica; MDRD: Modification of Diet in Renal Disease.

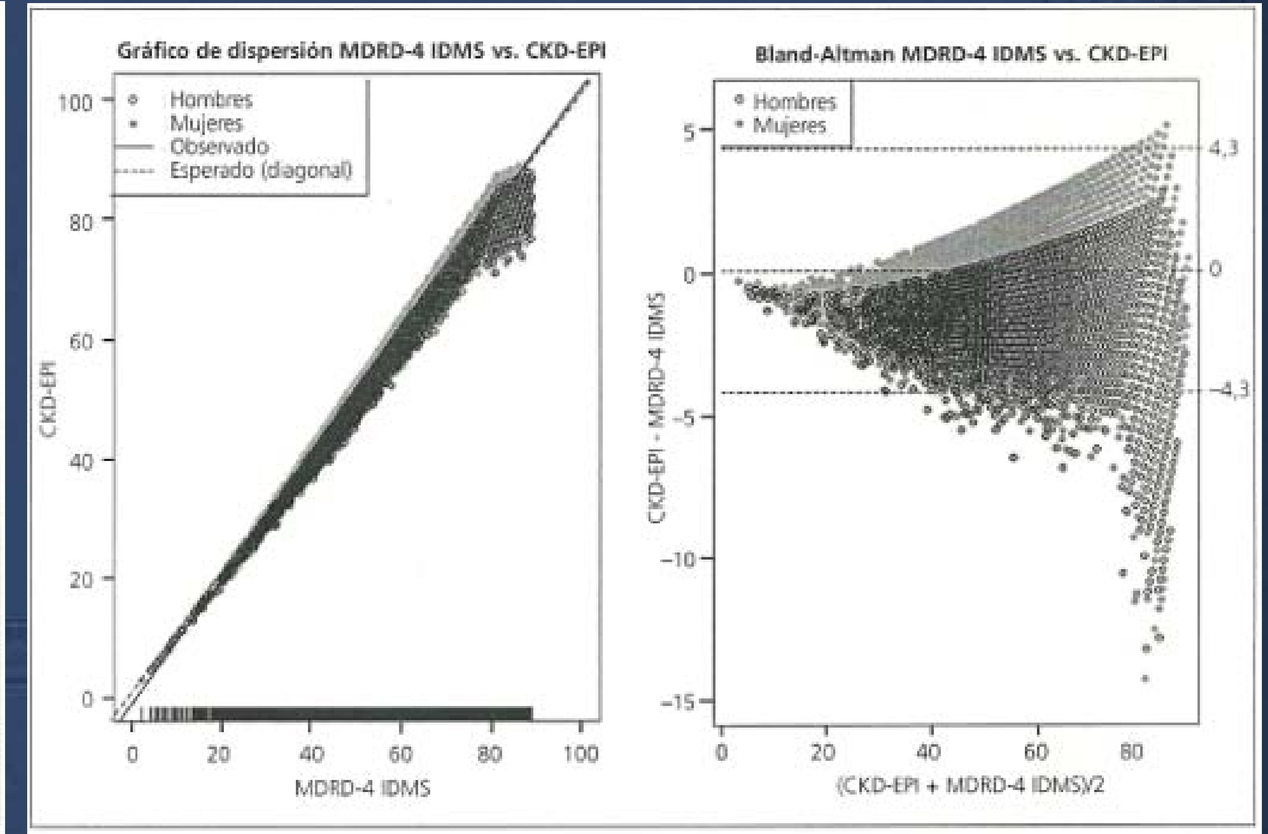


Figura 2. Relación entre la estimación del filtrado glomerular con MDRD-4 IDMS y CKD-EPI según sexo para individuos con valores de MDRD-4 IDMS < 90 y edad > 70 años.
CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration; IDMS: espectrometría de masas con dilución isotópica; MDRD: Modification of Diet in Renal Disease.

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Polar Views in Nephrology

Pro: Estimating GFR using the chronic kidney disease epidemiology collaboration (CKD-EPI) 2009 creatinine equation: the time for change is now

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Table 1. Comparison of the MDRD study and CKD-EPI creatinine equations

	MDRD study	CKD-EPI
General information		
Year of publication	1999	2009
Reference standard for mGFR	Urinary clearance of ^{125}I-iothalamate	Urinary clearance of ^{125}I-iothalamate
Unit	mL/min/1.73 m^2	mL/min/1.73 m^2
Variables included		
Creatinine	Linear on the log-scale	2-slope spline on the log scale with sex-specific knots (0.7 mg/dL for women and 0.9 mg/dL for men)
Age	Linear on the log-scale	Linear on the natural
Sex	Yes	Yes
Race	Black versus white and other	Black versus white and other
Standardized creatinine assay	Yes	Yes
Characteristics of development dataset		
Number	1628	8254
Age (mean, years)	51	47
mGFR (mean, mL/min/1.73 m^2)	40	67
Sex (% men)	60	57%
Race		
Black	12%	32%
Asian	Not Reported	1%
Hispanic	Not Reported	5%
White and other	88%	63%
CKD (%)	100%	73%*
Diabetes (%)	6%	29%
Transplant recipients (%)	0%	4%
Equation selection and validation		
Separate dataset used for equation selection	No	Yes
Validation in same report	No	Yes
Validation in separate reports	Many	Many
Features of a GFR estimation equation desirable for widespread implementation		
Developed in population similar to which it will be applied	No	Yes
No bias across the range of GFR	Underestimation of mGFR at eGFR < 60	Lesser bias than MDRD study equation across the full range of GFR
Precise	Greater precision than Cockcroft-Gault equation; Still limited	Greater precision than MDRD study equation; Still limited
Generalizable for international use	With modifications	Fewer modifications required
Usefulness in prognosis	Mortality; CVD; Kidney disease progression	More accurate for all outcomes compared with MDRD study equation

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Ventajas de la fórmula CKD-EPI creatinina

Table 4. **Comparison of the CKD-EPI and MDRD Study Equations in Estimating GFR Stage and Comparison With Measured GFR in the Validation Data Set***

CKD-EPI–Estimated GFR and Measured GFR	MDRD Study–Estimated GFR, *n* (%)					Total Patients, *n* (%)
	>90 mL/min per 1.73 m²	60–89 mL/min per 1.73 m²	30–59 mL/min per 1.73 m²	15–29 mL/min per 1.73 m²	<15 mL/min per 1.73 m²	
Estimated GFR >90 mL/min per 1.73 m²	670 (17.2)	319 (8.2)	0	0	0	989 (25.4)
Measured GFR						
>90 mL/min per 1.73 m²	586 (15.0)	221 (5.7)				
60–89 mL/min per 1.73 m²	75 (1.9)	93 (2.4)				
30–59 mL/min per 1.73 m²	9 (0.3)	4 (0.1)				
15–29 mL/min per 1.73 m²	0	1 (0.0)				
<15 mL/min per 1.73 m²	0	0				
Estimated GFR 60–89 mL/min per 1.73 m²	2 (0.0)	803 (20.6)	190 (4.9)	0	0	995 (25.5)
Measured GFR						
>90 mL/min per 1.73 m²	0	263 (6.8)	11 (0.3)			
60–89 mL/min per 1.73 m²	1 (0.0)	459 (11.8)	110 (2.8)			
30–59 mL/min per 1.73 m²	1 (0.0)	77 (2.0)	69 (1.8)			
15–29 mL/min per 1.73 m²	0	4 (0.1)	0			
<15 mL/min per 1.73 m²	0	0	0			
Estimated GFR 30–59 mL/min per 1.73 m²	0	3 (0.0)	1251 (32.1)	42 (1.1)	0	1295 (33.2)
Measured GFR						
>90 mL/min per 1.73 m²		0	118 (3.0)	0		
60–89 mL/min per 1.73 m²		2 (0.0)	221 (5.7)	0		
30–59 mL/min per 1.73 m²		0	903 (23.7)	20 (0.5)		
15–29 mL/min per 1.73 m²		0	105 (2.7)	21 (0.5)		
<15 mL/min per 1.73 m²		0	4 (0.1)	0		
Estimated GFR 15–29 mL/min per 1.73 m²	0	0	9 (0.2)	462 (11.9)	2 (0.0)	473 (12.1)
Measured GFR						
>90 mL/min per 1.73 m²			0	0	0	
60–89 mL/min per 1.73 m²			0	0	0	
30–59 mL/min per 1.73 m²			5 (0.1)	109 (2.8)	1 (0.0)	
15–29 mL/min per 1.73 m²			4 (0.1)	302 (7.8)	1 (0.0)	
<15 mL/min per 1.73 m²			0	51 (1.3)	0	
Estimated GFR <15 mL/min per 1.73 m²	0	0	0	5 (0.1)	139 (3.6)	144 (3.7)
Measured GFR						
>90 mL/min per 1.73 m²				0	0	
60–89 mL/min per 1.73 m²				0	2 (0.0)	
30–59 mL/min per 1.73 m²				0	0	
15–29 mL/min per 1.73 m²				2 (0.0)	32 (0.8)	
<15 mL/min per 1.73 m²				3 (0.1)	105 (2.7)	
Total	672 (17.3)	1124 (28.9)	1450 (37.2)	509 (13.1)	141 (3.6)	3896 (100)

Levey AS et al. A New Equation to Estimate Glomerular Filtration Rate. Ann Int Med 2009;150:604-612.

Tabla 6. Prevalencia de la estimación del filtrado glomerular < 60 en diferentes estudios

Estudio			eFG < 60			Reclasificación de estadio 3 a 2
			MDRD	CKD-EPI	Variación	
NHANES* (> 20 a. población general)	n = 15 563 53 % mujeres Edad 47 ± 19	Global	8,2 %	6,7 %	-18 %	43,5 %
		Mujeres	10,2 %	8,1 %	-21 %	
		Varones	6,2 %	5,4 %	-13 %	
		60-69 años	15,6 %	10,8 %	-31 %	
		≥ 70 años	37,4 %	37,8 %	+0,01 %	
AusDiab[15] (> 25 a. población general)	n = 11182 55,2 % mujeres Edad 51,5 ± 14,5	Global	7,8 %	5,8 %	-26 %	25 %
		Mujeres	9,5 %	6,6 %	-31 %	
		Varones	5,9 %	5,0 %	-15 %	
Metaanálisis CKDPC[13] (> 18 a.)	n = 940 366 57 % mujeres Edad 43	Población general	8,7 %	6,3 %	-28 %	34,7 %
	n = 151 494 59 % mujeres Edad 49	Alto riesgo	17,7 %	14,6 %	-18 %	26,3 %
3 Ciudades[16] (> 65 a. población general)	n = 8705 60,5 % mujeres Edad 74,3 ± 5,5	Global	13,7 %	12,9 %	-6 %	9,8 %
		Mujeres	14,7 %	13,0 %	-12 %	
		Varones	12,1 %	12,7 %	+5 %	
O'Callaghan et al.[17] (> 18 a. atendidos en Atención Primaria)	n = 175 671	Global	15,7 %	14,5 %	-8 %	11,1 %
		Mujeres 60-69 años	15,9 %	10,8 %	-32 %	
		Varones 60-69 años	10,6 %	8,6 %	-19 %	
		Mujeres > 70 años	41,3 %	41,2 %	-0,002 %	
		Varones > 70 años	33,3 %	35,5 %	+7 %	
Carter et al.[18] (> 18 a. atendidos en Atención Primaria)	n = 174 448 54,7 % mujeres Edad mediana 62 (49-74)	Global	19 %	17,2 %	-10 %	
		< 70 años	7,7 %	4,8 %	-38 %	
		≥ 70 años	41,1 %	41 %	-0,003 %	
AKDN[19] (> 18 a., registro provincial laboratorio)	n = 1 010 988	Global	9,2 %	7,3 %	-21 %	30,8 %
Esteve Poblador et al.[20] (determinación creatinina en hospital)	n = 20 000 51 % mujeres Edad 73,5 ± 8,3	Global	33,1 %	32,3 %	-2 %	7,5 %
		Mujeres	33,8 %	32,6 %	-4 %	
		Varones	32,1 %	32 %	-0,3 %	
Elorza-Ricart et al.[21] (20-99 a., atendidos en Atención Primaria)	n = 447 140 58,7 % mujeres Edad 56,6 ± 48,8	Global	14,1 %	12,3 %	-13 %	21 %
		< 70 años	5,3 %	2,8 %	-47 %	52,8 %
		≥ 70 años	35 %	35 %	0 %	5,7 %

* No incluye eFG < 15.
AKDN: Alberta Kidney Disease Network; CDK-EPI: Chronic Kidney Disease Epidemiology Collaboration; CKDPC: Chronic Kidney Disease Prognosis Consortium; eFG: estimación del filtrado glomerular; MDRD: Modification of Diet in Renal Disease; NHANES: National Health and Nutrition Examination Survey.

Salvador-Gonzalez B et al. Estimación del Filtrado Glomerular según MDRD-4 IDMS y CKD-EPI en individuos de edad igual o superior a 60 años en Atención Primaria. Nefrologia 2013;33(4):552-563.

Ventajas de la fórmula CKD-EPI creatinina

Shafi *et al. BMC Nephrology* 2012, **13**:42
http://www.biomedcentral.com/1471-2369/13/42

BMC Nephrology

RESEARCH ARTICLE Open Access

Comparing the association of GFR estimated by the CKD-EPI and MDRD study equations and mortality: the third national health and nutrition examination survey (NHANES III)

Tariq Shafi[1,2*], Kunihiro Matsushita[2,3], Elizabeth Selvin[2,3], Yingying Sang[2,3], Brad C Astor[4], Lesley A Inker[5] and Josef Coresh[2,3,6]

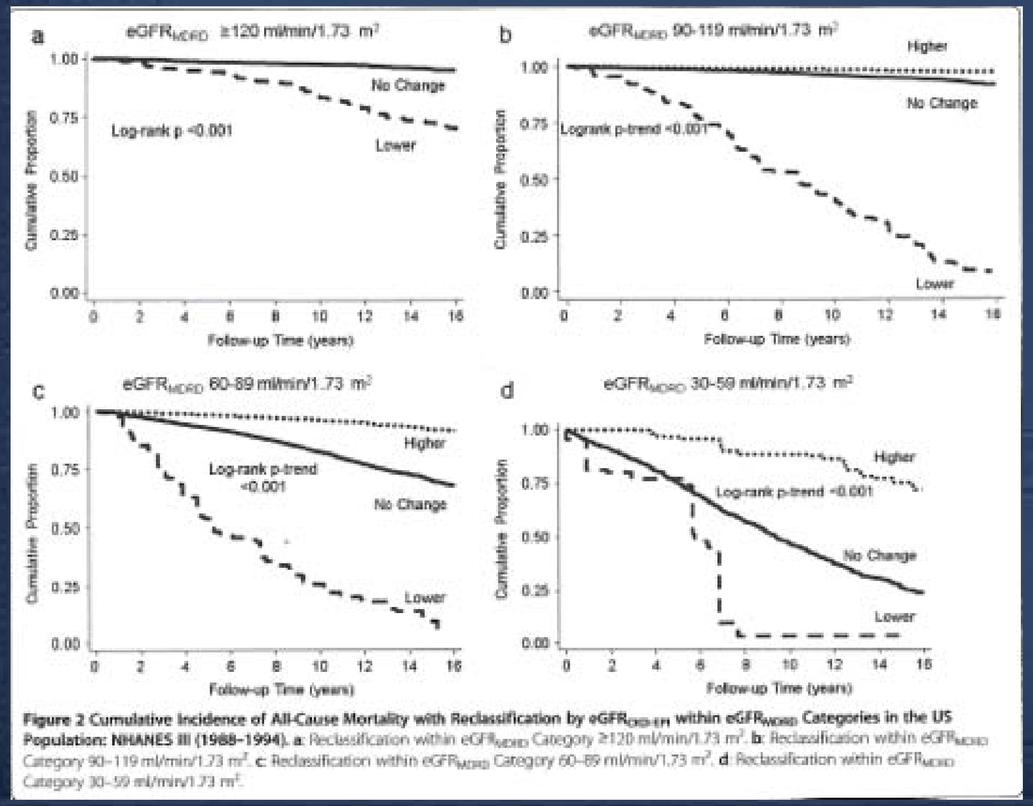

Figure 2 Cumulative Incidence of All-Cause Mortality with Reclassification by eGFR$_{CKD-EPI}$ within eGFR$_{MDRD}$ Categories in the US Population: NHANES III (1988–1994). **a**: Reclassification within eGFR$_{MDRD}$ Category ≥120 ml/min/1.73 m^2. **b**: Reclassification within eGFR$_{MDRD}$ Category 90–119 ml/min/1.73 m^2. **c**: Reclassification within eGFR$_{MDRD}$ Category 60–89 ml/min/1.73 m^2. **d**: Reclassification within eGFR$_{MDRD}$ Category 30–59 ml/min/1.73 m^2.

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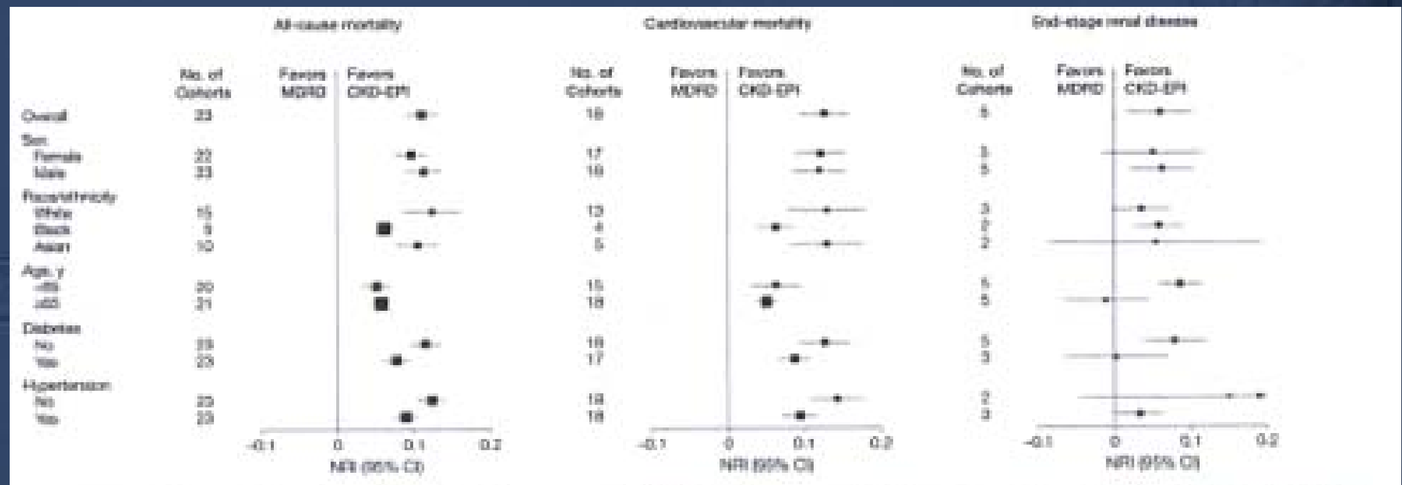

FIGURE 1: Meta-analysis of net reclassification improvements (NRI) for all-cause mortality, cardiovascular mortality, and end-stage renal disease. NRI summarizes the risk of clinical outcomes among participants who are reclassified from one estimated GFR category using the MDRD study equation to another estimated GFR category using the CKD-EPI equation compared with those who are not reclassified. The sizes of the data markers are proportional to the inverse of the variance of the NRIs. Adapted with permission from [17].

Limitaciones de la fórmula CKD-EPI creatinina

- Poblaciones diferentes en el mundo
- Sesgo de los diferentes estudios analizados
- No representación de la población general
- Parametros que afectan a la creatinina independientes del FG
- Complejidad de la ecuación
- Falta de mayor exactitud y precisión, y menor desviación

Argumentos para el uso de la CKD-EPI creatinina

A favor	En contra
Mejor precisión y exactitud que MDRD-4 IDMS	Falta mayor precisión y exactitud
Mejor estadiaje de los pacientes	Dificultad para tomar decisiones clínicas críticas (seguros, empleo)
Mejor predicción pronóstica	Difícil elección en trasplante renal (donante vivo-receptor)
Mejor guía para las decisiones clínicas	Dosis ajustada de fármacos
Escaso impacto en sist. informatizados	Efecto de la edad y de la mortalidad CV

Resumen

- *CKD-EPI creatinina es una fórmula basada en la creatinina, edad, sexo y raza*
- *Mejora las prestaciones de la MDRD-4 IDMS*
- *Clasifica mejor a los pacientes y se relaciona mejor con la mortalidad*
- *Limitaciones*
- *Recomendada por las guias KDIGO 2013*