THE VALIDATION OF ESTIMATED GLOMERULAR FILTRATION RATE EQUATION IN OBESE POPULATIONS

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BACKGROUND

Estimated glomerular filtration rate (eGFR) equations are essential for the kidney function's classification.Currently these equations have been validated in some races such as Causasian, African-Americans, Chinese, including Thais. he reexpressed Modification of Diet in Renal Disease equation for Thais is as follow : 175 x Cr enz$^{(-1.154)}$ x Age$^{(-0.203)}$ x 0.742 (if female) x 1.129 (if Thai) and we used multiple regression analysis, The Thai eGFR formula is : 375.5 x Cr enz$^{(-0.848)}$ x Age$^{(-0.364)}$ x 0.712 (if female). In Thai study, the mean body mass index is 25.3±4.8 kg/m^2. These equations can be applied to the obese populations whether or not. Therefore, we examined all eGFR equations available: Reexpressed MDRD equation, Thai eGFR formula, etc.

METHODS

A total 104 adults Thai obese patients and candidates (BMI ≥ 30 kg/m^2) were enrolled. The 99mTc-DTPA plasma clearance was used as a reference for GFR. The serum creatinine that was determined by IDSM reference enzymatic method (Cr_{enz}) was applied to these eGFR equations to compare accuracy and precision.

Referrence GFR measurement:

The reference GFR was determined by collecting plasma from 10 different time points using the ^{99m}Tc-Diethylene Triamine Pentaacetic Acid (^{99m}Tc-DTPA) plasma clearance method, which was performed at the Department of Radiology,Chulalongkorn University. ^{99m}Tc-DTPA was purchased from the Office of Atoms for Peace, Bangkok, Thailand, with a radiopurity of >95% and ^{99m}Tc-DTPA bound to plasma protein of <5%. The same protocol was applied to all patients. In brief, heparin lock was inserted in the arm to obtain blood samples to determine the radioactivity background and for serum creatinine assay. A single intravenous bolus of ^{99m}Tc-DTPA was injected into each patient. Blood specimens were drawn to assess plasma radioactivity at 5,10,20,30,60, 90, 120,180 and 240 min post ^{99m}Tc-DTPA injection. Plasma radioactive activities were then plotted as a function of time to create a time-activity curve to calculate for GFR (Figure 1). The GFR equation was determined by using bi-exponential fitting method.

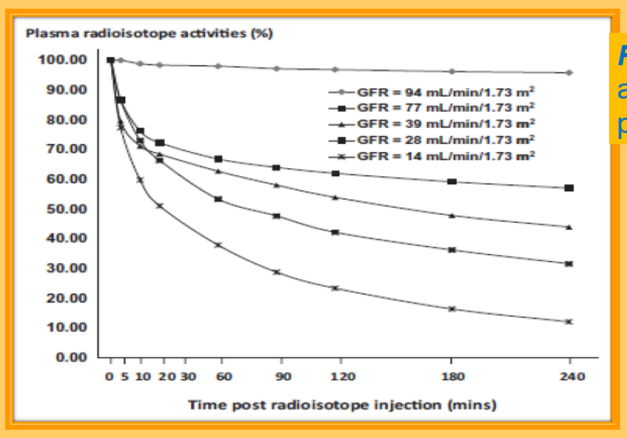


Fig 1 : The plot of plasma radioisotope activities as a function of time for GFR in patients

Table 1: eGFR calculation
The eGFR values were calculated by using Reexpressed IDSM traceable MDRD equation, CKD-EPI , Chinese equation, Japanese equation, Reexpressed MDRD with Thai racial factor, Thai equation

Table 1 : *eGFR equations presently available*

eGFR methods			
Reexpressed MDRD equation	not applicable	Cr_{enz}	175 x $(Cr_{enz})^{-1.154}$ x $(age)^{-0.203}$ (x 0.742 if female)
CKD-EPI	Female	Cr_{enz} ≤0.7 mg/dl	144 x $(Cr_{enz}/0.7)^{-0.329}$ x $(0.993)^{Age}$
		Cr_{enz} >0.7 mg/dl	144 x $(Cr_{enz}/0.7)^{-1.209}$ x $(0.993)^{Age}$
	Male	Cr_{enz} ≤0.9 mg/dl	144 x $(Cr_{enz}/0.7)^{-0.411}$ x $(0.993)^{Age}$
		Cr_{enz} >0.9 mg/dl	144 x $(Cr_{enz}/0.7)^{-1.094}$ x $(0.993)^{Age}$
Chinese equation	not applicable	Cr_{Jaffe}	175 x $(Cr_{Jaffe})^{-1.123}$ x $(age)^{-0.179}$ (x 0.79 if female)
Japanese equation	not applicable	Cr_{enz}	194 x $(Cr_{enz})^{-1.094}$ x $(age)^{-0.287}$ (x 0.739 if female)
Reexpressed MDRD equation with Thai racial factor	not applicable	Cr_{enz}	175 x $(Cr_{enz}^{-1.154})$x $(age^{-0.203})$ x 0.742 (if female)
Thai eGFR equation	not applicable	Cr_{enz}	375.5 x $(Cr_{enz}^{-0.848})$x(age $^{-0.0364}$) x 0.712 (if female)

RESULTS

Table 2 : *Characteristics of patients enrolled in the study*

Characteristic	All (n=85) (mean±SD) (range)	Male (n=22) 25.9% (mean±SD) (range)	Female (n=63) 74.1% (mean±SD) (range)
Age : years	5±12.7 (19-67)	9±15.1 (19-76)	±11.7 (21-63)
Weight : kg	5±20.1 (68.7-167)	.0±21.55 (79-156)	5±18.2 (68.6-167)
Height : kg	1.60±0.08 (1.43-1.86)	±0.77 (1.56-1.86)	±0.56 (1.43-1.69)
Body mass index: kg/m^2	±6.19 (30.1-64.5)	±21.4 31.6-51.5	±6.54 (30.1-64.5)
Body surface area: m^2	±0.22 (1.6-2.7)	±0.24 (1.8-2.7)	±0.18 (1.6-2.6)
DM cases	30 (35.3%)	13 (15.3%)	17 (19.0%)
Metabolic Syndrome	.0%	20%	32%
BIA :TBW (L)	±19.7 (24.4-152.5)	53.3±24.9 (37.7-152.5)	36.2±15.6(24.4-146.1)
:BFM (kg)	5±13.7 (4.9-39.6)	38.3±14.9 (5.0-75.1)	41.2±13.4 (4.9-39.6)
:SMM (kg)	±16.07 (3-58.8)	41.0±20.5 (28.4-122.7)	26.9±12.6(17.3-115.3)
: PBF (%)	±9.07 (3-57.8)	35.9±9.1 (3.0-50.4)	46.1±7.6 (3.0-57.8)

Table 3 : *Physiologic variables of patients enrolled in the study*

Physiologic variables	All (n=85) (mean±SD) (range)	Male (n=22) 25.9% (mean±SD) (range)	Female (n=63) 74.1% (mean±SD) (range)
Fasting Blood Sugar (FBS) mg/dl	108.3±63.1 (53-204)	124.6±62.9 (54-271)	103.1±62.17(53-304)
Blood Urea Nitrogen (BUN) mg/dl	15.8±16.3 (6.7-151)	23±30.5 (9-151)	13.2±4.5 (6.7-28)
Serum creatinine (Cr) mg/dl	0.85±0.97 (0.4-9)	1.37±1.78 (0.4-9.2)	0.67±0.25 (0.4-2.23)
Serum Albumin (Alb) g/dl	4.17±0.35 (2.2-4.8)	4.3±0.3 (3.4-4.8)	4.12±0.34 (2.2-4.8)
Fasting Blood Sugar (FBS) mg/dl	108.3±63.1 (53-204)	124.6±62.9 (54-271)	103.1±62.17 (53-304)
Serum Cholesterol (Chol) mg/dl	211±60.8 (119-619)	211.9±0.4 (119-408)	210.7±61.4 (142-619)

Fig 2: Bland–Altman plots of eGFR values calculated by different equations and the reference GFR to express the disagreement. The regression trend of the difference and the mean bias of the eGFRs toward the reference GFR illustrated the disagreement of different equations (A) reexpressed MDRD equation, (B) CKD-EPI equation, (C) Chinese equation, (D) Japanese equation, (E) reexpressed MDRD with Thai racial factor and (F) Thai eGFR equation.

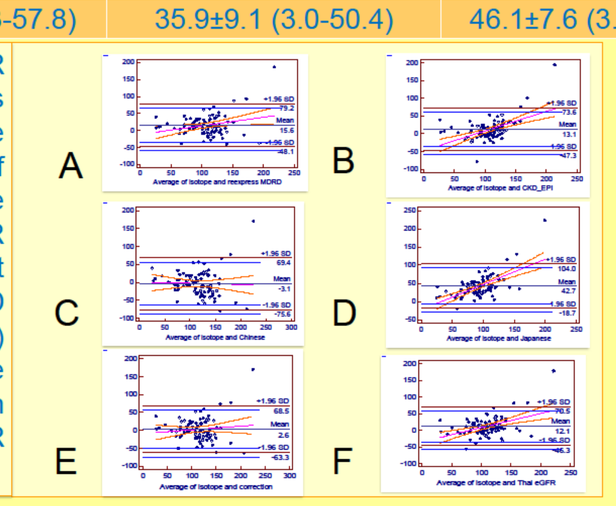
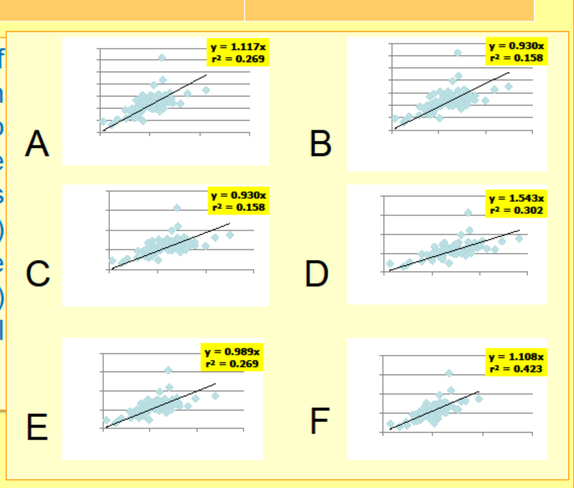


Fig 3 :linear regression analysis of eGFR values from different equation compare with the reference GFR to express the slope that define to the coefficience of among the equations (A) reexpressed MDRD equation, (B) CKD-EPI equation, (C) Chinese equation, (D) Japanese equation, (E) reexpressed MDRD with Thai racial factor and (F) Thai eGFR equation.



The disagreement between the reference GFR and eGFR (reference GFR minus eGFR) was 15.6 ml/min/1.73 m^2 in the reexpressed MDRD equation, 13.1 ml/min/1.73 m^2 in CKD–EPI equation, 2.6 ml/min/1.73 m^2 in reexpressed MDRD with Thai racial factor and 12.1 ml/min/1.73 m^2 in Thai eGFR equation. The Thai coefficient for reexpressed MDRD was 1.117.

CONCLUSION

Differrences in race, age, creatinine can significantly affect the results obtained from eGFR equation. However, the body mass index (BMI) may affect the results but not statistically significant. The validation of reexpressed MDRD with Thai racial factor and Thai eGFR equation can accurately and precisely apply to predict eGFR in Thai obese populations.

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