# LIPID RATIOS: AS A PREDICTOR OF METABOLIC SYNDROME

*Pushpa Sarkar[1], Mahadeva S. K[2], Raghunath H[3], Hamsa M[4]*

*[1]Professor, Department of Biochemistry, Mandya Institute of Medical Sciences, Mandya.*
*[2]Associate Professor, Department of Biochemistry, Mandya Institute of Medical Sciences, Mandya.*
*[3]Assistant Professor, Department of Biochemistry, Mandya Institute of Medical Sciences, Mandya.*
*[4]Post Graduate Cum Tutor, Department of Biochemistry, Mandya Institute of Medical Sciences, Mandya.*

**ABSTRACT**

Metabolic Syndrome (MetS) is a group of disorders characterized by obesity, hypertension, glucose intolerance and dyslipidemia. This study was undertaken to determine whether lipid ratios calculated by routinely measured lipid profile can be used as predictor of MetS and which among them could be used as better predictor.

**MATERIALS AND METHODS**

Data consisting of anthropometric measurements, blood pressure, laboratory parameters like fasting blood sugar, Total Cholesterol (TC), Triglycerides (TG), High Density Lipoprotein-C (HDL-C) and Low Density Lipoprotein-C (LDL-C) of 460 subjects was obtained by record of Community Outreach Programme conducted at Holalu village; 440 subjects with complete data were included in the study. MetS was diagnosed based on ATP III criteria. Various lipid ratios like TC/HDL-C, TG/HDL-C, Non-HDL-C/HDL-C and LDL-C/HDL-C were calculated. Results obtained were statistically analyzed using SPSS software.

**RESULTS**

Among 440 study subjects, 215 were males and 225 females with mean age of 54.37±12.68 years. 111 subjects (80 females and 31 males) were diagnosed as MetS based on ATP III criteria. As the number of components of MetS increased the mean values of lipid ratios increased in both males and females. Among lipid ratios analyzed by ROC curve, TG/HDL-C was best able to discriminate individuals with MetS; the Area Under Curve (AUC) being 0.717 in males and 0.760 in females. AUC of TC/HDL-C was 0.579 in males and 0.734 in females, LDL-C/HDL-C was 0.688 in females and 0.504 in males. AUC for non-HDL-C/HDL-C to identify individuals with MetS was 0.577 in males and 0.732 in females.

**CONCLUSION**

TG/HDL-C is a better indicator of the risk of MetS compared to various lipid ratios and can be used to predict the risk of MetS.

**KEYWORDS**

Metabolic Syndrome, Cardiovascular Risk Factors, Waist Circumference, Lipid Ratios, TG/HDL-C.

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## INTRODUCTION

Cardiovascular Disease (CVD) is an important non-communicable disease showing increase in its prevalence worldwide. According to the Global Burden of Disease study Indians experience CVD deaths decade earlier than developed countries, which estimates that 52% of CVD deaths occur below the age of 70 years in India as compared to 23% in developed country.[1,2]

There is increasing prevalence of cardiovascular risk factors like hypertension, dyslipidemia, diabetes, overweight or obesity, physical inactivity in both urban and rural India.[3,4] Metabolic Syndrome (MetS) is a disorder characterized by obesity, hypertension, glucose intolerance and dyslipidemia. It is also associated with increased risk of cardiovascular disease and cardiovascular mortality.[5] Early diagnosis of MetS is essential to prevent morbidity and mortality caused due to Cardiovascular Disease.[6]

MetS is diagnosed using National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP) III guidelines, which involved Waist Circumference (WC), Blood Pressure (BP), high density lipoprotein cholesterol (HDL-C), Triglycerides (TG) and Fasting Blood Glucose (FBS) as its components.[7]

As a part of regular checkup most of the general population undergo routine laboratory investigations, which include lipid profile. This helps in the early monitoring of cardiovascular risk factors.

Waist circumference is one of the important components in diagnosing MetS, but is not measured in routine clinical examination and hence early diagnosis of MetS would be missed in certain individuals.

Lipid profile is routinely estimated and the values obtained can be used for the calculation of various lipid ratios like TC/HDL-C, TG/HDL-C, Non-HDL-C/HDL-C, LDL-C/HDL-C. This study was undertaken to study lipid parameters in MetS and to determine a better indicator of MetS among various lipid ratios.

## MATERIALS AND METHODS

Community Outreach Programme was conducted by Department of Biochemistry, Mandya Institute of Medical Sciences in the population of Holalu Village, Mandya to create awareness about the CVD, its risk factors and their prevention. The residents of Holalu village aged more than 30 years were 1799 among whom 889 were males and 910 were females. Among them 460 subjects voluntarily participated in the Community Outreach Programme.

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*Corresponding Author:*
*Dr. Raghunath H,*
*Assistant Professor,*
*Department of Biochemistry,*
*Mandya Institute of Medical Sciences,*
*Mandya, Karnataka-571401.*
*E-mail: raghunath_h@yahoo.com*
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Written informed consent was taken from the study subjects, after explaining to them the plan and intention of the study in the language best known to them. Demographic details noted. History of smoking and alcohol consumption was taken. History of various CVD like DM and HTN was taken.

Physical measurements like height, weight, waist circumference and hip circumference noted. Height in cm was measured using stadiometer, weight in kg measured by analog weight scale and Body Mass Index was calculated using formula weight/height.[2] Waist circumference and Hip circumference was measured by measuring tape.

Blood pressure was recorded on right arm after 5 minutes of rest using mercury sphygmomanometer in sitting position.

Fasting blood samples were collected for analysis of lipid profile parameters and Fasting Blood Sugar (FBS). Under strict aseptic precautions, 2–3ml of venous blood was collected by venipuncture into a non-vacuum plain tube with clot activator from each participant. The samples were transported to the Central Diagnostic Laboratory of Mandya Institute of Medical Sciences for further processing.

Serum was separated by centrifugation and biochemical parameters like FBS, TC, TG and HDL-C were analyzed by fully automated analyzer Transasia - ERBA XL 300. FBS was estimated by GOD-PAP method, TC by CHOD-POD method, TG by GPO peroxidase method and HDL was estimated by direct determination using enzyme selective protection method. LDL-C was calculated by Friedwald's calculation in samples, where the TG is less than 400mg/dl. Various lipid ratios like TC/HDL-C, TG/HDL-C, non-HDL-C/HDL-C and LDL-C/HDL-C were calculated.

MetS was diagnosed using National Cholesterol Education Program - ATP III Guidelines. The criteria consist of 5 components of MetS namely abdominal obesity (Waist circumference in males >102cm and in females >88cm), raised TG (>150mg/dl), low HDL-C (in males <40mg/dl and in females <50mg/dl), raised blood pressure (≥130/85mmHg) and impaired blood glucose (≥110mg/dl). MetS is diagnosed in presence of 3 or more number of components according to the guidelines.

The 440 study subjects with complete data were included in the study for statistical analysis. The collected data was entered in the excel sheet and was analyzed using SPSSv15 software. Descriptive statistics like frequency, percentage, measure of central tendency was calculated. ROC cure analysis and 't' test were used for the analysis of data. In this study p value <0.05 at 95% Confidence Interval was considered as statistically significant.

## RESULT

In this study among 440 study subjects, 215 were males and 225 females. MetS was diagnosed based on the ATP III criteria, according to which 111(25.2%) participants had MetS as shown in Graph 1.

Study participants were distributed according to gender and presence of MetS as shown in Graph 2. Among the study participants 80(35.6%) females and 31(14.4%) males were diagnosed to have MetS as shown in Table 1.

Mean age of participants with MetS in the study was 57.23 years. The mean values of various lipid parameters and the lipid ratios along with their standard deviation showed that the mean values of lipid parameters had statistically significant difference between the subjects with and without MetS as displayed in Table 2.

The mean value of TC, TG and LDL-C in participants with MetS were significantly higher than the mean value in participants without MetS. The mean value of HDL-C was low in participants with MetS as compared to participants without MetS; showing statistically significant difference as detailed in Graph 3.

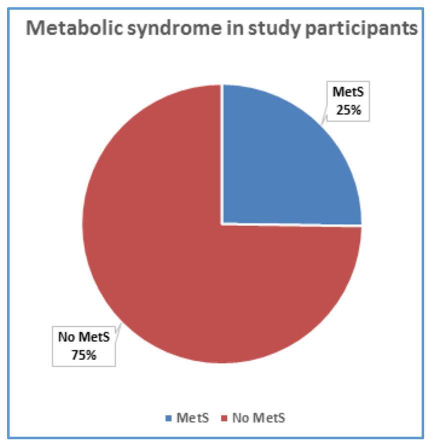
The mean values of various lipid ratios like TC/HDL-C, TG/HDL-C, non-HDL-C/HDL-C and LDL-C/HDL-C in participants with MetS were significantly higher when compared to the participants without MetS ($p<0.01$) as detailed in Graph 4.

The mean values of lipid ratios TC/HDL-C, TG/HDL-C, non-HDL-C/HDL-C and LDL-C/HDL-C in males and females according to the presence of number of components of MetS among study participants is graphically represented in Graph 5. Study shows that the mean value of lipid ratios increases as there is increase in the number of components of MetS in the study population.

Among all the other lipid ratios, TG/HDL-C proved to be a better indicator of MetS in both males and females according to its distribution in Receiver Operating Characteristic (ROC) curve as represented in Graphs 6 and 7.

The values of Area Under the Curve (AUC) for various lipid ratios obtained by ROC curve shows that TG/HDL-C (0.76 in females and 0.717 in males) is a better indicator of MetS compared to all other lipid ratios.

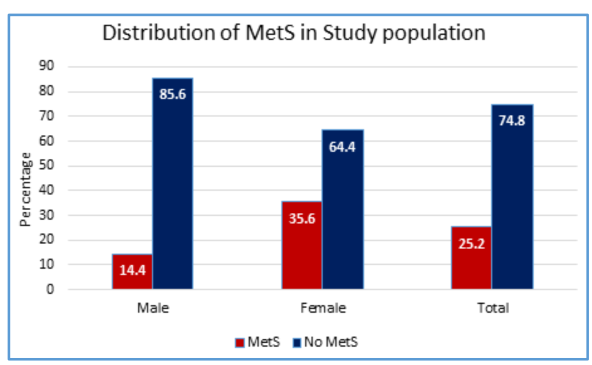
According to ROC curve, the cut-off value for prediction of MetS in females in the study population is 2.17 for TG/HDL-C with 86.3% sensitivity and 52.4% specificity (Table 3). In males, the cut-off value of TG/HDL-C for prediction of MetS in the study population is 2.66 with sensitivity of 80.6% and specificity of 52.2%. Table 4.




***Graph 1: Distribution of MetS in the study participants***

| | MetS | No MetS | p value |
|---|---|---|---|
| Males (%) | 14.4 | 85.6 | p<0.05 |
| Females (%) | 35.6 | 64.4 | |
| Total (%) | 25.2 | 74.8 | |

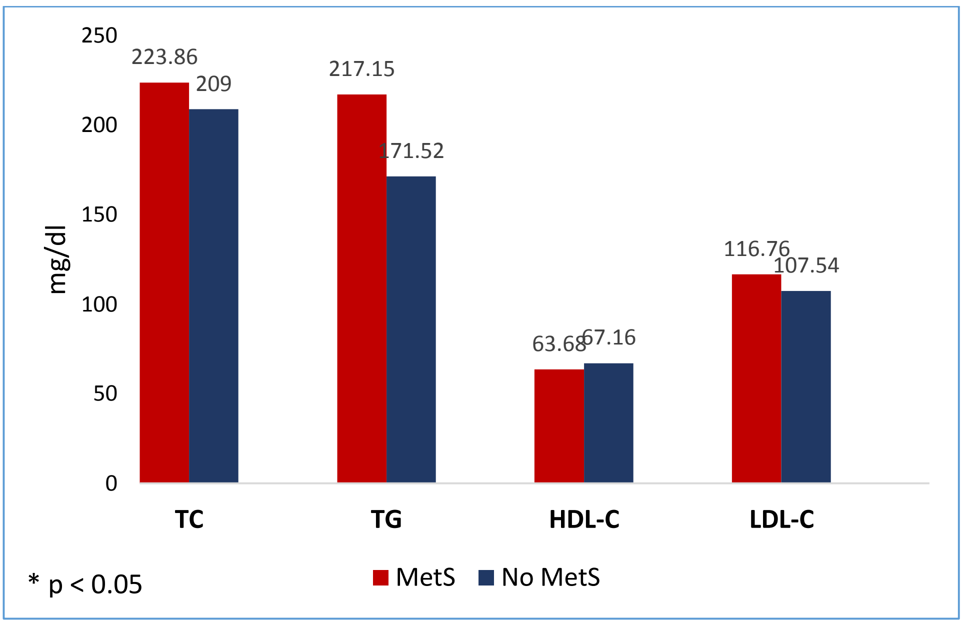
***Table 1: Distribution of the study participants based on MetS***



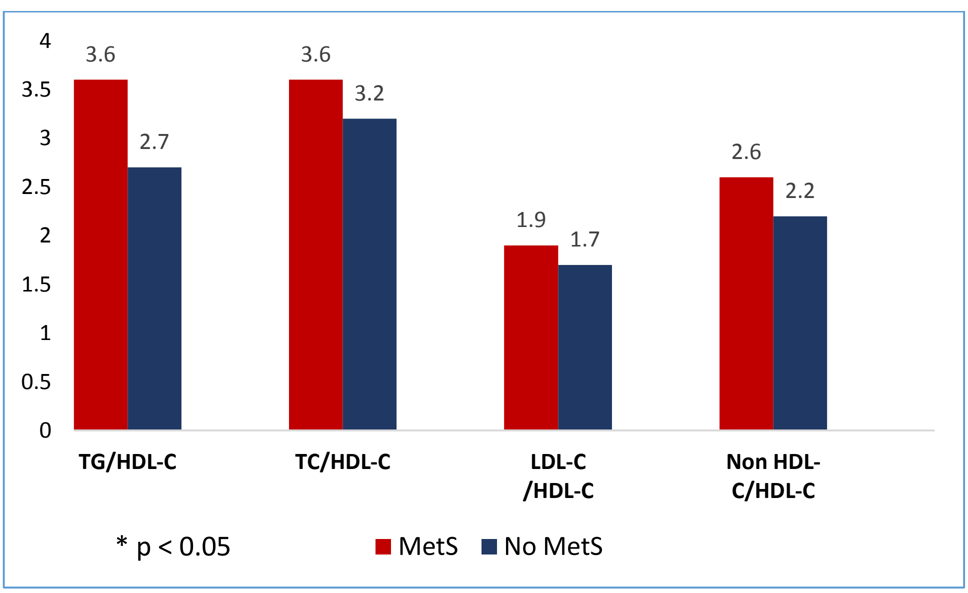

***Graph 2: Distribution of MetS in males and females***

| Parameters<br>* p < 0.05 | Mean ±Standard deviation | | |
|---|---|---|---|
| | Metabolic Syndrome Present | Metabolic Syndrome Absent | Total |
| Age (Years) | 57.23±11.5 | 53.41±12.93 | 54.37±12.68 |
| TC* (mg/dl) | 223.86±42.36 | 209.00±35.82 | 212.75±38.08 |
| TG* (mg/dl) | 217.15±61.64 | 171.52±61.47 | 183.03±64.57 |
| HDL-C* (mg/dl) | 63.68±12.12 | 67.16±14.29 | 66.28±13.85 |
| LDL-C* (mg/dl) | 116.76±37.71 | 107.54±28.74 | 109.87±31.46 |
| Non HDL-C* (mg/dl) | 160.19±39.83 | 141.84±33.36 | 146.47±35.96 |
| TG/HDL-C* | 3.6±1.5 | 2.7±1.3 | 2.9±1.4 |
| TC/HDL-C* | 3.6±0.8 | 3.2±0.7 | 3.3±0.7 |
| LDL-C/HDL-C* | 1.9 ±0.6 | 1.7±0.5 | 1.7±0.5 |
| Non-HDL-C/HDL-C* | 2.6 ±0.8 | 2.2±0.7 | 2.3±0.7 |

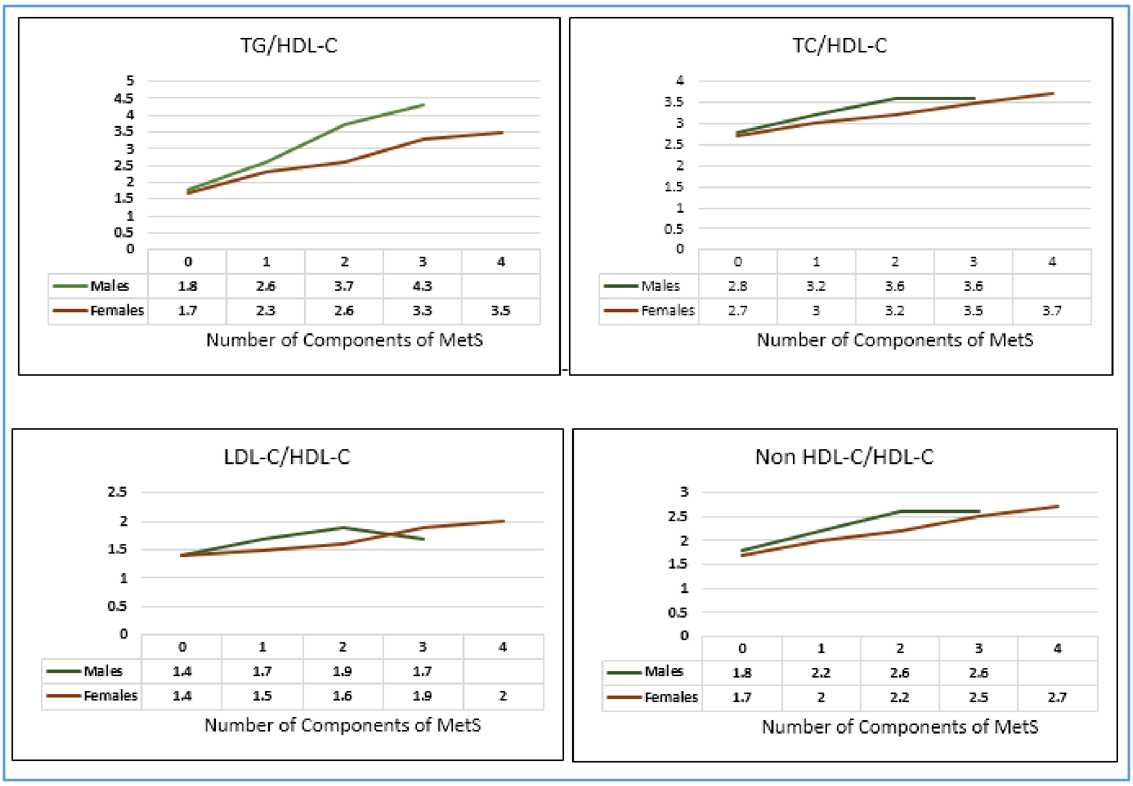
***Table 2: Various parameters with their mean and standard deviation***



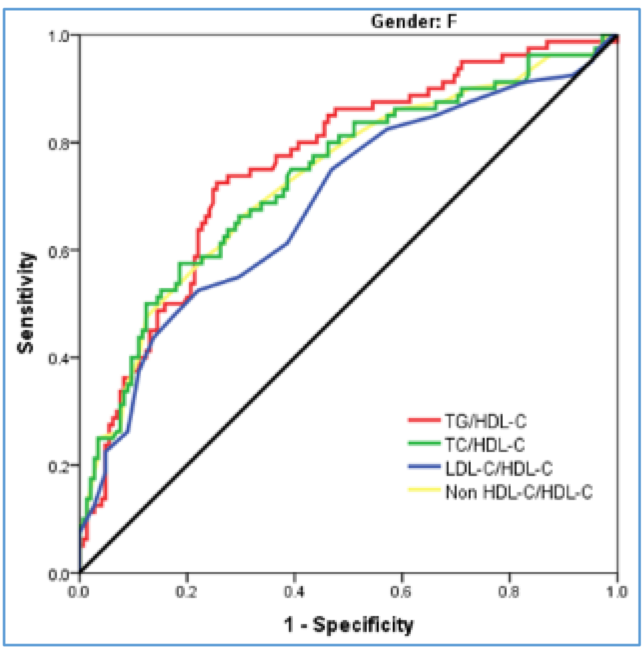

***Graph 3: Comparison of mean values of Lipid profile in subjects with and without MetS***



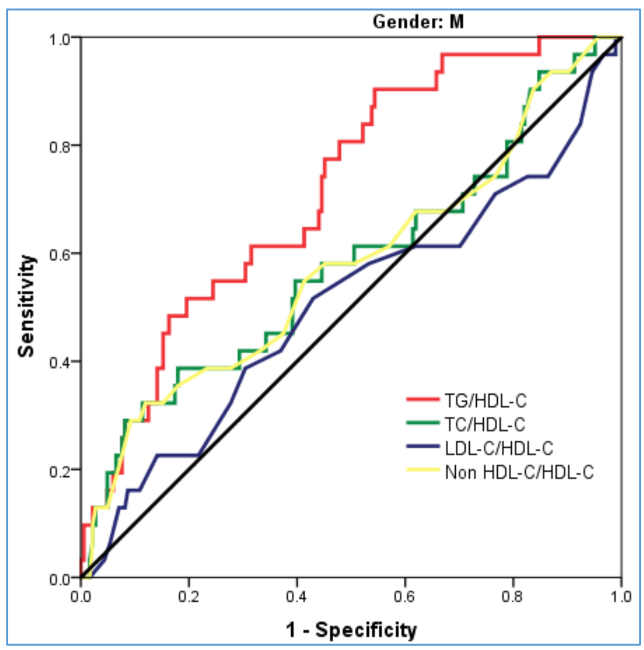

***Graph 4: Comparison of mean of Lipid ratios in subjects with and without MetS.***




*Graph 5: Representation of Lipid ratios with comparison of Number of components of MetS*




*Graph 6: Receiver Operating Characteristic curve to evaluate the lipid ratios in females*




*Graph 7: Receiver Operating Characteristic curve to evaluate the lipid ratios in males*

| Parameters Female | AUC | Coordinates (Sensitivity%, Specificity %) |
|---|---|---|
| TG/HDL-C | 0.760 | 2.17(86.3%, 52.4%) |
| TC/HDL-C | 0.734 | 3.11(75%, 60%) |
| LDL-C/HDL-C | 0.688 | 1.55(75%, 53.1%) |
| Non HDL-C/HDL-C | 0.732 | 2.15(72.5%, 61.4%) |

*Table 3: Results obtained from ROC curve for females*

| Parameters Male | AUC | Coordinates (Sensitivity%, Specificity %) |
|---|---|---|
| TG/HDL-C | 0.717 | 2.66(80.6%, 52.2%) |
| TC/HDL-C | 0.579 | 3.23(61.3%, 49.5%) |
| LDL-C/HDL-C | 0.504 | 1.75(51.6%, 57.1%) |
| Non HDL-C/HDL-C | 0.577 | 2.35(58.1%, 54.9%) |

*Table 4: Results obtained from ROC curve for males*

## DISCUSSION

MetS is a cluster of abnormalities associated with increased cardiovascular risk. This study showed that MetS is more common in females when compared to males. There was a statistically significant increase in mean values of lipid ratios in participants with MetS. Mean values of lipid ratios also show increases with increase in the number of components of MetS among the participants.

The present study showed that compared to various lipid ratios, TG/HDL-C was a better indicator to discriminate individuals with MetS. This is in agreement with a study conducted by Gasevic et al. in 2014 where TG/HDL-C was best able to discriminate between individuals with and without MetS compared to the other lipid ratios.[8]

Various other studies have shown the importance of lipid ratios. In a study conducted on Nigerian population, the ratios LDL-C/HDL-C and TC/HDL-C were considered in defining risks of cardiovascular disease compared to individual lipid values. In a report from the Swedish National Diabetes Register, study has demonstrated that non-HDL-C/HDL-C was better than LDL cholesterol for prediction of CHD risk in patients with type 2 diabetes.[9,10]

A retrospective report on diabetic and non-diabetic subjects of Northern India suggests that TG/HDL-C may be particularly useful as an atherogenic risk predictor in newly-diagnosed type 2 diabetic patients.[11]

In contrast to waist circumference and other anthropometric measurements, both TG and HDL-C are routinely measured and TG/HDL-C can be readily calculated and hence it can serve as a quick tool to identify population at increased risk for CVD. By obtaining the cut-off values for the various lipid ratios for a particular population, lipid ratios can be used as predictors of MetS.

The limitations of our study included the selection of study population, which was limited to certain age group. The participants with serum triglycerides >400mg/dl were not involved in the study. Lipid ratios can be obtained only by hospital and laboratory based data, hence the part of population who do not avail hospital and laboratory services cannot be reached by this method.

## CONCLUSION

TG/HDL-C better indicates the risk of MetS compared to various lipid ratios and can be used to predict the risk of MetS. WC is considered to be one of the many important criterias for diagnosing MetS, but when these indices cannot be measured, lipid ratios can be used as an alternative in diagnosing MetS. Lipid ratios can be important tool when the data generated by various laboratories from different sectors at the community level used for identifying MetS and in turn the risk for CVD in the population and helps in implementation of preventional and interventional strategies.

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