Influence of Age and Body Mass Index (BMI) in Estimation of Glomerular Filtration Rate (GFR) in Healthy Adults

[1]Samira Sharmin, [1]Md. Mahbub ur Rahman, [1]Hosne Ara Rahman, [1]Md. Abu Bakker Siddique, [1]Md. Monir Uddin, [1]Jasmine Ferdous, [2]Pupree Mutsuddy and [1]Farida Yasmin

[1]Institute of Nuclear Medicine and Allied Sciences , Sir Salimullah Medical College Campus ,Mitford

[2]National Institute of Nuclear Medicine & Allied Sciences, BSMMU Campus. Dhaka

Correspondence Address : Dr. Samira Sharmin, Senior Medical Officer. Institute of Nuclear Medicine and Allied Sciences, Sir Salimullah Medical College Campus ,Mitford , Dhaka, E-mail: samira 958@gmail.com

ABSTRACT

Objective: **Obesity is a major health problem which has clinically significant role to develop kidney disease. This study was performed to see the association between Body Mass Index (BMI) and glomerular filtration rate (GFR) in healthy adults.**

Patients and methods: **This cross sectional study was carried out at Institute of Nuclear Medicine and Allied Sciences, Mitford, Dhaka, over a period of 12 months from January 2014 to December 2014. A total 34 adult healthy person (prospective kidney donor) who underwent ^{99m}Tc Di-ethylene triamine penta acetic acid (DTPA) renogram with camera Gated GFR was studied to find out the relationship between BMI and GRF as well as age and GFR. Pearson's correlation coefficient and multiple regression analysis were done to see the relationship .**

Results: **This study included 34 healthy adults. Among them 09 (26.5%) were female and 25 (73.5%) were male. Mean age was 46.82±11.68 years (range 27 to 65 years), mean BMI was 22.76±4.06 kg/m2 (range 15 to 33 kg/m2), mean weight was 53.76±9.6 kg (range 33 to 71 kg), mean height was 152±7.8 cm (range 140 cm to 175 cm), mean GFR was 82.38±22.26 ml/min (range 41.2 to 131.15 ml/min), mean serum creatinine level was 0.92±0.20 mg/dl (range 0.57 to 1.40 mg/dl). Pearson correlation coefficient test showed that inverse relationship (r= -0.340, P= 0.049) exist between age and GFR whereas a positive (r= 0.425, P= 0.012) relationship exist between BMI and GFR and also with weight (r= 0.354, P=0.040). Multiple regression analysis showed that BMI (β =0.376,P=0.029) and age (β=-0.185,P=0.04) were independent predictors for GFR (both P < 0.05) but not with serum creatinine (β= -0.176,P=0.296) and sex (β= 0.135,P=0.399).**

Conclusion: **The findings of the study showed that GFR had a positive correlation with BMI and inverse relationship with age.**

Key words: **Age, Body Mass Index and Glomerular Filtration Rate.**

INTRODUCTION

GFR is considered the best overall index of kidney function for diagnosis, staging and appropriately treating kidney disease (1). GFR can be measured by filtration markers like inulin clearance which is gold standard but costly and not readily available (2, 3). ^{99m}Tc DTPA with GFR camera Gates method is simpler and popular method which is used in clinical practice (1). Overweight and obesity are significant risk factors for kidney disease (4,5). This study was performed to find out the relationship between GFR and BMI in healthy adults.

PATIENTS AND METHODS

This analytical cross sectional study was carried out at Institute of Nuclear Medicine and Allied Sciences, Mitford, Dhaka over a period of 12 months from January 2014 to December 2014. A total 34 healthy adults were included in the study having no major medical problems like hypertension, diabetes mellitus, endocrine disorder, connective tissue disorder and no history of taking drugs affecting kidney function . The BMI of the study subjects were recorded. Each of the study subjects underwent ^{99m}Tc DTPA renogram with camera Gated GFR. All patients were hydrated with 300 to 500 ml of water 30 minutes prior to examination. The patient lay down on a bed in the supine position and examination performed by dual head Siemens Symbia Gamma camera. ^{99m}Tc DTPA was administered in an antecuebital vein and was followed by infusion of 20 ml normal saline. The

post syringe count and antecuebital count was recorded. The semiluner background region of interest (ROI) of each kidney was defined. The GRF was automatically estimated by a commercially available computer according to the Gates algothrim. The collected data were complied and analyzed using computer based software SPSS program, version 21. Pearson's correlation coefficient test and multiple regression analysis were performed to find the relationship between age and BMI with GFR. P value is considered as ≤ 0.05 statistically significant.

RESULT

Among the 34 study subjects 09 (26.5%) were female and 25(73.5 %) were male.

The mean age of the study subjects was 46.82 years with a range of 38 to 27 years and mean BMI was 22.76 kg / m^2 with a range of 15 to 33 kg / m^2, mean ±SD of GFR was 82.39 ± 22.26 ml/min with a range of 41.2 to 131.5 ml/min, mean ± SD of serum creatinine was 0.922 ± 0.202 mg/dl with a range of 0.57 to 1.40 mg/dl, mean ± SD of weight 53.76 ± 9.6 kg with a range of 33 to 71 kg and mean ± SD of height was 152.53 ± 7.8 cm with a range of 140 to 175 cm.

General characteristics of the study subjects are shown in Table 1.

To see the relationship among weight and BMI with GFR, Pearson's correlation coefficient test was done and a positive correlation ($r = 0.421$, $P = 0.012$) was observed between GFR and BMI as well as with weight ($r = 0.354$, $P = 0.040$). The result was statistically significant ($P<0.05$). Age of the study subjects inversely correlate with BMI and the result was statistically significant ($r = -0.395$ $P = 0.049$). Multiple regression analysis were done among the dependent variable GFR and independent variable age, sex, serum creatinine and BMI . The standardized coefficients (β) was 2.298 ($P = 0.029$) for BMI, β was -1.064 ($P = 0.296$) for serum creatinine, β was -1.082 ($P = 0.04$) is for age and β was 0.135 ($P = 0.399$) is for sex. It revealed that a change in BMI had a great effect on GFR than sex, serum creatinine or age. Changing BMI by one unit would change GFR by 0.376 units. The result was statistically significant ($P<0.05$). This regression analysis also showed that sex ($\beta = 0.135$,$P = 0.399$) and serum creatinine ($\beta = - 0.176$,$P = 0.296$) were not the independent predictors of GFR.

DISCUSSION

The rising incidence of various kidney diseases and the epidemic of overweight and obesity are major public health problem (5). Several epidemiological studies have confirmed that both obesity and kidney disease are modifiable risk factors (6, 7).

In this study the age were in between 27 to 65 years with mean ± SD 46.82±11.68 years and female were 26.5% and male were 73%. These findings were consistent with study conducted by Levey et al where the study subjects of prospective kidney donors were within the range of 25 to 60 years with mean ± SD 42 ± 17.13 years (7).

In this study negative effect of age was found on GFR ($r = - 0.340$, $P < 0.049$) that is aging had been associated with decline GFR in healthy subjects. Very similar findings were observed in different studies and showed GFR was low with advancing of age. They showed that about 25% of the Glomeruli disappeared by the fourth decade of life and 50 % by the seventh decade and after 3rd decade glomerular sclerosis began to appear (8,9,10,11,12).

In this study mean GFR was 82.38 ± 22.26 ml/min with a range of 41.2 to 131.4 which was consistent with the other study where the mean GFR was 85.88 ± 28.29 ml/min with a range of 60.5 to 138.9 ml/min (10).

The Pearson correlation coefficient study showed that positive relationship between GFR and the BMI ($r = 0.425$, $P = 0.024$) and also with weight ($r = 0.354$, $P= 0.040$). These findings consistent with those of previous studies which reported that GFR was elevated in obese person . They also suggested that the presence of glomerular hyperfiltration in overweight and obese subjects did not indicate that they had healthy kidneys and if this glomerular hypertension persist, it would lead to subsequent structural change in the kidney which was one of the aetiopathogenetic factor in the predisposition to CKD and ESRD even in the absences of diabetes and hypertension (9,10,11, 12,13).

Most studies reported that GFR is elevated in obesity. Ribstein et al found the height indexed GFR was approximately 10 % higher in 20 obese normotensive subjects (mean BMI of 33.2 kg/m^2) than in lean subjects (mean BMI 22.4 kg/m^2) (13). Changnac et al. reported elevated GFR (not indexed) in obesity (BMI>30 kg/m^2) (14). Anastasio et al. however, reported no difference in height indexed GFR between severely overweight (mean BMI 46.8 kg/m^2) normotensive men and non obese (BMI 25.6 kg/m^2) control subjects (15). Some studies showed that increased BMI was strongly associated with decreased GFR which was dissimilar with the present study (8, 9). In a community based cross sectional study conducted by Ishizaka et al. in Japan found that increased BMI was associated with low GFR even in the absence of hypertension, dyslipidemia, diabetes mellitus even though the underlying mechanism behind this relationship was unclear (8).

Multiple regression analysis of this study revealed that age and BMI were the independent predictor for the GFR .The regression analysis also showed that per unit change of BMI , GFR had changed 0.376 unit which was very similar with other study. They showed that BMI was the positive predictor for the GFR and age was the negative (12). Ribesten et al reported higher GFR in high BMI was in line with the positive predictive value of BMI for GFR in multivariate analysis (13). In the present study sex and serum creatinine were not the independent predictor of GFR. This finding were not similar with the studies where sex and serum creatinine were the independent predictor (5,6,7).

Several limitations of this study should be considered such possible small sample size, cross sectional study, formal measurement of body composition; other methods of measurement of GFR were not taken in count.

Table1: General characteristics of the study subjects (n= 34)

Sex	Male -25 , Female - 09
Age in years	46.82±11.68 years
Weight in KG	53.76±9.60 KG
Height in cm	152.53±7.88 cm
BMI	22.76±4.06 kg/m^2
GFR	82.39±22.26 ml/ min
Serum creatinine	0.922±0.202 mg/dl

Data are expressed as mean±SD

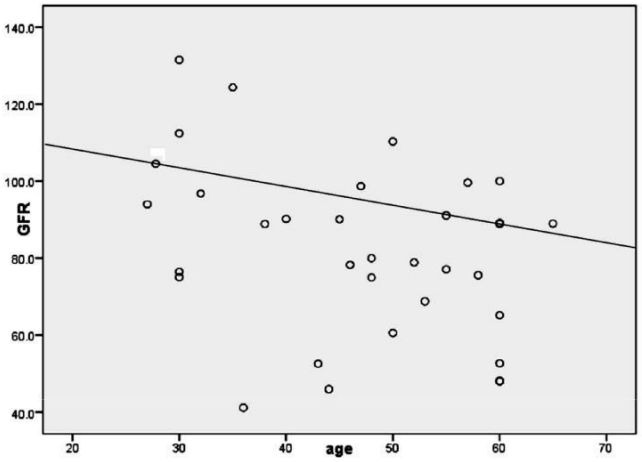

Figure1: Correlation between GFR and age showing negative relation

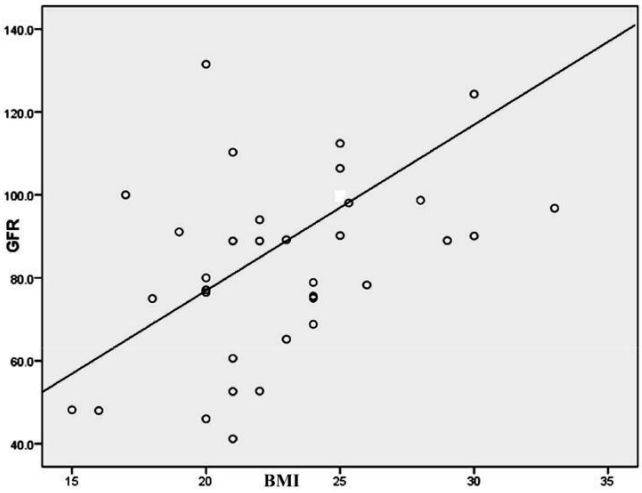

Figure 2: Regression between GFR and BMI showing positive relation

CONCLUSION

The present study showed that BMI is positively related with GFR and inverse relationship was found between the age and GFR. The underlying mechanism behind this relationship is unclear. For community dwelling healthy persons, prospective population based studies are needed to investigate the mechanisms underlying this association and to determine whether effective interventions that reduce BMI in adults population will reduce kidney disease.

REFERENCES

1. Lin J, knight El, Hogan ML, Singh Ak. A Comparison of Prediction equations for Estimating Glomerular Filtration Rate In Adults without kidney disease. J Am. Soc Nephrol. 2003; 14:2573-80.

2. Kiopper JF, Hauser W, Atkins HL et al. Evaluation of Tc-99m for the Measurement of Glomerular Filtration Rate. J Nucl Med1972; 13:107-78.
3. Gelber RP, Kurth T, Kausz A et al. Association between Body Mass Index (BMI) and CKD in Apparently Healthy Men. Am J Kidney Dis.2005;46:871-80
4. Gerchman F, Tong J, Utzschneider KM, et al. Obesity is Associated with Increased Glomerular Filtration Rate by a Mechanism Independent of Glucose Tolerance. Diabetes. 2006;55:45-56.
5. RossingP, Rossing K,Gaede P et al. Monitoring Kidney Function in Type 2 Diabetes Patients with Incipient and Overt Diabetic Nephropathy. Diabetes Care. 2006; 29:1024-30.
6. Ibrahim H, Mondress M, Tello A et al. An Alternative of Diet in Renal Diseases Formulas in Predicting GFR in Individuals with Type I Diabetes. J Am Soc Nephrol. 2005;16:1051-106.
7. Levey AS, Bosch JP, Lewis JB et al. A Simplified Equation to Predict Glomerular Filtration Rate from Serum Creatitine .J Am Soc Nephrol.2000; 11:155-60.
8. Ishizaka N, Ishizaka Y, Toda E et al. Association between Obesity and Chronic Kidney Disease in Japanese: Differences in Gender and Hypertensive Status? Hypertense Res. 2007; 30:1059-1064.
9. Griffin KA, Kramer H, Bidani AK. Adverse Renal Consequence of Obesity. Am J physiol Renal Physiol. 2008; 294:685-96.
10. Perrone RD, Madias NE, Levey AS. Serum Creatitine as an Index of Renal Function: New insights into old concepts. Cli Chem.1992; 38:1933-53.
11. Zhang R, Liao J, Morse S, et al. Kidney Disease and the Metabolic Syndrome. Am J Med Sc. 2005; 15:2775-91.
12. Abrass CK. Overview: Obesity – what does it have to do with Kidney Disease. J Am Soc Nephrol.2004; 15:2768-72.
13. Ribstein J, Du CG, Mimran A. Combined renal effects of overweight and hypertension. Hypertension1995; 26:610-615.
14. Chagnac A, Weinstein T, Korzets A et al. Glomerular Hemodynamics in Severe Obesity . Am J Physiol Renal Physiol 2000; 278:817-22.
15. Anastasio P, Spitali L, Frangiosa A et al. Glomerular Filtration Rate in Severely Overweight Normotensive Humans. Am J Kidney Dis 2000; 35:1144-48.