# Is Estimated Glomerular Filtration Rate (eGFR) a Better Predictor than Creatinine Cutoff to Detect Chronic Kidney Disease (CKD)?

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**Abstract**

Chronic kidney disease (CKD) with diabetes mellitus is one of the most common and major public health problems globally. In Bangladesh, several studies indicate an increasing prevalence of diabetes though very few studies are available on CKD. For CKD, diagnostic method, criteria or cutoffs still remained undecided. This study aimed to determine the prevalence of CKD among the hospitalized patients and to compare the diagnostic approach practiced in the hospital.

Methods: All patients admitted to the Department of Nephrology at BIRDEM from May 1 to July 31, 2012 were selected for investigation. An almost equal number of patients were also selected from other units of Medicine. The information included were age, sex, social class, blood pressure, height, weight, blood glucose, creatinine, triglycerides, total cholesterol, high-density lipoproteins and electrolytes. The $CKD_{creat}$ was diagnosed based on creatinine ($>1.2$mg/dl) and the $CKD_{gfr}$ based on estimated GFR ($<60$ ml/min/1.73m$^2$) following Kidney Disease Outcomes Quality Initiative (K/DOQI) guideline. The comparisons of characteristics were made between $CKD_{creat}$ and non-$CKD_{creat}$ ($\leq 1.2$ vs. $>1.2$ mg/dl) groups. Similar comparisons were also made between $CKD_{gfr}$ and non-$CKD_{gfr}$ ($>60$ vs. $\leq 60$ ml/min/1.73$^2$) groups.

Results: A total of 4172 patients got admitted in the study period of 90 days; and 442 patients (m / f = 256 / 186) were investigated. Of the total (n=4172), 241 (5.8%) had $CKD_{creat}$ and 272 (6.5%) had $CKD_{gfr}$. Of the investigated 442 patients, 241 (54.5%) had $CKD_{creat}$ and 272 (61.5%) had $CKD_{gfr}$. The differences of characteristics between $CKD_{creat}$ and non-$CKD_{creat}$ groups were almost similar to the differences between $CKD_{gfr}$ and non-$CKD_{gfr}$ groups. Higher age, higher social class and higher blood pressure showed significant ($p<0.001$) and similar associations with both $CKD_{creat}$ and $CKD_{gfr}$. Interestingly, if the cut-off of eGFR is taken at $<90$ ml/min/1.73$^2$, as suggested by K/DOQI, the prevalence of $CKD_{gfr}$ increases to 86.7%. This indicates a wide variation (32.2%) between the two criteria ($CKD_{creat}$: creat $>1.2$ mg/dl and $CKD_{gfr}$: $<90$ ml/min/1.73$^2$). Thus, a large proportion remained either under- or over-diagnosed depending on the criterion used.

Conclusion: The prevalence of CKD among the hospitalized patients was found not negligible. The comparisons of two diagnostic criteria did differ and eGFR (K/DOQI) could detect higher proportion of CKD, which might be an over-diagnosis. Further study taking microalbuminuria, gross proteinuria, albumin-creatinine ratio and cystatin C may validate the method for the diagnostic accuracy of CKD, which my help assessing the prevalence of CKD accurately.

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## Introduction

Chronic kidney disease (CKD) is a growing public health problem both in the developing and developed world.[1] Prevalence is estimated to be 8-16% worldwide. The complications of CKD related to and resulted in increased all-cause and cardiovascular mortality.[2] More striking is the fact that diabetes mellitus is the most common cause of chronic kidney disease, but in some regions other causes, such as herbal and environmental toxins, are more common.[2] About 5% of the adult populations have some form of kidney damage and every year millions of people die prematurely of cardiovascular diseases linked to CKD. The recent literatures indicate that diabetes and hypertension are becoming the most common causes of CKD, especially in older people both in developed and developing nations,[3,4] CKD is estimated to effect 19 million people of US population and greater than 50 million people worldwide.[5,6] In Bangladesh, a survey among the disadvantaged community in Dhaka City revealed that 13.1% had CKD.[7] This indicates that the prevalence of CKD is not negligible. Early diagnosis of CKD and intervention are the imperative measures to prevent or retard life-threatening complications. The intervention measures initiating low-protein dietary changes, close monitoring of blood pressure, control of blood glucose levels, health related education, exercise, and so on.[9] The aim of this study was to estimate the burden of CKD in hospitalized patients and to compare the two diagnostic criteria practiced in the hospital setting with a view to accept a cheaper and simpler diagnostic method.

## Subjects and Methods

The data were collected from admitted patients at BIRDEM general hospital for 90 days from May 1 to July 31, 2012. All patients with the diagnosis of CKD admitted to the Department of Nephrology unit were selected for investigation irrespective of the clinical status except those undergoing dialysis of any form. An equal number of patients were also randomly selected from Department of Medicine only. The data related to socio-demography (age, sex, social class), blood pressure, anthropometry (height, weight for BMI), laboratory investigation (blood glucose, creatinine, triglycerides, total cholesterol, high-density lipoproteins, electrolytes) were collected. Usually, two diagnostic criteria are used at BIRDEM for the diagnosis of CKD. The $CKD_{creat}$ group was diagnosed based on creatinine ($>1.2$mg/dl) and the $CKD_{gfr}$ group based on estimated GFR (eGFR: $<60$ ml/min/1.73m$^2$)) following Kidney Disease Outcomes Quality Initiative (K/DOQI) guideline. The characteristics of $CKD_{creat}$ group were compared with non-$CKD_{creat}$ and $CKD_{gfr}$ was compared with the non-$CKD_{gfr}$ group.[3] The eGFR for isotope dilution mass spectrometry (IDMS) traceable serum creatinine values were as follows:[8] $eGFR(mL/\text{min}/1.73m^2) = 175\text{x}(SCr)^{-1.154}\text{x}(Age)^{-0.203}$ (0.742 *if female)*.[3] The CKD stages (1 to 5) based on (K/DOQI) were analyzed in various combination with the $CKD_{creat}$ and $NCKD_{creat}$.

*Statistical analyses:* Socio-demographic characteristics were given in percentages for qualitative and mean (SD) for quantitative variables. Independent t-tests were applied for comparisons of characteristics between $CKD_{creat}$ and $NCKD_{creat}$ group and between $CKD_{gfr}$ and $NCKD_{gfr}$ groups to see any difference observed between these two comparisons. The prevalence rates for $CKD_{creat}$ and $CKD_{gfr}$ were given in percentages. We also used $\chi^2$-test to assess risk factors like sex, age, residence, social class, hypertension status, occupation and smoking for both types of CKD. The values for eGFR based on K/DOQI and the corresponding values for creatinine were shown in means with 95% confidence interval. A $p < 0.05$ was considered statistically significant. All statistical analyses were performed using SPSS 20.0.

## Results

A total of 4172 patients got admitted to BIRDEM during the study period of 90 days from May 1 to July 31, 2012. Of them, 442 patients were selected for investigation. All patients (n = 250) who had CKD admitted to the Department of Nephrology were included in this study. Additionally, 192 (5%) patients, randomly selected from the rest (4172 – 250 =3922, not known to have CKD) were also included.

Of the study population (n = 442) the males were 256 and females were 186. Based on the two criteria (creat $>1.2$mg/dl) and eGFR ($<60$ ml/min/ 1.73m$^2$), the prevalence of $CKD_{creat}$ and $CKD_{gfr}$ was 5.8% and 6.5%, respectively, among the admitted (n=4172) patients. In other words, at any given period in a hospital, the prevalence of CKD ranges from 5 – 7%. In contrast, when only the investigated (n = 442) patients were considered the prevalence of $CKD_{creat}$ was 54.5% and

**Table-1:** *Comparison of CKD prevalence based on creatinine (≥1.2mg/dl) and K/DOQI* (ml/min/1.73m²)*

| Stages of Kidney damage→ | K/DOQI (ml/min/1.73m²) | | | | | Total |
|---|---|---|---|---|---|---|
| | *≥90* 1 Kidney damage with normal or increased GFR | *60-89* 2 mild | *30-59* 3 moderate | *15-29* 4 Severe | *<15* 5 Failure | |
| NCKD (Creat ≤1.2) | 59 (29.4) | 111 (55.2) | 31 (15.4) | 0 (–) | 0 (–) | 201 (100) |
| CKD (Creat >1.2) | 0 (–) | 0(–) | 65 (27.0) | 70 (29.0) | 106 (44.0) | 241 (100) |
| Total | 59 (13.3) | 111 (25.1) | 96 (21.7) | 70 (15.8) | 106 (24.0) | 442 (100) |

Parenthesis indicates percentages
*K/DOQI – Kidney disease outcome quality initiative classification based on National Kidney Foundation (NKF)[3]
CKD – chronic kidney disease, NCKD – no CKD, BMI – Body Mass Index, mean ± SD (kg/m²)

$CKD_{gfr}$, was 61.5%. (table 1). If the cut-off of eGFR is taken at <90 ml/min/1.73m², as suggested by K/DOQI, the prevalence of $CKD_{gfr}$ increased further to 86.7%. Thus, there was a wide variation (32.2%) between the two criteria ($CKD_{creat}$: creat >1.2 mg/dl and $CKD_{gfr}$: <90 ml/min/1.73²).

The socio-demographic characteristics are shown in Table 2. The mean (SD) age was 56.1 (13.9) and BMI was 23.3 (4.3). Forty years and above comprised almost 90%.

The comparisons of characteristics between CKD and Non-CKD groups are shown in Table 3. The comparisons are shown separately ($CKD_{creat}$ vs. $NCKD_{creat}$ and $CKD_{gfr}$ vs. $NCKD_{gfr}$). Age, BMI, Hemoglobin and SBP differed significantly in either comparison. The results of comparisons between $CKD_{creat}$ and non-$CKD_{creat}$ groups did not differ from the results of comparisons between $CKD_{gfr}$ and non-$CKD_{gfr}$ groups.

**Table-2:** *Demographic characteristics of the study population (N=442)*

| Variables | | |
|---|---|---|
| Age, mean ± SD (years) | | 56.1±13.9 |
| Age Range, n (%) | 18-39 years | 40 (9.0) |
| | 40-59 years | 224 (50.7) |
| | 60 years and above | 178 (40.3) |
| Sex, n (%) | Male | 256 (57.9) |
| | Female | 186 (42.1) |
| Occupation, n (%) | Service | 161 (36.4) |
| | House Wife | 165 (37.3) |
| | Retired | 116 (26.2) |
| Residence, n (%) | Rural | 46 (10.5) |
| | Urban | 203 (46.3) |
| | Suburban | 189 (43.2) |
| Social Class n (%) | Rich | 38 (9.0) |
| | Middle | 317 (74.9) |
| | Poor | 68 (16.1) |
| Education, n (%) | Academic year <5y | 139 (31.6) |
| | Academic year ≥5y | 301 (68.4) |
| Body Mass Index, mean ± SD (kg/m²) | | 23.27±4.34 |

Regarding the risk factors higher age, higher social class and higher blood pressure showed significant ($p<0.001$) associations with both $CKD_{creat}$ and $CKD_{gfr}$ (Table 4). It was observed that the levels of significance related to risks were almost similar for both types. Additionally, we estimated the means with 95% confidence interval for creatinine level with the corresponding values for eGFR based on K/DOQI (Table 5).

## Discussion

This study is the first of its kind in a Bangladeshi diabetic population that compared the prevalence of $CKD_{creat}$ and $CKD_{gfr}$. The comparisons were made between the characteristics between $CKD_{creat}$ and $NCKD_{creat}$. Similar comparisons were made between $CKD_{gfr}$ and $NCKD_{gfr}$. Usually, the creatinine level exceeding 1.2mg/dl has long been used, at BIRDEM or elsewhere in Bangladesh, as a diagnostic cutoff for the impaired renal function. After the introduction of eGFR staging (K/DOQI)[3] most physicians are inclined to accept this staging. Possibly, this newer diagnostic staging criteria is more useful. But the estimation of eGFR needs body surface area (BSA: 1.73m²), which varies among populations. Thus, there remains a chance of usual variation of eGFR and may result differently in Bangladeshi population, and in particular,

**Table-3:** *Comparison of characteristics between non-CKD (NCKD) and CKD based on serum creatinine and eGFR (cut-off: creat 1.2mg/dl and eGFR 60 ml/min/1.73m²).*[3]

| Variables | Creatinine level | | | eGFR level | | |
|---|---|---|---|---|---|---|
| | NCKD (n=201) (Creat ≤ 1.2) | CKD (n=241) (Creat >1.2) | *p* | NCKD (n=170) (eGFR ≥ 60) | CKD (n=272) (eGFR < 60) | *p* |
| Age (y) | 54.0 ± 15.5 | 57.9 ± 12.3 | *0.003* | 53.6 ± 16.3 | 57.7 ± 11.9 | *0.003* |
| BMI (kg/m²) | 22.7 ± 4.1 | 23.8± 4.5 | *0.019* | 22.5 ± 4.2 | 23.8 ± 4.4 | *0.008* |
| Duration of DM (y) | 9.1 ± 6.9 | 14.4 ± 9.3 | *<0.001* | 8.9 ± 6.9 | 13.9 ± 9.1 | *<0.001* |
| Duration of HTN (y) | 7.6 ± 5.2 | 9.7 ± 8.5 | *0.034* | 7.8 ± 5.5 | 9.5 ± 8.3 | *ns* |
| FBG (mmol/l) | 11.1 ± 5.3 | 10.9 ± 5.3 | *ns* | 11.2 ± 5.4 | 10.8 ± 5.3 | *ns* |
| 2-hBG (mm0l/l) | 13.7 ± 5.9 | 14.2 ± 6.0 | *ns* | 13.7 ± 5.89 | 14.2 ± 5.9 | *ns* |
| Hemoglobin (gm/dl) | 11.0 ± 1.7 | 9.5 ± 1.9 | *<0.001* | 11.2 ± 1.7 | 9.5 ± 1.9 | *<0.001* |
| Serum creatinine (mg/dl) | 0.90 ± 0.18 | 4.3 ± 3.3 | *<0.001* | 0.88 ± 0.18 | 4.0 ± 3.2 | *<0.001* |
| SBP (mmHg) | 126 ± 19 | 139± 27 | *<0.001* | 126 ± 19 | 137 ± 26 | *<0.001* |
| DBP (mmHg) | 77 ± 11 | 79 ± 12 | *ns* | 77 ± 11 | 78 ± 12 | *ns* |
| Electrolytes (mEq/l) | | | | | | |
| Sodium | 138 ± 5 | 136 ± 8 | *<0.001* | 137 ± 5 | 135 ± 8.0 | *<0.001* |
| Potassium | 4.1 ± 0.63 | 4.8 ± 4.6 | *0.022* | 4.1 ± 0.6 | 4.8 ± 4.3 | *0.041* |
| Chloride | 101 ± 5 | 98 ± 13 | *ns* | 101 ± 5 | 98.± 12 | *ns* |
| CO2 | 24.2 ±4.8 | 21 ± 5.1 | *<0.001* | 24.3 ±4.9 | 21.5 ± 5.4 | *<0.001* |

CKD – chronic kidney disease, NCKD – non-CKD, BMI – Body Mass Index, mean ± SD (kg/m²)
FBG – fasting blood glucose, 2-hBG – 2-h after 75gm glucose load, SBP, DBP – systolic, diastolic blood pressure.

diabetic population. Diabetic nephropathy is the leading cause of chronic kidney disease in patients starting renal replacement therapy[10] and is associated with increased cardiovascular mortality.[11] So, accurate assessment of the prevalence of CKD is important and so is the importance of its correct diagnostic criteria.

Then which criteria should we follow? The prevalence of $CKD_{gfr}$ (eGFR <90 ml/min/1.73 m²) was found 86.7%, based on K/DOQI (table 3). In contrast, the prevalence of $CKD_{creat}$ was found 54.5%. based on creatinine level (>1.2mg/dl). This means that about 38.5% remained undiagnosed by $CKD_{creat}$ or over-diagnosed by $CKD_{gfr}$ criteria. The controversy remained still unsettled as reported from Pakistan.[12] Had we included other variables like micro-albuminuria, gross proteinuria, albumin-creatinine ratio or evidence of other micro-angiopathic (retinopathy or neuropathy) and macro-angiopathic lesions like coronary artery disease or cardiovascular morbidity then we could have better assessment of diagnosis or grading of CKD. The recent suggestion is that serum cystatin C alone or creatinine plus cystatin C may predict better CKD.[13] But, this recommendation was challenged by others.[14] Considering the above mentioned studies it remained unsettled issue to recommend an accurate diagnostic tool for CKD.

As regards the risk factors CKD was found significantly associated with older age (table 4) which is consistent with the other studies.[15,16] This study also suggests that urbanization, presence of hypertension, are major risk factors for the development of diabetes as well as CKD. As we know low socioeconomic status was associated with a greater risk for CKD, but in our study we observed that the rich socioeconomic group had greater risk for CKD. This may or may not be true because in Bangladesh hospitalized patients mostly comprised of rich class. Further study based on population may yield a reasonable assessment.

This study concludes that the prevalence of CKD among the hospitalized patients is almost comparable to other studies and the prevalence was found much higher if K/DOQI is used. Older age, hypertension, rich class and urbanization were found significantly associated CKD. The study suggests that inclusion of serum creatinine with eGFR, micro-albuminuria, gross proteinuria, albumin-creatinine ratio and cystatin C in a prospective cohort may determine more reliable

**Table-4:** *Comparison of Prevalence of CKD (based on both criteria) according to sex, age, residence, social class, hypertension, occupation and smoking habit.*

| | CKD Creatinine≥1.2mg/dl | | | | CKD eGFR* | | | |
|---|---|---|---|---|---|---|---|---|
| Variables | n | % | $\chi^2$ | *p* | n | % | $\chi^2$ | *p* |
| Sex | | | | | | | | |
| Male | 142 | 55.5 | 0.22 | *0.64* | 143 | 55.9 | 8.29 | *0.004* |
| Female | 99 | 53.2 | | | 129 | 69.4 | | |
| Age group (y) | | | | | | | | |
| ≤ 50 | 72 | 45.9 | 7.4 | *0.007* | 79 | 50.3 | 12.951 | *<0.001* |
| > 50 | 169 | 59.3 | | | 193 | 67.7 | | |
| Residence | | | | | | | | |
| Rural | 6 | 13.0 | 36.2 | *<0.001* | 15 | 32.6 | 18.999 | *<0.001* |
| Urban | 124 | 61.1 | | | 136 | 67.0 | | |
| Suburban | 109 | 57.5 | | | 119 | 63.0 | | |
| Social class | | | | | | | | |
| Middle | 181 | 57.1 | 48.7 | *<0.001* | 199 | 62.8 | 38.81 | *<0.001* |
| Rich | 31 | 81.6 | | | 34 | 89.5 | | |
| Poor | 12 | 17.6 | | | 21 | 30.9 | | |
| Hypertension | | | | | | | | |
| Yes | | | | | | | | |
| No | 21 | 15.6 | 105 | *<0.001* | 34 | 25.2 | 94.808 | *<0.001* |
| | 194 | 69.3 | | | 211 | 75.4 | | |
| Occupation | | | | | | | | |
| Service | 79 | 49.1 | 6.0 | *0.049* | 83 | 51.6 | 10.922 | *0.004* |
| House Wife | 88 | 53.3 | | | 113 | 68.5 | | |
| Retired | 74 | 63.8 | | | 76 | 65.5 | | |
| Smoking | | | | | | | | |
| Smoker | 30 | 40.5 | 7.0 | *0.008* | 30 | 40.5 | 16.56 | *<0.001* |
| Nonsmoker | 211 | 57.3 | | | 242 | 65.8 | | |

*eGFR < 60 ml/min/1.73m² [3]

**Table-5:** *Kidney disease outcome quality initiative (K/DOQI) classification based on National kidney Foundation (NKF)³*

| K/DOQI based on NKF | | | The Study findings | | |
|---|---|---|---|---|---|
| Stage | Description | eGFR ml/min/1.73m² | N (%) | eGFR ml/min/1.73m² | Corresponding *Creatinine level |
| | | | | Mean (95% CI) | Mean (95% CI) |
| 1.00 | Kidney damage with normal or increased GFR | ≥ 90 | 59 (13.3) | 111 (106 – 115) | 0.70 (0.67- 0.73) |
| 2.00 | Kidney damage with mild decreased GFR | 60 – 89 | 111 (25.1) | 74.4 (73.0 – 75.8) | 0.97 (0.95 - 1.00) |
| 3.00 | Moderately decreased GFR | 30 – 59 | 96 (21.7) | 43.9 (42.1 – 45.8) | 1.47 (1.40 - 1.54) |
| 4.00 | Severely decreased GFR | 15 – 29 | 70 (15.8) | 21.9 (20.9 – 23.0) | 2.78 (2.62 - 2.92) |
| 5.00 | Kidney failure | <15 | 106 (24.0) | 8.5 (7.9 – 9.1) | 7.04 (6.42 - 7.66) |
| | | Total | 442 (100) | 48.6 (45.3 – 51.9) | 2.78 (2.51 - 3.06) |

* One-way ANOVA taking creatinine as a dependent and eGFR as a factor.

and acceptable method for the staging of CKD, which in turn may help screening of CKD. We also propose that any population, free from diseases, should have the reference values (mean, median, deviation percentile) of creatinine and body surface area (for eGFR), any value exceeding 95$^{th}$ percentile may be considered abnormal for staging of CKD.

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