Receiver Operating Characteristic curve analysis of Anthropometric, Physiological and Biochemical indices and a comparison between four International definitions: JSS, mATP-III, IDF and ATP-III for screening Metabolic Syndrome among Pre-and Postmenopausal Rural females of Amritsar (Punjab)

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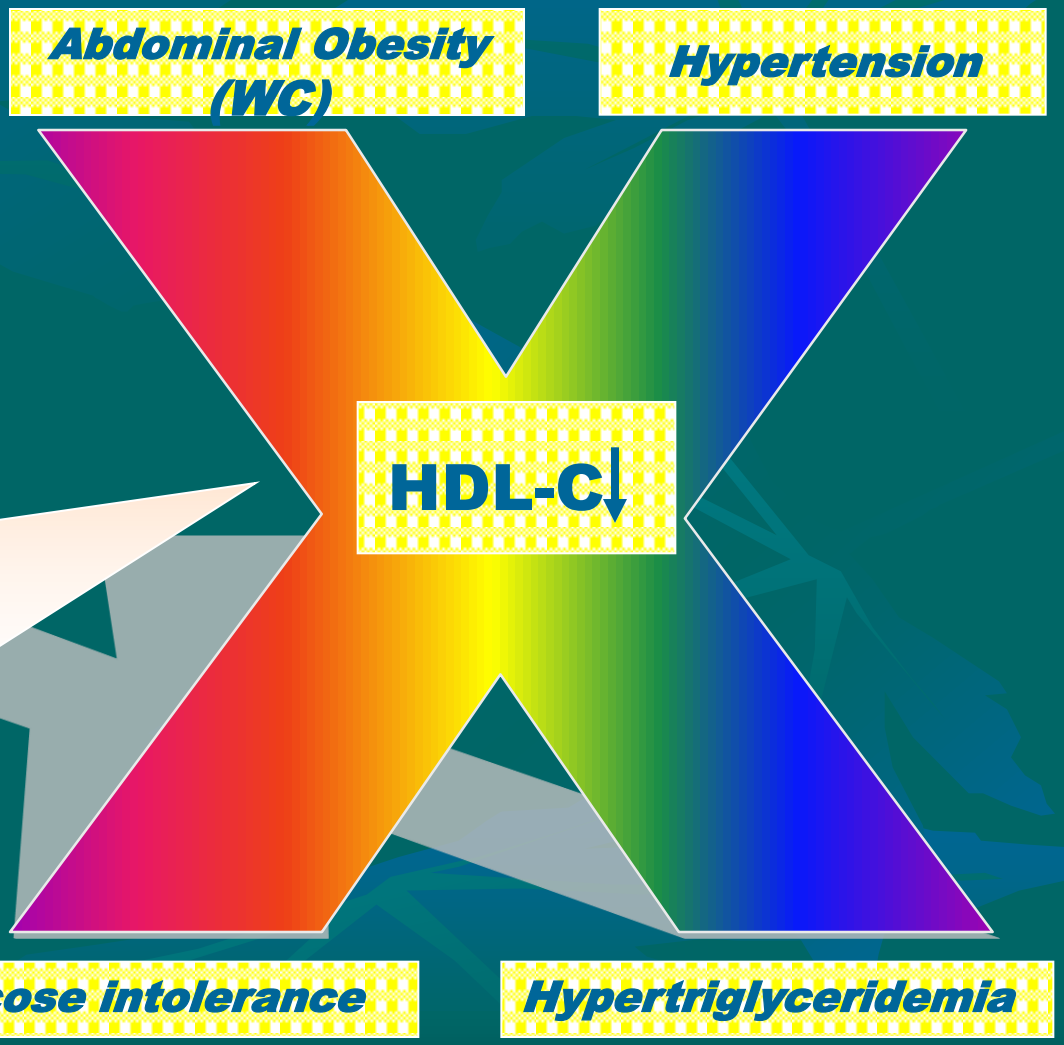
INTRODUCTION

- **Metabolic Syndrome (MS) is defined as a web of interconnected physiological, biochemical, clinical and metabolic risk factors that directly increases the risk of various non-communicable diseases like T2DM and CVDs and all-cause morbidity and mortality across the globe.**

- **According to International Classification of Disease (ICD-9), the code of MS is 277.7 (WHO).**

MS-Cluster of risk factors

Presence of atleast any three risk factors



MS - (Predictor of Diabetes and CVD epidemic)

Individuals with MS confers a 5-fold risk of developing T2DM and a 2-fold risk of developing CVDs as compared to individuals without syndrome.

Further, patients with MS are at 2-to 4-fold risk of stroke, 3-to 4-fold increased risk of myocardial infarction and 2-fold risk of dying from such an event compared with those without the syndrome.

Emergence of METABOLIC SYNDROME

Morgagni (1765)

Kylin (1920)

Vague (1947)

Avogadro and Crepaldi (1965)

Haller (1977)

Reaven (1988)
Syndrome 'X'

WHO (1999)

Deadly Quartet

Kaplan (1989)

Criteria used for the clinical diagnosis of Metabolic Syndrome among females

Variables	WHO (1999)	NCEP ATP-III (2001)	IDF (2005)	mNCEP ATP-III (2005)	JSS (2009)
WC (cm) **BMI (kg/m²)** **WHR**	BMI ≥ 30 Or WHR > 0.85	WC ≥ 88	WC ≥ 80	WC ≥ 80	WC ≥ 80
Blood Pressure (mm Hg)	≥ 140/90	≥ 130/85	≥ 130/85	≥ 130/85	≥ 130/85
Fasting Blood Glucose (mg/dl)	≥110	≥ 110	≥ 100	≥ 110	≥ 100
Triglycerides (mg/dl)	≥ 150	≥ 150	≥ 150	≥ 150	≥ 150
HDL-C (mg/dl)	< 39	≤ 50	≤ 50	≤ 50	≤ 50
Assessment of MS	***Glucose intolerance*** *plus any two risk factors*	*Atleast any three risk factors*	***Abdominal obesity*** *plus any two risk factors*	*Atleast any three risk factors*	*Atleast any three risk factors*

WHO (World Health Organization)
NCEP ATP-III (National Cholesterol Education Program Adult Treatment Panel- III)
mNCEP ATP-III (National Cholesterol Education Program Adult Treatment Panel- III)
IDF (International Diabetes Federation)
JSS (Joint Scientific Statement)

Synonyms of MS

- Syndrome X
- Insulin resistance syndrome
- Cardiometabolic syndrome
- Dysmetabolic syndrome
- The Deadly Quartet
- Multiple metabolic syndrome
- CHAOS
- Syndrome of Affluence





Prevalence of METABOLIC SYNDROME

- Worldwide, the prevalence of MS ranges from <10% to as much as 84%, depending on the variation in SES, population variation, different lifestyle patterns, menopausal status, periodic dissimilarity and criterion used for defining MS (Kaur, 2014)

- It has been estimated that 17-25% of the world population have MS.

- According to NCEP ATP-III (2001), the prevalence of MS varied from 8% to 43% in men and from 7% to 56% in women around the world.

Prevalence of METABOLIC SYNDROME contd..

- Among Asian women, the prevalence of MS ranged from 13.8% in premenopausal to more than 60% in postmenopausal .

- Recent studies of MS in Indian menopausal women show a prevalence ranging from 19.2% in premenopausal and 32.4% in postmenopausal women (Shah, 2010)

INTERNATIONAL SCENARIO

Area	Age	Number of females	Criteria Used	Percentage Prevalence	Investigator
China	≥20	3196	JIS	28.2	Xu *et al.* (2014)
Bangladesh	≥15	Pre-M=1094 Post-M=708	ATP-III	16.80 39.30	Jesmin *et al.* (2013)
Italy (Post-M women)	------	161	IDF	43.50	Spadafranca *et al.* (2013)
Turkey	20-80	310	ATP-III	55.10	Pinar *et al.* (2012)
Iran (Sistanee women)	20-40	160	ATP-III	23.75	Marjani *et al.* (2012)
Ghana (Pre vs Post)	20-78	Pre-M=143 Post-M=107	JIS	24.00 44.40	Arthur *et al.* (2012)
Iran(Fars ethnic women)	20-40	160	ATP-III	20.62	Marjani *et al.* (2012)
Malaysia (Post-M)	≥45	411	IDF	36.70	Hussain *et al.* (2012)
Iran(Pre vs Post)	20-76	Pre-M=725 P0st-M=215	ATP-III	18.3 53.50	Eshtiaghi *et al.*(2010)
Iran(Pre/ Early M/ Post)	>45	Pre-M=303 Early M=233 Post-M=987	ATP-III	44.90 57.90 64.30	Heidari *et al.* (2010)
Iran (Pre/ Meno/ Post)	Pre-M=47±1.9 Meno=53.0±4.0 Post-M=61.0±4.3	537 311 1334	ATP-III	53.00 54.00 69.00	Ainy *et al.* (2007)

INDIAN SCENARIO *(Rural females)*

Area	Age	Number of females	Criteria Used	Percentage Prevalence	Investigator
Rural Amritsar females	25-55	Total=300 Pre-M=186 Post-M=114	mATP-III IDF ATP-III	25.66 24.33 21.66	Randhawa and Sidhu (2015)
Mandur /Goa	>25	176	ATP-III	39.80	Peixoto and Shah (2014)
North Indian population	Pre-M=25-40 Post-M=45-60	200	ATP-III	Pre-M=20.00 Post-M=41.00	Chhabra *et al.* (2014)
Tumkur/Karnataka	≥18	433	mATP-III	55.19	Shalini *et al.* (2013)
Ambala/Haryana	≥20	627	IDF	11.64	Pathania *et al.* (2013)
Thiruvallur /TamilNadu	30-50	150	ATP-III mATP-III	30.70 36.00	Selvaraj *et al.* (2012)
Jammu & Kashmir	Mean age=49.35 (Post-M women)	500	ATP-III	13.00	Tandon *et al.* (2010)
Chandigarh	≥18	315	ATP-III IDF	34.90 41.30	Mangat *et al.* (2010)
Wardha/Mumbai	≥18	131	ATP-III	7.60	Kamble *et al.* (2010)
Tribal Himalayan populations	≥12	Toto=150 Bhutia=46	ATP-III	52.20	Sarkar *et al.* (2006)

Statement of the Problem

- The MS is a modern day epidemic in India at the moment
- There is paucity of studies on MS and menopausal status in the developing countries especially in North India .

The present study presents one of the first report from Punjab which has attempted to evaluate the relationship of anthropometric, physiological, body composition and biochemical variables for screening MS among rural premenopausal and postmenopausal females using four international criteria JSS, mATP-III, IDF and ATP-III.

AIMS and OBJECTIVES

- To assess general obesity and abdominal obesity among Pre- and Postmenopausal Punjabi rural women.

- To perform a comparative validation of obesity indices (BMI, WC, HC WHR, WHtR, PBF, TBW and FMI) for screening MS in premenopausal and postmenopausal women to determine which of these adiposity measures are the best predictors of metabolic risk factors.

- To determine and compare the prevalence of MS and each of its components using different international criteria to initiate and implement lifestyle changes so as to decrease the risk of NCDs in females of Punjab.

AIMS and OBJECTIVES contd...

- To generate baseline data about the lipid profile of Punjabi females to lay the foundation for future intervention studies of Dyslipidemia.

- To study the association between anthropometric, physiological, body composition and biochemical variables.

- To create awareness among Punjabi rural women regarding their health status and to decrease the social taboo embedded in the mindset of rural females in context to their menopausal status.

Research Design and Methodology

- **This cross-sectional study was conducted among 500 rural females (289 premenopausal and 211 postmenopausal) of Amritsar ranging in age 25 to 55 years during the period from September 2014 to May 2015.**

- **Study protocol was approved by Ethical Review Committee of Guru Nanak Dev University, Amritsar.**

- **After fully explaining the nature, procedure, aims and objectives of the study to all the females in a language they understand (Punjabi and Hindi), verbal as well as written consent was obtained**

INCLUSION CRITERIA

- *Age ≥ 25 years*
- *Apparently healthy subjects*
- *Premenopausal- normal menstrual cycle*
- *Postmenopausal- natural menopause*

EXCLUSION CRITERIA

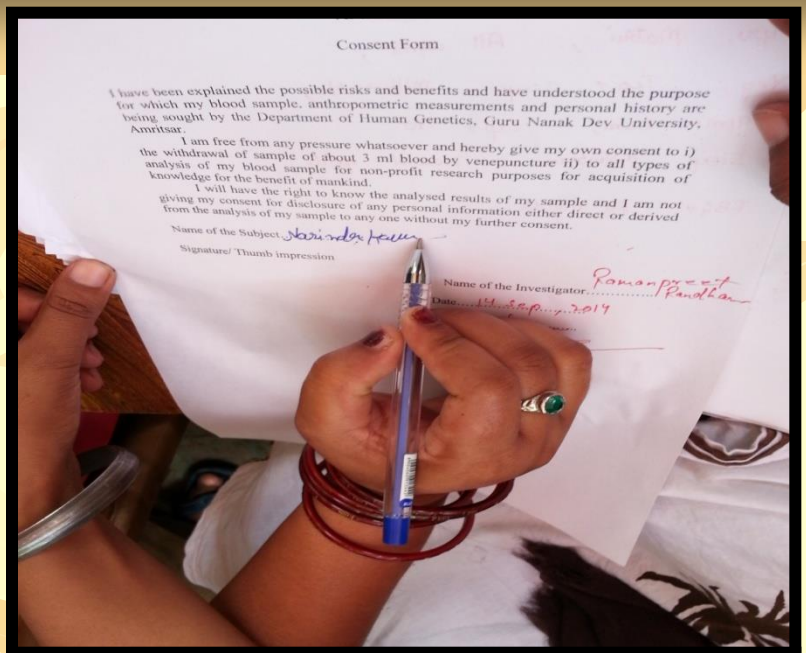
- *Physical deformity*
- *Pregnant females*
- *Postmenopausal - surgical removal of uterus/hysterectomy*
- *People who refused to participate*

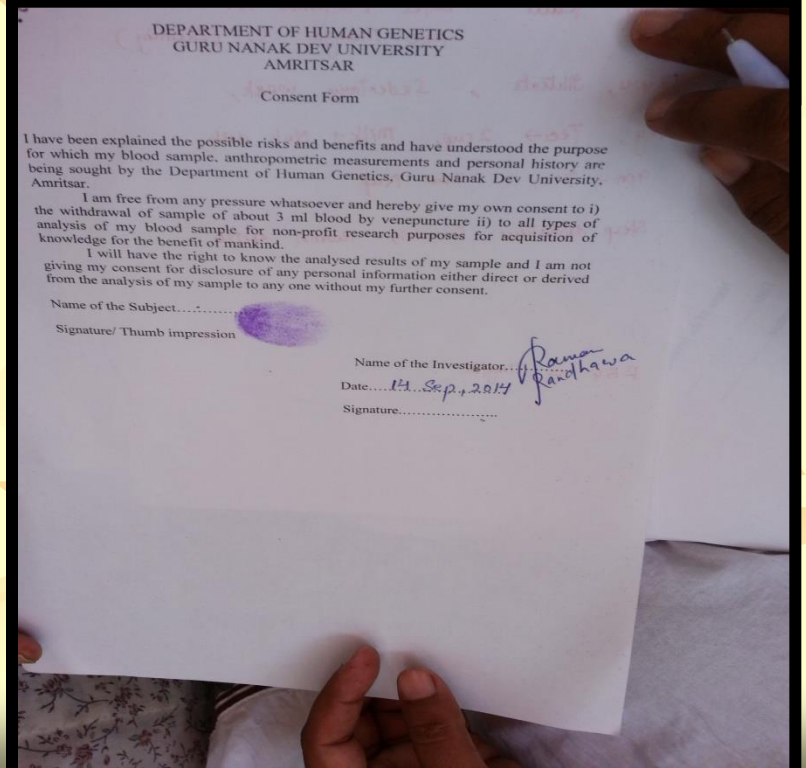
STEP I

CONSENT FORM





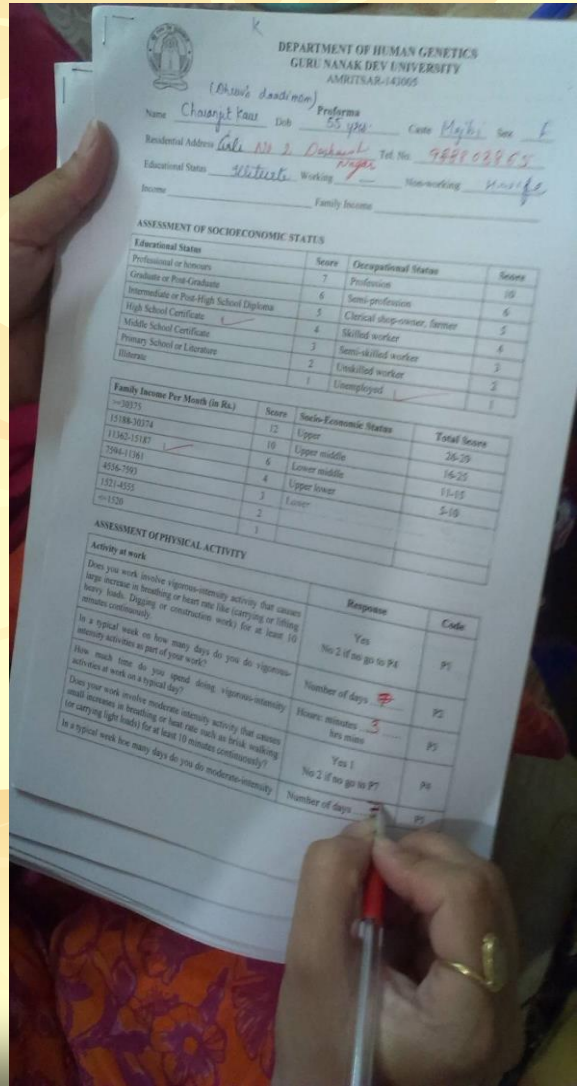




STEP II

Data collection using well designed and structured PROFORMA





STEP III

ANTHROPOMETRIC Measurements

WEIGHT (kg)



HEIGHT (cm)



Waist Circumference (WC)



Hip Circumference (HC)



STEP IV

PHYSIOLOGICAL measurements

- Systolic Blood Pressure (SBP)
- Diastolic Blood Pressure (DBP)





STEP V

Bioelectrical Impedance Analysis (BIA)



A simple, non-invasive, portable, reliable, fast and relatively easy means to assess body composition by sending a low intensity electric current through the body.

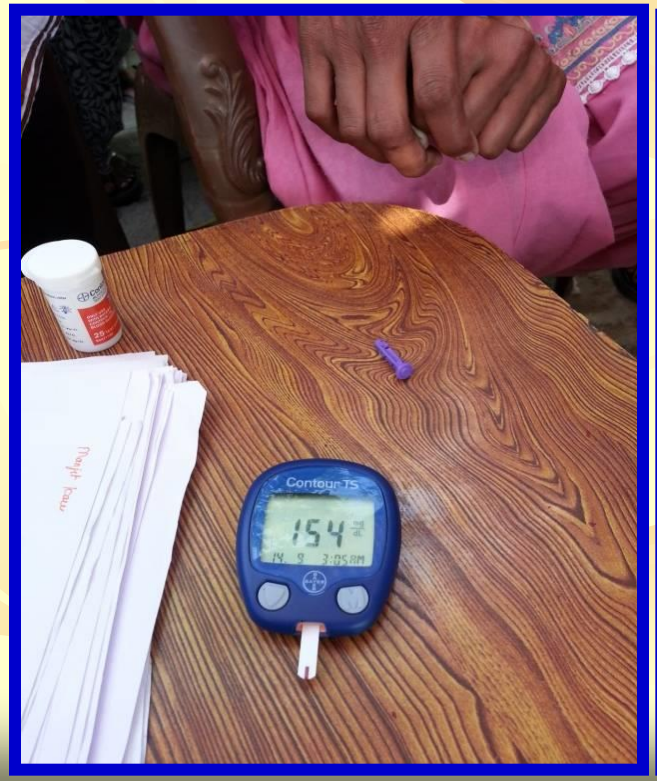
Precautions

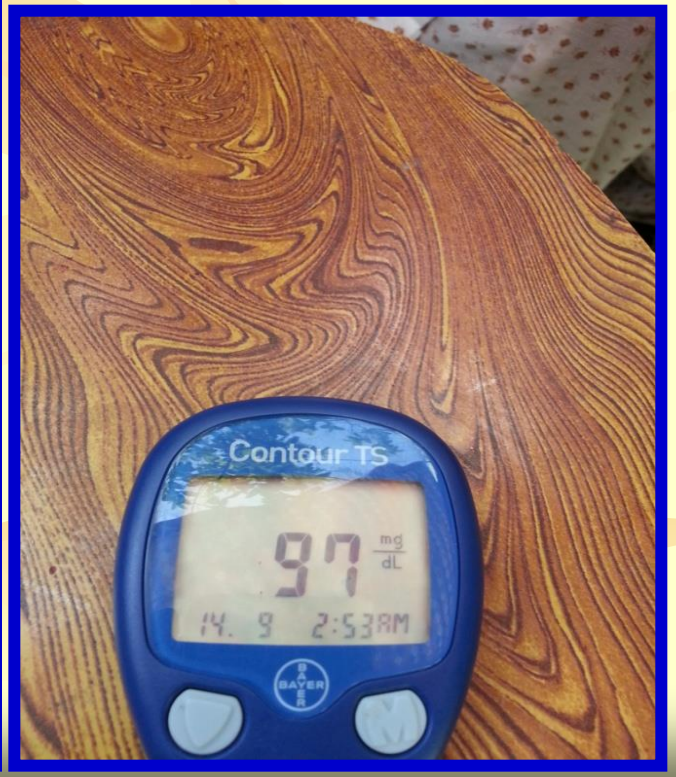
- Not recommended for females in the early stages of pregnancy and menstruation
- Subjects with pace-makers or any implantable electronic device are not advised
- No eating or drinking 4 to 5 hours prior to the test
- No exercise 12 hours prior and no alcohol or caffeine consumption 24 hours prior to the test
- No Sweating
- Urination should have been done to maintain hydration levels

STEP VI

Fasting Blood Glucose (mg/dl) was estimated with the help of automated Glucometer







STEP VII

Fasting Blood Sample Collection for lipid profile

2 ml of blood sample was with drawn in the morning after a 12 hours overnight fast from all the subjects with the assistance of a certified technician



STEP VIII

DISTRIBUTION OF REPORTS



Analysis of Data: Biochemical and Derived Variables

- Total Cholesterol (TC)
- Triglycerides (TGL)
- High Density Lipoproteins-Cholesterol (HDL-C)
- Low Density Lipoproteins-Cholesterol (LDL-C)
- Very Low Density Lipoproteins-Cholesterol (VLDL-C)
- Body Mass Index (BMI)
- Waist-to-Height Ratio (WHtR)
- Waist-to-Hip Ratio (WHR)
- Percent Body Fat (PBF)
- Fat Mass Index (FMI)
- Total Body Water (TBW)
- Pulse Pressure (PP)
- Mean Arterial Pressure (MAP)

STATISTICAL ANALYSIS

Entire data was entered into MS-EXCEL Programme and analyzed using Statistical Software for Windows Version 16.0 (SPSS inc. Chicago, IL) .

RESULTS

TABLE 1 : Baseline characteristics of Pre- and Postmenopausal rural Punjabi women

Variables	Groups				't'- value
	Premenopausal		Postmenopausal		
	Mean	S.D	Mean	S.D	
WC(cm)	79.00	11.6	85.98	13.0	2.063***
HC (cm)	96.00	13.0	99.00	14.0	2.934**
WHR	0.8	0.06	1	0.05	3.531***
WHtR	0.51	0.07	0.56	0.08	2.785***
BMI (kg/m^2)	25.29	5.8	27.73	4.9	4.623***
SBP(mm/Hg)	126.00	17.1	128.8	17.6	0.037*
DBP(mm/Hg)	84.00	12.8	84.9	11.6	1.742
PBF	43.3	10.1	46.61	9.8	135.68***
FMI (kg/m^2)	12.00	4.6	13.9	4.9	137.39***
TBW (ltr)	29.00	6.5	29.34	6.5	169.07***
TC (md/dl)	137.71	46.6	138.16	48.8	0.005**
TGL (mg/dl)	134.87	53.1	129.7	56.1	1.343**
HDL-C (mg/dl)	45.8	15.3	46.06	16.4	1.483
LDL-C (mg/dl)	65.0	43.9	66.17	46.8	1.043**
VLDL (mg/dl)	26.97	10.6	25.95	11.2	1.343
FBG (mg/dl)	96.0	31.6	92.0	31.5	1.157*

significant at $p<0.05$* significant at $p<0.01$** significant at $p<0.001$***

TABLE 2: Percentage prevalence of general obesity among rural Punjabi females using WHO (2000) criteria

Status	Total (500)	Premenopausal (289)	Postmenopausal (211)
Underweight	5.4 (27)	7.2 (21)	2.8 (06)
Normal	23.4 (117)	32.1 (93)	11.3 (24)
Overweight	16 (80)	13.1 (38)	19.9 (42)
Obese 1	30 (150)	27.3 (79)	33.6 (71)
Obese 2	25.2 (126)	20 (58)	32.2 (68)

Figures in parenthesis indicate the number of subjects

TABLE 3: Percentage prevalence of abdominal obesity among rural Punjabi females on the basis of WC using Snehalatha et al. (2003) criteria

Status	Total (500)	Premenopausal (289)	Postmenopausal (211)
Normal	41.6 (208)	51.2 (148)	28.4 (60)
Obese	58.4 (292)	48.7 (141)	71.5 (151)

Figures in parenthesis indicate the number of subjects

TABLE 4: Percentage prevalence of abdominal obesity among rural Punjabi females on the basis of WHtR using Hseih and Muto (2004) criteria

Status	Total (500)	Premenopausal (289)	Postmenopausal (211)
Normal	38 (190)	47.4 (137)	25.1 (53)
Obese	62 (310)	52.5 (152)	74.8 (158)

Figures in parenthesis indicate the number of subjects

TABLE 5: Percentage prevalence of MS in Pre- and Postmenopausal rural Punjabi women according to four international criteria

Criteria	Total (500)		Premenopausal (289)		Postmenopausal (211)	
	Normal	MS	Normal	MS	Normal	MS
JSS (2009)	66.2 (331)	33.8 (169)	68.16 (197)	31.8 (92)	63.50 (134)	36.49 (77)
mATP-III (2005)	70.4 (352)	29.6 (148)	73.01 (211)	26.98 (78)	66.82 (141)	33.17 (70)
IDF (2005)	73.4 (367)	26.6 (133)	77.50 (224)	22.49 (65)	67.77 (143)	32.22 (68)
ATP-III (2001)	75.6 (378)	24.2 (121)	79.23 (229)	20.76 (60)	71.09 (150)	28.90 (61)

Figures in parenthesis indicate the number of subjects

JSS (Joint Scientific Statement)
mNCEP ATP-III (National Cholesterol Education Program Adult Treatment Panel- III)
IDF (International Diabetes Federation)
NCEP ATP-III (National Cholesterol Education Program Adult Treatment Panel- III)

TABLE 6: Percentage prevalence of components of MS in Pre- and Postmenopausal rural Punjabi females

JSS (2009)	**Total (500)**	**Premenopausal (289)**	**Postmenopausal (211)**
WC (cm)			
BP (mm Hg)			
TGL (mg/dl)			
HDL-C (mg/dl)			
FBG (mg/dl)			
mATP-III (2005)	**Total (500)**	**Premenopausal (289)**	**Postmenopausal (211)**
WC (cm)			
BP (mm Hg)			
TGL (mg/dl)			
HDL-C (mg/dl)			
FBG (mg/dl)			

TABLE 6: Conti….

IDF (2005)	**Total (500)**	**Premenopausal (289)**	**Postmenopausal (211)**
WC (cm)			
BP (mm Hg)			
TGL (mg/dl)			
HDL-C (mg/dl)			
FBG (mg/dl)			
ATP-III (2001)	**Total (500)**	**Premenopausal (289)**	**Postmenopausal (211)**
WC (cm)			
BP (mm Hg)			
TGL (mg/dl)			
HDL-C (mg/dl)			
FBG (mg/dl)			

TABLE 7: Clustering of components of MS in rural Punjabi females

Components of MS	Total (500)	Premenopausal (289)	Postmenopausal (211)
	JSS (2009)		
0	6.8 (34)	7.6 (22)	5.6 (12)
1	23.6 (118)	26.2 (76)	19.9 (42)
2	35.4 (177)	34.2 (99)	36.9 (78)
3	22 (110)	20 (58)	24.6 (52)
4	9.6 (48)	5.6 (28)	9.4 (20)
5	2.6 (13)	1.2 (6)	3.3 (07)
Components of MS	**mATP-III (2005)**		
0	7.2 (36)	7.9 (23)	6.1 (13)
1	27 (135)	30.1 (87)	22.7 (48)
2	35 (175)	33.2 (96)	37.4 (79)
3	22 (110)	19 (55)	26 (55)
4	6.8 (34)	7.9 (23)	5.2 (11)
5	2 (10)	1.7 (5)	2.3 (05)

Figures in parenthesis indicate the number of subjects

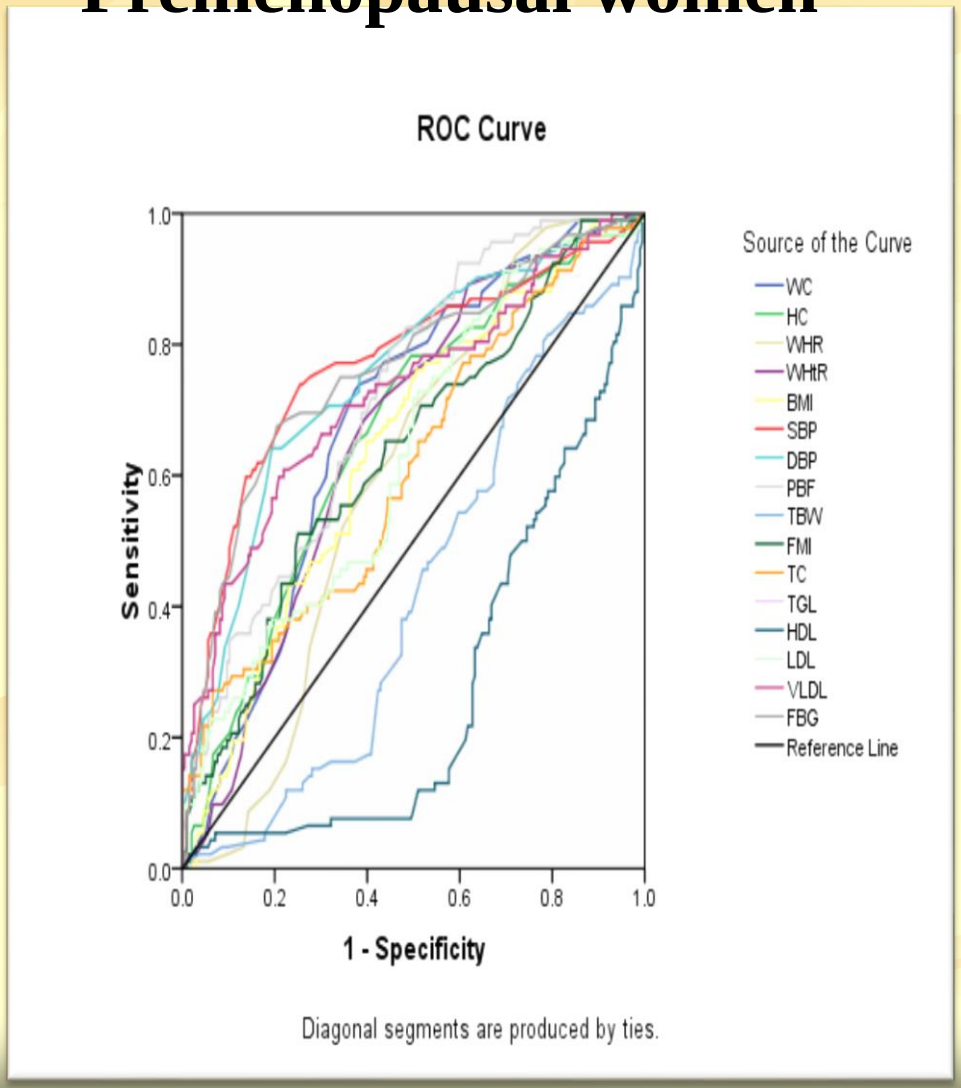
TABLE 7: Conti….

Components of MS	Total (500)	Premenopausal (289)	Postmenopausal (211)
	IDF (2005)		
0	6.8 (34)	7.6 (22)	5.6 (12)
1	24 (120)	26.6 (77)	20.3 (43)
2	34.8 (174)	34.2 (99)	35.5 (75)
3	22.8 (114)	19.7 (57)	27 (57)
4	9.6 (48)	10.3 (30)	8.5 (18)
5	2 (10)	1.3 (04)	2.8 (06)
Components of MS	**ATP-III (2001)**		
0	6.4 (32)	7.2 (21)	5.2 (11)
1	23.2 (116)	25.9 (75)	19.4 (41)
2	34.4 (172)	33.9 (98)	35 (74)
3	21.6 (108)	19.7 (57)	24.1 (51)
4	12.2 (61)	11 (32)	13.7 (29)
5	2.2 (11)	2 (06)	2.3 (05)

Figures in parenthesis indicate the number of subjects

TABLE 8: ROC curve analysis of Anthropometric , Physiological, Body composition and Biochemical variables to evaluate the best metabolic indicators

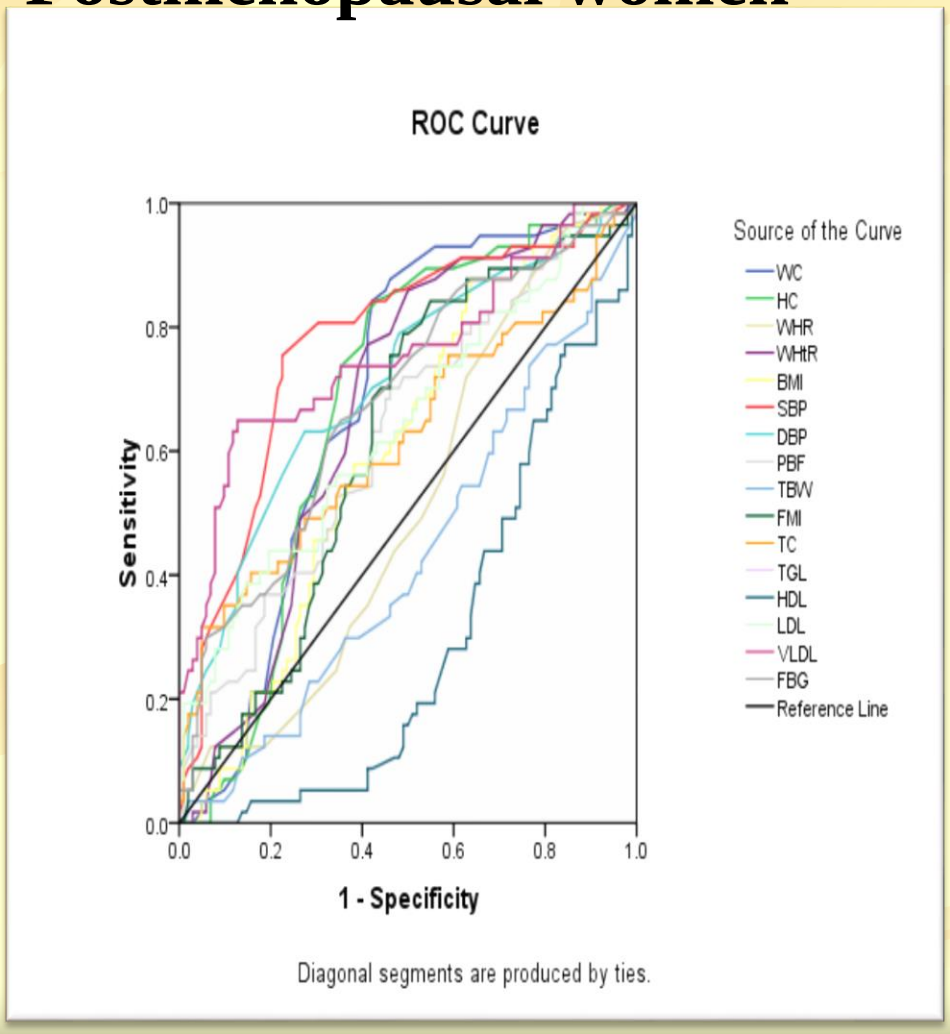
Premenopausal women



Variable	AUC
SBP (mm Hg)	.768
FBG (mg/dl)	.760
DBP (mg/dl)	.751
TGL (mg/dl)	.725
VLDL (mg/dl)	.725
PBF (%)	.717

TABLE 8: conti…

Postmenopausal women



Variable	AUC
SBP (mm Hg)	.768
TGL (mg/dl)	.760
VLDL (mg/dl)	.725
DBP (mg/dl)	.717
WC (cm)	.682
FBG (mg/dl)	.661

MS – Acknowledged Health Hazard
(Risk for clinical outcomes)

- Metabolic Syndrome as a Predictor of CVD
- MS manifests onset of Dyslipidemia
- MS driving force behind the occurrence of T2DM
- MS is a bridge between obesity and NCDs
- During the menopausal transition, MS poses a great threat for women in terms of physiological and psychological changes



Conclusion

- This study highlights the high prevalence of MS among rural women which could increase the burden of diabetes and CVDs in near present future in Punjabi females.

- Women especially in rural areas cannot abandon the “Caretaker role” in the family and have to continue to prioritize the health of the men and children in family leaving them with less time to devote to their own well-being.

- This study also emphasizes the need for education about risk factors, complications , diet control, physical activity, and health awareness camps in rural areas as women have a social taboo to discuss their health issues.

- The economic cost attributable to MS is high that country like India can ill-afford to spend its meager resources on the co-morbidities which are strongly influenced by MS.

- There is an urgent need to establish magnitude of the problem and the risk estimates for various NCDs and incorporate management prevention strategies within the existing health infrastructure.

Between stimulus and response there is a space; In that space is our power to choose our response;

In our response lies our GROWTH and Freedom…





























THANKS…