Original Research Article

Waist hip ratio as predictor of incident diabetes in young adults

Sonia Singh[1],*, Sanju Acharya[1]

[1]*Dept. of Physiology, Hind Institute of Medical Sciences, Lucknow, Uttar Pradesh, India*

ARTICLE INFO

ABSTRACT

Introduction: Obesity is associated with impaired glucose tolerance which is a risk factor for cardiovascular disease. Central obesity (approximated by waist/hip ratio) is more informative than general obesity (body mass index). Thus, central obesity markers can be used to predict diabetes.

Objective: To find a correlation between blood sugar level and waist hip ratio in young adult males and females.

Materials and Methods: A cross sectional study was conducted among 60 students (30 males and 30 females) of first year MBBS in the department of Physiology of Hind Institute of Medical Sciences. Their WHR was measured and their venous blood sample was drawn in fasting and 2 hr post lunch. Statistical analysis was done using SPSS 21.

Results: According to WHR criteria, post prandial blood sugar level was significantly raised in males 'at risk level' (WHR $\geq$ 0.90) as compared to males 'below risk level' (WHR $\leq$ 0.90).

Conclusion: WHR is a good predictor of post prandial hyperglycemia and both are independent predictors of cardiovascular disease.

1. Introduction

Obesity has become a major worldwide epidemic affecting more than 300 million people. It is an important risk factor for diabetes mellitus type 2, a chronic disorder of carbohydrate, fat, and protein metabolism. From the clinical perspective, visceral adipose tissue is known to generate diabetogenic substances[1] and, as such, may be more informative than total fat for diagnostic evaluation. The standard epidemiologic translation of these important clinical facts uses anthropometric measures. Waist circumference and waist/hip ratio have been used as measures of central obesity (where visceral adipose tissue is stored), and body mass index (kg/m$^{2)}$) has been used as a measure of general obesity.[2]

Clinical evidence suggests that the association of diabetes with central obesity is stronger than the association with general fat. Studies using computed tomography and magnetic resonance imaging have provided further evidence to support that central obesity, visceral adipose tissue, and upper-body nonvisceral fat are the major contributors to the metabolic complications[2,3] Central obesity has been associated with decreased glucose tolerance, alterations in glucose insulin homeostasis, reduced metabolic clearance of insulin, and decreased insulin-stimulated glucose disposal.

In addition, the ability of these obesity indicators to predict diabetes may differ by ethnicity, age, and sex.[4] For example, among Asian populations, central obesity has been shown to be a more consistent predictor of diabetes than is total obesity.[5]

Thus, we aimed to make a comparison between blood sugar level and waist hip ratio in young healthy males and females. We included waist/hip ratio because it was the most common obesity-related predictor of diabetes after body mass index.

Corresponding author.
E-mail address: drsonias.27@gmail.com (S. Singh).

2. Materials and Methods

The present study was conducted in healthy medical students of first professional M.B.B.S. (n = 60) with 30 males (n = 30) and 30 females (n = 30) of 18 to 27 years age groups at Hind Institute of Medical Sciences, Sitapur. Waist Circumference (WC) and Hip Circumference (HC) of each subject were recorded and Waist - Hip Ratio (WHR) was calculated. A fasting and 2 hour post-prandial venous blood samples were drawn from each subject for blood sugar assay.

The subjects were divided into following groups:

2.1. According to WHR

Males with WHR < 0.90: "Below risk level" males

Males with WHR ≥ 0.90: "At risk level" males

Females with WHR < 0.85: "Below risk level" females

Females with WHR ≥ 0.85: "At risk level" females

Blood sugar levels were done by Biochemical Autoanalyser at the pathology lab using Enzymatic – colorimetric – Trinder – End Point method (Glucose oxidase and glucose peroxidase method). Normal reference value taken as 75 -100 mg/dl (4.2 - 5.6 mmol/L).

2.2. Statistical analysis

"SPSS statistical package for Windows version 21". Mean, standard deviation and Student's unpaired "t"-test were used to compare quantitative data. Correlation coefficient was used to compare continuous variables. The level of significance used was at 5% confidence limit (p<0.05).

3. Results

It was found that in males " below risk level" (WHR < 0.9), post prandial blood sugar level ranged from 89 to 119 mg/dl with mean and SD of 102.86 ± 9.37 and in males at risk level (WC ≥ 0.9), post prandial blood sugar ranged from 96 to 184 mg/dl with mean and SD of 115.88 ± 22.72. Post-prandial blood sugar level was increased in males "at risk level" as compared to males "below risk level" and the difference was statistically significant (p < 0.05). Fasting blood sugar level was also increased in males "at risk level" as compared to males "below risk level" but the difference was not statistically significant (p > 0.05).

In females, the variation in values of fasting and post-prandial blood sugar was not statistically significant (p > 0.05).

Waist Hip Ratio was positively correlated with fasting blood sugar (r = 0.120) and post-prandial blood sugar level (r = 0.028). None of these correlations were statistically significant (p > 0.05).

4. Discussion

Post-prandial blood sugar level was increased in males "at risk level" according to waist hip ratio (WHR ≥ 0.9), as compared to males "below risk level" (WHR < 0.9), and the difference found was statistically significant (p < 0.05). McKeigue et al.[6] (1991) and Mohan et al.[7] (2003) similarly found increase in glucose intolerance with increase in WHR. Gharakhanlou et al[8] (2012) found that in men, WHR was a significant predictor for glucose. Though, Ghosh et al (2004)[9] reported that centrally obese subjects had a significantly higher FPG (P<0.01) compared with centrally non-obese subjects. Ko et al[10] (1999) concluded that higher levels of WHR is associated with risk of diabetes. Palacios et al[11] (2011) found that WHR had the highest prevalence odds ratio for overall cardiometabolic risk and glycosylated hemoglobin. Mckeigue et al[6] (1991) stated that. Mean waist-hip girth ratios and trunk skinfolds were higher in the South Asian than in the European group. Within each ethnic group waist-hip ratio was correlated with glucose intolerance. Mohan et al[7] (2003) stated that regression analysis revealed waist-hip ratio (p < 0.0001) to be associated with glucose intolerance. Chien et al[12] (2004) told that for men, increased risk of fasting hyperglycemia started from WHR > or =0.82. For women, increased risk of fasting hyperglycemia started from WHR > or =0.74. In study by Joshi et al[13] (2019), the range of WHR in both male and female diabetic participants(100) was higher than non-diabetic participants(100) and the result was statistically significant in both the cases. Kharal et al[14] (2013) stated that mean waist hip ratio was 0.87 and increase in Waist hip ratio correlated significantly with increase in random blood sugar level both in males (p=0.008) and females (p=0.007).

Propective studies have also been done like a study by Hong et al[15] (2009) who did a prospective study on 3031 subjects without hyperglycemia. The Three-year cumulative incidence of hyperglycemia was 6.7%, with male 6.3% and female 7.0%. By multiple linear regression, on average, an increase in WHR was associated with increase in fasting plasma glucose. Similarly, Xu et al[16] (2010) did prospective study from 2004 to 2007 and found WHR to be positively associated with subsequent hyperglycemia. Koning et al[17] (2007) found WHR was more strongly associated with CVD than that for WC (WHR: RR = 1.95, 95% CI: 1.55-2.44; WC: RR = 1.63, 95% CI: 1.31-2.04)

Gu et al[18] (2011) stated the associations of anthropometries with each metabolic factor(in metabolic syndrome) to be significant and equal for BMI, WC, WHR and WHtR.

Vazquez et al (2007) concluded waist/hip ratio was the most common obesity-related predictor of diabetes. Shah A et al[19] (2009) showed that in female, age (82.9%) is the strongest predictor followed by WHR (78.1%), WC (70.2%) and least for BMI (55.0%) whereas for male

Table 1: Blood sugar level (mg/dl) according to waist hip ratio

	Males		Females	
	"Below risk level" n=14	"At risklevel" n=16	"Below risk level" n=23	"At risk level" n=7
Fasting Sugar	89.79±6.97	93.44±7.28	89.61±5.91	87.86±3.48
PP S ugar	102.86±9.37	115.88±22.72*	107.39±10.95	106.14±9.72

Normal fasting sugar level= 100-125 mg/dl
Normal pp sugar level= <200 mg/dl
(* Significant, $p < 0.05$)

Table 2: Correlation coefficients analysis

	WHR
Fasting Sugar	0.120
PP Sugar	0.028

**. Correlation is significant at the 0.01 level (2-tailed).

WC (87.0%) is the strongest followed by WHR (81.6%), BMI (68.5%) and least: for age (6.4.6%) using Receiver Operating Characteristic (ROC) curves.

Q Qiao et al[20] (2009) concluded that WC or WHR discriminate better the cases with diabetes from those without, as compared with BMI. Gokhale VS et al[21] (2017) included family history also in their study on 184 diabetic patients and found that Waist circumference and waist hip ratio above cut-off values emerged as common positive findings in majority of type 2 diabetic patients. Family history, individually as paternal or maternal diabetes did not show statistically significant correlation with waist circumference or Waist-hip ratio. This was study in a palindromic way toours.

Perez-pavida et al[22] (2019) opined that one in four subjects had post-prandial hyperglycaemia despite normal fasting glycaemia. Similar to our result, they found that anthropometric indices of central fat distribution were strongly and independently associated with an increased risk of post-prandial hyperglycaemia. Misra et al. (2006) also reported that post-prandial blood sugar level was raised in subjects with high WHR.

But contrary to this, Hardiman et al.[5] (2009) observed that there was no association between blood glucose level and WHR and Ghosh et al.[9] (2004) found WHR to be associated with fasting plasma glucose level which was again different from our result. The difference in the results may be due to their larger and wide spectrum groups of all ages.

Abdul Ghani MS et al (2009)[23] proved that measurement of the postload plasma glucose concentration has additive value to models based only on fasting measurements in predicting the future risk for type 2 diabetes. Jiang J et al[24] opined that post prandial blood sugar is more informative for screening of coronary heart disease and in our study also, we are finding post prandial hyperglycemia to be more significant.

5. Conclusion

The present study demonstrated strong associations of waist/hip ratio with incident diabetes. But we need to do more studies with higher sample size to corroborate these findings.

6. Abbreviations

WHR Waist Hip Ratio, FPG Fasting Plasma Glucose, WC Waist Circumference, HC Hip Circumference, BMI Body Mass Index, WHtR Waist Height Ratio.

7. Source of Funding

None.

8. Conflict of Interest

None.

References

1. DeFronzo RA. Pathogenesis of type 2 diabetes mellitus. *Med Clin North Am*. 2004;88(4):787–835. doi:10.1016/j.mcna.2004.04.013.
2. Després JP, Moorjani S, Lupien PJ, Tremblay A, Nadeau A, Bouchard C. Regional distribution of body fat, plasma lipoproteins, and cardiovascular disease. *Arteriosclerosis*. 1990;10(4):497–511. doi:10.1161/01.atv.10.4.497.
3. Jensen MD. Is visceral fat involved in the pathogenesis of the metabolic syndrome? Human model. *Obes (Silver Spring)*. 2006;14:20–24.
4. Haffner SM, Mitchell BD, Hazuda HP, Stern MP. Greater Influence of central distribution of adipose tissue on incidence of non-insulin-dependent diabetes in women than men. *Am J Clin Nutr*. 1991;53(5):1312–1317. doi:10.1093/ajcn/53.5.1312.
5. Shinta H, L, Bernanthus IN, Puspa K, Rustati E, Susiyanti. Waist circumference as a predictor for blood glucose levels in adults. *Universa Med*. 2009;28:77–82.
6. Mckeigue PM, Shah B, Marmot MG. Relation of central obesity and insulin resistance with high diabetes prevalence and cardiovascular risk in South Asians". *Lancet*. 1991;16:382–386.
7. Mohan V, Cs S, Deepa R. Glucose intolerance (diabetes and IGT) in a selected South Indian population with special reference to family

history, obesity and lifestyle factors–the Chennai Urban Population Study (CUPS 14). *J Assoc Physicians India*. 2003;51:771–777.

8. Gharakhanlou R, Farzad B, Agha-Alinejad H, Steffen LM, Bayati M. Anthropometric measures as predictors of cardiovascular disease risk factors in the urban population of Iran". *Arq Bras Cardiol*. 2012;98:126–135.

9. Ghosh A, Bose K, Chakravarti S, Chaudhuri ABD, Chattopadhyay J, et al. Central obesity and coronary risk factors. *Perspect Public Health*. 2004;124(2):86–91.

10. Ko GTC, Chan JCN, Cockram CS, Woo J. Prediction of hypertension, diabetes, dyslipidaemia or albuminuria using simple anthropometric indexes in Hong Kong Chinese. *Int J Obes*. 1999;23(11):1136–1142. doi:10.1038/sj.ijo.0801043.

11. Palacios C, Pérez CM, Guzmán M, Ortiz AP, Ayala A, Suárez E. Association between adiposity indices and cardiometabolic risk factors among adults living in Puerto Rico. *Public Health Nutr*. 2011;14(10):1714–1723. doi:10.1017/s1368980011000796.

12. Chien LY, Liou YM, Chen JJ. Association between indices of obesity and fasting hyperglycemia in Taiwan. *Int J Obes*. 2004;28(5):690–696. doi:10.1038/sj.ijo.0802619.

13. Joshi B, Shrestha L. A Comparative Study of Waist Hip Ratio and Body Mass Index (BMI) in Diabetic and Non Diabetic Individuals of Chitwan, Nepal. *J Diabetes Metab*. 2019;10(01):817. doi:10.35248/2155-6156.19.10.817.

14. Kharal PM, Prasad PN, Acharya RP. Gross correlation between waist hip ratio and blood sugar level in a village". *J Nepal Med Assoc*. 2013;52:361–365.

15. Hong X, Li JQ, Liang YQ, Wang ZY, Xu F ; 2009,.

16. Xu F, Wang YF, Lu L, Liang Y, Wang Z, et al. Comparison of anthropometric indices of obesity in predicting subsequent risk of hyperglycemia among Chinese men and women in Mainland China". *Asia Pacific J Clin Nutr*. 2010;19:586–593.

17. de Koning L, Merchant AT, Pogue J, Anand SS. Waist circumference and waist-to-hip ratio as predictors of cardiovascular events: meta-regression analysis of prospective studies. *Eur Heart J*. 2007;28(7):850–856. doi:10.1093/eurheartj/ehm026.

18. Gu JJ, Rafalson L, Zhao GM, Wu HY, Zhou Y, et al. Anthropometric Measurements for Prediction of Metabolic Risk among Chinese Adults in Pudong New Area of Shanghai. *Exp Clinl Endocrinol Diabetes*. 2011;119(07):387–394. doi:10.1055/s-0031-1277141.

19. Shah A, Bhandary S, Malik SL, Koju R. Waist circumference and waist-hip ratio as predictors of type 2 diabetes mellitus in the Nepalese population of Kavre district. *Nepal Med Coll J*. 2009;11:261–267.

20. Qiao Q, Nyamdorj R. Is the association of type II diabetes with waist circumference or waist-to-hip ratio stronger than that with body mass index? *Eur J Clin Nutr*. 2010;64(1):30–34. doi:10.1038/ejcn.2009.93.

21. Gokhale VS, Jagdale N, Batra T, Gulati S. A study of waist circumference, waist-hip ratio as markers of type 2 diabetes mellitus and their correlation with family history of diabetes. *Int J Res Med Sci*. 2017;5:1–5.

22. Pérez-Pevida B, Núñez-Córdoba JM, Romero S, Miras AD, Ibañez P, et al. Discriminatory ability of anthropometric measurements of central fat distribution for prediction of post-prandial hyperglycaemia in patients with normal fasting glucose: the DICAMANO Study. *J Transl Med*. 2019;17(1):48. doi:10.1186/s12967-019-1787-5.

23. Abdul-Ghani MA, Lyssenko V, Tuomi T, DeFronzo RA, Groop L. Fasting Versus Postload Plasma Glucose Concentration and the Risk for Future Type 2 Diabetes: Results from the Botnia Study. *Diabetes Care*. 2009;32(2):281–286. doi:10.2337/dc08-1264.

24. Jiang J, Zhao L, Lin L, Gui M, Aleteng Q, et al. Postprandial Blood Glucose Outweighs Fasting Blood Glucose and HbA1c in screening Coronary Heart Disease. *Sci Rep*. 2017;7(1):14212. doi:10.1038/s41598-017-14152-y.

Author biography

Sonia Singh Assistant Professor

Sanju Acharya Tutor