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Metabolic syndrome in type 2 diabetes mellitus : comparison of WHO,IDF and modified NCEP criteria.

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Abstract :

Background :

Metabolic syndrome is a constellation of metabolic abnormalities that has increased risk of cardiovascular diseases and diabetes mellitus.

Aim:

The current study aims for the detection of metabolic syndrome in diabetes patients using three different criteria's and to identify most sensitive criteria among WHO, IDF and modified NCEP ATP criteria.

Methods :

The data for this study was collected from 200 patients with diabetes mellitus who presented to the Department of Medicine, Kempegowda Institute of Medical Sciences Hospital, Bangalore . A detailed history, clinical examination was done and anthropometric measurements were undertaken and they were subjected to relevant investigations. Subjects were classified into three different groups according to three set of criteria's for comparison of important variables. Data collected for the study was analysed statistically.

Results :

Out of total 200 subjects with type 2 diabetes, 185 patients had fulfilled WHO criteria, 189 patients had fulfilled modified NCEP-ATP III criteria's and 154 patient had fulfilled IDF criteria for metabolic syndrome. 176 patients had fulfilled both WHO and modified NCEP-ATP III CRITERIA'S , 15 patients had fulfilled both modified NCEP-ATP III CRITERIA'S and IDF criteria and 146 patients fulfilled WHO and IDF CRITERIA.

Number of male patients were 114(57.0%) ,and female patient were 86(43.0%), mean age was 57.64 years(p value 0.6) .The mean duration of diabetes is 6.8 yrs. Mean waist hip ratio was 1.03 (p value <0.001) Number of male and female patient diagnosed to have obesity according to WHO criteria are 105 and 80 respectively. With mean waist hip ratio of 1.05 in male and 1.01 in female. The p value for waist to hip ratio is <o.ooo1.

The number of male and female patients diagnosed to have obesity according to waist circumference defined in modified NCEP-ATP III CRITERIA'S and IDF criteria are 78 and 75 respectively. The p value for waist circumference is <0.0001 which is significant.

Low HDL was found in 158 patients out of 185 in WHO criteria group, 162 patients out of 189 in modified NCEP-ATP III CRITERIA'S group and 128 patients out 154 in IDF criteria group. The mean value of HDL is 31.9mg/dl.

Triglycerides were elevated in 107 patients out of 185 in WHO criteria group, 189 with NCEP – ATP criteria and 91 patients out of 154 with IDF criteria.

CONCLUSION: In this study modified NCEP-ATP III criteria was able to identify more number of metabolic syndrome cases in type 2 diabetes compared to other criteria's and is more sensitivity

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(94.5%) when compared to other criteria's WHO and IDF being 92.5% and 77% .

KEYWORDS: Metabolic Syndrome, Type-2 diabetes mellitus, obesity

Introduction :

Metabolic syndrome is a cluster of interconnected factors that increases the risk of developing coronary heart diseases and type 2 diabetes mellitus.[1] Major features of metabolic syndrome includes –

- Central obesity,
- Hypertension,
- Hyperglycemia
- Decreased HDL cholesterol
- Elevated triglycerides

Co-occurrence of metabolic syndrome and diabetes further potentiates the cardiovascular risk Therefore, diagnosing metabolic syndrome in type2diabetes helps in risk stratification & allocating health resource and prioritization of patient for preventive strategies.
Several Sets of Criteria have been suggested for the diagnosis of Metabolic syndrome. These includes

- World Health Organization (WHO, 1998)
- Modified National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III) in 2004
- International Diabetes Federation (IDF) in 2005.

Gerald Reaven in 1988 enumerated the elements of a syndrome, which he called "syndrome X," that was characterized by multiple CVD risk factors, including hypertension, hyperglycemia, and dyslipidemia. Importantly he proposed that insulin resistance was underlying pathophysiologic abnormality explaining this clustering of CVD risk factors.[2] Obesity was not considered as risk factor by him now seen by many as an essential component, especially visceral obesity. Various names were subsequently proposed, the most popular being metabolic syndrome. The World Health Organization (WHO) reached a consensus definition of what they termed the "metabolic syndrome". Based on the notion that insulin resistance was the underlying pathophysiologic abnormality, the WHO definition required evidence of insulin resistance (diabetes, impaired glucose tolerance, or insulin resistance) as well as at least two other CVD risk factors, including obesity, hypertension, dyslipidemia, and hyperglycemia.for the diagnosis of metabolic syndrome.

WHO, NCEP ATP III , IDF criteria are very similar and they identify individuals with a given set of symptoms as having metabolic syndrome. NCEP ATP III definition differed from WHO in that insulin resistance was not considered as a diagnostic component. In 2005 IDF published new criteria focussed on the measurement of waist circumference for the detection of abdominal obesity as a simple screening tool. Currently , the two most widely used criteria for the diagnosis of Metabolic syndrome are of NCEP ATP III and IDF focuses on the measurement of central obesity by the waist circumference. Where as WHO focuses largely on insulin resistence.[1]

In 2001, the US National Cholesterol Education Program Adult Treatment Panel (**NCEP ATP III)** released a new definition of the metabolic syndrome. This definition was intended to be more clinically oriented, and required subjects to have at least three of five clinical/metabolic abnormalities[3], which included the following:
1) abdominal obesity(defined as a waist circumference > 89 cm for women and > 102 cm for

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men);
2) Hypertriglyceridemia (fasting triglycerides >150mg/dL);
3) Low high-density lipoprotein cholesterol (< 50mg/dL for women or < 40 mg/dL for men);
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4) Elevated blood pressure (130/85 mm Hg); or
5) Hyperglycemia (a fasting glucose >110 mg/dL, impaired glucose tolerance, or diabetes).[3]

According to the new IDF definition , for a person to be defined as having the metabolic syndrome they must have:
1. Central obesity which is pre requisite (defined as waist circumference >/= 90 cm for men and >/=80 cm for women,(south asians with ethnicity specific values)plus any two of following
2. Raised triglycerides level: > 150 mg/dL (1.7 mmol/L), or specific treatment for this lipid abnormality or
3. Reduced HDL-cholesterol: < 40 mg/dL (1.03 mmol/L) in men and < 50 mg/dL (1.29 mmol/L) in women, or specific treatment for these lipid abnormalities
4. Raised blood pressure: systolic BP >/= 130 or diastolic BP >/= 85 mm Hg, or treatment of previously diagnosed hypertension
5. Raised fasting plasma glucose >/= 100 mg/dL (5.6 mmol/L), or previously diagnosed type 2 diabetes. (If above 5.6 mmol/L or 100 mg/dL, an oral glucose tolerance test [OGTT] is strongly recommended, but is not necessary to define presence of the syndrome.)[4]

WHO definition

Diabetes /Glucose intolerance/ Impaired fasting glucose/ Insulin resistance
Plus at least two of the following criteria:
a. Waist-to-hip ratio of >0.90 in men and >0.85 in women
b. Serum triglycerides >150 mg/dL (1.7 mmol/L)
c. HDL cholesterol <35 mg/dL in men and <39 mg/dL in women
d. Blood pressure >140/90mmhg
e. Urinary albumin excretion rate >20 ug/min or Albumin: creatinine ratio >30mg/g.[5]

In most people with glucose intolerance or type 2 diabetes mellitus, there is a multiple set of risk factors that commonly appear together forming what is known as metabolic syndrome. This clustering of metabolic abnormalities in an individual confer an additional cardiovascular risk over and above the sum of risk associated with each abnormality. More the components of metabolic syndrome detected higher is the cardiovascular mortality rate.[6,7]

Cardiovascular death is the primary clinical outcome of the metabolic syndrome according to with NCEP ATP III most of the people having insulin resistance which increases the risk for type 2 diabetes mellitus, when diabetes becomes clinically apparent, cardiovascular disease risk rises sharply. Individuals with metabolic syndrome are susceptible to other conditions PCOD, fatty liver, cholesterol gall stones, asthma, sleep disturbances other than cardiovascular disease and type 2 diabetes.[8]

Individuals with metabolic syndrome are at increased risk for cardiovascular diseases. In Framingham study, the metabolic syndrome alone predicted 25% of all new onset cardiovascular disease.Framingham cohort showed the presence of metabolic syndrome was predictive of new onset diabetes and also explained half of the population attributable risk for diabetes by the presence of NCEP ATP III metabolic syndrome.[8]

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So, In our study we are going to see which of the three set of criteria's is more sensitive in diagnosing metabolic syndrome in type 2 diabetes patient in Indian population .

Aims and objectives :

To identify metabolic syndrome in type 2 diabetes and to know the most sensitive criteria in diagnosing metabolic syndrome in type 2 diabetes among WHO, IDF, modified NCEP-ATP III criteria's in Indian population.

MATERIALS & METHODS

Type of study : Comparative study

Subjects/Source of patients : Inpatient and Outpatient of Medicine department, KIMS hospital, Bangalore.

Duration :18months

Sample size : 200

Inclusion criteria:

1. Patient with type2 diabetes with metabolic syndrome diagnosed by atleast any one of the three criteria's (WHO , modified NCEP-ATP III criteria).

Exclusion criteria :

1. Patients with diabetes mellitus age less than 35years
2. Gestational diabetes

Informed consent for participation in the study will be obtained from all patients
After obtaining consent from type 2 DM patient following details are taken

- Age of the Patient
- History of diabetes and medication
- History of hypertension and medication
- History of dyslipidemia and medication,

Physical Examination :

- Blood pressure recording

- Anthropometric measurement such as
  1. Height in mts, Weight in kgs, ,
  2. Waist circumference in cms , Hip circumference in cms are taken.
  3. BMI & Waist Hip Ratio are calculated

Investigations :

Fasting lipid profile
• HDL Cholesterol
• TG
FBS & PPBS
Urinary Microalbuminuria by spot test are done.

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STATISTICAL METHOD

Type 2 diabetic patients were screened for presence of risk factors like hypertension , obesity elevated triglyceride and low HDL .Descriptive statistical characteristics and variables of the patients will be described, the biochemical and other numerical parameters will be obtained and then we are going to compare three different criteria's they are WHO , modified NCEP-ATP and IDF criteria's in each patient and will see which all the criteria's can diagnose metabolic syndrome in each patient. patients diagnosed to have metabolic syndrome with at least any one of the three criteria's were analysed.

Results :

TABLE NO 1: NUMBER OF METABOLIC SYNDROME CASES DETECTED BY DIFFERENT DIAGNOSTIS CRITERIAS

Criteria	N (%)
Total	200
Metabolic syndrome – WHO	185(92.5%)
Metabolic syndrome NCEP-ATP	189(94.5%)
Metabolic syndrome - IDF	154(77%)

GRAPH NO 1: FREQUENCY OF METABOLIC SYNDROME

Out of total 200 subjects , 185 patients had fulfilled WHO criteria , 189 patients had fulfilled modified NCEP-ATP III criteria and 154 patient had fulfilled IDF criteria .

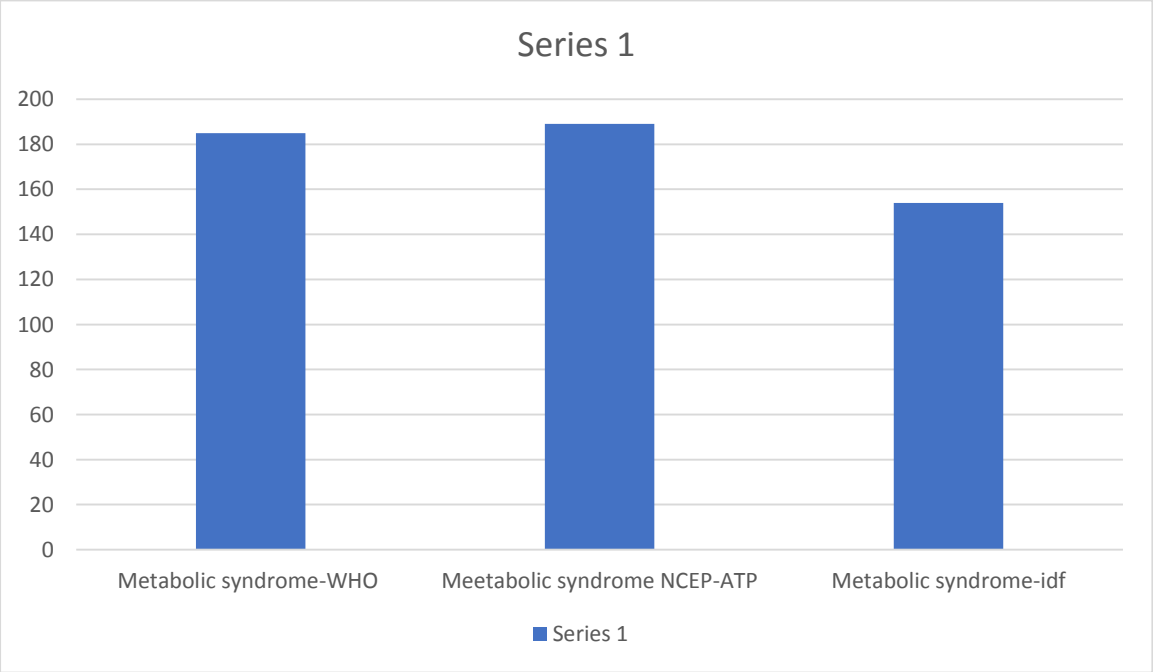

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TABLE NO 2: SENSITIVITY OF INDIVIDUAL CRITERIAS IN DIAGNOSING METABOLIC SYNDROME IN TYPE 2 DIABETES MELLITUS

Criteria	Sensitivity
WHO	**92.5%**
NCEP – ATP	**94.5%**
IDF	**77%**

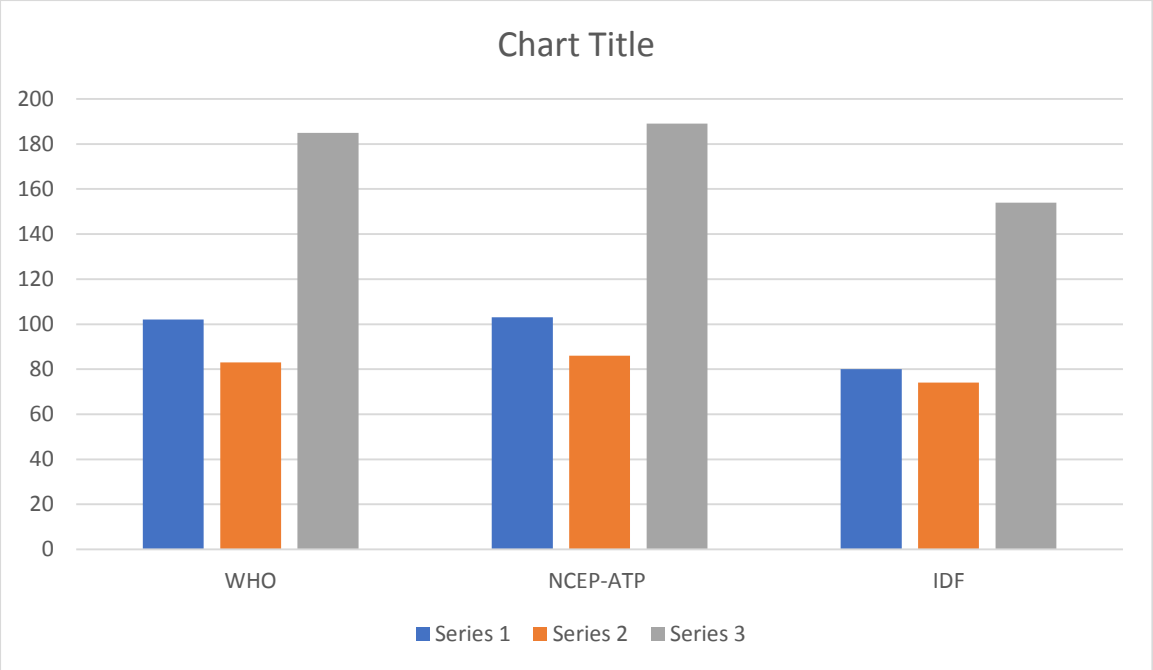
Sensitivity for WHO criteria is 92.5%, modified NCEP-ATP criteria is 94.5% and IDF criteria is 77%.

GENDER DISTRIBUTION

TABLE NO 3: GENDER DISTRIBUTION.

Criteria	Male	Female	Total
	114(57.0%)	**86(43.0%)**	**200**
WHO	**102**	**83**	**185**
NCEP – ATP 3	**103**	**86**	**189**
IDF	**80**	**74**	**154**

Graph no 3 :



Number of male patients were 114(57.0%) and female patient were 86(43.0%).
WHO criteria detected metabolic syndrome in 102 out of 114 males and 83 out of 86 females.Modified NCEP ATP III criteria detected metabolic syndrome in 103 out of 114 males and 86 out of 86 females.

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IDF criteria detected metabolic syndrome in 80 out of 114 males and 74 out of 86 females.

AGE
TABLE NO 4: MEAN AGE IN YEARS.

	N	Mean age (years)	P value
Male	114	57.9	
Female	86	57.6	
Total	200	57.64	0.604

Mean age in years among males is 57.9yrs and in females is 57.6yrs.
Mean age in years is 57.64 with p value 0.604 and in reference study p value is 0.12

WAIST HIP RATIO
TABLE NO 5: WAIST HIP RATIO OF MALES AND FEMALES IN WHO CRITERIA FULFILLING GROUP.

	Waist to hip ratio	N	Mean
Male	>0.9	105	1.05
Female	>0.85	80	1.01
Total		185	1.03

TABLE NO 6: WAIST HIP RATIO MEAN

Waist Hip Ratio (mean)	P value
1.03	< 0.0001

Number of male and female patient diagnosed to have obesity according to WHO criteria(WHR) are 105 and 80 respectively . With mean WHR of 1.05 in male and 1.01 in female .
The p value for WHR is <o.ooo1 .

WAIST CIRCUMFERENCE OF MALES AND FEMALES IN IDF /NCEP CRITERIA FULFILLING GROUPS.
TABLE NO 7 : WAIST CIRCUMFERENCE IN MALES AND FEMALES

	Waist circumference	N	Mean
Male	>90	78	98.98
Female	>80	75	94.42
Total		153	96.7

The number of male and female patients diagnosed to have obesity according waist circumference defined in modified NCEP-ATP III and IDF criteria are 78 and 75 respectively.
TABLE NO 8 : WAIST CIRCUMFERENCE MEAN

Waist circumference	P value
96.7	<0.0001

In our study the p value for waist circumference is <0.0001 which is significant

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BMI
TABLE NO 9 : BMI MEAN

	N	
Male	114	24.19
Female	86	25.85
Total	200	24.93

TABLE NO 10 : BMI p VALUE

BMI Kg/m2 (mean)	P value
24.93	0.088

Mean value of BMI among males is 24.19 kg/m2 and among females is 25.85kg/m2.
The p value for BMI was 0.088.
P value for BMI was not significant.

HDL
TABLE NO 11: HDL MEAN VALUES IN THREE DIFFERENT GROUPS

	N	Mean	
WHO	185	31.9	158
NCEP-ATP 3	189	31.7	162
IDF	154	32.74	128

Low HDL was found in 158 patients out of 185 in WHO criteria group ,162 patients out of 189 in modified NCEP-ATP III criteria group and 128 patients out 154 in IDF criteria group.

TABLE NO 11: HDL MEAN AND P VALUE

HDL cholesterol Mean (mg/dl)	P value
31.9	0.148

The mean value of HDL is 31.9mg/dl is with p value 0.148 which was not significant compared to reference study .

TRIGLYCERIDES
TABLE NO 12 : TRIGLYCERIDES MEAN VALUES IN THREE DIFFERENT GROUPS

	N	Mean	Elevated TG(>150mg/dl)
WHO	185	178.8	107
NCEP-ATP 3	189	179.2	107
IDF	154	181.1	91

Triglycerides were elevated in 107 patients out of 185 in WHO criteria group , 107 patients out of 189 with modified NCEP –ATP criteria and 91 patients out of 154 with IDF criteria.

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TABLE NO 13 : TRIGLYCERIDES MEAN AND p VALUE

Triglycerides (mean)	p valve
162	0.012

The p value for triglycerides in present study is 0.012, which was significant.

DISCUSSION :

Totally 200 subjects of type 2 diabetes with metabolic syndrome were enrolled into study. out of these 200 subjects ,114 were males (57%.) and 86 were females (43%).in these 200 subjects mean duration of type 2 diabetes mellitus is 6.8yrs.

Out of total 200 subjects with type 2 diabetes, 185 patients had fulfilled WHO criteria for metabolic syndrome, 189 patients had fulfilled modified NCEP-ATP III criteria for metabolic syndrome and 154 patient had fulfilled IDF criteria for metabolic syndrome. 176 patients had fulfilled both WHO and modified NCEP ATP criteria for metabolic syndrome, 159 patients had fulfilled both modified NCEP-ATP III and IDF criteria and 146 patients fulfilled WHO and IDF CRITERIA for metabolic syndrome.

It was found that Sensitivity for WHO criteria is 92.5%, for modified NCEP-ATP III criteria is 94.5% and IDF criteria is 77%. Among these three criteria's , modified NCEPATP III criteria was more sensitive in diagnosing metabolic syndrome in type 2 diabetes patients .

Higher prevalence of MS by modified NCEP-ATP III definition in comparison to IDF could be attributed to the relative flexibility of the modified NCEP-ATP III in which abdominal obesity is not considered as a prerequisite for the diagnosis.

In this study IDF criteria was able to detect metabolic syndrome in less number of cases (i.e, 154 cases out of total 200 cases with a sensitivity of 77%) when compared to modified NCEP-ATP III and WHO criteria. This is because in IDF criteria central obesity defined by waist circumference of > 90cm males and >80 cm in females) is a compulsory prerequisite for diagnosing metabolic syndrome cases , so cases with waist circumference below 90cms in males and 80cms in females are left out of metabolic syndrome.

WHO criteria detected metabolic syndrome in 102 out of 114 males and 83 out of 86 females.

Modified NCEP ATP III criteria detected metabolic syndrome in 103 out of 114 males and 86 out of 86 females.

IDF criteria detected metabolic syndrome in 80 out of 114 males and 74 out of 86 females.

So WHO and modified NCEP-ATP III criteria detected more metabolic syndrome cases both in males and females compared to IDF criteria.

Mean age in years among males is 57.9yrs and in females is 57.6yrs. Mean age in years among type 2 patients fulfilling WHO criteria , modified NCEP-ATP III criteria and IDF criteria is 57.96 ,57.47 and 57.42 respectively. Mean age in years is 57.64 with p value 0.604 and in reference study conducted by Ahmed et al**6** p value is 0.12 ,Mean age was not significant in this study.

Mean waist hip ratio was 1.03 (p value <0.001).Number of male and female patient diagnosed to have obesity according to WHO criteria are 105 and 80 respectively. With mean WHR of 1.05 in male and 1.01 in female. The p value for WHR is <o.ooo1.

The number of male and female patients diagnosed to have obesity according waist circumference defined in modified NCEP-ATP III and IDF criteria are 78 and 75 respectively. The p value for waist circumference in this study is <0.0001 and in reference study conducted by Ahmed et**6** al the p value for waist circumference is 0.01 which is significant both studies

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Mean value of BMI among males is 24.19 kg/m2 and among females is 25.85kg/m2 .The p value for BMI was 0.088 and p value in study conducted by Ahmed et al**6** is 0.10 which is not significant in both studies.
Low HDL was found in 158 patients out of 185 in WHO criteria group, 162 patients out of 189 in modified NCEP-ATP III criteria group and 128 patients out 154 in IDF criteria group. The mean value of HDL is 31.9mg/dl is with p value 0.148 which was not significant compared to reference study**6** in which HDL was significant with p value being <0.001
Triglycerides were elevated in 107 patients out of 185 in WHO criteria group, 189 with modified NCEP-ATP III criteria and 91 patients out of 154 with IDF criteria. The p value for triglycerides in this study is 0.012, and in reference study**6** it is 0.005 which is significant in both studies.

Conclusion :

In this study modified NCEP-ATP III criteria was able to identify more number of metabolic syndrome (i.e., 189 0ut of 200) cases in type 2 diabetes with a sensitivity of 94.5 % .Next is WHO criteria which was able to detect 185 metabolic syndrome cases out of total 200 cases with sensitivity of 92.5%.
In this study IDF criteria with a sensitivity of 77% (154 metabolic cases out of total 200 cases) is the least in detecting metabolic syndrome cases in type 2 diabetes mellitus.
So to conclude modified NCEP ATP III criteria is best in detecting metabolic syndrome in type 2 diabetes mellitus.

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