Obesity is a major public health problem worldwide. India is experiencing an epidemic of Type-2 Diabetes Mellitus and related disorders. With an estimated 50.8 million diabetic people, India has the world’s largest diabetes population. Individuals with Type 2 DM are at particular risk of the adverse consequences of obesity. The American Heart Association has designated DM as a ‘CAD risk equivalent.’ Type 2 diabetes mellitus patients without a prior MI have a similar risk for coronary artery-related events as non-diabetic individuals who had a prior MI.[1,2]

Obesity has major adverse effects on health. Obesity is associated with an increase in mortality, with a 50–100% increased risk of death from all causes compared to normal-weight individuals, mostly due to cardiovascular causes. Mortality rates rise as grade of obesity increases, particularly when obesity is associated with increased intra-abdominal fat. Life expectancy of a moderately obese individual could be shortened by 2–5 years.[5]

A 20- to 30-year-old male with a BMI >45 may lose 13 years of life. It is also apparent that the degree to which obesity affects particular organ systems is influenced by susceptibility genes that vary in the population. When the additional glucose intolerance associated with obesity are included, the adverse impact of obesity is even more evident.

BMI and WHR are commonly used clinical parameters to measure obesity. Increase in BMI and WHR is associated with increase in risk of several cardiovascular diseases. ELECTROCARDIOGRAPHY and 2D ECHO DOPPLER are the non-invasive and easy methods to assess heart function and the complications.[6]

Hence we designed this study whether there is any correlation between anthropometric measurements, E.C.G and 2D ECHO DOPPLER in obese patients with type-2 diabetes mellitus.

**INTRODUCTION**

India is experiencing an epidemic of Type-2 Diabetes Mellitus and related disorders. With an estimated 50.8 million diabetic people, India has the world’s largest diabetes population. Almost 30-65% of adult urban Indians are either overweight or obese or have abdominal obesity. The rising prevalence overweight and obesity in India has a direct correlation with the increasing prevalence of obesity-related comorbidities; systemic hypertension, metabolic syndrome, Dyslipidemia, type 2 diabetes mellitus (T2DM), and cardiovascular disease (CVD).[3,4]

Obesity is an increasingly important health problem worldwide including the developing countries. In India, obesity is emerging as an important health problem particularly in urban areas. Almost 30-65% of adult urban Indians are either overweight or obese or have abdominal obesity. The rising prevalence overweight and obesity in India has a direct correlation with the increasing prevalence of obesity-related comorbidities; systemic hypertension, metabolic syndrome, Dyslipidemia, type 2 diabetes mellitus (T2DM), and cardiovascular disease (CVD).[3,4]

**INCLUSION CRITERIA**

1. Age 25 year to 60 years.
2. Both male and female cases.
3. Cases who met the diagnostic criteria for diabetes mellitus type 2.
5. Old as well as newly detected diabetic cases with various risk factors.

**EXCLUSION CRITERIA**

1. Age < 25 year and case with age > 60 years not included because cases with < 25 year of age may have often diabetes mellitus type 1 and severe other age related diseases may see in senior citizens.
2. Cases with normal/subnormal BMI.
3. Seriously ill cases with multisystem disease.
4. Cases were excluded who had clinical hypeo or hyperthyroidism.
5. COPD cases.
6. Cases with deranged renal function.
7. Cases not giving consent.
Informed consent was taken prior to taking cases for present work. In all selected cases detailed clinical workup was done. Various anthropometric measurements were taken and relevant investigations done.

**METHOD**

The anthropometric measurements of cases were recorded by observer and his colleagues, using standard protocol. Cases were instructed to empty their bladder prior to anthropomorphic measurements. Cases stood in light clothing without shoes/chalpas.

Height, Weight, Body mass index (BMI) was calculated from weight (Kg) divided by the square of height in meter square. A plastics coated inch/centimeter tape was used for the waist circumference and hip circumference measures.

As grade of BMI increases, percentage of cases with poor progression of R wave increase

**TABLE 1 DISTRIBUTION OF CASES WITH ABNORMAL ECG FINDINGS**

<table>
<thead>
<tr>
<th>ECG CHANGES</th>
<th>NO. OF CASES</th>
<th>ECG CHANGES</th>
<th>NO. OF CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low voltage QRS complex</td>
<td>24</td>
<td>Left ventricular hypertrophy</td>
<td>4</td>
</tr>
<tr>
<td>QS complex</td>
<td>14</td>
<td>T inversion in I, AVL, V5-V6</td>
<td>4</td>
</tr>
<tr>
<td>ST elevation</td>
<td>3</td>
<td>BBB</td>
<td>10</td>
</tr>
<tr>
<td>ST depression in precordial leads</td>
<td>6</td>
<td>VPC'S</td>
<td>3</td>
</tr>
<tr>
<td>T inversion in lead II, III, AVL</td>
<td>7</td>
<td>Early Repolarisation</td>
<td>3</td>
</tr>
<tr>
<td>Poor progression of R wave</td>
<td>7</td>
<td>QT prolongation</td>
<td>1</td>
</tr>
<tr>
<td>Left atrial overload</td>
<td>7</td>
<td>Nonspecific changes</td>
<td>4</td>
</tr>
<tr>
<td>Right atrial overload</td>
<td>2</td>
<td>10 heart block</td>
<td>2</td>
</tr>
</tbody>
</table>

**TABLE 2 CORRELATION BETWEEN BMI & VARIOUS ECG CHANGES**

<table>
<thead>
<tr>
<th>BMI</th>
<th>POOR PROGRESSION OF R WAVE</th>
<th>T INVERSION IN II, III, AVL</th>
<th>T INVERSION IN I, AVL V3-V6</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-29.9</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>30-34.9</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>35-39.9</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>&gt;40</td>
<td>7</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
</table>

As grade of BMI increases, percentage of cases with poor progression of R wave increase

**TABLE 3 VARIOUS 2D ECHO DOPPLER FINDINGS IN OUR STUDY (OBSESE DM TYPE 2) CASES**

<table>
<thead>
<tr>
<th>2D ECHO DOPPLER FINDING</th>
<th>NO OF CASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>LV systolic + diastolic dysfunction</td>
<td>24</td>
</tr>
<tr>
<td>Severe</td>
<td>5</td>
</tr>
<tr>
<td>Moderate</td>
<td>9</td>
</tr>
<tr>
<td>Mild</td>
<td>10</td>
</tr>
<tr>
<td>LVDD (LV Diastolic Dysfunction)</td>
<td>37</td>
</tr>
<tr>
<td>Grade I</td>
<td>26</td>
</tr>
<tr>
<td>Grade II</td>
<td>9</td>
</tr>
<tr>
<td>Grade III</td>
<td>2</td>
</tr>
<tr>
<td>Grade IV</td>
<td>0</td>
</tr>
<tr>
<td>LVH with grade LVDD</td>
<td>11</td>
</tr>
<tr>
<td>LVH</td>
<td>4</td>
</tr>
<tr>
<td>PAH</td>
<td>5</td>
</tr>
<tr>
<td>Dilated RA and RV</td>
<td>2</td>
</tr>
<tr>
<td>Dilated LA and LV</td>
<td>1</td>
</tr>
<tr>
<td>MR</td>
<td>4</td>
</tr>
<tr>
<td>TR</td>
<td>3</td>
</tr>
</tbody>
</table>

24% cases had both systolic + diastolic dysfunction, 72% cases had diastolic dysfunction. 11% cases had diastolic dysfunction with concentric LVH. 4% cases showed concentric LVH.

**TABLE 4 CORRELATION BETWEEN BMI AND 2D-ECHO DOPPLER ABNORMALITY**

<table>
<thead>
<tr>
<th>BMI</th>
<th>PAH</th>
<th>MR</th>
<th>TR</th>
<th>DILATED RA+RV</th>
<th>DILATED LA+LV</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-29.9</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>30-34.9</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>35-39.9</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>&gt;40</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

**TABLE 5 CORRELATION BETWEEN WHR AND VARIOUS 2D ECHO DOPPLER ABNORMALITIES (FEMALE CASES) (n=70)**

<table>
<thead>
<tr>
<th>WHR</th>
<th>LV Systolic + Diastolic Dysfunction</th>
<th>LV Diastolic Dysfunction</th>
<th>LVH+LVDD</th>
<th>LVH</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;0.81</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>0.81-0.85</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>&gt;0.85</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

**TABLE 6 CORRELATION BETWEEN WHR & LV DYSFUNCTION (n=30 MALE CASES)**

<table>
<thead>
<tr>
<th>WHR</th>
<th>LV Systolic + Diastolic Dysfunction</th>
<th>LV Diastolic Dysfunction</th>
<th>LVH+LVDD</th>
<th>LVH</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;or=0.90</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.91-0.95</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0.96-1.0</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>&gt;1.0</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

**RESULTS**

**A) WAIST HIP RATIO:**

In our study 12(40%) male cases showed ECG changes (qs complex, ST elevation, ST depression, T inversion in lead II,III, AVL, T inversion in V5-V6) suggestive of myocardial infarction. As WHR increase, percentage of male cases with ECG (qs complex) suggestive of fully evolved myocardial infarction increases.

5(62%) female cases with WHR < 0.81 (N=8) have ECG criteria
(QS complex, ST elevation, ST depression, T inversion in II, III, AVF) suggestive of myocardial infarction. I(6%) female cases with WHR 0.81-0.85(N=16) had ECG criteria (QS complex, ST elevation, ST depression) suggestive of myocardial infarction. 16(34%) female cases with WHR >0.85(N=46) had ECG criteria (QS complex, ST elevation, ST depression, T inversion in lead II, III, AVF, T inversion in V5-V6) suggestive of myocardial infarction. In our study there are slight decreases in percentage of essentially normal ECG with increases in WHR.

B) ECG CHANGES:
7(23%) male cases had normal ECG, while 23(32%) female cases had normal ECG. 12(40%) male cases out of 30 male cases showed ECG changes (qs complex, ST complex, ST depression T inversion in lead II,III, avf, T inversion in V5-V6) suggestive of myocardial infarction. In female cases, 22(31%) cases out of 70 cases studied had ECG suggestive of MI; the differences of number of obese DM type 2 cases was possibly due to random selection. 5(8%) male cases (N=30) showed diastolic dysfunction grade II &III increases but not of grade I. % of female cases with normal 2D ECHO DOPPLER study decrease in percentage of normal 2D ECHO DOPPLER, % of male cases with normal 2D- ECHO DOPPLER dysfuntion. 20(66%) male cases (N=30) show diastolic dysfunction increases in waist hip ratio, % of female cases with diastolic (systolic+diastolic ) are seen only with WHR >1.0. 9(30%) male cases in our study, male cases showing only diastolic dysfunction. % of male cases with normal 2D ECHO DOPPLER dysfuntion. 22(32%) female cases in our study show ECG criteria (qs complex, ST complex, ST elevation, ST depression, T inversion in II,III,AVF, T inversion in lead II, III avf, T inversion in V5-V6) suggestive of myocardial infarction. In our study 77 cases had abnormal 2D- ECHO DOPPLER finding decrease as increase in WHR.

C) ECHOCARDIOGRAPHY CHANGES:
In our study, male cases showing only diastolic dysfunction were seen with WHR <0.81(N=8) had ECG criteria suggestive of myocardial infarction. 16(34%) female cases with WHR >0.85(N=46) had ECG criteria (QS complex, ST elevation, ST depression) suggestive of myocardial infarction. 16(34%) female cases with WHR >0.85(N=46) had ECG criteria (QS complex, ST elevation, ST depression T inversion in II, III, AVF, T inversion in lead II, III, avf, T inversion in V5-V6) suggestive of myocardial infarction. 21(30%) female cases showed low voltage QRS complex. There was slight decrease in percentage of normal ECG with increases in WHR.

STATISTICAL ANALYSIS:
• Statistical analysis of the data observed by us was done with help of statistician department of community medicine, M.G.M.Medical College, Indore. Various types of statically analysis tests including chi square test, Mann Whitney test, Fisher exact test were utilized.

DISCUSSION
The results observed in 100 obese DM type 2 cases studied during October 2012- September 2013 in Medicine Department M.Y. H. Indore are presented for discussion.

Association between components of the metabolic syndrome and electrocardiographic abnormalities in Korean adults was studied by Kim HK, Kim CH et al. Resting electrocardiogram (ECG) abnormalities have been strongly associated with cardiovascular disease mortality. Ischemic ECG findings were separately identified and analyzed. The overall prevalence rates of ECG abnormalities were significantly higher in subjects with than in those without metabolic syndrome (p < 0.01). Ischemic ECG was strongly associated with metabolic syndrome in all age groups of both sexes, except for younger women. In multiple logistic regression analysis, metabolic syndrome was independently associated with ischemic ECG (odds ratio, 2.30 [2.04 to 2.62]; p < 0.01), after adjusting for sex, age, smoking, and family history of cardiovascular disease. Of the metabolic syndrome components, hyperglycemia in younger subjects and hypertension in elderly subjects were major factors for ischemic ECG changes, whereas hypertriglyceridemia was not an independent risk factor in any age group. The association between ischemic ECG findings and central obesity was weaker in women than in men. Hong-Kyu Kim et al found that overall rates of ECG abnormalities were significantly higher in subjects with metabolic syndrome than in those without metabolic syndrome (p < 0.01). Metabolic syndrome was strongly associated with ECG abnormalities, especially ischemic ECG findings. The association between ischemic ECG findings and central obesity was weaker in women than in men. Looking at the results of both studies the authors concluded that metabolic syndrome was strongly associated with ECG abnormalities, especially ischemic ECG findings, in Koreans. The association between each component of metabolic syndrome and ECG abnormalities varied according to age and sex. [7]

Guzder RN, Gatling et al studied prognostic value of the Framingham cardiovascular risk equation and the UKPDS risk engine for coronary heart disease in newly diagnosed type 2 diabetes. The Framingham equations underestimated the overall number of cardiovascular events by 33% and coronary events by 32% and showed modest discrimination and poor calibration for CVD (P < 0.001) and CHD risk (P = 0.01]). Although the overall underestimate was lower and non-significant with the UKPDS risk engine for CHD (13%), its performance in terms of discrimination and calibration were similar. The 15%, 10-year CHD risk threshold with both the Framingham and UKPDS risk engines had similar sensitivity for primary CVD as the lipid level threshold [85.7 and 89.8% vs. 83.9% (P = 0.21 and 0.34)] and both had greater specificity [33.0 and 30.3% vs. 12.1% (P < 0.001) and P < 0.001]. Conclusion of the study was in people with newly diagnosed Type 2 diabetes, both the Framingham equation and UKPDS risk engine are moderately effective at identifying those at high-risk (discrimination) and are poor at quantifying risk (calibration). Nonetheless, at a population level, a 15% 10-year CHD risk threshold using either risk calculator has similar sensitivity as an approach based on a single lipid risk factor level and may have benefits in terms of cost-effectiveness given the improved specificity. [8]

Out of 100 cases studied by us, 77 cases had abnormal 2D-ECHO DOPPLER. Various abnormalities found in 2D-ECHO DOPPLER were LV dysfunction (systolic/diastolic or combined). Other abnormalities were LVH, PAH, dilated RV, LA, LV, MR, and TR. Effort was made to correlate BMI with LV dysfunction (systolic-diastolic) or isolated diastolic dysfunction. Despite various 2D-ECHO DOPPLER abnormalities, there was insignificant correlation between grade of BMI and 2D-ECHO DOPPLER abnormalities. Out 100 cases 23 had normal 2D-ECHO DOPPLER. Maximum cases with normal 2D-ECHO DOPPLER, 11 cases were in subgroup of BMI 25-29.9. As per WHO criteria these cases were in pre-obesity group however as per revised Indian guidelines these cases are considered as obese.

BEPPU S, PARK YD et al studied clinical features of intracardiac thrombosis based on echocardiographic...
In a study of cardiac profile in Type 2 DM patients with normal resting ECG with special reference to ECHOCARDIOGRAPHY and TMT done by Dr.Seema Mahant et al., out of 50 patients, 30 patients (60%) had abnormal 2D-ECHO finding. Also, Dr. Seema mahant et al. concluded in their study that incidence of left ventricular diastolic dysfunction was higher in NIDDM patients who were free of clinically detectable heart disease. Further, they found that the incidence of diastolic dysfunction had a strong correlation with age, duration of diabetes, HbA1C level and diabetic complications.[11]

Punekar J, Jain et al. did a similar work to study Effect of Isolated Obesity on Diastolic Dysfunction in Echocardiography. Likewise Dwivedi S, Aggarwal A et al. did work on Pedigree Profile: a valuable tool in the risk assessment of coronary artery disease in young. According to WHR we divided the female cases in 3 sub groups.[12,13]

Subgroup 1 WHR < OR=0.90,
Subgroup 2 WHR 0.91-0.85,
Subgroup 3 WHR >0.85

Similarly, we divided male cases according to WHR in 4 sub groups (since guidelines for WHR are different for male and female).

Subgroup 1 WHR < OR=0.90,
Subgroup 2 WHR 0.91-0.95,
Subgroup 3 WHR 0.96-1.0
Subgroup 4 WHR >1.0

Pandey ak et al. did assessment of myocardial mechanics in overweight and obese Indian subjects. They found in their study that Subclinical diastolic dysfunction was more prevalent among obese subjects, & BMI correlated significantly with indices of left ventricular systolic and diastolic function. Further, they observed that subclinical left ventricular diastolic dysfunction was there in all grades of obesity which correlates with BMI.[14]

Pascual M, Pascual DA et al. studied effects of isolated obesity on systolic and diastolic left ventricular function. In their study, they concluded that Subclinical left ventricular diastolic dysfunction is present in all grades of isolated obesity, correlated with BMI, and was associated with increased systolic function in the early stages of obesity. Subclinical left ventricular diastolic dysfunction is present in all grades of isolated obesity, correlates with BMI, and is associated with increased systolic function in the early stages of obesity. BMI correlated significantly with indices of left ventricular function.[15]

In a similar study Misra A, Chowbey P et al. gave a consensus statement for diagnosis of obesity, abdominal obesity and the metabolic syndrome for Asian Indians and recommendations for physical activity, medical and surgical management. There was a significant positive correlation of cardiovascular disease mortality with prevalence of obesity (R = 0.37) and dietary consumption of fats (R = 0.67), milk and its products (R = 0.27) and sugars (R = 0.51) and negative correlation with green leafy vegetable intake (R = -0.42) (p < 0.05). There are large disparities in cardiovascular disease mortality in different Indian states. This can be epidemiologically explained by difference in dietary consumption of fats, and prevalence of obesity.[18]

Ruisanchez Villar C. et al studied The impact of new echocardiographic techniques to detect myocardial dysfunction in asymptomatic type 1 diabetes mellitus: insight myocardial deformation and three dimensional echocardiography. Patil S. did a A Comparative Study Of Coronary Artery Disease In Diabetics And Non-Diabetics (Doctoral dissertation). Abd Almonem N, Selem A et al. did Assessment of Cardiac Changes in Obese Children and Its Relations to Metabolic Syndrome. The results and conclusions were similar to what we saw in our study.[19-21]

Vijay Achari, AK Thakur, Arun K Sinha observed in their study that out of 936 cases subjected to study, 596 (64.2%) were positive for the metabolic syndrome while 516 (55.6%) tested positive for coronary artery disease. There was a strong correlation between these entities (p = < 0.001). When the individual components were tested for their relationship with coronary artery disease, it was found that obesity and microalbuminuria had the strongest association with the presence of ischemic heart disease.[22]

CONCLUSION

a) Basic anthropometrics measurements (BMI + WHR) are simple clinical parameters to evaluate obese DM type 2 cases for cardiovascular complications.

b) Obese DM type 2 cases with abnormal WHR and BMI may have abnormalities in ECG and/or 2D-ECHO DOPPLER. Hence ECG and 2D-ECHO DOPPLER study may help for proper evaluation of obese DM type 2 cases.

c) In obese DM type 2 female cases; there was significant correlation between the difference of WHR and LV dysfunction (systolic/diastolic or combined).

d) In obese DM type 2 male cases; although there were abnormalities in ECG and 2D-ECHO DOPPLER study but
WHAT THIS STUDY ADD TO EXISTING KNOWLEDGE: BMI and WHR are commonly used clinical parameters to measure obesity. Increase in BMI and WHR is associated with increase in risk of several cardiovascular diseases. ELECTROCARDIOGRAPHY and 2D ECHO DOPPLER are the non-invasive and easy methods to assess heart function and the complications.

CONTRIBUTION BY DIFFERENT AUTHORS
First author: Dr. Bharat Kumar Parmaq2rp, Assistant Professor Department of medicine Govt. Medical College; Ratlam. Worked on Concept, materials and methods and data collection
Corresponding Author: Dr Sanjay Kumar Dubey Assistant Professor Department of medicine Govt. Medical College; Ratlam. Worked on statistical analysis and discussion

REFERENCES