Analysis of Body Mass Index and Waist-Hip Ratio in Type 2 Diabetic Males With or Without Hypertension

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Abstract: Background- Obesity is defined as an excess body fat. Abdominal obesity is related to glucose intolerance, insulin resistance and hypertension. Studies have shown that increase in abdominal obesity increases risk of type 2 diabetes and hypertension individually. Hypertension is found to co-exist in many type 2 diabetics. Prevalence of type 2 diabetes with hypertension is increasing in our country. Hence is the present study to compare the risk associated with obesity in type 2 diabetes with or without hypertension. Obesity indices generally measured are Body Mass Index (BMI) and Waist-Hip Ratio (WHR).

Aim - To analyze the association of BMI and WHR in type 2 diabetic males with or without hypertension. Materials and Methods - The study was conducted among 200 male subjects divided into four groups of 50 each namely group I (non diabetic), group II (diabetic only), group III (diabetic with hypertension) and group IV (hypertension only). They were assessed for height, weight, waist circumference, hip circumference, BMI, WHR. Results - The association of BMI and WHR with group I, II, III and IV were statistically analyzed using chi-square test and ANOVA. BMI strongly correlates with group III and IV (p less than 0.05) and with group II is insignificant (p more than 0.05). WHR is significantly correlated with group II and III (p less than 0.05) and with group IV is insignificant (p more than 0.05). But the mean difference of BMI and WHR between group II, group III and group IV were insignificant (p more than 0.05). Conclusion - BMI and WHR are individual risk factors for type 2 diabetes and hypertension. But the associations of these risk factors are equally strong in diabetics and diabetics with hypertension.
**Keywords**: BMI, WHR, Type 2 diabetes, Hypertension.

**Introduction**: Obesity is defined as an excess body fat which results from greater energy intake than energy expenditure. For each 9.3 calories of excess energy that enters the body, approximately one gram of fat is stored. Recent studies have shown that new adipocytes can differentiate from fibroblast-like preadipocytes at any period of life and that the development of obesity in adults is accompanied by increased numbers, as well as increased size of adipocytes. Obese individuals differ not only in the amount of excess fat that they store, but also in the regional distribution of fat within the body. The distribution of fat induced by the weight gain affects the risk associated with obesity. First adverse effect of obesity to emerge in population in transition is hypertension, glucose intolerance and hyperlipidaemia followed by coronary heart disease (CHD) and type 2 diabetes. Abdominal obesity is important in the development of insulin resistance and the metabolic syndrome that link obesity with CHD. Obesity indices generally measured are Body Mass Index (BMI) and Waist-Hip Ratio (WHR). BMI is a measure of general obesity while WHR is a measure of abdominal or visceral obesity. BMI is the widely used simple measure of body size which is used to estimate the prevalence of obesity. Although BMI has been found to be regularly associated with increased risk of type 2 diabetes and CHD, it does not reflect the variations associated with body fat and abdominal fat mass which can differ largely across population and also can vary within a narrow range of total body fat and BMI. Studies found a higher percentage of body fat in Asians at lower BMI as well. Several studies have shown that abdominal obesity measured by fasting plasma glucose of 126mg/dl. Hence WHR as a measure of abdominal obesity is being increasingly used. WHR easily makes the distinction between significant intra abdominal fat and subcutaneous abdominal fat than subcutaneous fat in other parts of the body. Obesity is an increasingly important health problem all over the world including the developing countries. Almost 30% to 65% of adult urban Indians have abdominal obesity, which has direct correlation with increasing prevalence of comorbidities like type 2 diabetes, hypertension, metabolic syndrome and CHD. Prevalence of type 2 diabetes with hypertension is increasing in our country. Diabetes and hypertension coexist in approximately 40% to 60% of type 2 diabetics. The prevalence of hypertension is 1.5 to 2 times more in diabetics than those without diabetes. One third of patients with hypertension develop diabetes later. This coexistence presents an increasing risk and accelerates vascular complications. Hence is the present study to compare the risk associated with obesity in type 2 diabetes with or without hypertension.

**Aim**: To analyze the association of BMI and WHR in type 2 diabetic males with or without hypertension.

**Materials and Methods**: The study was conducted among 200 male subjects divided into four groups of 50 each namely group I (non diabetic), group II (diabetic only), group III (diabetic with hypertension) and group IV (hypertension only). Criteria for type 2 diabetes are either a known diabetic or fasting plasma glucose of 126mg/dl. Criteria for type 2 diabetes are either a known diabetic or shown that abdominal obesity measured by fasting plasma glucose of 126mg/dl. Criteria for type 2 diabetes are either a known diabetic or shown that abdominal obesity measured by fasting plasma glucose of 126mg/dl. Criteria for type 2 diabetes are either a known diabetic or shown that abdominal obesity measured by fasting plasma glucose of 126mg/dl. Criteria for type 2 diabetes are either a known diabetic or shown that abdominal obesity measured by fasting plasma glucose of 126mg/dl. Criteria for type 2 diabetes are either a known diabetic or shown that abdominal obesity measured by fasting plasma glucose of 126mg/dl. Criteria for type 2 diabetes are either a known diabetic or shown that abdominal obesity measured by fasting plasma glucose of 126mg/dl.
for hypertension was defined as a systolic blood pressure 140mm of Hg or diastolic blood pressure 90mm of Hg or a known hypertensive on treatment. Weight was measured in the upright position to the nearest 0.5kg using mechanical weighing scale. Height was measured with barefoot to the nearest 0.5cm using stadiometer. BMI was calculated by dividing weight in kilograms by the square of the height in meter (kg/m²). Waist circumference was measured to the nearest 0.1cm at the mid-point between the last palpable ribs to the top of the iliac crest. Hip circumference was measured around the widest part below the iliac crest at the level of greater trochanter. WHR was calculated as waist circumference divided by hip circumference. Blood pressure was measured in a seated position after the participant had rested for at least 5 minutes by standard procedure using a mercury sphygmomanometer. Fasting blood sugar was taken following a 0 hour overnight fasting period.

Institute ethics committee clearance was obtained. Written and informed consent was obtained from all the participants.

**Results**

The association of BMI and WHR with group I, group II, group III and group IV were statistically analyzed using chi-square test and ANOVA. Cut off points taken for BMI are 18.0 – 22.9kg/m² for normal, 23.0 – 24.9kg/m² for overweight and 25kg/m² for obese. Cut off point for WHR taken was 0.90 for males as obese as per WHO guidelines for Asians²³. About 18%, 18%, 26% and 38% of overweight subjects were from group I, II, III and IV respectively, while 4%, 32%, 42% and 32% of subjects in group I, II, III and IV were obese as per BMI cut offs. As per WHR cut off abdominal obesity is more prevalent among diabetic with hypertension (27.4%) compared to the controls (20.6%).

The mean BMI of groups I, II, III, and IV were 22.14kg/m², 23.24kg/m², 24.30kg/m² and 23.98kg/m² respectively while the mean WHR was 0.94, 0.98, 0.99 and 0.97 respectively.

<table>
<thead>
<tr>
<th>Mean ± Standard Deviation of BMI and WHR of four groups</th>
<th>BMI kg/m²</th>
<th>WHR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non diabetic</td>
<td>22.14±2.02</td>
<td>0.94±0.08</td>
</tr>
<tr>
<td>Diabetic</td>
<td>23.24±2.41</td>
<td>0.98±0.05</td>
</tr>
<tr>
<td>Diabetic with hypertension</td>
<td>24.30±2.04</td>
<td>0.99±0.05</td>
</tr>
<tr>
<td>Hypertension only</td>
<td>23.88±2.22</td>
<td>0.97±0.06</td>
</tr>
<tr>
<td>P value</td>
<td>0.000*</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

*P<0.05 was considered as the level of significance.
Table 1: Mean±Standard Deviation of BMI and WHR of four groups

BMI strongly correlates with group III and IV (P<0.05) while with group II (P>0.05), it is insignificant in comparison with controls. While WHR is significantly correlated with group II and group III (P<0.05) and the correlation is insignificant with group IV (P>0.05). But the mean difference of BMI and WHR between group II, group III and group IV were insignificant (P>0.05).

Discussion:

BMI is a measure of general obesity whereas WHR is a measure of visceral obesity which links obesity with type 2 diabetes and hypertension. The present study has shown that BMI is significantly increased in diabetics with hypertension and hypertensives while WHR is significantly increased in diabetics and diabetics with hypertension. But there is no difference in the BMI and WHR between diabetics, diabetics with hypertension and hypertensives. Kaur et al in their study highlighted that WHR is the best predictor of type 2 diabetes while BMI is significantly associated with hypertension which is consistent with the present study. In Australian adults, Dalton et al observed that, WHR is strongly associated with type 2 diabetes and hypertension in both men and women and also revealed that WHR is superior in its ability to identify the risk factors of CHD namely type 2 diabetes, hypertension and dyslipidaemia. The mean BMI and WHR were higher in diabetic population than in non-diabetic Punjab population. Sayeed et al noted that BMI and WHR were significantly higher among the hypertensives irrespective of their diabetic status in their study on risk of obesity for hypertension among diabetics. Ankur Joshi and coworkers found that both BMI and WHR are not associated with diabetes in both sexes while only BMI is associated with hypertension. In the 9 year follow up study on diabetes and hypertension in African origin population by Barbara Nemesure, it was observed that the incidence of diabetes had a strong association with BMI while the incidence of hypertension is strongly associated with WHR. Many studies have compared obesity based on both BMI and WHR as predictor of type 2 diabetes and HTN.
but with varied result with WHR showing superior association with central obesity which is currently the linking factor of hypertension and type 2 diabetes with CHD.

**Conclusion**

BMI and WHR are individual risk factors for type 2 diabetes and hypertension. But the associations of these risk factors are equally strong in diabetics and diabetics with hypertension. With rising trends in incidence of type 2 diabetes and hypertension, in developing countries like India, obesity indices like BMI and WHR are simple measures which can be done in the clinical setting. This can serve to predict these potential CHD risk factors and pave the way for early intervention at primary health care level itself to prevent the future complications.

**References:**


11. Prabhdeep Kaur, Ezhi Radhakrishnan, Suresh Sankarasubbaiyan et al.


