RESEARCH ARTICLE

A case–control study to assess the association of obesity and insulin resistance in hypertension at a tertiary care hospital in North Kerala

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ABSTRACT

Background: Non-communicable diseases (NCDs) kill 41 million people each year, equivalent to 71% of all deaths globally. Cardiovascular diseases account for most of the NCD deaths, followed by cancers, respiratory diseases, and diabetes. Detection, screening, and treatment of NCDs are the key components of response to NCDs. Aim and Objective: The objective of this work is to study the association of body mass index (BMI), abdominal obesity, and insulin resistance with hypertension and those with both diabetes and hypertension. Materials and Methods: A case–control study was done among 30–70 years old people who came to Government Medical College, Kozhikode between August 2014 and July 2015. They were divided into two study groups and one control group. Complete history, physical, and laboratory examination was done among them and the data were entered in a pro forma. Results: The mean ages in each group were 57.73, 58.5, and 48.71, respectively, in each group. The male: female ratio was 1.37:1, 1.06:1, and 1:1 in each group. BMI, waist circumference, waist hip ratio, and waist-to-height ratio (WHtR) were increased progressively in patients with hypertension and those with both diabetes and hypertension. Insulin resistance was highest in patients with both hypertension and diabetes mellitus. Conclusion: Obesity is an important contributor to the development of Type 2 diabetes and hypertension. Among the parameters to measure obesity, WHtR is considered the supreme. Insulin resistance is found in hypertensives and those with diabetes and hypertension.

KEY WORDS: Hypertension; Type 2 Diabetes Mellitus; Insulin Resistance; Abdominal Obesity

INTRODUCTION

Hypertension or elevated blood pressure is a serious medical condition that significantly increases the risk of heart, brain, kidney, and other diseases. It is estimated that globally, 1.28 billion adults aged 30–39 years suffer from hypertension. About two thirds of this population lives in low- and middle-income countries. It is a premature cause of death worldwide. About 46% of the individuals with hypertension are unaware of their hypertensive status.⁵ Around 7.5 million deaths or 12.8% of the total of all annual deaths worldwide occur due to high blood pressure.⁶ This accounts for 57 million disability adjusted life years (DALYS) or 3.7% of total DALYS.⁷

National Family Health Survey-5 (NFHS-5) data in India show that the prevalence of elevated blood pressure or those taking medicine to control blood pressure is 30.2% in men and 25.3% in women. The proportion of mildly elevated blood pressure in males and females were 15.7% and 12.4%, respectively. Whereas, the proportion of moderately or
severely elevated blood pressure in males and females were reported to be 5.7% and 5.2%, respectively.\[10\] GBD Study estimates that high blood pressure caused 1,638,049 deaths and led to 33,887,690 DALY’s lost in India in 2015.\[10\]

India is considered to be a developing country with rapid urbanization and industrialization. This has resulted in a significant number of people being overweight/obese and/or having elevated blood pressure and blood glucose.\[6,7\] Overweight and obesity are considered to be a significant public health problem worldwide which is found to be increasing in proportion.\[8\] Obesity has been referred as a "gateway disease" that leads to several health problems including Non-Communicable diseases (NCDs).\[9\]

The 2016 World Health Organization (WHO) report described overweight/obesity as an epidemic in India because of a 3.4% increase in prevalence. It was 8.4% in 2006, which rose to 11.8% in 2016.\[8\] A previous review also reported an overall increase in the prevalence of overweight and obesity from 11 to 15% between 1998 and 2006, in those aged 15–49 years.\[10\] This sort of an increase in obesity will ultimately lead to exponential increase in number of persons with hypertension and Type 2 Diabetes Mellitus (T2DM).\[10\]

The WHO defines obesity as abnormal or excessive fat accumulation that may impair health.\[10\] Weighing the person underweight and dual energy X-ray absorptiometry are measures which directly measure body fat. Anthropometric measures such as the weight-for-height index, body mass index (BMI), waist circumference (WC), waist hip ratio (WHR), and body fat percentage estimated by skinfold thickness (ST) are widely accepted indirect measures. BMI has been widely used to classify overweight and obesity since 1990s,\[11\] and has been considered as an ideal measure of adiposity since it is easy to measure and is closely associated with obesity related health risks.\[13\] NFHS-5 data show that the proportion of Indian males and females with BMI ≥25 kg/m² is 22.9% and 24%, respectively.\[14\]

Decreased sensitivity of the tissue to insulin is a characteristic of various pathological conditions termed the insulin resistance syndrome, also known as the metabolic syndrome or cardiometabolic syndrome.\[14\] This syndrome is not a single disease, but it is a constellation of symptoms which comprise hypertension, hyperglycemia, dyslipidemia, increased WC, and insulin resistance.\[15\]

It is commonly thought that insulin resistance predicts Type 2 Diabetes. Recent evidences now suggest that insulin resistance could also have a role in development of hypertension.\[16\]

Studies quote that obesity plays a central role in the insulin resistance syndrome, which includes hyperinsulinemia, hypertension, hyperlipidemia, T2DM, and an increased risk of atherosclerotic cardiovascular disease.\[17,18\]

Although there is considerable evidence that patients with essential hypertension are insulin resistant/hyperinsulinemic as compared with normotensive individuals,\[19-24\] some population-based studies have not been able to prove a significant relationship between insulin resistance and hyperinsulinemia.\[25-27\]

The objective of the present study is to find the relationship between obesity and insulin resistance in patients with hypertension. It was also decided to find if insulin resistance increased if patients with hypertension also had T2DM.

**MATERIALS AND METHODS**

This case–control study was conducted on all patients aged between 30 and 75 years attending General Medicine Outpatient department and admitted in the medical wards of Government Medical College, Kozhikode between August 2014 and July 2015. There were three groups of people with Group 1 being those with systemic hypertension and on antihypertensives, Group 2 being those with T2DM and Hypertension and finally Group 3 being healthy controls selected from general population.

Patients with impaired glucose tolerance, pregnant women, nursing mothers, those with physical disabilities preventing anthropometric measurements, those with endocrine diseases such as Cushing’s syndrome, thyroid diseases, and renal impairment were excluded from the study.

Sixty-four subjects were taken in each group and control group subjects were selected from among the hospital staff.

Height was measured in centimeters using a stadiometer which was calibrated to the nearest 0.5 cm. Weight was measured using a bathroom scale which was validated on a daily basis with known weights. Abdominal obesity measured by WC and WHR. Other obesity parameters such as waist height circumference and BMI were also assessed. The patients were subjected to physical and laboratory evaluation.

**Ethical Consideration**

The study protocol was submitted and approved by the Institutional Ethics Committee.

**Statistical Analysis**

The data of all patients were entered in a pro forma and then transferred to Microsoft Office Excel 2007 for analysis. IBM Statistical Package for the Social Sciences version 16 was used for analysis of the data. The significance of the difference of mean of each parameter among the three groups was analyzed using the Analysis of variance (ANOVA) test. The $P < 0.05$ was taken as the level of significance. Pearson’s correlation coefficient was used to find the correlation...
between the obesity parameters - BMI and WC with insulin resistance in all the three groups.

RESULTS

The study population were divided into three groups with Group 1 containing people with hypertension, Group 2 containing people with both diabetes and hypertension, and Group 3 containing control group without any of these health problems who were selected from hospital staff. Majority of the study population belonged to 46–60 years age group with the proportion being 59.37%, 53.12%, and 62.5%, respectively, in each of the groups. The mean ages in each group were 55.43, 55.43, and 53.76, respectively, in each group. The male: female ratio was 1.37:1, 1.06:1, and 1:1 in each group. Most of them were manual laborers in Group 1 and Group 2 but Group 3 had many professionals. There was no statistically significant difference in age, gender, and occupation among the groups [Table 1].

Table 2 shows that the anthropometric parameters such as BMI, WC, and WHR increased progressively in patients with hypertension and those with both hypertension and diabetes mellitus, respectively. Insulin resistance was highest in patients with both hypertension and diabetes mellitus. ANOVA test was done to find the difference between the groups and it was found that P < 0.001 revealing that there was highly significant difference that existed. Post Tukey test showed that each group was significantly different from the control group (Group 3). It was also seen that there was significant difference between the groups.

Table 3 shows correlation of insulin resistance with certain anthropometric parameters. Pearson correlation was done to assess the relationship. In Group 1 (hypertensives), there was a positive relationship between WC, hip circumference, WHR, and insulin resistance. In Group 2 (diabetics and hypertensives), there was a positive relationship between WC, hip circumference, WHR, and insulin resistance.

DISCUSSION

The present study was done to assess the relationship of obesity and insulin resistance with hypertension and those with both hypertension and diabetes.

In the present study, BMI was highest in patients with hypertension and diabetes followed by those with hypertension alone and this was statistically significant. Similar difference was observed with WC and WHR. In the present study, it was noted that the mean obesity parameters were higher in patients when diabetes was also present in patients with hypertension. Insulin resistance was highest in patients with both diabetes and hypertension, followed by patients with hypertension alone. There was significant difference in insulin resistance when compared to the control group and also among inter groups.

**Table 2: Anthropometric parameters in the study population**

<table>
<thead>
<tr>
<th>Obesity parameter</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>BMI (Kg/m²)</em></td>
<td>23.5±3.32</td>
<td>25.5±2.4</td>
<td>21.3±1.2</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>84.3±5.7</td>
<td>91.95±6.2</td>
<td>80.5±2.8</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>WHR</td>
<td>0.9±0.02</td>
<td>0.91±0.026</td>
<td>0.8±0.02</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>WHTr</td>
<td>0.5±0.04</td>
<td>0.571±0.041</td>
<td>0.5±0.03</td>
<td>&lt;0.0001*</td>
</tr>
<tr>
<td>IR</td>
<td>3.0±1.0</td>
<td>3.832±0.924</td>
<td>1.3±0.2</td>
<td>&lt;0.0001*</td>
</tr>
</tbody>
</table>

*BMI: Body mass index, WC: Waist circumference, WHR: Waist hip ratio, WHTr: Waist height ratio, IR: Insulin resistance

**Table 3: Correlation of insulin resistance with selected anthropometric parameters in different groups**

<table>
<thead>
<tr>
<th>Anthropometric parameters</th>
<th>Statistic</th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>BMI (Kg/m²)</em></td>
<td>R value</td>
<td>0.6550</td>
<td>0.3299</td>
<td>0.0748</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>&lt;0.0001*</td>
<td>0.007*</td>
<td>0.5569</td>
</tr>
<tr>
<td>WC (Cms)</td>
<td>R value</td>
<td>0.4410</td>
<td>0.3899</td>
<td>−0.0527</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.0002*</td>
<td>0.0014*</td>
<td>0.6791</td>
</tr>
<tr>
<td>HC</td>
<td>R value</td>
<td>0.4271</td>
<td>0.2785</td>
<td>0.6219</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.0004*</td>
<td>0.0258*</td>
<td>0.6270</td>
</tr>
<tr>
<td>WHR</td>
<td>R value</td>
<td>0.0288</td>
<td>0.3693</td>
<td>−0.2000</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.8212</td>
<td>0.0026*</td>
<td>0.1130</td>
</tr>
<tr>
<td>WHTR</td>
<td>R value</td>
<td>0.4888</td>
<td>0.1722</td>
<td>0.1033</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.0004*</td>
<td>0.1736</td>
<td>0.4166</td>
</tr>
</tbody>
</table>

*BMI: Body mass index, WC: Waist circumference, WHR: Waist hip ratio, WHTr: Waist height ratio
Obesity is known to be a main risk factor for the occurrence of many NCDs and of these diseases, type 2 diabetes is more strongly associated with obesity.[28] This close association has led to the connotation “diabesity,” which highlights the fact that majority of the diabetics are overweight or obese.[29] Even in the present study, it was noted that the mean obesity parameters were higher in patients when patients with diabetes had hypertension also. The study results are concordant with findings observed in other studies.[30,31] A meta-analysis conducted by Babu et al. concluded that obesity showed a significant, potentially plausible association with hypertension and T2DM in studies conducted in India.[32] In another study conducted by Kumar et al., obesity was found to be significantly associated with hypertension.[33]

BMI is the most commonly used tool to identify and classify obesity. In a study conducted by Mitra et al., it was observed that as the BMI increases, the percentage of hypertensives also increases, that is, those with BMI <18.5 did not have hypertension while 58.33% hypertensive respondents were present in those with BMI >30.[34] But by itself, BMI is considered as an inadequate biomarker of obesity[35] because it does not differentiate between muscle and fat.[36] Further, it does not tell us precisely about the body fat mass nor it distinguishes between the genders with regards to body fat.[37] WC and WHR are low cost parameters and are also easily accessible but not without limitations.[38] Waist-to-height ratio (WHtR) is another anthropometric parameter which can be easily measured and has been associated with cardiovascular disease in the general population. The advantage of WHtR is that there is a unisex cut off value of 0.5.[38,39] Further meta-analysis has shown that WHtR is a better tool than WC and BMI as a cardiometabolic risk factor.[39]

Asian Indians are highly insulin resistant compared with other ethnic groups and apparently healthy young Asian Indians exhibit the presence of insulin resistance.[40,41] Approximately 50% of hypertensive patients are insulin resistant and these subjects are at great risk of cardiovascular disease.[42] The association between insulin resistance and hypertension was also confirmed by another approach in the Insulin Resistance Atherosclerosis Study.[43]

**CONCLUSION**

BMI and abdominal obesity parameters are important contributors to the development of Type 2 Diabetes and Hypertension. A combination of BMI and the abdominal obesity parameters will be helpful to identify those at risk. Among these parameters, WHtR is considered the best parameter as it allows correction for the stature of each individual and is a unified value for all ethnic groups and both sexes.[44] Appropriate lifestyle modifications can be made to prevent or at least delay the development and progression of Type 2 Diabetes and hypertension. Insulin resistance is associated with hypertension and also in those with both hypertension and diabetes mellitus.

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