

Original Research Article

Study to assess predictive value of waist to height ratio and body mass index as a risk factor of hypertension and type 2 diabetes mellitus

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ABSTRACT

Background: Hypertension and diabetes have become important world-wide public-health challenges. Assessment of risk for Hypertension and Diabetes requires identifying an easy tool that can be used by health workers in screening programmes. To compare predictive value of WHtR against BMI in assessing risk of Hypertension and Diabetes.

Methods: A case-control study was carried out at MB Hospital and Urban Health Training Centre (UHTC) attached to RNT Medical College, Udaipur, Rajasthan. Selected individuals were examined and interviewed using semi-structured questionnaire. Anthropometric measurements were carried out. Odds ratios were derived for quantitative analysis.

Results: Observed proportion of BMI ≥ 25 kg/m² was 60.4% in type 2 diabetes cases, whereas 39.6% in controls. Odds ratio was 2.383. Observed proportion of BMI ≥ 25 kg/m² was 66.7% in HTN cases, whereas 33.3% in controls with a Odds ratio of 3.484. An Odds ratio of 3.151, showed existence of strong association of WHtR above 0.5 with hypertension. Observed proportion of WHtR above 0.5 was 56.3% in type 2 diabetes cases, whereas 43.7% in controls and Odds ratio was 4.292.

Conclusions: The OR of WHtR in diabetes (4.292) in compared to OR of BMI (2.303), shows the strength of association of WHtR as an alarming risk factor for diabetes than BMI; whereas an equivalent strength of association was observed for hypertension. Study favours the use of anthropometric measures especially WHtR for predicting type 2 diabetes mellitus and hypertension.

Keywords: Hypertension, Diabetes mellitus, Body mass index, Waist to height ratio

INTRODUCTION

Non-communicable diseases are “An impairment of bodily structure and / or function that necessitates a modification of the patients normal life, and has persisted over an extended period of time”.¹

Chronic non-communicable diseases are assuming increasing importance among the adult population in both developed and developing countries. Cardiovascular diseases and cancer are at present leading causes of death in developed countries. Hypertension and diabetes have

become important world-wide public-health challenges because of their high prevalence and concomitant risk of coronary artery disease, congestive heart failure, stroke, end stage renal disease, dementia and blindness.^{2,3}

Of the 57 million global deaths in 2008, 36 million or 63 per cent were due to non-communicable diseases (NCDs). By cause, cardiovascular diseases were responsible for the largest proportion of NCD deaths (47.9%), followed by cancers (21%), chronic respiratory diseases (11.72%), digestive diseases (6.1%), diabetes (3.5%) and rest of the NCDs were responsible for 9.78% of deaths. As population will age, annual NCD deaths are

projected to rise substantially, to 52 million in 2030. In low and middle income countries NCDs will be responsible for three times as many DALYs and nearly five times as many deaths as communicable diseases, maternal, perinatal and nutritional conditions combined.^{4,5}

There are various risk factors associated with hypertension and diabetes. Some of the known risk factors for primary hypertension and diabetes type 2 like age, heredity, and gender are non-modifiable. However, the majority of the other risk factors like tobacco use, alcohol use, unhealthy diet, physical inactivity, overweight and obesity are modifiable and can be effectively prevented. Increased abdominal fat accumulations assessed by waist circumference (WC), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR) have been extensively documented as independent risk factors across different ethnic groups. Hypertension and diabetes are “ice-berg” diseases and scarcity of data is sometimes understood as non-existence of these problems.⁶

There is paucity of data on prevalence of hypertension and diabetes in many parts of India specially the rural areas. Thus, burden of hypertension and diabetes in these populations might be underestimated and might leave the disease undiagnosed and untreated.

Assessment of risk for Hypertension and Diabetes requires identifying an easy tool that can be used by health workers in screening programmes. With this background, this study was carried out to compare predictive value of WHtR against BMI in assessing risk of Hypertension and Diabetes.

METHODS

It was a case-control OPD based study conducted at MB Hospital and Urban Health Training Centre (UHTC) attached to RNT Medical College, Udaipur, Rajasthan from July 2014 to December 2014. Patients attending OPD of Endocrinology and Cardiology department of MB hospital and UHTC Dhanmandi of department of PSM of RNT Medical College, Udaipur during the study period were included as study participants. A minimum sample size of 67 subjects in each group (cases and controls) was selected on the basis of a previous study in 2012 by Praso et al to detect a difference of BMI in hypertension and non-hypertension cases at a power of 80% and confidence Interval of 99% and Odds ratio 4.53.⁷ A minimum sample size of 103 subjects in each group (cases and controls) was calculated on the basis of a previous study conducted in 2009 by Shah et al to detect association of BMI with Type 2 Diabetes Mellitus and non-diabetic cases at the power of 80%, confidence Interval 99% and Odds ratio 2.89.⁸ Patients attending the Outpatient department of Urban Health Training Centre, who were free from Hypertension and type 2 diabetes mellitus, were included as controls. Purpose of the study

was fully explained to participants and written consent was taken. Study participants were examined and interviewed using semi-structured, pre-tested questionnaire containing questions pertaining to the lifestyle risk factors. Two blood pressure reading were recorded using mercury sphygmomanometer in a sitting position and mean of two was considered for analysis. Based on the definition of hypertension published by the Seventh Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure guidelines (Chobanian et al 2003); a cut of point of 140/90 mmHg for hypertension was adopted.⁹ Those with the BP of less than or equal to 140/90 mmHg were considered normotensive while those with higher values or who reported to be on antihypertensive medications were classified as hypertensive.

Anthropometric measurements

- Weight: Measured with a bathroom weighing scale calibrated from 0–120 kg with the participant standing with shoes removed and minimum clothing. Body weight will measured in kilograms and rounded off to the nearest 0.5 kg.
- Height: For measuring height, the participant’s heels, the back, and the occiput touching the scale with the participants looking straight ahead during measurement. The height of each participant was measured to the nearest 0.5 cm.
- Body Mass Index (BMI), (Quetelet’s Index): Weight calculated by weighing machine and height by measuring tape.¹⁰

BMI was calculated using the formula: - BMI (kg /m²) =Weight (kg) /Height² (m).

WHO Classification BMI (kg/m²).¹¹

Underweight: <18.5, Normal: 18.5 – 24.99, Over weight: 25 – 29.99, Obese: ≥30.

- 4. Waist Circumference (WC): Measured at the approximate midpoint between the lower margin of the last palpable rib and top of the iliac crest at the end of normal expiration by a non-elastic graduated in centimeters (0-150) measuring tape to the nearest 1 mm.^{8,10}
- 5. Waist Height Ratio (WHtR): Waist Height Ratio was calculated using the following formula.

WHtR = Waist (cm)/ Height (cm)
General healthy cut off = 0.5 and risk for male and female when WHtR exceed 0.536 and 0.492 respectively.^{8,10}

Method for estimation of blood sugar: Random blood sugar detected by using standardized glucometer (Accu-check). The current WHO diagnostic criteria were adopted for diagnosis of diabetes- fasting plasma glucose

≥ 7.0 mmol/l (126 mg/dl) or 2 hour plasma glucose ≥ 11.1 mmol/l (200 mg/dl).¹²

Data were compiled and collated using MS Excel 2010 and EPI- info7 software. Odds ratios were derived for quantitative analysis.

RESULTS

Total 134 subjects for hypertension (67 cases and 67 controls) and 206 subjects (103 cases and 103 controls) for type 2 diabetes mellitus were assessed. Maximum hypertensive cases (43.3%) were in age group 50-59 years followed by 26.9% in 40-49 yrs. age group while maximum type 2 diabetes cases (39.8%) were in age group 40-49 yrs. followed by 21.4% in 50 years. and above. Observed proportion of BMI ≥ 25 kg/ m² was 66.7% in HTN cases, whereas 33.3% in controls. Calculated Odds ratio 3.484 was suggestive of strong association of BMI ≥ 25 kg/ m² with hypertension as shown in Table 1. Observed proportion of BMI ≥ 25 kg/ m² was 60.4% in type 2 diabetes cases, whereas 39.6% in controls. Odds ratio was 2.383, suggestive of strong association of BMI ≥ 25 kg/ m² with type 2 diabetes also as shown in Table 2. In HTN cases, observed proportion of WHtR above 0.5 was 56.3%, whereas in controls, it was 43.7%. An Odds ratio of 3.151, showed existence of strong association of WHtR above 0.5 with hypertension as shown in Table 3. Observed proportion of WHtR above 0.5 was 56.3% in type 2 diabetes cases, whereas 43.7% in controls. Odds ratio was 4.292, suggestive of a strong association of WHtR above 0.5 with type 2 diabetes. Awareness regarding risk factors of hypertension among cases was more about overweight and obesity (82.1%), high salt intake (41.8%), family history (40.3%) followed by poor diet (22.4%), whereas in controls awareness for overweight and obesity was (53.7%), high salt intake (29.9%), family history (29.9%) followed by Lack of physical activity (16.4%). Awareness regarding risk factors of diabetes type 2 among cases was more about overweight and obesity (96.1%), poor diet (34.0%), family history (29.1%), followed by Lack of physical activity (27.2%), whereas in controls awareness about risk factors such as overweight and obesity was (73.8%), poor diet (22.3%), Lack of physical activity (18.4%) and family history (15.5%) as shown in Table 5.

Table 1: Distribution of cases and controls of hypertension according to BMI groups.

BMI Groups	HTN Cases (%)	Control (%)	Total (%)
≥25 kg/ m ²	40 (66.7)	20 (33.3)	60 (100)
< 25 kg/ m ²	27 (36.5)	47 (63.5)	74 (100)
Total	67 (100)	67 (100)	134 (100)

OR =3.484, (95% CI, 1.702 - 7.121)

Table 2: Distribution of cases and controls of type 2 diabetes according to BMI groups.

BMI Groups	DM II Cases (%)	Control (%)	Total (%)
≥ 25 kg/ m ²	64 (60.4)	42 (39.6)	106 (100)
< 25 kg/ m ²	39 (39.0)	61 (61.0)	100 (100)
Total	103 (100)	103 (100)	206 (100)

OR=2.383, (95% CI, 1.362 - 4.170)

Table 3: Distribution of cases and controls of hypertension according to WHtR groups.

WHtR	HTN Cases (%)	Controls (%)	Total (%)
Above 0.5	58 (56.3)	45 (43.7)	103 (100.0)
Below 0.5	9 (29.0)	22 (71.0)	31 (100.0)
Total	67 (100)	67 (100)	134 (100)

OR =3.151, (95% CI, 1.323-7.504)

Table 4: Distribution of cases and controls of type 2 diabetes according to WHtR groups.

WHtR	DM II Cases (%)	Controls (%)	Total (%)
Above 0.5	94 (56.3)	73 (43.7)	167 (100)
Below 0.5	9 (23.1)	30 (76.9)	39 (100)
Total	103 (100)	103 (100)	206 (100)

OR =4.292, (95% CI, 1.919 - 9.602)

Table 5: Awareness among study participants about risk factors related to high blood pressure and Type 2 DM.

Risk factors	Hypertension		Type 2 DM	
	Cases (%) n=67	Controls (%) n=67	Cases (%) n=103	Controls (%) n=103
Family history	27 (40.3)	20 (29.9)	30 (29.1)	16(15.5)
Lack of physical activity	13 (19.4)	11 (16.4)	28 (27.2)	19 (18.4)
High salt intake	28 (41.8)	20 (29.9)	0 (0.0)	0 (0.0)
Poor diet	15 (22.4)	8 (11.9)	35 (34.0)	23 (22.3)
Overweight and Obesity	55 (82.1)	36 (53.7)	99 (96.1)	76 (73.8)

DISCUSSION

In an effort to use a cheaper and easier measure and a rapid and effective global indicator for health risk for obesity, are risk factor for hypertension and diabetes. This study was design to explore WHtR as better

predictor of diabetes mellitus and cardiovascular diseases over BMI.

In present study, proportion of BMI ≥ 25 was 66.7% in HTN cases, whereas it was 33.3% in controls. An OR 3.484, (95% CI, 1.702-7.121) is showing increased risk of developing hypertension in cases with BMI ≥ 25 kg/m². The Framingham Study (1987) and a study by S. Mishra et al (1997) found BMI was a significant predictor of cardiovascular diseases including hypertension.^{13,14}

Likewise in present study proportion of candidates having BMI ≥ 25 kg /m² was 60.4% in type2 diabetes cases, whereas 39.6% in controls. An OR=2.383, (95% CI, 1.362-4.170) is showing strong risk of type 2 diabetes in candidates having BMI ≥ 25 Kg/m². Our study is comparable with Shah et al (2009) who found that BMI equal or above 23.63 was 2.37 times likely to be found in a case with Type 2 DM than a non-diabetic male.⁸

In our study proportion of individuals having WHtR above 0.5 was 56.3% in HTN cases, whereas 43.7% in controls. An odds ratio 3.151, (95% CI, 1.323-7.504) is suggestive of increased risk of hypertension in cases with WHtR >0.5 . In congruence to our findings, Zhe-qing Zhang et al (2013) and Wen-Cheng Li et al (2013) found OR (95% CI) in the highest (Vs. lowest) quartile of WHtR was 3.69 (2.82,4.83) for hypertension and after adjustment for potential confounders for metabolic syndrome for each standard deviation increase in WHtR was 1.32 (1.31–1.33), 3.69 (2.82, 4.83) and 3.99 for 40-49 age group, 4.3for 50-59 age group and 6.16 for those above 60 age group respectively.^{15,16} Finally, patients of either sex with a normal BMI or WC level, but with an elevated WHtR, had higher levels of various cardio-metabolic risk factors in comparison with their normal BMI or WC, but low WHtR.

In our study proportion of candidates having WHtR above cut off 0.5 was 56.3% in type 2 diabetes cases, whereas 43.7% in controls. An OR 4.292, (95% CI, 1.919-9.602) showing increased risk of type 2 diabetes in cases with WHtR >0.5 . In congruence to our findings Zhe-qing Zhang et al (2013) and Wen-Cheng Li et al (2013) found OR (95%CI) in the highest (vs. lowest) quartile of WHtR was 2.75 (1.80, 4.20) for diabetes/IFG and the odds ratio for MS for each standard deviation increase in WHtR were 1.32 (1.31–1.33) respectively.

Although present study had limitations of sample size, time & resources in comparison to other studies still our findings suggest that WHtR is as good a predictor of risk factor for hypertension and diabetes mellitus as BMI. Since 56.3% HTN as well DM II patients has WHtR more than 0.5 and this could be easier tool to be used as a predictor of diabetes and CVD and related risk factor and would encourage the use of this index in future studies.

CONCLUSION

In present study an attempt was made to test the predictive value of WHtR and BMI. The OR of WHtR in diabetes (4.292) in our study compared to OR of BMI (2.303), shows the strength of association of WHtR as an alarming risk factor for diabetes than BMI, whereas an equivalent strength of association has been observed for hypertension. The study favours the use of anthropometric measures especially WHtR for predicting type 2 diabetes mellitus. BMI may be used as an alternative obesity measure for detecting people suffering from hypertension and type 2 diabetes mellitus. Further prospective studies are needed before definite conclusions can be made regarding the best predictor of future hypertension and type 2 diabetes mellitus.

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