

The Aging Male

ISSN: 1368-5538 (Print) 1473-0790 (Online) Journal homepage: http://www.tandfonline.com/loi/itam20

Low glomerular filtration rate as an associated risk factor for sarcopenic muscle strength: is creatinine or cystatin C-based estimation more relevant?

Asli Tufan, Fatih Tufan, Timur Selcuk Akpinar, Birkan Ilhan, Gulistan Bahat & Mehmet Akif Karan

To cite this article: Asli Tufan, Fatih Tufan, Timur Selcuk Akpinar, Birkan Ilhan, Gulistan Bahat & Mehmet Akif Karan (2017) Low glomerular filtration rate as an associated risk factor for sarcopenic muscle strength: is creatinine or cystatin C-based estimation more relevant?, The Aging Male, 20:2, 110-114, DOI: 10.1080/13685538.2016.1225032

To link to this article: https://doi.org/10.1080/13685538.2016.1225032

Published online: 20 Sep 2016.

Submit your article to this journal

Article views: 69

View related articles

View Crossmark data

Citing articles: 2 View citing articles

Full Terms & Conditions of access and use can be found at
http://www.tandfonline.com/action/journalInformation?journalCode=itam20

The Aging Male

http://informahealthcare.com/tam
ISSN: 1368-5538 (print), 1473-0790 (electronic)

Aging Male, 2017; 20(2): 110–114
© 2016 Informa UK Limited, trading as Taylor & Francis Group. DOI: 10.1080/13685538.2016.1225032

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

Low glomerular filtration rate as an associated risk factor for sarcopenic muscle strength: is creatinine or cystatin C-based estimation more relevant?

Asli Tufan[1], Fatih Tufan[2], Timur Selcuk Akpinar[3], Birkan Ilhan[2], Gulistan Bahat[2], and Mehmet Akif Karan[2]

[1]*Department of Internal Medicine, Division of Geriatrics, Marmara University Hospital, Istanbul, Turkey,* [2]*Department of Internal Medicine, Istanbul Faculty of Medicine, Division of Geriatrics, Istanbul University, Istanbul, Turkey, and* [3]*Department of Internal Medicine, Istanbul Faculty of Medicine, Istanbul University, Istanbul, Turkey*

Abstract

Introduction: We aimed to evaluate the association of a decreased glomerular-filtration-rate (GFR <60 ml/min/1.73 m^2), estimated using Modification of Diet in Renal Disease (MDRD), creatinine- and cystatin C-based (CKDEPI-CR and CKDEPI-CC) Chronic Kidney Disease Epidemiology Collaboration equations with handgrip strength (HGS).
Methods: Community-dwelling males aged ≥ 60 years admitted to outpatient clinic were included. We used MDRD, CKDEPI-CR, and CKDEPI-CC formulas for GFR estimation and corrected these for body surface area. Muscle strength was assessed by HGS.
Results: 209 men (mean age 67.8 ± 6.4) were enrolled. Sixty-two patients (29.7%) had sarcopenic HGS. Subjects with sarcopenic HGS were older, had higher rate of a GFR <60 ml/min/1.73 m^2, had lower mid-upper arm circumference; tended to have lower creatine kinase, albumin, CKDEPI-CC-GFR levels; and higher BUN/creatinine ratio and cystatin C. Multivariate logistic regression analysis revealed a CKDEPI-CC lower than 60 ml/min/1.73 m^2 as the only independent factor underlying sarcopenic HGS. Higher age tended to have an independent association. Only higher age was independently associated with low HGS when other estimations were used ($p = 0.013$ and $p = 0.021$ when MDRD and CKDEPI-CR were used, respectively).
Conclusions: There is a strong association of a GFR level of <60 ml/min/1.73 m^2 with sarcopenic HGS, when CKDEPI-CC formula is used.

Keywords

Male, extracorporeal shock-wave therapy, sarcopenia

History

Received 4 July 2016
Revised 7 August 2016
Accepted 12 August 2016
Published online 14 September 2016

Introduction

Sarcopenia is recognized as age-related loss of muscle mass and function and is defined as one of the geriatric syndromes [1]. Due to the structural and functional regression of the muscles, mobility decreases and frailty, falls, and morbidity increase with aging. Interactions of neurological, environmental, nutritional, hormonal, and genetic factors may be important in the development of the sarcopenia [2]. Chronic kidney disease (CKD) is common in the older adult population. Sarcopenia is frequently seen in community-dwelling older adults with CKD [3]. Handgrip strength (HGS) is the most common method for estimating upper extremity muscle strength in sarcopenia assessment. A decline in HGS is closely associated with an increased length of hospitalization and all-cause mortality in patients with CKD [4].

Address for correspondence: Timur Selcuk Akpinar, Istanbul Faculty of Medicine, Department of Internal Medicine, Istanbul University, Fatih, 34093, Istanbul, Turkey. Tel: + 90 212 414 20 00. E-mail: timur.akpinar@istanbul.edu.tr

The most commonly used marker for glomerular filtration rate (GFR) estimation is creatinine (CR), which is widely available and inexpensive. CR is affected by sex, age, muscle mass, and by a small but significant tubular secretion. One limitation of estimation of GFR using CR is that it remains within the reference range until significant renal function has been lost and this limitation is especially important in the older adult population [5]. Thus, a normal CR concentration does not exclude significant renal impairment. This is very important in the process of determination and adjustment of medication doses commonly prescribed in elderly patients (e.g. digoxin, lithium, antibiotics, and chemotherapeutic agents). Using CR may contribute to drug dosage errors [6]. Thus, assessment and follow-up of renal function by estimating GFR are becoming increasingly important in the setting of global aging. Various formulas have been described to estimate GFR in adults using CR corrected for factors such as sex, body size, race, and age [7]. The Modification of Diet in Renal Disease (MDRD) Study equation is commonly used, but may underestimate GFR at higher levels [8]. The serum

CR-based Chronic Kidney Disease-Epidemiology Collaboration (CKDEPI-CR) equation generally provides more accurate estimation at GFR >60 ml/min/1.73 m^2 [9].

Cystatin C (CC) has attracted significant attraction as a new marker for GFR estimation [10]. CC is a low molecular weight protein produced at a stable rate and freely filtered by the glomerulus. Because it is not influenced by dietary factors or muscle mass, CC-based GFR estimation may theoretically be more appropriate for older adults who are susceptible to sarcopenia [11,12]. There are new equations using CC either alone (CKDEPI-CC) or in combination with CR (CKDEPI-CR-CC]). The CKDEPI-CR equation may be more accurate than the MDRD Study equation in older people [13–15].Current CKD guidelines recommend using CKDEPI-CR formula for estimation of GFR in older people [15]. We aimed to evaluate the association of a decreased GFR level (<60 ml/min/1.73 m^2) estimated using MDRD, CKDEPI-CR, and CKDEPI-CC formulas with HGS in community-dwelling older men.

Methods

Subjects

We performed this cross-sectional study in the outpatient internal medicine clinic of a university hospital. The study participants were recruited between June 2014 and September 2014. We enrolled community-dwelling men ≥ 60 years old who provided informed consent and excluded subjects with a history of cancer or those under dialysis treatment. The Ethical Committee of Istanbul University Istanbul Faculty of Medicine approved the study protocol, and we carried out the study in accordance with the Helsinki declaration and its later amendments.

Measurements

We measured subjects' weights and heights. Blood samples were obtained from the antecubital vein between 08:30 and 10:00 AM, following fasting of ≥ 8 h and analyzed blood urea nitrogen (BUN), CR, CC, creatine kinase, and albumin levels. Serum CR levels were measured through the alkaline picrate method on a Creatinine Jaffé Gen.2® kit, Hitachi Cobas C 311® analyzer – Roche Diagnostics, Indianapolis, IN. Serum CR levels were expressed in mg/dl. CC levels were assessed from the serum of patients by using commercial kit Tina-quant Cystatin C Gen.2®, Hitachi Cobas C 701 analyzer – Roche Diagnostics, Indianapolis, IN. The test is performed via Roche's turbidimetry technology for homogeneous immuno-assay detection. Test results were expressed in mg/L. Expected values were 0.61–0.95 mg/L. All laboratory specimens were controlled by a single laboratory and by a single machine. Body surface area was calculated using DuBois DuBois formula [16]. We used short MDRD, CKDEPI-CR, and CKDEPI-CC formulas for GFR estimation and corrected these for body surface area (BSA) [8,9,17]. Subjects were grouped according to their GFR levels (decreased-GFR: <60 ml/min and preserved-GFR: ≥60 ml/min).

Muscle strength was assessed by measuring HGS with a Jamar hydraulic hand dynamometer using a validated protocol [18]. HGS was measured in sitting position, elbow in 90° flexion, and wrist in neutral position. Participants were asked to apply the maximum grip strength for three times with both left and right hands. Between the each measurement at least 30-s resting intervals were allowed. The maximal measured HGS was used in the analysis.

We defined sarcopenic HGS as reported in the cardiovascular health study (<29 kg when BMI is ≤24 kg/m^2, <30 when BMI is between 24.1 and 28 kg/m^2, and <32 kg when BMI is > 28 kg/m^2) [1]. Calf circumference was measured using a standard anthropometric tape with the participants in a standing position. The tape was wrapped around the widest part of the calf of the non-dominant leg to obtain the maximal circumference; subcutaneous tissues were not compressed [19]. Mid-upper arm circumference was measured according to a standardized and recommended technique [20].

Statistical analysis

Distributions of continuous variables were determined with the Kolmogorov–Smirnov test. For inter-group comparisons, we used Chi square and Fisher's exact tests for categorical variables and Student's *t*-test or Mann–Whitney *U* test for continuous variables. To assess the agreement between categorical variables, we used Kappa statistics. We performed multivariate logistic regression analyses to assess independent associations with low HGS. We used factors which had significant ($p < 0.05$) or borderline ($p < 0.25$) associations with sarcopenic HGS as covariates in the regression analyses.

In all analyses, we accepted a two-sided *p* values of <0.05 as statistically significant. The statistical analysis was performed using the statistical package IBM SPSS for Windows version 21 (IBM Corporation, Armonk, NY).

Results

A total of 209 elderly men with a mean age of 67.8 ± 6.4 (range 60–87) were enrolled. Sixty-two patients (29.7%) had sarcopenic HGS. General characteristics of these subjects are shown in Table 1.

Mean GFR was lower with MDRD formula compared with the two CKDEPI formulas ($p < 0.001$ for both comparisons). CKDEPI-CC-GFR was significantly higher than CKDEPI-CR-GFR ($p < 0.001$). Level of agreement was poor between MDRD and CKDEPI-CC (kappa 0.27), modest between MDRD and CKDEPI-CR (kappa 0.4), and highest between CKDEPI-CR and CKDEPI-CC (kappa 0.54) (Table 2).

Subjects with sarcopenic HGS were older, had higher rate of a GFR < 60 ml/min/1.73 m^2, and had lower mid-upper arm circumference measurements (Table 3). They tended to have lower creatine kinase, albumin, CKDEPI-CC-GFR levels, and

Table 1. General characteristics of the study population ($n = 209$).

Body mass index (kg/m^2)	28.1 ± 4.3
Mid-upper arm circumference (cm)	30.3 ± 3
Calf circumference (cm)	37.4 ± 3.5
Handgrip strength (kg)	35.4 ± 8.4
Albumin (g/dl)	4 ± 0.45
Creatine kinase (U/L)	104.6 ± 77.2
Blood urea nitrogen (mg/dl)	19.2 ± 13.1
Creatinine (mg/dl)	1 ± 0.3
Cystatin C (mg/L)	0.94 ± 0.35
Sarcopenic muscle strength (*n*, %)	62 (29.7%)

higher BUN/CR ratio and CC level. Other study variables were similar between subjects with low and normal HGS measurements.

Multivariate logistic regression analysis revealed a CKDEPI-CC lower than 60 ml/min/1.73 m^2 as the only independent factor underlying sarcopenic HGS (Table 4). Higher age tended to have an independent association. When other two methods were used for GFR estimations in similar logistic regression models instead of CKDEPI-CC, only higher age was independently associated with low HGS ($p = 0.013$ when MDRD estimation was used and $p = 0.021$ when CKDEPI-CR estimation was used).

Discussion

We assessed the effect of several clinically relevant variables on sarcopenic HGS among community-dwelling older men in this study. Nearly one-third of the study population had sarcopenic HGS. Between aforementioned methods for GFR estimation, only when CKDEPI-CC formula was used, a GFR level of <60 ml/min/1.73 m^2 seemed to be a risk factor for sarcopenic HGS. After adjustment for age, mid-upper arm circumference, creatine kinase, BUN/CR ratio, and albumin levels, CKDEPI-CC-GFR level of <60 ml/min/1.73 m^2 remained significantly associated with sarcopenic HGS.

We also observed a tendency toward higher age, CC, lower creatine kinase, lower albumin, and a higher BUN/CR ratio in subjects with low HGS. HGS measurement is the most common method for determining muscle strength in the screening of sarcopenia [4]. In patients with chronic kidney disease, HGS was demonstrated to correlate with other nutritional markers and nutritional scores [21].

To the best of our knowledge, there is very small number of studies regarding the relationship between CC and sarcopenic muscle strength or muscle mass. Kim et al. [22] studied a total of 538 nonsarcopenic women older than 75 years in their 4-year longitudinal study. They studied risk factors for development of all stages of sarcopenia according to the European Working Group on Sarcopenia in Older People criteria in these subjects. The authors observed that CC was positively associated with the development of severe sarcopenia (odds ratio 1.83, 95% CI 1.08–3.12).

Recently, Kim et al. [23] developed a new equation with CC and CR to estimate muscle mass. In their equation, after adjustment for GFR, serum CR was correlated with muscle mass, while serum CC was correlated with body fat mass.

Sarcopenia is a prevalent geriatric syndrome in the older adult population, particularly in those affected by CKD [24]. Thus, accurate determination of older adults with CKD is important. There is inadequate information about the accuracy of GFR measurement methods in older adults with CKD [25]. Compared with CR-based estimation of GFR, CC-based estimation is less affected by age, gender, and muscle mass [11,12].

Otaki et al. [26] compared CR-based with CC-based estimation of GFR in 234 patients with peripheral artery disease who underwent endovascular therapy. On multivariate Cox proportional hazard analysis, unlike CR-based estimation, CC-based estimation was an independent predictor of cardiovascular and cerebrovascular events. Shlipak et al. [27] compared CR-based GFR estimation (by MDRD formula) with CC concentration in 4663 older adults without CKD in

Table 2. Glomerular filtration rate characteristics.

MDRD-GFR (ml/min/1.73 m^2)	59.4 ± 18.8
CKDEPI-C-GFR (ml/min/1.73 m^2)	73.4 ± 18.4
CKDEPI-CC-GFR (ml/min/1.73 m^2)	81.1 ± 25.7
MDRD-GFR < 60 ml/min/1.73 m^2 (%)	55
CKDEPI-C-GFR < 60 ml/min/1.73 m^2 (%)	23.1
CKDEPI-CC-GFR < 60 ml/min/1.73 m^2 (%)	19.2

Table 4. Multivariate logistic regression analysis for sarcopenic muscle strength.

Factor	OR (95% CI)	*p*
CKDEPI-CC-GFR < 60 ml/min/1.73 m^2	2.4 (1.04–5.4)	0.04
Age (years)	1.1 (1–1.1)	0.07
Upper arm circumference (cm)	0.9 (0.8–1.0)	0.10
Creatine kinase (U/L)	0.9 (0.9–1)	0.18
BUN/creatinine ratio	1.0 (0.9–1.0)	0.42
Albumin (g/dl)	1.0 (0.5–2.1)	0.94

Table 3. Comparison of subjects with low and normal muscle strength.

	Normal HGS	Low HGS	*p*
Age	66.9 ± 5.8	70 ± 7.1	0.003
Body mass index (kg/m^2)	28 ± 4.1	28.3 ± 5	0.6
Upper arm circumference (cm)	30.6 ± 2.9	30 ± 3.2	0.04
Calf circumference (cm)	37.5 ± 3.5	37 ± 3.6	0.3
Handgrip strength (kg)	39.4 ± 6.1	25.9 ± 4.7	<0.001
Albumin (g/dl)	4.1 ± 0.4	4 ± 0.5	0.24
Creatine kinase (U/L)	111.1 ± 81.1	89.1 ± 64.9	0.06
Blood urea nitrogen (mg/dl)	18.6 ± 14.3	20.7 ± 9.8	0.29
Creatinine (mg/dl)	1 ± 0.3	1 ± 0.2	0.6
Cystatin C (mg/L)	0.9 ± 0.4	1 ± 0.3	0.13
Blood urea nitrogen creatinine ratio	20.8 ± 14.5	23.2 ± 10.8	0.24
MDRD-GFR (ml/min/1.73 m^2)	58.4 ± 18.1	61.9 ± 20.2	0.22
CKDEPI-C-GFR (ml/min/1.73 m^2)	72.9 ± 18.2	74.5 ± 18.8	0.5
CKDEPI-CC-GFR (ml/min/1.73 m^2)	82.7 ± 25	77.3 ± 27.3	0.17
MDRD-GFR < 60 ml/min/1.73 m^2 (%)	57	50	0.36
CKDEPI-C-GFR < 60 ml/min/1.73 m^2 (%)	15	29.5	0.29
CKDEPI-CC-GFR < 60 ml/min/1.73 m^2 (%)	21.1	27.9	0.015

the Cardiovascular Health Cohort-Study. The authors observed that CC concentration had strong associations with incident heart failure, stroke, myocardial infarction, CKD, cardiovascular death, and noncardiovascular death among these participants.

Although there are limited data about the accuracy of the MDRD equation in our country and using MDRD formula for GFR estimation has some drawbacks, a recent study from our country showed that MDRD was a good tool to estimate GFR in our population [28].

Among limitations of our study are the cross-sectional design, limited data about comorbidities. Furthermore absence of a gold standard GFR measurement is an important limitation of our study. Because of the cross-sectional nature of our study and one-time sampling for laboratory measurements, we cannot rule out if some of our study participants had acute kidney injury. However, we think that this potential confounder should be rare because none of our subjects had symptoms of acute kidney injury such as nausea, vomiting, significant edema, or encephalopathy. Furthermore, relatively large sample is among the strong points of this study. To the best of our knowledge, this study was the first one to investigate the association between HGS and a GFR lower than 60 ml/min/1.73 m^2 which was estimated using CR or CC-based formulas. There is need to perform studies evaluating the longitudinal association of GFR estimations with sarcopenia in which gold standard measurements of GFR are also included.

Conclusions

Findings of this study suggest that a GFR level of <60 ml/min/1.73 m^2, when estimated using the CKDEPI-CC formula, is an important risk factor for sarcopenic HGS. However, there was no such association for other two CR-based formulas (CKDEPI-CRor MDRD). We cannot come to ultimate conclusions about the association of CKDEPI-CC with measures of sarcopenia because in this study we did not investigate cause–effect relationships. We suggest that investigation of the longitudinal association between GFR estimated by CC-based formulas with sarcopenia could provide clinically relevant information.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

References

1. Cruz-Jentoft AJ, Baeyens JP, Bauer JM, et al. Sarcopenia: European consensus on definition and diagnosis: report of the European Working Group on sarcopenia in older people. Age Ageing 2010; 39:412–23.
2. Chow LS, Nair KS. Sarcopenia of male aging. Endocrinol Metab Clin North Am 2005;34:833–52.
3. Foley RN, Wang C, Ishani A, et al. Kidney function and sarcopenia in the United States general population: NHANES III. Am J Nephrol 2007;27:279–86.
4. Chang YT, Wu HL, Guo HR, et al. Handgrip strength is an independent predictor of renal outcomes in patients with chronic kidney diseases. Nephrol Dial Transplant 2011;26:3588–95.
5. Duncan L, Heathcote J, Djurdjev O, Levin A. Screening for renal disease using serum creatinine: who are we missing? Nephrol Dial Transplant 2001;16:1042–6.
6. Hu KT, Matayoshi A, Stevenson FT. Calculation of the estimated creatinine clearance in avoiding drug dosing errors in the older patient. Am J Med Sci 2001;322:133–6.
7. National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis 2002;39:S1–266.
8. Stevens LA, Li S, Kurella Tamura M, et al. Comparison of the CKD Epidemiology Collaboration (CKD-EPI) and Modification of Diet in Renal Disease (MDRD) study equations: risk factors for and complications of CKD and mortality in the Kidney Early Evaluation Program (KEEP). Am J Kidney Dis 2011;57: S9–16.
9. Levey AS, Stevens LA, Schmid CH, et al. A new equation to estimate glomerular filtration rate. Ann Intern Med 2009;150: 604–12.
10. Newman DJ, Thakkar H, Edwards RG, et al. Serum cystatin C measured by automated immunoassay: a more sensitive marker of changes in GFR than serum creatinine. Kidney Int 1995;47: 312–18.
11. Schaeffner ES, Ebert N, Delanaye P, et al. Two novel equations to estimate kidney function in persons aged 70 years or older. Ann Intern Med 2012;157:471–81.
12. Dharnidharka VR, Kwon C, Stevens G. Serum cystatin C is superior to serum creatinine as a marker of kidney function: a meta-analysis. Am J Kidney Dis 2002;40:221–6.
13. Kilbride HS, Stevens PE, Eaglestone G, et al. Accuracy of the MDRD (Modification of Diet in Renal Disease) study and CKD-EPI (CKD Epidemiology Collaboration) equations for estimation of GFR in the elderly. Am J Kidney Dis 2013;61: 57–66.
14. Flamant M, Haymann JP, Vidal-Petiot E, et al. GFR estimation using the Cockcroft-Gault, MDRD study, and CKD-EPI equations in the elderly. Am J Kidney Dis 2012;60:847–9.
15. Andrassy KM. Comments on 'KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease'. Kidney Int 2013;84:622–3.
16. Du Bois D, Du Bois EF. A formula to estimate the approximate surface area if height and weight be known. 1916. Nutrition 1989;5: 303–11.
17. Stevens LA, Coresh J, Schmid CH, et al. Estimating GFR using serum cystatin C alone and in combination with serum creatinine: a pooled analysis of 3,418 individuals with CKD. Am J Kidney Dis 2008;51:395–406.
18. Massy-Westropp NM, Gill TK, Taylor AW, et al. Hand grip strength: age and gender stratified normative data in a population-based study. BMC Res Notes 2011;4:127.
19. Rolland Y, Lauwers-Cances V, Cournot M, et al. Sarcopenia, calf circumference, and physical function of elderly women: a cross-sectional study. J Am Geriatr Soc 2003;51:1120–4.
20. Eveleth PB, Andres R, Chumlea WC, et al. Uses and interpretation of anthropometry in the elderly for the assessment of physical status. Report to the Nutrition Unit of the World Health Organization: the Expert Subcommittee on the Use and Interpretation of Anthropometry in the Elderly. J Nutr Health Aging 1998;2:5–17.
21. Heimburger O, Qureshi AR, Blaner WS, et al. Hand-grip muscle strength, lean body mass, and plasma proteins as markers of nutritional status in patients with chronic renal failure close to start of dialysis therapy. Am J Kidney Dis 2000;36:1213–25.
22. Kim H, Suzuki T, Kim M, et al. Incidence and predictors of sarcopenia onset in community-dwelling elderly Japanese women: 4-year follow-up study. J Am Med Dir Assoc 2015;16: 85 e1–8.
23. Kim SW, Jung HW, Kim CH, et al. A new equation to estimate muscle mass from creatinine and cystatin C. PLoS One 2016;11: e0148495.
24. Painter P, Roshanravan B. The association of physical activity and physical function with clinical outcomes in adults with chronic kidney disease. Curr Opin Nephrol Hypertens 2013;22: 615–23.
25. Fontsere N, Bonal J, Navarro M, et al. A comparison of prediction equations for estimating glomerular filtration rate in adult patients

with chronic kidney disease stages 4–5. Effect of nutritional status and age. Nephron Clin Pract 2006;104:c160–8.
26. Otaki Y, Takahashi H, Watanabe T, et al. Cystatin C-based eGFR is a superior prognostic parameter to creatinine-based eGFR in post-endovascular therapy peripheral artery disease patients. Circ J 2015;79:2480–6.
27. Shlipak MG, Katz R, Sarnak MJ, et al. Cystatin C and prognosis for cardiovascular and kidney outcomes in elderly persons without chronic kidney disease. Ann Intern Med 2006;145:237–46.
28. Altiparmak MR, Seyahi N, Trabulus S, et al. Applicability of a different estimation equation of glomerular filtration rate in Turkey. Ren Fail 2013;35:1116–23.