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# "TYPE 2 DIABETES AND ITS CORRELATION WITH BODY MASS INDEX, WAIST CIRCUMFERENCE, HIP CIRCUMFERENCE, AND WAIST-HIP RATIO: AN OBSERVATIONAL STUDY IN WESTERN RAJASTHAN"

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Conflicts of Interest: Nil

**ABSTRACT:**

**Aim:** The aim of the study was to evaluate body mass index, waist circumference, hip circumference waist-hip ratio and find their association with type 2 diabetes patients at a tertiary care teaching hospital in Western Rajasthan.

**Methodology:** This was a prospective, non intervention and observational study, conducted over a period of 1 year with association of the Department of Pharmacology and the Department of Medicine, Dr. S. N. Medical College, Jodhpur Information of patients collected included age, sex, diagnosis, height, weight, waist circumference and hip circumference noted in case record form. BMI and waist-hip ratio was calculated and all data further analyzed.

**Results:** Total 250 patients were analyzed. The majority of patients had BMI more then 25 kg/$m^2$ (54.4%), The majority of patient belongs to Waist Circumference ≥100 cm (42%) while Hip circumference ≥ 100 cm found in 58.4% and 68.4 % patients had WHR more than 0.96.

**Conclusion:** The increasing prevalence of diabetes is driven by a combination of several factors like rapid urbanization, sedentary lifestyles increasing life expectancy and unhealthy diets. The majority of patients were obese or over obese which further increased insulin resistance and interfered in function of insulin in diabetic patients. The most common reason behind this is lack of awareness, poor socioeconomic status and lack of education.

**Keywords:** Type 2 Diabetes Mellitus, Body mass index, waist circumference, hip circumference waist-hip ratio.

## Introduction

Diabetes Mellitus (DM) refers to a group of common metabolic disorders characterized by hyperglycemia [1]. Factors associated with hyperglycemia are a defect in insulin action, insulin secretion, decreased glucose utilization and increased glucose production. In a broad sense diabetes can be defined as follows:-

"The term diabetes mellitus described a metabolic cum vascular syndrome of multiple etiology characterized by chronic hyperglycemia with disturbance of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action, or both leading to changes in both small blood vessels (microangiopathy) and large blood vessels (macroangiopathy)".

In long term, DM leads to a pathological change in multiple organs especially, kidney, nerve, eye, blood vessels and heart [2].

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Obesity especially central obesity is the main risk factor for T2DM and risk is related to both the duration and degree of obesity. T2DM is very much associated with body mass index (BMI), weight gain, waist circumference or waist to hip ratio. Indeed waist circumference or waist-hip ratio is a more preferred determinant of subsequent risk of T2DM than BMI. Central obesity is also an important determinant of insulin resistance underlying abnormality in most cases of T2DM. In some instance, obesity decreases the number of insulin receptor at the target cell. However all obese are not diabetic [3].

Diabetes is an important public health problem, as the prevalence and number of people with diabetes continue to rise. This is because of change in the way people eat, move and aging global population so that expenditure of diabetes on health and economy is growing. This expenditure can be reduced through effective actions like lifestyle modification, lifelong proper antidiabetic management, and regular follow-up so that people with diabetes can live longer and healthier. We need further improvement in management and modifying the risk factors.

Type 2 diabetes (T2DM) is first and foremost, a lifestyle disease. Nonpharmacological management mainly consists education about diabetes, healthy diet, lifestyle modification, weight reduction in T2DM, an adequate level of physical activity and exercise can bring about result comparable to some of the commonly used antidiabetic drugs. Therefore, every patient with T2DM should incorporate therapeutic lifestyle change as part of his or her management. Lifestyle modification should be initiated in all individual detected to be at high risk for diabetes and who do not already have the disease[4,5].

## MATERIALS AND METHODS

This study was a prospective, noninterventional and observational study. It was conducted in association with the Department of Medicine in Mathura Das Mathur (MDM) Hospital, Jodhpur (Tertiary Care Teaching Hospital). This study included 250 outpatients with Type 2 Diabetes Mellitus. The candidate has not been advised any new drug by the investigator during the study period. All participants in the study were clearly explained the purpose and nature of study in their language. All patients were included after receiving informed consents. All data of patients were kept confidential.

Every Wednesday we visited Diabetic OPD and collected all information pertaining to every patient, such as the name, age, gender, address, relevant medical history, past history, family history etc complete information was obtained either by direct conversation with patients or from prescribed OPD slips, then recorded in Case Record Form.

Known case of Type 2 diabetes mellitus with or without complications, patients aged more than 20 yrs were included in this study only after receiving written informed consent and only outpatients were included in the study. While Pregnant females, Gestational diabetes patients, Type 1 diabetes patients, patient not willing to participate and bedridden patients were excluded from the study.

A general examination of every patient, in term of weight (kg), height (cm), waist circumference, hip circumference was measured. Body mass index (BMI), Waist-Hip Ratio (WHR) were calculated from collected data and recorded in Case Recorded Form.

After recording the obtained information in the Case Record Form the data were subjected to further analysis.

## RESULTS

A total of 250 patients who fulfilled the inclusion criteria were taken for study at Mathura Das Mathur Hospital Jodhpur, attached group of Hospitals of Dr. S. N. Medical College, Jodhpur (Rajasthan) and they were analyzed further as :

**1) BMI Wise Distribution of Study Patients:-**

**Table 1: BMI wise distribution of study patients**

| BMI (kg/m2) | Male | | Female | | Total |
|---|---|---|---|---|---|
| | N | % | N | % | |
| ≤19.99 | 11 | 5.70 | 0 | 0 | 11 (4.4%) |
| 20-24.99 | 74 | 38.34 | 23 | 40.35 | 97 (38.8%) |
| 25-29.99 | 88 | 45.60 | 23 | 40.35 | 111 (44.4%) |
| 30-34.99 | 17 | 8.81 | 8 | 14.04 | 25 (10%) |
| ≥35 | 3 | 1.55 | 3 | 5.26 | 6 (2.4%) |
| Total | 193 | 77.2 | 57 | 22.8 | 250 |

Among male patients, maximum number of patients had BMI between 25-29.99 kg/m$^2$ (45.60%) followed by 20-24.99 kg/m$^2$ (38.34%), 30-34.99 kg/m$^2$ (8.81%), ≤19.99 kg/m$^2$ (5.70%), and lowest from group ≥ 35kg/m$^2$ (1.55%) respectively shown in table 1 and figure 1.

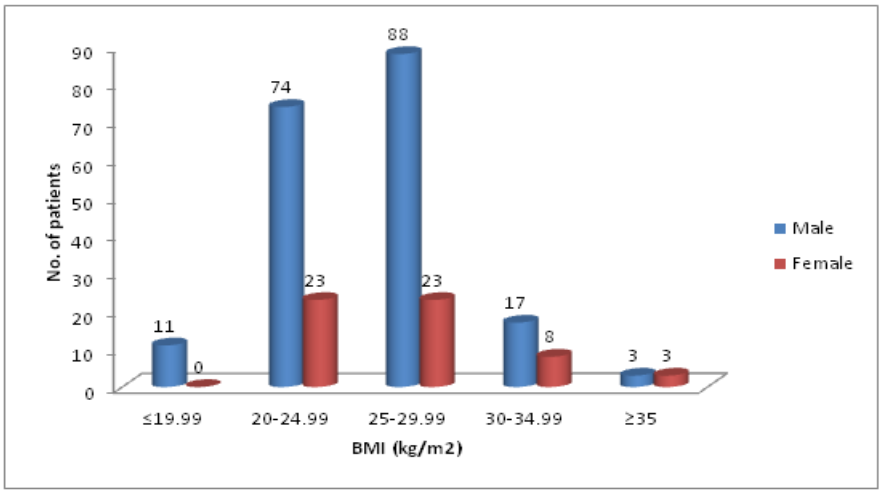


**Figure 1: BMI wise distribution of study patients.**

According to BMI, maximum patients were obese or over obese.

Among female patients, maximum no of patients had BMI between 20-24.99 kg/m$^2$ and 25-29.99 kg/m$^2$ (each 40.35%) followed by 30-34.99 kg/m$^2$ (14.04%) and lowest from BMI group ≥35 kg/m$^2$ (5.26%).The majority of patients (both male and female) had BMI between 25-29.99 kg/m$^2$(44.4%) shown in table 1 and figure 1. So maximum obese or over obese according to BMI.

**2) Waist Circumference Distribution of Study Patients:-**

**Table 2: Waist Circumference Distribution of Study Patients**

| Waist circumference (cm) | Male | | Female | | Total |
|---|---|---|---|---|---|
| | N | % | N | % | |
| ≤90 | 30 | 15.54 | 3 | 5.26 | 33 (13.2%) |
| 91-95 | 42 | 21.76 | 8 | 14.04 | 50 (20%) |
| 96-100 | 46 | 23.83 | 16 | 28.07 | 62 (24.8%) |
| ≥100 | 75 | 38.86 | 30 | 52.63 | 105 (42%) |
| Mean±SD | 98.66+9.25 | - | 102.87+8.85 | - | 99.62+9.31 |

Among males, a maximum number of patients belongs to Waist circumference group ≥100cm (38.86%) followed by 96-100 cm (23.83%), 91-95 cm (21.76%) and minimum in group ≤90 cm (15.54%). Mean waist circumference among male patients observed is 98.66cm whereas standard deviation is 9.25. Among females, a maximum number of patients belong to Waist Circumference group ≥100cm (52.63%) followed by 96-100 cm (28.07%), 91-95 cm (14.04%) and least with Waist Circumference group ≤90cm 3 patients (5.26%) respectively shown in table 2. Mean waist circumference in the female is 102.87cm whereas standard deviation is 8.85. The majority of patient belongs to Waist Circumference group ≥100 cm (42%) whereas, Mean Waist circumference in is 99.62cm whereas standard deviation is 9.31(Table 2).

**3) Hip Circumference Distribution of Study Patients:-**

**Table 3: Hip Circumference Wise Distribution of Study Patients**

| Hip circumference (cm) | Male | | Female | | Total |
|---|---|---|---|---|---|
| | N | % | N | % | |
| ≤90 | 24 | 12.44 | 1 | 1.75 | 25 (25%) |
| 91-95 | 33 | 17.10 | 5 | 8.77 | 38 (15.2%) |
| 96-100 | 31 | 16.06 | 10 | 17.54 | 41 (16.4%) |
| ≥100 | 105 | 54.40 | 41 | 71.93 | 146 (58.4%) |
| Mean±SD | 100.53+8.55 | - | 105.28+9.40 | - | 101.62+8.96 |

Among male patients, the maximum number of patients had Hip Circumference between ≥100cm (54.40%) followed 91-95 cm (17.10%), 96-100 cm (16.06%) and lowest in group ≤90 cm (12.44%) respectively. Mean hip circumference among male patients observed is 100.53 cm whereas standard deviation is 8.55 shown in table 3. Among females, a maximum number of patients belongs to Hip Circumference group ≥100cm (71.93%) followed by 96-100 cm (17.54%), 91-95 cm (8.77%) and lowest with Hip Circumference group ≤90cm only one patient (1.75%) were recorded. Mean Hip circumference in the female is 105.28 cm whereas standard deviation is 9.40. The majority of patient belongs to Hip circumference group of ≥100 cm (58.4%). While mean hip circumference is 101.62 cm whereas standard deviation is 8.96 shown in Table 3.

**4) Waist Hip Ratio (WHR) Wise Distribution of Study Patients**

**Table 4: Waist Hip Ratio (WHR) Wise Distribution of Study Patients**

| WHR | Male | | Female | | Total |
|---|---|---|---|---|---|
| | N | % | N | % | |
| ≤0.90 | 14 | 7.25 | 6 | 10.53 | 20(8%) |
| 0.91-0.95 | 45 | 23.32 | 14 | 24.56 | 59(23.6%) |
| 0.96-1.00 | 75 | 38.86 | 14 | 24.56 | 89(35.6%) |
| ≥1.00 | 59 | 30.57 | 23 | 40.35 | 82(32.8%) |
| Mean±SD | 0.98+0.11 | - | 0.98+0.06 | - | 0.98+0.09 |

In our study among male patients, the maximum number of patients belongs to WHR between 0.96-1.00 (38.86%) followed by ≥1.00 (30.57%), 0.91-0.95 (23.32%) and minimum ≤ 0.90 (7.25%). Mean WHR among male patients observed is 0.98 whereas standard deviation is 0.11. Among females, a maximum number of patient belong to WHR group ≥1.00 (40.35%) followed by 0.91-0.95 and 0.96-1.00 (each 24.56%), and minimum number with WHR group ≤0.90 (10.53%) were recorded. Mean WHR among

female patients observed is 0.98 whereas standard deviation is 0.06. The majority of patient belongs to WHR of 0.96-1.00 (35.6%). While mean WHR among patients observed is 0.98 whereas standard deviation is 0.09 (Table 4 and Figure 2).

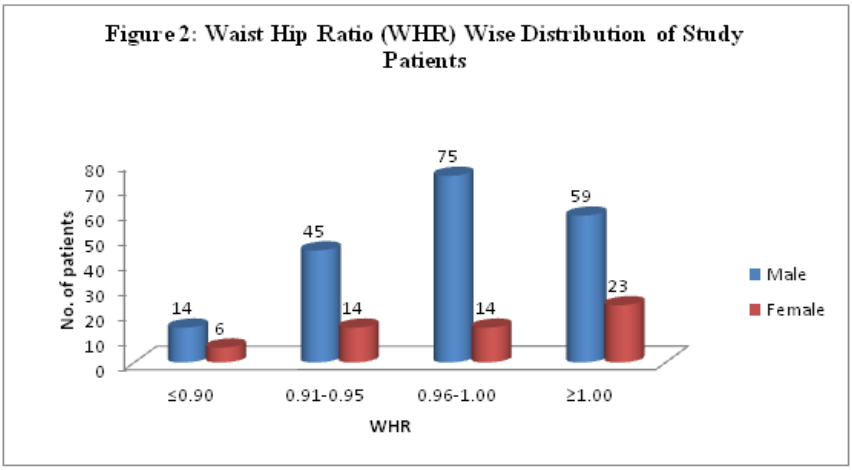


**Figure 2: Waist Hip Ratio (WHR) Wise Distribution of Study Patients.**

Maximum patients had a waist-hip ratio of more than 0.9 which show maximum patient had central obesity.

## DISCUSSION

As Diabetes mellitus is now reaching potentially epidemic proportions in worldwide as well as in India. The level of morbidity and mortality due to diabetes and its potential complications are enormous and had significant healthcare burdens on both society and families. Worryingly, DM is now being shown to be associated with a wide spectrum of complications. In India, the steady migration of people from rural to urban areas, a corresponding change in lifestyle and the economic boom are all affecting the level of diabetes.

According to BMI classification recommended for Asians population. Categories according to the classification were <18.50 $kg/m^2$ as underweight, 18.5–24.99 $kg/m^2$ as normal, 25.00–29.99 $kg/m^2$ as overweight, and 30.00 $kg/m^2$ above as obese (WHO expert consultation 2004)[6].

In the present study, the majority of male belong to between 71-80 kg of weight group while the majority of females belongs to weight group 61-70 kg. On the other hand, the majority of male belong to 161-170 cm height group and the majority of female belong to height group to 151-160 cm. and when we have calculated BMI then we found that 44.4% of patients were overweight and 12.4% of patients were obese or over obese. In other words, in the present T2DM maximum patients belong to higher BMI group. Similar findings were confirmed by Daousi C et al studies confirming that the majority of patients with T2DM are overweight or obese and that obese or over obese people are having the highest risk of developing T2DM[7]. In Guh DP et al meta-analysis of prospective cohort studies from the United States (US) and Europe, obese males had a 7 time higher risk of developing T2DM, and obese females a 12 time higher risk, compared with individuals in the normal weight range[8]. Similar to our study, comparison of data from two national surveys SHIELD and NHANES by Bays HE et al reported that patients with higher BMI are at higher risk of having DM, hypertension, and dyslipidemia. These survey also confirm that the maximum number of patients with this metabolic syndrom are either overweight or obese[9]. Schienkiewitz A et al in their study reported that weight gain in early adulthood is associated with higher risk and earlier onset of T2DM than is weight gain between 40yrs to 55 yrs of age[10]. Jerant A et al reported in their study

that The higher BMI category for physical health status was more among DM patients than a non-DM person. The findings are consistent with a BMI physical health status paradox in diabetes and, in turn, a mortality paradox[11].

Similar to our study, Zhao Q et al found in their study that higher BMI is associated with increased insulin resistance and which lead to decreased insulin sensitivity in the elderly with T2 DM[12]. Whereas Su Y found in their study that higher BMI is an independent and adjusted dose-dependent risk factor for DM among obese and overweight participants in China, with substantial population-level effects. Their findings demonstrated that there is a dose-response relationship between BMI and DM, and they advised that weight reduction interventions according to the association between continuous variations in BMI and the risk of diabetes, rather than traditional BMI levels[13]. The BMI values are the best sensitivity and specificity for identifying individuals risk for diabetes mellitus and arterial hypertension and found that Japanese-Brazilians with BMI ≥ 25kg/m2 is more on the risk of developing diabetes mellitus and hypertension[14]. Whereas not only is BMI strongly and independently associated with the risk of being diagnosed with T2D, but also that the magnitude of this positive association is larger for higher BMI values[15]. Insulin Deltimer therapy was associated with improved glycemic control and a low number of serious adverse drug reactions. More weight loss was observed with higher BMI pateints[16].

In the present study, we found that maximum patients belong to Waist and hip circumference ≥100 cm which indicates maximum T2DM patients were obese or over obese and having central obesity. Whereas maximum patients having WHR were more than 0.95, which further indicate that the prevalence of T2DM in over study was more in overweight or obese patients. According to the Waist Circumference and Waist-Hip Ratio Report of a WHO Expert Consultation, Geneva, December 8-11, 2008, sex-specific cut-off points for waist circumference are 94 cm (men) and 80cm (women) for increased risk, and 102 cm (men) and 88cm women for substantially increased the risk of metabolic complications. Whereas the waist-hip ratio above 0.90 for males and above 0.85 for females increased the risk of metabolic complications. Emdin CA et al in their study demonstrated that A genetic predisposition to higher Waist to Hip Ratio adjusted for BMI was associated with increased risk of T2DM and Coronary Heart Disease[17]. The waist-to-hip ratio might have a role in the effect of T2DM polygenic scores on depression case-status. Higher adiposity is associated with a greater level of inflammation, which is associated with an increased risk of type 2 diabetes and depression[18].

In the present study, we found that a maximum number of male patient belongs to Waist Circumference group ≥100cm (38.86%) and maximum no. of female patient belongs to Waist Circumference group ≥100cm (52.63%) which indicate maximum patients were having central obesity. Gokhale VS et al study shows, the majority of their type 2 diabetic patients having waist circumference and waist-hip ratio, above cutoff values for Asian[19]. Vazquez G et al in their study demonstrated strong associations of body mass index, waist circumference, and waist/hip ratio with the incidence of Diabetes Mellitus. The statistical waist circumference and body mass index are very highly correlated and likely to behave similarly in diabetes prediction. Waist-hip ratio, despite lower correlation with body mass index and waist circumference, is having the same ability to predict diabetes as do both body mass index and waist circumference[20]. Schmidt MI et al suggested that central obesity, as measured by the Waist/Hip Ratio, is important and Independently associated with T2DM[21]. Qiao Q et al found in their study that most prospective studies far presented all anthropometric measures of BMI, WC, WHR, and the waist-to-stature ratio. But most of the cross-sectional studies showed that WC or WHR discriminate better the cases with DM from those without DM, the prospective studies are limited and covered only limited ethnic groups. The cross-sectional studies have shown that either BMI or WC predicted or was associated with increased diabetes risk, independent of other factors[22].

## CONCLUSION

Diabetes Mellitus is a metabolic disorder and obesity especially central obesity is a major risk factor. In India, the steady migration of people from rural to urban areas, a corresponding change in lifestyle and the economic explosion have led to increase in prevalence of obesity among population and thus indirectly increased prevalence of diabetes mellitus. Hence, counseling, awareness program and educating the patient on the importance of physical activity, exercise and diet in the management of T2DM are of essential importance.

## LIMITATIONS OF THE STUDY

1. The study was of short duration and sample size of study also small.

2. The study was a hospital-based study and may not truly reflect findings in the rural areas and the entire area.

## RECOMMENDATIONS

1. Future studies are recommended with large sample size and to be conducted over a longer period of time to establish a trend in drug therapy of T2DM.

**2.** To prevent Diabetes Mellitus and attain optimal diabetes management, an organized, systematic approach is needed which targets to improve patients lifestyle, motivation for self management , good glycemic control and satisfaction apart from routine pharmacotherapy.

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## CONFLICT OF INTEREST

The authors declare that no conflict of interest, financial or otherwise, exists

## REFERENCES

1. Baynes HW Classification, Pathophysiology, Diagnosis and Management of Diabetes Mellitus. J Diabetes Metab. 2015; 6:541. doi:10.4172/2155-6156.1000541
2. Chawla A, Chawla R, Jaggi S. Microvascular and macrovascular complications in diabetes mellitus: Distinct or continuum? Indian J Endocrinol Metab [Internet]. 2016;20(4): 546–51.
3. GBD 2013 Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 79 behavioral, environmental and occupational, and metabolic risks or clusters of risks in 188 countries, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet. 2015;386(10010):2287–323.
4. Darnton-Hill I, Nishida C, James WPT. A life-course approach to diet, nutrition and the prevention of chronic diseases. Public Health Nutrition. 2004;7(1A):101–21.
5. Diet, nutrition and the prevention of chronic diseases. Report of a Joint WHO/FAO Expert Consultation. Geneva: World Health Organization; 2003.
6. Pradeepa R, Mohan V. The changing scenario of the diabetes epidemic: Implications for India. Indian J Med Res 2002;116:121-32.
7. Daousi C, Casson IF, Gill GV, et al. Prevalence of obesity in type 2 diabetes in secondary care: association with cardiovascular risk factors. Postgrad Med J. 2006; 82:280–4.
8. Guh DP, Zhang W, Bansback N, et al. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. BMC Public Health. 2009;9:88.
9. Bays HE, Chapman RH, Grandy S. The relationship of body mass index to diabetes mellitus, hypertension and dyslipidemia: Comparison of data from two national surveys. Int J Clin Pract. 2007;61(5):737–47.
10. Schienkiewitz A, Schulze MB, Hoffmann K, Kroke A, Boeing H. Body mass index history and risk of type 2 diabetes: results from the European Prospective Investigation into

Cancer and Nutrition (EPIC)-Potsdam Study. Am J Clin Nutr. 2006;84(2):427–33.

11. Jerant A, Bertakis KD, Franks P. Body mass index and health status in diabetic and non-diabetic individuals. Nutr Diabetes. 2015;5(4):e152.
12. Zhao Q, Laukknen J, Li Q, Li G. Body mass index is associated with type 2 diabetes mellitus in Chinese elderly. Clin Interv Aging. 2017;12:745–52.
13. Su Y, Ma Y, Rao W, Yang G, Wang S, Fu Y, et al. Association Between Body Mass Index and Diabetes in Northeastern China. Asia Pacific J Public Heal. 2016;28(6):486–97.
14. Simony RF, Gimeno SGA, Ferreira SRG, Franco LJ. Which body mass index is best associated with risk of diabetes mellitus and hypertension in a Japanese-Brazilian population? TT - Que valor de índice de massa corporal melhor se associa a risco de diabetes mellitus e hipertensão em nipo-brasileiros? Cad Saude Publica. 2007;23(2):297–304.
15. Ganz ML, Wintfeld N, Li Q, Alas V, Langer J, Hammer M. The association of body mass index with the risk of type 2 diabetes: a case-control study nested in an electronic health records system in the United States. Diabetol Metab Syndr. 2014;6(1):50.
16. Khamseh ME, Prusty V, Latif Z, Gonzalez-Galvez G, Dieuzeide G, Zilov A. Type 2 Diabetes Mellitus Management and Body Mass Index: Experiences with Initiating Insulin Detemir in the A1chieve Study. Diabetes Ther. 2014;5(1):127–40.
17. Emdin CA, Khera A V., Natarajan P, Klarin D, Zekavat SM, Hsiao AJ, et al. Genetic association of waist-to-hip ratio with cardiometabolic traits, type 2 diabetes, and coronary heart disease. JAMA - J Am Med Assoc. 2017;317(6):626–34.
18. Kan C, Coleman J, Mahajan A, McCarthy M, Breen G, Ismail K, et al. Effect of waist-to-hip ratio on the association between type 2 diabetes and depression: an exploratory study using the polygenic scores approach in the UK Biobank. Lancet. 2017;389: S53.
19. Gokhale VS, Jagdale N, Batra T, Gulati S. Original Research Article A study of waist circumference, waist-hip ratio as markers of type 2 diabetes mellitus and their correlation with family history of diabetes. 2017; 5(1):70–4.
20. Vazquez G, Duval S, Jacobs DR, Silventoinen K. Comparison of body mass index, waist circumference, and waist/hip ratio in predicting incident diabetes: A meta-analysis. Epidemiol Rev. 2007;29(1):115–28.
21. Schmidt MI, Duncan BB, Canani LH, Karohl C, Chambless L. Association of waist-hip ratio with diabetes mellitus: Strength and possible modifiers. Diabetes Care. 1992;15(7):912–4.
22. 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):30–4.