Original article

Evaluation of Estimated Glomerular Filtration Rate in Obese Male Adults and Its Correlation with BMI

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Abstract

Background:

Overweight and obesity has been announced as a global epidemic by The World Health Organization. These conditions have strong associations with renal function impairment.

Objectives:

To evaluate the estimated glomerular filtration rate (eGFR) in obese male adults and to observe the correlation of eGFR with body mass index (BMI).

Methods:

This cross-sectional analytical study was conducted at the Department of Physiology, Rangpur Medical College, Rangpur. After briefing about objectives, adult males who met the inclusion and exclusion criteria were enrolled in the study by consensus. The study involved 60 people who were divided into two groups: apparently healthy adult males of average weight (Group A) and apparently healthy adult males who were obese (Group B). The subjects were selected from different districts of the city of Rangpur. Their body mass index & serum creatinine were measured. eGFR was calculated by Cockcroft-Gault equation using serum creatinine. For statistical analysis, unpaired t-test and Pearson's correlation coefficient test were performed as applicable by computer-based SPSS–25.0 for windows. Regarding the interpretation of results, $p \leq 0.05$ was accepted as significant.

Results:

The mean of estimated glomerular filtration rate was significantly ($p \leq 0.001$) lower in obese male adults than in normal-weight male adults. This study also found a highly significant ($p \leq 0.05$) negative correlation of eGFR ($r = -0.317$) with body mass index.

Conclusion:

eGFR is reduced in obese male adults, and it is negatively correlated with BMI. Regular body mass index screening is recommended as an easy and effective means of assessing body weight.

Keywords: Obesity, Estimated Glomerular Filtration Rate, Body Mass Index.

Introduction:

The global epidemic of overweight and obesity termed "globesity" is a major public health problem in developed as well as developing world.[1] In 2016, more than 1.9 billion adults aged 18 years and older were overweight worldwide, of these over 650 million were obese.[2] The rate of being overweight or obese climbed from 7% in 1980 to 17% in 2013 for Bangladeshi adults.[3] Overweight and obesity are the fifth leading preventable cause of death worldwide.[4] WHO estimated that 4.5 million deaths worldwide in 2013 were attributable to complications caused by being overweight and obese.[5]

Obesity is a leading nutritional disorder.[6] It is the condition of abnormal or excessive fat accumulation to the extent that health may be impaired. The fundamental cause of obesity is an energy imbalance between consumed and expended calories.[2] Nowadays, this effect has been attributed to dietary changes and reduced physical activities. The risk associated with increased body weight is determined by the amount of fat as well as fat distribution.[7] Adverse health outcomes associated with obesity range from non–fatal debilitating diseases to increased risk of mortality.[8]

Body mass index (BMI) is a simple index of weight for height that is commonly used to classify overweight and obesity in adults.[2] The regional office of the World Health Organization for the Western Pacific Region, The International Association for The Study of Obesity, And The International Obesity Task Force have categorized normal weight as BMI 18.5 to 22.9 kg/m2, overweight as BMI 23 to 24.9 kg/m2 and obesity as BMI 25 kg/m2 or higher for the Asian adults.[7] When body weight is >20% above average, mortality rises 20% in men and 10% in women.[6]

eGFR stands for Estimated Glomerular Filtration Rate. It is calculated as an estimate of the actual glomerular filtration rate and is based on blood creatinine level along with other variables such as age, sex, and race depending on the equation used. Measuring GFR directly is complicated, requires experienced personnel, and is typically performed only in research settings and transplant centers. Because of this, the estimated GFR is commonly used. eGFR is used to screen for and detect early kidney damage, monitor kidney status, and help diagnose and stage CKD.[9]

Normal GFR varies according to age, sex, and body size & declines with age. According to the National Kidney Foundation, normal eGFR for adults is equal to or greater than 90ml/min/1.73 m^2. An eGFR below 60 mL/min/1.73 m^2 indicates renal dysfunction. A decrease in glomerular filtration rate precedes the onset of renal failure; therefore, a consistently low GFR (eGFR < 60 mL/min/1.73 m^2 for more than three months) is a specific diagnostic criterion for chronic kidney disease (CKD). Less than 60mL/min/L.73 m^2 increases the incidence of complications of chronic kidney disease and the risk of cardiovascular disease (CVD).[9,10]

World Kidney Day 2017 promoted education on the harmful consequences of obesity and its association with kidney diseases.[11] A study on 6475 subjects in the UK revealed that increased BMI is directly associated with reduced eGFR and increased CKD. The adult prevalence of CKD is 13% and still growing.[12] According to a national survey in China, approximately 10.8% of adults are suffering from CKD and are at increased risk for end-stage renal disease (ESRD), cardiovascular complications, and premature mortality.[13] A higher BMI is associated with increased prevalence and incidence of nephrolithiasis. 10% of all kidney cancers are attributable to excess body weight. It is also evident that weight loss improves kidney function in obese subjects.[11,12]

The renal consequences of excess body weight may begin at an early stage before the clinical manifestations become apparent.[14] This study has been designed to assess the estimated glomerular filtration rate (eGFR) in obese male adults, which would emphasize screening of obese male adults on the basis of BMI to prevent associated renal complications.

Methods:

Study design and sample

This cross-sectional analytical study was conducted from January 2019 to December 2019 in the Department of Physiology, Rangpur Medical College, Rangpur. The Rangpur Medical college ethical committee and thesis protocol review committee approved the study protocol. A total number of 60 male adults aged from 20–45 years from different areas of Rangpur city, who fulfill the inclusion and exclusion criteria, were included by numbering. A purposive sampling technique was used for the selection of study subjects. After the selection of subjects, the objectives and procedures of the study were explained in detail and their informed written consent was taken in easily understandable Bengali phrases. A standard questionnaire was filled up after taking history and thorough clinical examinations.

All the study subjects were divided into two groups on the basis of their body mass index, among them, 30 normal-weight male adults were denoted as group A and 30 obese male adults were denoted as group B. The subjects in each group were matched in their age and socio-economic condition. Being overweight and history of diabetes mellitus, hypertension, chronic kidney & liver disease, tobacco, and alcohol abuse, endocrine disorders (thyroid, adrenal diseases, etc.), psychiatric disorder (depression), and taking the neurotoxic drugs were taken as exclusion criteria.

Measurement of body mass index (BMI):[15]

The height and weight of each individual were measured by measuring tape and a medical weighing machine, respectively. Body mass index was calculated as the body weight in kilograms divided by the square of height in meters.

BMI = Weight in kilograms / Square of height in meters (kg/m2)

Collection of blood and sample processing:
All study subjects were advised to be in an overnight (8-10 hrs) fasting state. Then they were attended the next day at 8.00 am at the Department of Physiology, Rangpur Medical College, Rangpur. 5 ml of fasting venous blood was collected from ante-cubital vein from each subject under all aseptic precautions by a disposable syringe. Needles were detached from the nozzle and blood was immediately transferred into a de-ionized test tube with a gentle push to avoid hemolysis. The test tubes containing blood were kept in a standing position till the formation of a clot. Serum was separated by centrifuging the blood at 3000 mp for 5 minutes. The clear supernatant was collected and stored in Ependorffs. The biochemical study of serum creatinine was performed as early as possible by enzymatic colorimetry at the Department of Biochemistry, Rangpur Medical College, Rangpur.

Calculation of eGFR:
The National Kidney Disease Education Program (NKDEP), National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK), National Kidney Foundation (NKF), and American Society of Nephrology (ASN) recommend estimating the GFR based on serum creatinine.[10]
In this study, the estimated glomerular filtration rate of the study subjects has been estimated by Cockcroft-Gault equation proposed by Cockcroft and Gault. This formula calculates eGFR by using the serum creatinine level, age, sex, and body weight of the individual.

$$\text{eGFR (male)} = \frac{(140 - \text{Age in years}) \times \text{Body Weight in kg}}{27 \times \text{Serum Creatinine (mg/dl)}}$$

and adjusted for body surface area of $1.73m^2$.[10,16]
Statistical analysis:
All data were recorded systematically in a preformed history sheet and statistical analysis was done by computer using SPSS–25.0 version for windows. Comparison of eGFR between study groups was done by unpaired t test. Regarding the interpretation of results, ≤0.05 level of probability (p) was accepted as significant.

Results:
Table-I showed the mean±SD of age, height, weight and BMI of total 60 adult males. The mean±SD of age were 30.10±7.66 years in group A and 33.93±5.76 years in group B. The mean±SD of height were 1.67±0.06 m in group A and 1.66±0.05 m in group B. The mean±SD of weight were 58.60±5.28 kg in group A and 76.00±8.63 kg in group B. The mean±SD of BMI were 21.04±1.43 kg/m² in group A and 27.56±2.9 kg/m² in group B. There was no significant difference in age and height between the groups but weight and BMI were significantly (p≤ 0.001) higher in group B than group A.

Table-I: Mean±SD of of age, height, weight and BMI of the study subjects in group A and group B

Parameters	Mean ± SD		p-value
	Group A (n=30)	Group B (n=30)	
Age (years)	30.10±7.66	33.93±5.76	.061 NS
Height (m)	1.67±0.06	1.66±0.05	.583 NS
Weight (kg)	58.60±5.28	76.00±8.63	.000 ***
BMI (Kg/m 2)	21.04±1.43	27.56±2.9	.000 ***

Unpaired t-test was performed for comparison.
*** = p 0.001, NS = p > 0.05

Table- II showed the statistical analysis of the mean±SD of eGFR of the study groups. The mean ± SD eGFR were 134.66±68.06 ml/min/1.73m² in group A and 82.32±12.92 ml/min/1.73m² in group B. The mean eGFR in group B was significantly (p ≤0.001) lower than that in group A.

Table-II: Statistical analysis of mean±SD of eGFR of study subjects in group A and group B

Variable	Mean ± SD		p-value
	Group A (n=30)	Group B (n=30)	
eGFR (ml/min/1.73m 2)	134.66±68.06	82.32±12.92	.000***

Unpaired t test was performed for comparison.
***=p 0.001

Table-III and Figure-1 showed the correlation of eGFR with BMI in the whole study group. eGFR was negatively correlated with BMI, considering eGFR as dependent and BMI as an independent variable. The correlation coefficient was statistically highly (p ≤ 0.05) significant, (r = -0.317).

Table-III: Correlation of eGFR with body mass index (BMI) in the whole study group (n=60)

Variable	Correlation with	Correlation coefficient (r value)	p-value
eGFR	BMI	-0.317	.014*

Statistical analysis was done by Pearson's correlation coefficient test. *= p 0.05

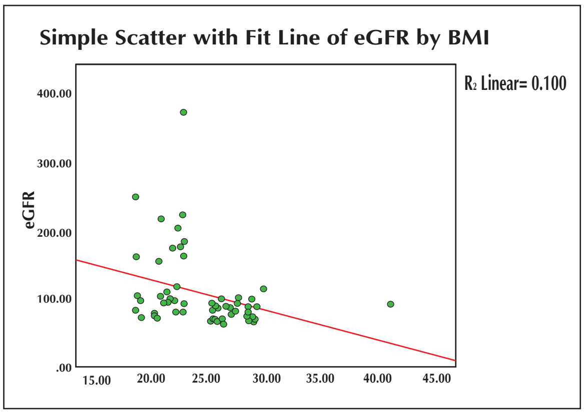

Figure-1: Correlation of eGFR with BMI in the whole study group

Discussion:

This cross-sectional analytical study was carried out to evaluate the estimated glomerular filtration rate (eGFR) in obese male adults and to find out the relationship of eGFR with BMI. In this study, the mean of the estimated glomerular filtration rate was significantly ($p \le 0.001$) lower in obese male adults than in normal-weight male adults. This study also found a highly significant ($p \le 0.05$) negative correlation of eGFR ($r = -0.317$) with body mass index. Both findings are similar to the reports by others.[11-14,17-19]

Increased body weight results in complex metabolic abnormalities that bring harmful effects on kidney function. Graded decrease in eGFR with increasing BMI starts at a BMI of 22 kg/m2.[17] The mechanisms that lead to reduced eGFR in obese individuals are not completely understood. But it is suggested that some harmful renal consequences are mediated through diabetes mellitus and hypertension, as the risk of these comorbidities is increased by obesity.[11,17,18]

Adiposity has direct impacts on kidney function induced by the endocrine activity of adipose tissue. It produces various adipokines like adiponectin, leptin, resistin, and interleukin-6. These adipokines are responsible for inflammation, oxidative stress, abnormal lipid metabolism, activation of the rennin-angiotensin-aldosterone system, insulin resistance, and increased production of insulin. As a result, specific pathological changes occur in the kidneys.[11,12] It increases single nephron perfusion and intracapillary perfusion pressure that causes glomerulosclerosis and loss of GFR over time.[13]

Visceral obesity is associated with increased deposition of renal sinus fat causing compression of the kidneys. This may initially increase the loop of Henle sodium chloride reabsorption, reducing sodium chloride delivery to the macula densa. Via tubuloglomerular feedback, it reduces afferent arteriolar resistance and increases renal blood flow, GFR, and rennin secretion. Several adipocytokines including resistin, adiponectin, and leptin are also associated with glomerular hyperfiltration.[19] These mechanisms lead to increased glomerular wall tension and glomerular membrane injury leading to increased glomerular permeability. As a result, there is the development of glomerular hypertrophy and focal and segmental glomerulosclerosis, with the ultimate loss of nephron. These changes progressively reduce filtration surface area. Thus a vicious cycle is created causing further increased blood pressure and additional kidney injury. Ultimately the glomerular hyperfiltration that occurs after weight gain eventually subsides and is replaced by a gradual decrease in GFR.[11,12,18]

In addition, the metabolism of ectopic renal deposition of fatty acids and sphingolipids leads to the accumulation of toxic metabolites which causes mitochondrial dysfunction, endoplasmic reticulum stress, apoptosis, and eventually renal injury and dysfunction.[18]

Increased fat mass also causes increased production of pro-inflammatory cytokines including tumor necrosis factor-alpha (TNFα), CRP, and interleukin 6. CRP is a marker of renal injury and a risk marker of renal function loss.[19]

Increased BMI and decreased renal function might be associated with other risk factors like- low-grade inflammation, homocysteinemia, oxidative stress, hyperlipidemia, hyperleptinemia, increased sympathetic activity, hyperfiltration due to insulin resistance, co-expression of a local renin-angiotensin system in adipose tissue and elevated cytokines. All these risk factors result in atherosclerosis. CKD may be complicated by both severity and duration of atherosclerosis, and vice versa.[17]

The mechanisms by which excess body weight causes nephron injury and promotes progressive kidney disease likely involve a combination of hemodynamic, metabolic, and inflammatory changes.[18] These changes begin in the early stage before overt renal manifestations are clinically apparent.[14]

Conclusion:

The result of this study suggested that increased body mass index is correlated with reduced eGFR in obese male adults. As body weight increases, modifications in the renal system are also found to be increased. These changes may precede the development of overt clinical diseases and may be responsible for the maintenance of an obese state. These findings highlight the importance of recognizing obese individuals as an at-risk population. This might help in early diagnosis and could be used to prevent further complications associated with excess body weight. Regular body mass index screening is recommended for easy and effective assessment of body weight.

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