CORRELATION OF BODY MASS INDEX AND ESTIMATED GLOMERULAR FILTRATION RATE IN PATIENTS WITH RHEUMATIC HEART DISEASE AT TERTIARY CARE HOSPITAL

Shreewastav RK[1*], Nepal R[2], Dhungana SP[2], Singh AG[3]

Affiliation

1. Assistant Professor, Department of Biochemistry, Nobel Medical College Teaching Hospital

2. Associate Professor, Department of Internal Medicine and cardiology unit, Nobel Medical College Teaching Hospital

3. Professor, Department of Biochemistry, Nobel Medical College Teaching Hospital

ORA 134

* Corresponding Author

Rupesh Kumar Shreewastav
Assistant Professor
Department of Biochemistry
Nobel Medical College Teaching Hospital, Biratnagar, Nepal
Email: rupeshaiims4@gmail.com
ORCID ID: https://orcid.org/0000-0002-0102-5862

ABSTRACT

Introduction

Rheumatic heart disease (RHD), the leading cause of acquired heart disease worldwide, is a major health problem in developing countries. Rheumatic Heart Disease (RHD), affects the heart valve system, leading to congestive heart failure and arrhythmias. The effects of body mass index (BMI) on kidney function have been reported and become a subject of increased concern. BMI is strongly associated with decreased eGFR in healthy persons. But the association between BMI and eGFR is not well characterized in chronic disease like RHD.

Objective

The aim of this study was to investigate the association between body mass index (BMI) and estimated glomerular filtration rate (eGFR) among RHD patients as studies have evaluated the significance BMI as a risk factor for the development of kidney diseases.

Methodology

It was an analytical cross-sectional study, which was conducted in a tertiary care hospital. A questionnaire was used to record the demographic characteristics of the patients. Height in meter and weight in kg of the study patients were recorded to calculate body mass index. Serum creatinine level of the patients was estimated in the clinical laboratory and estimated glomerular filtration rate was calculated by cockroft-Gault formula. The data was analyzed into SPSS 20.0 V

Results

The total number of rheumatic heart disease patients enrolled in this study was 120. The Mean ± Standard deviation values of body mass index, serum creatinine and estimated glomerular filtration rate of all the patients were 21.39 ± 3.91 kg/m^2, 0.93 ± 0.41 mg/dl and 69.53 ± 19.4 ml/min respectively. Increased body mass index was associated with reduced estimated glomerular filtration rate (r = -0.04) of the patients. Similarly, body mass index showed negative correlation with that of serum creatinine (r = -0.03) and also with that of age (r = -0.05) of the patients. Age (r = -0.043) and serum creatinine (r = -0.056) of the patients were negatively correlated with estimated glomerular filtration rate.

Conclusion

The study reveals that in rheumatic heart disease, body mass index is negatively but non-significantly associated with estimated glomerular filtration rate.

KEYWORDS

Body mass index, creatinine, rheumatic heart disease

INTRODUCTION

Obesity has become the major worldwide public health problem.[1,2] Many of the studies have established association between higher BMI and kidney disease.[3,4] The obese patients with higher BMI remain at higher risk for the advanced renal failure.[5]

Acute rheumatic fever is an important public health problem in developing countries[6], which leads to Rheumatic Heart Disease (RHD). The association between higher rate of mortality and cardiac complications with the increasing prevalence of kidney disease has become a concern of major public health issue.[7] The prevalence of chronic kidney disease was found to be 10.8% in China, which might lead to significantly higher death rate following cardiovascular disease.[8] A study carried out in Chitwan, Nepal reported that cardiovascular disease was present in 74% of the patients, who were diagnosed with end stage renal disease.[9]

The early identification of the potential risk factors for chronic kidney disease is critical for preventing the development of kidney damage and other adverse outcomes like cardiovascular disease. Loss of muscle mass is common in patients with chronic disease like RHD. Loss of muscle mass leads to a decrease in physical performance and may be associated with a decline in eGFR and poor clinical outcomes. However, eGFR calculation based on plasma creatinine, which is dependent on muscle mass, may be inaccurate when relating eGFR to muscle mass in chronic diseases. In healthy individuals, increased BMI has adverse effect on eGFR but to our knowledge, the association between BMI and eGFR has not been examined in patients with RHD. So, our aim was to investigate the correlation between BMI and e GFR in patients with RHD.

METHODOLOGY

An analytical cross-sectional study design was adopted for this study. It was carried out between a periods of 1st April 2017 to 31st March 2018 at cardiology unit of Nobel Medical College Teaching Hospital (NMCTH) after getting the approval from the Institutional review committee, NMCTH. All the participants had signed the informed consent for the study.

Inclusion criteria

1. Participants who provided informed consent
2. Who were diagnosed as RHD by trained cardiologist by echocardiography
3. Age ≥ 15 years
4. Participants with normal or near normal ejection fraction with stable hemodynamics

Exclusion criteria

1. Participants with underlying chronic kidney disease at baseline (serum creatinine >1.4 mg/dl)
2. Participants with other co morbidities like hypertension, diabetes mellitus and COPD

Sample Size Calculation

The study considers 95% ($\alpha = 0.05$) confidence interval and 80% ($\beta = 0.20$) power to estimate the sample size and it become 105 at correlation r = 0.27 (0.266)[10] by the formula mentioned below:

The standard normal deviate for $\alpha = Z\alpha = 1.960$
The standard normal deviate for $\beta = Z\beta = 0.842$
$C = 0.5 * \ln[(1+r)/(1-r)] = 0.277$
Total sample size = $N = [(Z\alpha+Z\beta)/C]^2 + 3 = 105$

Altogether 120 patients, diagnosed as RHD by using electrocardiography and echocardiography were enrolled in this study purposely in the consecutive manner. A semi structured questionnaire was administered to record the demographic characteristics and other related factors. Physical examination was performed to note vital signs and abnormal cardiac and neurological findings. Height and weight of the patients were recorded to calculate BMI by the formula given below:

BMI= Weight in Kg/ Height in meter^2

Serum creatinine level (mg/dl) of all the patients was estimated by the reagents provided by the manufacturer in the fully automated Beckman machine in the department of biochemistry of clinical laboratory services, NMCTH. The results were cross-verified by respective reagents in semi automated analyzers of the companies named as Erba and Mura. Creatinine clearance (eGFR) was calculated by cockroft-Gault formula mentioned below:

CCr= {((140–age) x weight)/ (72xSCr)} x 0.85 (if female)

Where, CCr is creatinine clearance in mL/min, Age in years, Weight in kg and SCr is serum creatinine in mg/dL. Creatinine clearance (CCr) can also be expressed as estimated glomerular filtration rate (eGFR).

Collected data were entered at MS excel 2010 and analyzed using SPSS 20.0 V. Descriptive statistics was calculated as Mean and SD for numerical variables and percentage were calculated for categorical variables. For inferential statistics, independent t test, one-way ANOVA and correlation were applied to find out the relationship between eGFR and other selected variables at 95.0% CI where p consider as <0.05.

RESULTS

The total number of RHD patients visited at cardiac clinic of NMCTH during the study period was 120, out of them 88 (73.3%) were female and 32 (26.6%) were male respectively. Mean age in years and SD value of patients was 50.24 ± 11.40, minimum and maximum being 22 and 80 years respectively. Mean± SD value of body mass index (BMI) of all patients was 21.39 ± 3.91 kg/m^2 with maximum and minimum value of 33.7 kg/m^2 and 13.2 kg/m^2 respectively. Mean± SD value of serum creatinine (SCr) and estimated glomerular filtration rate (eGFR) of all patients were 0.93 ± 0.41 mg/dl and 69.53±19.4 ml/min respectively as shown in Table 1.

Table 1. Baseline demographics of study patient.	
Demographics	**Number**
Male	32 (26.6%)
Female	88 (73.3%)
Age (Mean±SD)	50.24 ± 11.40 years
BMI (Mean±SD)	21.39 ± 3.91 kg/m^2
eGFR (Mean±SD)	69.53±19.4 ml/min
Scr (Mean±SD)	0.93 ± 0.41 mg/dl
Systolic BP(Mean±SD)	107.09 ± 13.06 mmHg
Diastolic BP(Mean±SD)	72.0 ± 9.34 mmHg

Abbreviations: SD (Standard deviation), BP (Blood pressure)

The study was carried out by categorizing all the RHD patients in three groups on the basis of BMI (Low, Normal and High BMI groups). The mean value of BMI of these three groups was 16.33, 21.16 & 28.02 kg/m^2 respectively. The mean BMI value of High BMI group was significantly higher (p < 0.001) than the two other groups. The mean value of serum creatinine of the patients in the low BMI group was 0.94mg/dl, which was non significantly higher (p =0.84) than normal BMI group (0.92mg/dl) and high BMI group (0.91mg/dl). The mean eGFR value of patients in high BMI group was 67.46 ml/min, which was non significantly (p=0.87) lower than the mean eGFR value of patients in low and normal BMI group, which were 70.63 and 69.77 ml/min respectively as shown in Table 2.

We have also analyzed the variables in RHD patients by categorizing them in three different age group (≤40, 41 – 60 & >60). The mean BMI of < 40 age group was 21.08 Kg/m^2, where as the mean BMI of 41-60 and > 60 age group were 21.5 Kg/m^2 and 21.47 Kg/m^2 respectively. The mean BMI of 41-60 age group was insignificantly higher (p=0.89) than rest of the age groups. Similarly, the mean of serum creatinine in the three age group were 0.9, 0.92 and 0.99 mg/dl respectively showing the highest mean value for the age group of >60 (0.99mg/dl), but not upto the significant level (p=0.24). The mean eGFR value of age group ≤40, 41 – 60 & >60 were 81.7, 69.2 & 50.9 ml/min respectively. The mean eGFR value for age group of >60 was significantly (p<0.001) reduced than other age group as shown in Table 3. The study was extended by analyzing the different variables gender wise also on RHD patients and found that mean age of male and female patients were 51.09 and 49.93 in years respectively. The mean BMI values of male and female patients were 20.79 Kg/m^2 and 21.61 Kg/m^2 showing a higher value for women. We noted a significant (p=0.01) difference between the mean serum creatinine value of male and female patients, the mean value being 0.86 mg/dl 0.95 mg/dl respectively. The mean eGFR value of male (72.04ml/min) and female (68.62ml/min) patients were not found to be significantly different (p=0.41) as shown in Table 4.

Table 2. Study of variables in patients with different BMI.

Variable	Mean ± SD by BMI			P value	Remarks
	Low BMI (<18.5 Kg/m^2)	Normal BMI (18.5-24.9 Kg/m^2)	High BMI (>25 Kg/m^2)		
BMI (Kg/m^2)	16.33±1.23	21.16±1.91	28.02±2.49	<0.001	Significant
SCr(mg/dl)	0.94±0.21	0.92±0.17	0.91±0.18	0.84	NS
eGFR (ml/min)	70.63±23.47	69.77±19.62	67.46±17.70	0.87	NS

Abbreviations: NS (Non-significant)

Table 3. Comparison of study variables in different age group of patients.

Variable	Mean ± SD by age groups in years			P value	Remarks
	≤40	41 – 60	>60		
BMI (Kg/m^2)	21.08±4.1	21.50±4.14	21.47±3.91	0.89	NS
SCr(mg/dl)	0.91±0.14	0.92±0.18	0.99±0.23	0.24	NS
eGFR (ml/min)	81.7±19.6	69.2±17.4	50.9±14.37	<0.001	Significant

Abbreviations : NS (Non-significant)

Table 4. Gender wise analysis of study variables in patients.

Variable	Mean ± SD by gender		P value	Remarks
	Male	Female		
Age in years	51.09±10.4	49.93±11.8	0.62	NS
BMI (Kg/m^2)	20.79±3.96	21.61±4.1	0.33	NS
SCr(mg/dl)	0.86±0.13	0.95±0.19	0.01	Significant
eGFR (ml/min)	72.04±19.16	68.62±20.3	0.41	NS

Table 5. Correlation matrix of study variables.

Variable	Correlation	Age	BMI	Cr	Egfr
Age	Correlation r	1			
	p-value				
BMI	Correlation r	-0.05	1		
	p-value	0.57			
SCr	Correlation r	0.59	-0.03	1	
	p-value	0.12	0.74		
eGFR	Correlation r	-0.43	-0.04	-0.056	1
	p-value	0.001	0.65	0.001	

While analyzing the correlation matrix of different study variables in overall of all the study patients, it was noted that the BMI (r = -0.05) was negatively and non significantly (p=0.57) correlated with age. Similarly, BMI (r = -0.03) was also negatively and non significantly (p=0.74) correlated with serum creatinine. We found that increased BMI was associated with reduced eGFR. The BMI (r = -0.04) was negatively and non significantly (p=0.65) correlated with eGFR. Serum creatinine was positively (r = 0.59) and non-significantly (p=0.12) associated with age, where as it is negatively (r = -0.056) and significantly (p=0.001) correlated with eGFR. Age is negatively (r = -0.043) and significantly (p=0.001) correlated with eGFR. Increased age is strongly associated with reduced eGFR as shown in Table 5.

DISCUSSION

The purpose of conducting this study was to know the possible impact of BMI on the functional state of kidney in RHD patients by studying the relationship of BMI to eGFR and comparing it to those of other risk factors like age and creatinine to eGFR. The study showed that increased BMI was consistently associated with decreased eGFR. Similar finding was observed in a community based cross-sectional study in Japan, which revealed that increased BMI was associated with low eGFR.[11] While analyzing the other dependable factors, we found that age and BMI of the RHD patients was negatively correlated, whereas, a different finding was observed by Muhammad Farooq Rai et. al. in United States, which revealed that age and BMI were significantly positively correlated in a patients undergoing arthroscopic partial meniscectomy.[12] We also found a different finding in our study which showed that BMI was negatively correlated with serum creatinine, whereas the opposite finding was obtained in a study, conducted by Banfi G et. al. in Italy, which showed a positive correlation between serum creatinine and BMI in elite athletes of different sport disciplines.[13] The possible reason for such a different finding in RHD patients in our study may possibly due to chronic nature of the disease and decreased muscle mass, which we usually find in patients with RHD. Another possibility may be due to low sample size used in our study

and therefore a further study is required to find out the mechanism behind it.

While analyzing the correlation between age and serum creatinine in RHD patients, it was found that both the variables were positively associated. Similar finding was observed in Australia, where it was seen that Serum creatinine concentration increased steadily with age.[14] Increased serum creatinine was associated with reduced eGFR in our finding as both of the variables were negatively associated. This finding resembles the result of a study, carried out by Aw Nelson et. al. in United Kingdom, which showed that the serum creatinine and eGFR were negatively correlated.[15] Age and eGFR of the RHD patients were negatively associated in our finding, which was similar to the finding of the study conducted in UK, which stated that eGFR was found to be reduced in increasing age groups.[16]

The study was conducted by categorizing the all RHD patients in three groups i.e. low BMI (< 18.5 Kg/m^2), normal BMI (18.5-24.9 Kg/m^2) and High BMI (> 25 Kg/m^2). The basis of the division of the patients on the ground of BMI value was done according to the guidelines provide by WHO.[17,18] It was noted that mean eGFR value of high BMI group was lower than the low and normal BMI group. We have also analyzed the study by categorizing all the patients in three different age group (≤40 age, 41 – 60 age & >60 age) and found that the Mean±SD value of BMI of the patients between 41-60 age was higher (non-significant) than the other two groups but the Mean±SD value of serum creatinine was higher (non-significant) in the patients with age more than 60 when compared to other age groups of patients. While observing the mean eGFR value, it was significantly reduced in >60 age group than the remaining two groups.

The study variables were also evaluated gender wise in RHD patients and it was noted that the number of female patients was more than the male suffering with RHD.

Lawrence JG et. al. and Parnaby MG et. al. have also reported that RHD tends to be more common in females.[19,20] The mean value of BMI of all female patients with RHD was non-significantly higher than male, whereas the mean serum creatinine value was significantly higher in female than male. While analyzing the mean eGFR value gender wise in all patients with RHD, it was found that the value was non-significantly higher for male than female.

CONCLUSION

The present study revealed the non-significant difference in eGFR in RHD patients with different BMI although there was a trend of decreased eGFR with increased BMI. Though, BMI is strongly associated with decreased eGFR in healthy persons, this may not be appropriate for RHD patients who tend to have lower BMI due to the chronic nature of the disease. Further studies with large sample size are required to find out the association between BMI and eGFR in RHD patients.

LIMITATIONS OF THE STUDY
Low sample size.

CONFLICT OF INTEREST
None

FINANCIAL DISCLOSURE
None

REFERENCES

1. Kramer H, Luke A.Obesity and kidney disease: a big dilemma.Curr Opin Nephrol Hypertens. 2007 May;16(3):237-41. [PubMed] PMID: 17420667.

2. Rutkowski P, Klassen A, Sebekova K, Bahner U, Heidland A: Renal disease in obesity: the need for greater attention. J Ren Nutr. 2006; 16: 216–223. [PubMed] PMID: 16825023

3. Nagel G, Zitt E, Peter R, Pompella A, Concin H, Lhotta K. Body mass index and metabolic factors predict glomerular filtration rate and albuminuria over 20 years in a high-risk population. BMC Nephrol. 2013; 14:177. [PubMed] PMID: 23962027.

4. Silverwood RJ, Pierce M, Thomas C, et al. Association between younger age when first overweight and increased risk for CKD. J Am Soc Nephrol. 2013; 24:813-821. DOI: https://doi.org/10.1681/ASN.2012070675

5. Kambham N, Markowitz GS, Valeri AM, Lin J, D'Agati VD: Obesity-related glomerulopathy: an emerging epidemic. Kidney Int. 2001; 59: 1498–1509. [PubMed] PMID:11260414.

6. Marijon E, Mirabel M, Celermajer DS, Jouven X. Rheumatic heart disease. Lancet 2012; 379:953–64. [PubMed] PMID: 22405798.

7. Weiner DE, Tighiouart H, Stark PC, et al. Kidney disease as a risk factor for recurrent cardiovascular disease and mortality. Am J Kidney Dis. 2004; 44: 198–206. [PubMed] PMID: 15264177.

8. Zhang L,Wang F,Wang L, et al. Prevalence of chronic kidney disease in China: a cross-sectional survey. Lancet. 2012; 379:815-822. [PubMed] PMID: 22386035.

9. Rajesh Panjiyar, Rajeev Sharma, Shankar Laudari, Madhu Gupta, Madhav Ghimire, Pawina Subedi et. al. Cardiovascular complications in end stage renal disease in a tertiary hospital in Nepal. Journal of College of Medical Sciences-Nepal. 2017; 13 (2): 279-283. DOI: http://dx.doi.org/10.3126/jcmsn.v13i2.17310.

10. Duan Y, Wang X, Zhang J, Ye P, Cao R, Yang X et. al. Body mass index is an independent predictive factor for kidney function evaluated by glomerular filtration rate in a community-dwelling population. Eat Weight Disord. 2017 Sep 4. doi: 10.1007/s40519-017-0434-5. [Epub ahead of print]. [PubMed] PMID:28871501.

11. Ishizaka N, Ishizaka Y, Toda E, et al. Association between obesity and chronic kidney disease in Japanese: differences in gender and hypertensive status? Hypertens Res. 2007; 30: 1059–1064. [PubMed] PMID:18250555.

12. Muhammad Farooq Rai, Linda J. Sandell, James M. Cheverud, and Robert H. Brophy. Relationship of age and body mass index to the expression of obesity and osteoarthritis related genes in human meniscus. Int J Obes (Lond). 2013 Sep; 37(9): 1238–1246. [PubMed] PMID:23318714.

13. Banfi G1, Del Fabbro M, Lippi G. Relation between serum creatinine and body mass index in elite athletes of different sport disciplines. Br J Sports Med. 2006 Aug; 40(8):675-8. [PubMed] PMID:16723402.

14. Tiao JY1, Semmens JB, Masarei JR, Lawrence-Brown MM. The effect of age on serum creatinine levels in an aging population: relevance to vascular surgery. Cardiovasc Surg. 2002 Oct; 10(5):445-51. [PubMed] PMID:12379401.

15. Aw Nelson, B Mackinnon, J Traynor, CC Geddes. The Relationship between Serum Creatinine and Estimated Glomerular Filtration Rate: Implications for Clinical Practice. Scott Med J. 2006; 51(4):5-9. [PubMed] PMID:17137139.

16. Richard J. Glassock and Christopher Winearls. Ageing and the Glomerular Filtration Rate: Truths and Consequences. Trans Am Clin Climatol Assoc. 2009; 120: 419–428. [PubMed] PMID:19768194.

17. World Health Organization, bulletin on Body mass index. http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body- mass-index-bmi, 2019 (accessed 18.01.19).

18. World Health Organization, bulletin on Mean Body mass index. https://www.who.int/gho/ncd/risk_factors/bmi_text/en/, 2019 (accessed 18.01.19)

19. Lawrence JG, Carapetis JR, Griffiths K, Edwards K, Condon JR. Acute rheumatic fever and rheumatic heart disease: incidence and progression in the Northern Territory of Australia, 1997 to 2010. Circulation. 2013; 128 (5):1492–1501. [PubMed] PMID:23794730.

20. Parnaby MG, Carapetis JR. Rheumatic fever in indigenous Australian children. Journal of Paediatrics and Child Health. 2010; 46: 527–33. [FullText] DOI: https://doi.org/10.1111/j.1440-1754.2010.01841.x.