National Journal of Physiology, Pharmacy and Pharmacology

RESEARCH ARTICLE

# Correlation between non-diabetic fasting blood glucose levels and 2-h post loading blood sugar levels with waist-to-height ratio in rural population of Malwa region of Central India

**Abhilasha Dutta[1], Abhishek Kumar[2], Sarbil Kumari[2]**

[1]Department of Physiology, Hospital and Research Centre, Index Medical College, Indore, Madhya Pradesh, India, [2]Department of Physiology, Vardhman Institute of Medical Sciences, Pawapuri, Bihar, India

**Correspondence to:** Abhishek Kumar, E-mail: abhi83feb22@gmail.com

**Received:** September 17, 2019; **Accepted:** November 25, 2019

## ABSTRACT

**Background:** Prediabetes is a stage of glucose tolerance between normal glucose tolerance and diabetes and is characterized by impaired fasting glucose (IFG) and impaired glucose tolerance (IGT). The prevalence of diabetes and prediabetes is rapidly rising in India, in both urban and rural sectors. Obesity represents one of the major modifiable risk factors of the disease and waist-to-height ratio (WHtR) accounts as being one of the indicators of obesity and its association with IFG and IGT in non-diabetics needs to be studied. **Aims and Objectives:** This study aims to assess if a correlation exists between IFG and IGT and W: Ht ratio in a non-diabetic population. **Materials and Methods:** A total of 150 subjects, over the age of 20 years from village Hatpiplia, district Dewas, Madhya Pradesh, who were not known cases of diabetes mellitus were evaluated. Anthropometric measurements included waist circumference (in cm) and height (in cm) and WHtR was calculated. Blood samples for fasting blood sugar and 2-h post-glucose blood sugar were taken and analyzed on fully automated analyzer MERCK Microlab 300 LX by enzymatic colorimetric method. **Results:** The prevalence of IFG was found to be 18% (95% confidence interval [CI] 12.68–24.92) and 15.3% (95% CI 10.44–21.96) had IGT based on their 2-h post-glucose loading blood sugar levels. About 74% of the subjects who had IFG and 69% of the subjects with IGT were also found to have impaired WHtR. Moreover, more than 80% of the patients with newly detect diabetes had an impaired WHtR. **Conclusion:** Prediabetes is a growing concern in rural India and if we aim to control the epidemic of diabetes then focus has to be directed toward the stage of IFG and IGT where awareness and lifestyle intervention programs need to implement at basic levels. There is a strong association between impaired WHtR and prediabetes marking it as a very important prognostic indicator in the occurrence of the disease.

**KEY WORDS:** Impaired Fasting Glucose; Impaired Glucose Tolerance; Prediabetes; Waist-Height Ratio

## INTRODUCTION

Diabetes mellitus (DM), in today world, exhibits as a very pervasive disease, occurring suddenly but with massive impacts. It is a metabolic disorder, defined by chronic hyperglycemia with deranged fat, carbohydrate, and protein metabolism[1] that result from relative or absolute deficiency of insulin due to the impairment of insulin action and/or moderate to gross inadequacy of insulin secretion.[2] The concerns associated with diabetes can never be overemphasized because it is a chronic condition associated with long-term complications involving almost all organs.

Despite the concerns, the prevalence of diabetes is rising and it is expected to rise to 10% by 2030,[3] where India expects to see a rise to 151 million from its present 72 million by 2045

| Access this article online | |
|---|---|
| **Website:** www.njppp.com | Quick Response code |
| **DOI:** 10.5455/njppp.2020.10.0931726112019 | |

unless preventive measures are applied.[4] Furthermore, the International Diabetes Federation projects an increase in the prevalence of prediabetes to 471 million globally by 2035.[5]

Keeping the ever-increasing prevalence rates in mind, it is also notable to point out that a number of diabetic patients remain asymptomatic for a long duration of time and, therefore, are undiagnosed further increasing their chances of developing the associated complications, it is worth pointing out that a patient with newly onset DM has DM for approximate 4–7 years before being diagnosed.[6] This can be surmounted by regular screening of all non-diabetics to detect the asymptomatic period known as prediabetes.

Prediabetes,[7] as per the American Diabetic Association, is defined as that state, in which the blood glucose levels are more than normal but not high enough to be diagnosed as DM. It includes two parameters, impaired fasting glucose (IFG) and impaired glucose tolerance (IGT).

Studies on Indian population suggest that approximately 40–55% of the people with prediabetes will develop type 2 DM (T2DM) over a period of 3–5 years if no preventive measures are taken.[8] This brings us to those risk factors which if modified can actually change the course of the disease, obesity being one of the important ones. A lot of studies have directly labeled increased waist circumference and waist–hip ratio as indicators of obesity and many studies have been done in associating obesity with increased waist-to-height ratio (WHtR) and it has been observed that indeed, an abnormal WHtR is also an important marker for obesity.

The probability of association between abnormal WHtR and development of diabetes has also been proven time and again but has the fact that rural India boasts of a healthy lifestyle along with lesser ingestion of processed foods as compared to urban India and this important observation has made it a must for us to carefully observe the connection between the occurrence of prediabetes and its association with the two concerned parameters from the rural perspective.

## MATERIALS AND METHODS

The study was conducted at a rural mission hospital in a remote village Hatpiplia, district Dewas, Madhya Pradesh, beginning from November 2018 to March 2019. It was a cross-sectional study which was done as per the Declaration of Helsinki, after obtaining permission from the Ethical Committee of the Rural Mission Hospital, Hatpiplia. The study had a sample size of 150 subjects (95% confidence level) as calculated from OpenEpi, version 2, open-source calculator. The subjects chosen for the study were >20 years in age, who have never been diagnosed with T2DM.

Informed consent was taken before the initiation of survey. On receiving the consent, we collected the basic vital data which included age, gender, education, and occupation. Anthropometric measurements, including height and waist circumference, were recorded as per standard guidelines,[9] and WHtR was calculated.

### Instrumentation

Inelastic tape measure graduated in centimeters (0–150) was used to measure the waist circumference at the level of the umbilicus.

### Height Scale

A vertical wooden bar calibrated from 0 cm to 200 cm, with a movable horizontal bar which could be adjusted to touch the vertex of the participant's head was used to measure the height of the participants. The subject stood straight, with feet placed together and flat on the ground, heels, buttocks, and scapulae against the vertical backboard, and arms loose and relaxed with the palms facing medially. Height was measured to the nearest of centimeter.

The investigations done were as follows:

- Fasting blood sugar (FBS). After an overnight fasting of 10 h, venous blood samples were taken and the FBS was estimated
- Two hours post-glucose loading blood sugar (PLBS). Seventy-five grams of anhydrous glucose were given in 200 ml of water to the patient after taking the venous blood sample for FBS. After 2 h, venous blood samples were taken again to measure the 2-h PLBS.

The blood samples were sent immediately to the biochemistry laboratory for glucose levels to be analyzed on fully automated analyzer MERCK Microlab 300 LX by enzymatic colorimetric method (Manufacturer Vital Scientific N.V, Netherlands).

The collected data were tabulated and analyzed. Glucose tolerance was assessed as according to the World Health Organization criteria and WHtR was calculated and WHtR >0.5 was taken as abnormal.[10]

### Inclusion Criteria

The patients age >20 years who were not known cases of T2DM were included in the study.

### Exclusion Criteria

Included patients with known diabetes, chronic renal failure, liver cell diseases, endocrine disorders such as insulinoma and post-pancreatectomy, patients on drugs such as somatostatin, beta-blockers, diazoxide, thiazide diuretics, phenytoin, alloxan, and steroids pregnant women, postmenopausal women, people with fever, people who had edema, patient with osteoporosis with very low bone density, bodybuilders,

or professional athletes, patients undergoing dialysis, and persons with pacemaker were excluded from the study.

Criteria for diagnosis of new cases of DM, IFG, and IGT were as per the World Health Organization criteria.[11]

**DM**

- Symptoms of diabetes and random plasma glucose concentration >200 mg/dl odds ratio (OR)
- FBS >126 mg/dl OR
- Two hours PLBS >200 mg/dl.

Prediabetes was defined as follows:

- IFG included fasting venous plasma glucose ≥100 mg/dl <126 mg/dl, irrespective of the 2 h values
- IGT is 2-h PLBS ≥140 mg/dl <200 mg/dl after 75 g glucose loading.

## RESULTS

Table 1 shows a comparison between the subjects having IFG and 2-h IGT between males and females. Of the 150 study subjects, there was a slight predominance of males (59%) as compared to females (41%). Out of these, 27 subjects had IFG based on their FBS levels alone (prevalence of 18 % [95% confidence interval (CI) 12.68–24.92]) and 23 subjects, 15.3% (95% CI 10.44–21.96) had IGT based on their 2-h PLBS levels.

The entire study population permanently resided in villages. All of them were above the age of 20 years having varied occupations predominately including farming (57%), shopkeepers or shop workers (18%), and household helpers or housewives (11%). Their educational qualifications were on the downside where only 22% had completed high school and 5% attended some level of college and sadly, majority (39%) of them had no formal education.

When asked if they had any knowledge of diabetes or "madhumeh" as it is commonly known in vernacular, they responded in affirmative saying that it was related to sugar. Interestingly, some of them were unsure if the blood sugar increased or decreased during the course of the disease.

Table 2 shows the relationship between WHtR and FBS in the study subjects. Of the 27 subjects with IFG, 20 (74%) had WHtR >0.050 (95% CI 55.32–86.83), making it extremely statistically significant. Moreover, there were 15 new cases that were diagnosed with T2DM, 12 (80%) out of the 15 (95% CI 54.82–92.95) had an abnormal WHtR marking it as an important finding. In comparison, subjects found to have normal FBS also were seen to have a normal WHtR (55%).

Table 3 shows the relation between WHtR and 2-h PLBS and it was observed that a smaller number of subjects were detected with IGT (15%) as opposed to IFG (18%), and of all the detected cases of IGT, 69% had an abnormal WHtR (95% CI 49.14–84.4); also, all the cases with newly diagnosed DM by 2-h PLBS levels had WHtR more than 0.5 (95% CI 77.19–100] pointing at a direct correlation between impaired WHtR and occurrence of DM. Furthermore, 74 out of 114 subjects with normal 2-h PLBS levels also had WHtR within normal range.

**Table 1:** Gender-based comparison of IFG and IGT

| Variables | Males | Females | Total |
|---|---|---|---|
| IFG (FBS ≥100 mg/dl <126 mg/dl) | 15 | 12 | 27 |
| IGT (2-h PLBS ≥140 <200 mg/dl | 13 | 10 | 23 |

IFG: Impaired fasting glucose, IGT: Impaired glucose tolerance, FBS: Fasting blood sugar, PLBS: Post-glucose loading blood sugar

**Table 2:** Relationship between WHtR and FBS

| WHtR | IFG (100–126 mg/dl) | DM (>126 mg/dl) | Normal (FBS <100 mg/dl) |
|---|---|---|---|
| <0.50 | 7 | 3 | 59 |
| >0.50 | 20 | 12 | 49 |
| Total | 27 | 15 | 108 |

WHtR: Waist-to-height ratio, FBS: Fasting blood sugar, IFG: Impaired fasting glucose, DM: Diabetes mellitus

## DISCUSSION

We are already aware of increasing the prevalence of diabetes and prediabetes in developed as well as developing countries.[4] However, it was previously thought that this burden of increasing the rate of T2DM was more in the urban population and not so much in the rural sector. However, now, we have few studies that are pointing otherwise.[12] Unfortunately, despite T2DM being a major epidemic in our country, very few studies[13,14] have actually been done in rural India and almost negligible in Central India. Our study aimed at finding the correlation between prediabetes (IFG and IGT) and WHtR in the rural population of Central India and at the same time also to determine the prevalence of prediabetes in

**Table 3:** Relationship between WHtR and 2-h post loading blood sugar

| WHtR | IGT (140–200 mg/dl) | DM (>200 mg/dl) | Normal (2-h PLBS <140 mg/dl) |
|---|---|---|---|
| <0.50 | 7 | 0 | 74 |
| >0.50 | 16 | 13 | 40 |
| Total | 23 | 13 | 114 |

IGT: Impaired glucose tolerance, PLBS: Post-glucose loading blood sugar, DM: Diabetes mellitus, WHtR: Waist-to-height ratio

the study population. We found that the prevalence of IFG was 18% (95% CI 12.68–24.92) and 10% (95% CI 6.1–15.8) of the study population was found to have new diagnosed DM on the basis of their fasting sugar levels alone. Moreover, 15.3% (95% CI 10.44–21.96) of the subjects had impaired glucose levels on 2-h PLBS and DM by this method came to be very similar to the FBS method. Such high prevalence of prediabetes through alarming but is consistent with other recently done studies in India.[14,15]

In the previous studies, a number of anthropometrical variables such as waist circumference,[16] hip circumference, and body mass index (BMI) have been studied in correlation to the occurrence of prediabetes and diabetes. It was seen that BMI fails to distinguish between excess fat or more muscle mass[17] and, therefore, is unable to predict its role in T2DM. Meanwhile, waist circumference[18] only points out toward central deposition of fat and not an overall fat in the body. Waist-to-hip ratio was previously considered an important parameter, but the ratio remains the same if inches loss from waist and hip is equal. In comparison, WHtR is considered a better anthropometric variable to predict T2DM[19] because the height of an individual influences the distribution of body fat. Moreover, one of the variables in WHtR is constant making it easier was us to gauge if any changes take place. Furthermore, the WHtR cutoff value has been shown to be consistent across different ages, sexes, and ethnicities.[20,21] We found a strong correlation between WHtR >0.5 and IFG and IGT. Moreover, of all the cases of newly detected T2DM, almost all had a higher WHtR, making the finding very statistically significant. Our findings are consistent with similar studies.[22-25]

The rationale behind detecting prediabetes includes, prevention of development of diabetes, prevention of consequences of diabetes and being aware that about 70% of Indians resides in rural areas,[26] even a small increase in the rural prevalence of diabetes will very rapidly increase the diabetic burden in our country and therefore our aim in this regard should be to include lifestyle intervention program to change the modifiable risk factors, mainly targeting obesity with increase in physical activity and dietary changes.

## CONCLUSION

Prediabetes is a growing concern in rural India and if we aim to control the epidemic of diabetes then focus has to be directed toward the stage of IFG and IGT, and awareness and lifestyle intervention programs need to implement at basic levels. There is a strong association between impaired WHtR and prediabetes marking it as a very important prognostic indicator in the occurrence of the disease. The association of WHtR and IFG is comparatively stronger than that with IGT, but as both the variables point toward prediabetes, it is safe to say that an impaired WHtR (>0.5) is definitely the strong possibility of being prediabetic and ultimately developing T2DM.

## REFERENCES


1. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2004;27:5-10.
2. Tripathi BB. Definition, classification and diagnosis. In: Ahuja MM, Tripathi BB, Moses GP, Chandalia HB, Das AK, Rao PV, *et al*., editors. RSSDI Textbook of Diabetes Mellitus. 1st ed. Hyderabad: Research Society for the Study of Diabetes in India; 2002. p. 75-90.
3. Whiting DR, Guariguata L, Weil C, Shaw J. IDF diabetes atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res Clin Pract 2011;94:311-21.
4. Danaei G, Finucane MM, Lu Y, Singh GM, Cowan MJ, Paciorek CJ, *et al*. National, regional, and global trends in fasting plasma glucose and diabetes prevalence since 1980: Systemic analysis of health examination surveys and epidemiological studies with 370 country-years and 2 7 million participants. Lancet 2011;378:31-40.
5. International Diabetes Federation. IDF Diabetes Atlas. 6th ed. Brussels, Belgium: International Diabetes Federation; 2013.
6. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care 2007;30 Suppl 1:S42-7.
7. Genuth S, Alberti KG, Bennett P, Buse J, Defronzo R, Kahn R, *et al.* Follow-up report on the diagnosis of diabetes mellitus. Diabetes Care 2003;26:3160-7.
8. Mohanty B. Prediabetes precursor to Type 2 diabetes, act today-block the road to diabetes. Paripex Indian J Res 2018;7:188-9.
9. Molarius A, Kuulasmaa K, Susana S. Quality Assessment of Weight and Height Measurements in the WHO MONICA Project. WHO MONICA Project; 1998. Available from: http://www.thl.fi/publications/monica/bmi/bmiqa. [Last accessed on 2019 Apr 10].
10. Ashwell M, Gibson S. Waist-to-height ratio as an indicator of 'early health risk': Simpler and more predictive than using a 'matrix' based on BMI and waist circumference. BMJ Open 2016;6:e010159.
11. World Health Organization. Definition and Diagnosis of Diabetes Mellitus and Intermediate Hyperglycemia: Report of A Who/Idf Consultation. Geneva: World Health Organization; 2006. p. 1-50.
12. Little M, Humphries S, Patel K, Dewey C. Decoding the Type 2 diabetes epidemic in rural India. Med Anthropol 2017;36:96-110.
13. Misra P, Upadhyay RP, Misra A, Anand K. A review of the epidemiology of diabetes in rural India. Diabetes Res Clin Pract 2011;92:303-11.
14. Anjana RM, Deepa M, Pradeepa R, Mahanta J, Narain K, Das HK, *et al*. Prevalence of diabetes and prediabetes in 15 states of India: Results from the ICMR-INDIAB population-based cross-sectional study. Lancet Diabetes Endocrinol 2017;5:585-96.
15. Vijayakumar G, Manghat S, Vijayakumar R, Simon L, Scaria LM, Vijayakumar A, *et al*. Incidence of Type 2 diabetes mellitus and prediabetes in Kerala, India: Results from a 10-year prospective cohort. BMC Public Health 2019;19:140.
16. Gouveia LA, Mde FM, Lebrao ML, Duarte YA. Association between waist circumference (WC) values and hypertension, heart disease (HD) and diabetes, reported by the elderly-SABE survey: Health, wellness and aging, 2000 and 2006. Arch Gerontol Geriatr 2014;59:62-8.
17. Yajnik CS, Yudkin JS. The Y-Y paradox. Lancet 2004;363:163.

18. Hsieh SD, Yoshinaga H. Do people with similar waist circumference share similar health risks irrespective of height? Tohoku J Exp Med 1999;188:55-60.
19. Son YJ, Kim J, Park HJ, Park SE, Park CY, Lee WY, *et al*. Association of waist-height ratio with diabetes risk: A 4-year longitudinal retrospective study. Endocrinol Metab (Seoul) 2016;31:127-33.
20. Browning LM, Hsieh SD, Ashwell M. A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0·5 could be a suitable global boundary value. Nutr Res Rev 2010;23:247-69.
21. Ashwell M, Gunn P, Gibson S. Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: Systematic review and meta-analysis. Obes Rev 2012;13:275-86.
22. Rajput R, Rajput M, Bairwa M, Singh J, Saini O, Shankar V. Waist height ratio: A universal screening tool for prediction of metabolic syndrome in urban and rural population of Haryana. Indian J Endocrinol Metab 2014;18:394-9.
23. Chen BD, Yang YN, Ma YT. Waist-to-height ratio and triglycerides/high-density lipoprotein cholesterol were the optimal predictors of metabolic syndrome in Uighur men and women in Xinjiang, China. Metab Syndr Relat Disord 2015;13:214-20.
24. Jayawardana R, Ranasinghe P, Sheriff MH, Matthews DR, Katulanda P. Waist to height ratio: A better anthropometric marker of diabetes and cardio-metabolic risks in South Asian adults. Diabetes Res Clin Pract 2013;99:292-9.
25. Park YS, Kim JS. Association between waist-to-height ratio and metabolic risk factors in Korean adults with normal body mass index and waist circumference. Tohoku J Exp Med 2012;228:1-8.
26. Chandramouli C. Rural Urban Distribution of Population. Available from: http://www.censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural_Urban_2011.pdf. [Last accessed on 2019 Mar 03].

**How to cite this article:** Dutta A, Kumar A, Kumari S. Correlation between non-diabetic fasting blood glucose levels and 2-h post loading blood sugar levels with waist-to-height ratio in rural population of Malwa region of Central India. Natl J Physiol Pharm Pharmacol 2020;10(02):104-108.

**Source of Support:** Nil, **Conflict of Interest:** None declared.