International Journal of Medical Research Professionals
P-ISSN: 2454-6356; E-ISSN: 2454-6364
DOI: 10.21276/ijmrp

IJMRP

*Original Research Article*

# Estimated GFR: Screening Tool for Kidney Dysfunction

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## ABSTRACT

**Background:** Serum Creatinine (SCr) is the most widely used endogenous marker of GFR (Glomerular Filtration Rate), expressed as its serum concentration or renal clearance. Estimated GFR (eGFR) have been devised for more valid estimate of GFR.

**Aims:** The aim of the study was to evaluate the effectiveness of eGFR in screening of kidney failure.

**Material and Methods:** 370 subjects including 100 healthy controls, 100 diabetic patients, 100 patients with CVD and 70 patients with both DM and CVD were selected. They were analysed for SCr and eGFR was calculated by the 4 variable Modification of Diet in Renal Disease (MDRD) equation using QxMD nephrology calculator.

**Results:** Variations in SCr levels among the study groups as compared to controls was not statistically significant (p>0.01). Decrease in e-GFR in study groups i.e. DM (p<0.0001), CVD (p<0.01) and DM with CVD (p<0.001) as compared to controls was found statistically significant.

**Conclusion:** For early diagnosis of preventable renal impairment, eGFR can be routinely implemented in renal function tests.

**Keywords:** Cardiovascular Disease, Diabetes Mellitus, eGFR, Kidney Dysfunction.

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**Article History:**

**Received:** 18-07-2016, **Revised:** 26-07-2016, **Accepted:** 28-07-2016

| Access this article online | |
|---|---|
| **Website:** www.ijmrp.com | Quick Response code |
| **DOI:** 10.21276/ijmrp.2016.2.4.027 | |

## INTRODUCTION

In chronic kidney disease (CKD), Glomerular Filtration Rate (GFR) provides a tool for evaluation of kidney function. A decrease in GFR precedes all forms of kidney failure. Creatinine is freely filtered at the level of glomerulus and concentration of which is inversely proportional to GFR. However, a small but significant and variable proportion of creatinine appearing in the urine is derived from tubular secretion. However, creatinine concentration in isolation has a complicated nonlinear relationship to kidney function measured as GFR. This filtration may lead to inadequate recognition of CKD in patients with risk factors for CKD. In patients with CKD, extra renal clearance of creatinine blunts the anticipated increase in serum creatinine in response to falling GFR, at early stages of CKD (Table 1).[1]

Though specific, serum creatinine (SCr) may not exceed upper limit of reference range, until Glomerular Filtration Rate (or Creatinine Clearance Rate (CCR) reduced by 60% of normal. Commonly CCR is a more sensitive indicator of early glomerular dysfunction than that of S.Cr concentration.[2]

The alternative approaches like equations to predict GFR have been devised and tested in large number of studies. Utility of relevant equations in both children and adults has been shown to give more valid estimates of GFR than serum creatinine alone. Estimation of GFR by using Modification of Diet in Renal Disease (MDRD) equation which is based on SCr, age, sex, ethnicity and body size could improve the GFR prediction from SCr. The MDRD equation which can be easily implemented in clinical practice has several advantages and predicts GFR over a wide a range of values and can be used for identifying renal insufficiency, assessing progression of renal disease, detecting onset of end stage renal disease (ESRD). It does not require collection of timed urine sample, measurement of height and weight, and does not require the cause of renal disease.

For early detection of CKD, evaluation of eGFR should be performed for all individuals at risk of CKD even if they show no microalbuminuria. Also by the time microalbuminuria manifests itself almost 25% of nephron function is already lost. Early detection allows enough time for diagnosis and treatment but requires explicit testing strategies for asymptomatic individuals at risk.[3,4] This study was designed to evaluate the effectiveness of eGFR in screening of kidney failure.

## MATERIALS AND METHODS

### Study Population

Ethical approval for the present study was obtained from the Institutional Ethics Committee. Informed written consent was taken from the participants of the study. The study sample consisted of 370 individuals with age group in the range of 40-60 years. The study subjects were comprised of 100 healthy controls, 100 pre-diagnosed patients with DM, 100 patients with CVD and 70 patients having both DM and CVD.

**Biochemical Analysis**

From each study subject 5 mL of fasting venous blood was drawn by disposable syringe with full aseptic precaution. 4 ml of collected blood was taken in a properly cleaned & dried test tube without anticoagulant for serum creatinine.

SCr estimation was done on Olympus AU 680 Clinical Chemistry Analyzer with Modified Jaffe's Method. GFR was estimated by the 4 variables Modification of Diet in Renal Disease (MDRD) equation using QxMD nephrology calculator. Low eGFR was defined as eGFR <60 mL/min/1.73 $m^2$. MDRD Formula is given below:

$$\text{eGFR} = 186 \times (\text{SCr})^{-1.154} \times (\text{Age in years})^{-0.203} \times (0.742 \text{ if female}) \times (1.210 \text{ if Black})$$

**Statistical Analysis**

Results were expressed as Mean ± SEM. Data were analysed with SPSS Statistical Software (v22.0). Unpaired't' test & Pearson's Correlation test were done for the comparison and correlation with each other among the study groups. P<0.05 was the level of significance.

## RESULTS

The study population comprising of 370 subjects was investigated for serum creatinine. The eGFR was calculated using MDRD formula. Gender distribution in the study population is given in Table 1.

21.9% (81/370) of the subjects had decreased eGFR (<60 ml/min/1.73 $m^2$) indicative of CKD. 22.22% (18/81) subjects with decreased eGFR had SCr values within the reference range (0.6-1.2 mg/dl). 77.78% (63/81) subjects with decreased eGFR, had high SCr values. Among subjects with decreased eGFR, 50.61% were suffering from diabetes mellitus, 8.64% were suffering from CVD and 23.46% were suffering from DM as well as CVD. Frequency of decreased eGFR in diabetic subjects was 41%, in CVD subjects was 7.00%, in control subjects were 14% and that in subjects suffering from DM as well as CVD was 19%.

Levels of SCr and e-GFR were compared among the study groups as given in Table II and III respectively. Variations in SCr levels among the study groups i.e. DM (n=100, p>0.05), CVD (n=100, p>0.05) and DM with CVD (n=70, p>0.05) as compared to controls (n=100) was not statistically significant (Table 2).

**Table 1: Gender distribution in Study Population**

| Study Groups | Males | Females |
|---|---|---|
| **Controls** | 54 (54%) | 46 (46%) |
| **DM** | 48 (48%) | 52 (52%) |
| **CVD** | 49 (49%) | 51 (51%) |
| **DM + CVD** | 36 (51.42%) | 34 (84.58%) |

**Table2: Comparison of Sr. Creatinine among Study Groups**

| Study Groups | Mean | SEM | p - value |
|---|---|---|---|
| **Controls** | 1.14 | 0.06 | |
| **DM** | 1.20 | 0.04 | 0.5420 |
| **CVD** | 1.04 | 0.03 | 0.1271 |
| **DM + CVD** | 1.07 | 0.04 | 0.3384 |

**Table 3: Comparison of e-GFR among the Study Groups**

| Study Groups | Mean | SEM | p - value |
|---|---|---|---|
| **Controls** | 79.85 | 1.93 | |
| **DM** | 65.95 | 1.95 | < 0.0001 |
| **CVD** | 73.81 | 1.12 | < 0.01 |
| **DM + CVD** | 69.84 | 2.12 | < 0.001 |

**Table 4: Correlation between Serum Creatinine and eGFR among the Study Groups**

| Study Groups | Parameter | eGFR | | p - value |
|---|---|---|---|---|
| | | r | $R^2$ | |
| **Controls** | **SCr** | -0.710 | 0.505 | < 0.01 |
| **DM** | | -0.661 | 0.548 | < 0.01 |
| **CVD** | | -0.388 | 0.151 | < 0.01 |
| **DM + CVD** | | -0.746 | 0.556 | < 0.01 |

Decrease in e-GFR in study groups i.e. DM (n=100, p<0.0001), CVD (n=100, p<0.01) and DM with CVD (n=70, p<0.001) as compared to controls (n=100) was found statistically significant (Table 3).

There was statistically significant negative correlation between SCr and eGFR values (Table 4) in Controls (n=100, p<0.01) (Fig 1), DM (n=100, p<0.01) (Fig 2), CVD patients (n=100, p<0.01) (Fig 3) and DM with CVD (n=70, p<0.01) (Fig 4).

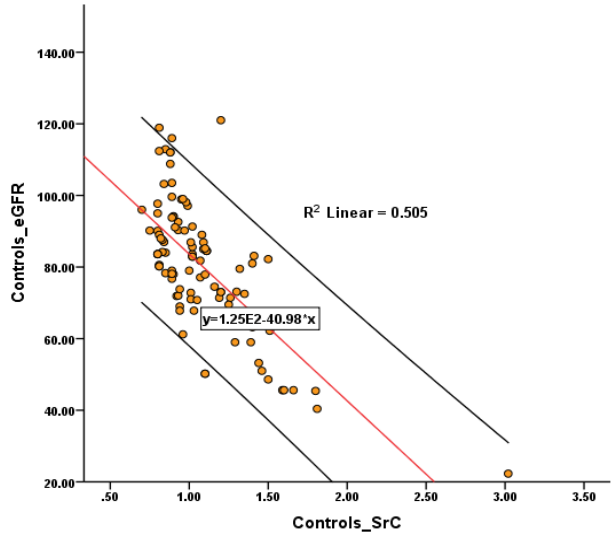


**Fig 1: Correlation between SCr and eGFR amongst controls**

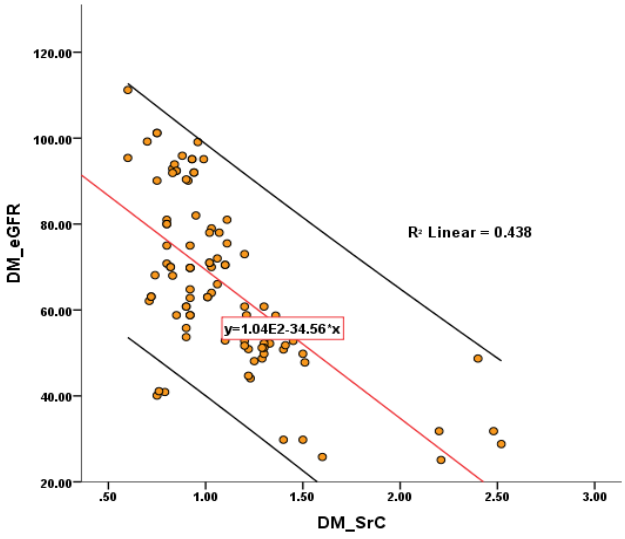


**Fig 2: Correlation between SCr and eGFR amongst DM patients**

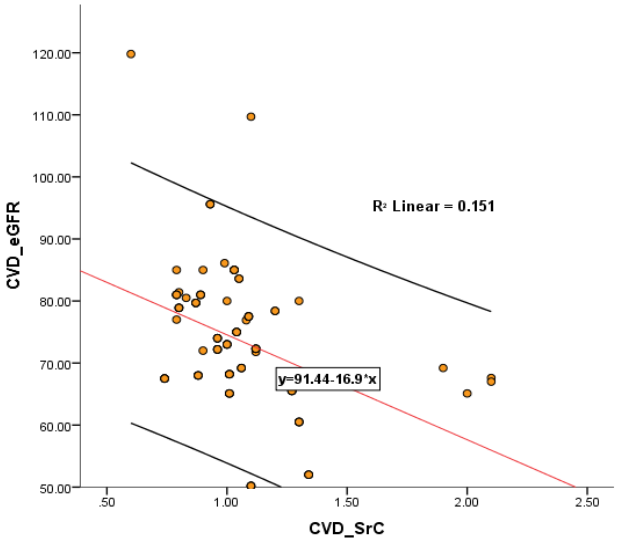


**Fig 3: Correlation between SCr and eGFR amongst CVD patients**

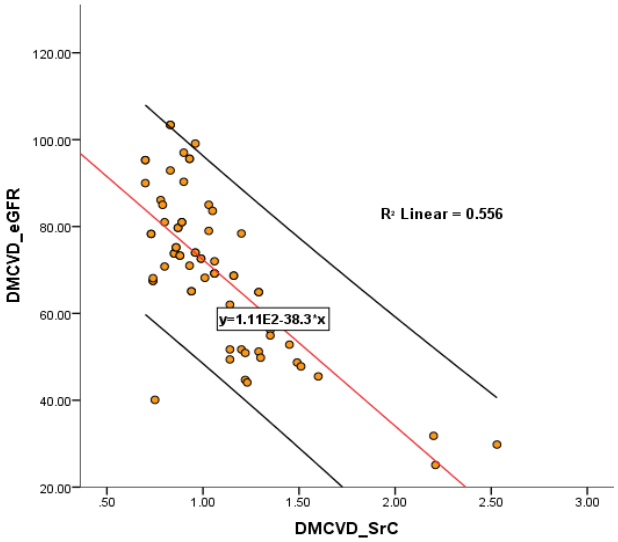


**Fig 4: Correlation between SCr and eGFR amongst DM+CVD patients**

## DISCUSSION

In early renal impairment, classical markers (Urea & Creatinine) may be normal, but there are early glomerular changes like thickening of basement membrane, accumulation of matrix material in the mesangium, subsequently nodular deposits with consequent microalbuminuria. At this stage, glomerular pathological changes can be reversed by pharmacological intervention.[5]

On comparison, the variation in mean SCr values in the study subjects compared to controls was not statistically significant. But the decrease in eGFR in patients of DM, CVD and DM with CVD was statistically significant as compared to controls. This observation is consistent with previous studies.[3,4] This clearly shows that the early onset of kidney dysfunction DM and CVD was failed to be indicated by the changes in SCr values. But eGFR detects it at a very early stage even when SCr levels were in the normal reference range. These finding in the study were consistent with our hypothesis.

The correlational studies between SCr and eGFR showed statistically significant negative correlation in all the four categories of study subjects, which clearly states the validity of eGFR in screening of the kidney dysfunction.

The extent of decrease in mean eGFR values in DM and DM with CVD patients was more as compared to the mean eGFR values in CVD group in our study. This may be attributed to the accelerated renal damage caused by damage to the glomerular basement membrane in diabetic nephropathy.

22.22% (18/81) subjects with decreased eGFR had serum creatinine values within the reference range (0.6-1.2 mg/dl). This observation in our study signifies the importance of eGFR in detecting renal dysfunction at the early stage even with normal SCr values. Moreover, amongst the apparently healthy controls with no recorded disease or related symptomatology, the eGFR values were below the recommended range with normal SCr values in 14% of controls. This was the unique finding in our study insisting implementation of eGFR estimation in routine health check-ups along with SCr, so that the impending renal dysfunction can be detected even in normal individuals or pre-diabetic population.

## CONCLUSION

It can be concluded that, eGFR can be routinely implemented in renal function tests for early diagnosis of preventable renal impairment.

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**Source of Support:** Nil.

**Conflict of Interest:** None Declared.



**Cite this article as:** Surekha Prabhu, Rekha Dhamnaskar, Yogesh Pawade, Rashmi Karamchandani. Estimated GFR: Screening Tool for Kidney Dysfunction. Int J Med Res Prof. 2016; 2(4):114-16.