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Original Research Article

New surrogate anthropometrical markers for early detection of insulin resistance

Naveen Bhartia Porwal, Shraddha Singh, N.S Verma, Sandeep Bhattacharya, Amit Kumar Madeshiya, Kalpana Singh, Pravesh Kumar and Sunita Tiwari[*]

Department of Physiology, King George Medical University Lucknow, India

*Correspondence Info:

Dr Sunita Tiwari,
Professor and Head,
Department of Physiology,
King George Medical   University Lucknow, India
E-mail: email-sunita_kgmu@yahoo.com

Abstract

Background: Insulin resistance is the pathophysiological basis of several cardiometabolic risk conditions. The early identification of insulin resistance decreases the risk of cardiometabolic complications. The correlation between the increase in visceral fat, central obesity and with insulin resistance is a important indicator. Present study was conducted to find the correlation between various anthropometric measurements and insulin resistance (HOMA-IR) and to find out the anthropometric marker, which correlates most significantly with insulin resistance.

Material and methods: This is a population based cross-sectional study. Total 100 apparently healthy subjects (n=55 male and n=45 female) aged between 18-25 years were recruited with prior ethical approval and with written informed consent. All the anthropometrical measurements were done as per the standard methods. Fasting glucose and insulin were estimated by using commercially available kit. Insulin resistance was quantified using homeostasis model

Results: There was positive correlation between HOMA-IR and waist circumference (r=0.395, p=0.0001). However, significant positive & mild correlation between HOMA-IR and waist hip ratio was found (r=0.263, p =0.008). The correlation between HOMA-IR and waist height ratio was also observed to be positive and moderate.

Conclusion: As per the findings we concluded that, waist circumference and waist height ratio are better predictors of insulin resistance compared to the other anthropometric measurements in apparently healthy north Indian subjects.

Keywords: Insulin resistance, waist circumference, waist height ratio, waist hip ratio.

1.Introduction

Insulin resistance (IR) syndrome is one of the important risk factor for cardiovascular diseases[1-7]. The evaluation of the insulin resistance has received considerable attention in the last few years. The laboratorial methods for the determination of insulin resistance are expensive and with standardization deficiencies for its execution, limiting its application in clinical practice [8].

Direct quantification of insulin resistance is difficult; the hyperinsulinemic-euglycemic clamp technique, based on direct intravenous insulin and glucose infusion, is considered as the gold standard procedure, but its complexity limits its clinical use. Therefore, indirect methods have been developed, out of which homeostasis model assessment (HOMA) index is one of the most commonly used method to assess the insulin resistance. This index shows a good correlation to the clamp procedure[9]. Indian adolescents have an increased sensitivity to obesity especially abdominal obesity [10,11].

Studies in adolescents have shown that visceral obesity is associated with the development of insulin resistance in this age group, with evidence of a 50% increase in insulin resistance in overweight adolescents with every half unit increase in body mass index (BMI)[12-14]. Therefore it is of growing interest in studying different anthropometric measures as indicators of insulin resistance and

diabetes, in order to understand the increased susceptibility of leaner Indian populations to diabetes. Measurement of waist circumference (WC) is a useful measure of obesity-related diabetes risk in Indians, who are more prone to abdominal obesity at normal BMI[15,16]. Furthermore, Indians have greater amounts of visceral adipose tissue and a higher percentage of body fat than individuals of European population[17,18]. Percent of body fat and central obesity, measured by waist hip ratio (WHR) as compared to generalize obesity (measured by BMI) have been evaluated as risk factors for diabetes with conflicting reports in Indian populations.

In the INTERHEART study, waist hip ratio was the strongest marker of myocardial infarction in South Asians, followed by waist circumference and then BMI[19]. Other anthropometric measures, such as Waist-Height Ratio (WHtR), and body fat percent (BF %), have been also found to be correlated with Type 2 Diabetes, but their predictive value for insulin resistance remains to be fully understood[20,21]. Therefore, due to the lack of consensus on a single anthropometric measure as the best indicator of insulin resistance in Indian population we undertook this study to investigate the correlation between the anthropometrical parameters and insulin resistance in north Indian adult population.

2. Material and Method
2.1 Ethical statement and subject recruitment
This is population based cross-sectional study conducted in the Department of Physiology, King George's Medical University (KGMU), Lucknow. Total 100 apparently healthy subjects (n=55 male and n=45 female) aged between 18-25 years were recruited with prior ethical approval and with written informed consent. The sample size was statistically calculated with 80% of power. Subjects having history of diabetes mellitus, endocrine disorder, metabolic disorder, and use of medication that affect carbohydrate and lipid metabolism were excluded from the study. 2 ml venous fasting blood sample (> 8 hours) was collected from each subject and out of which 1 ml blood was collected in fluoride vial, and remaining 1 ml blood in plain vial. Serum and plasma were separated immediately, aliquot prepared and stored at -80^{0}C till further analysis.
2.2 Anthropometrical measurements
For measuring weight, the subject was requested to stand still on the platform and weight measured with the help of a digital weighing machine. Height was measured using stadiometer with the help of a fixed scale. Body mass index was calculated by the formula; weight (kg)/height (m^2).

Waist circumference (WC) was measured mid-way between iliac crest and lowermost margin of the ribs, in quiet breathing. Hip circumference (HC) was measured at the maximum protruding part of buttocks at the level of the greater trochanter with the subjects wearing minimal clothing. Waist hip ratio and Waist height ratio was calculated with the help of the formula WC (cm.)/HC (cm.) and WC (cm.)/height (cm.) respectively.
2.3 Biochemical analysis
Fasting plasma glucose was estimated using the glucose oxidase-peroxidase method by using commercially available kit with the help of a semi automated glucose analyzer (Microlab 300, Merck) on the same day of sample collection. Plasma insulin was estimated using a radio immuno assay kit (Immunotech) with the help of a gamma counter. Insulin resistance was quantified using homeostasis model assessment (HOMA), an index of insulin resistance (IR) [HOMA-IR = fasting insulin (μU/mL) × fasting plasma glucose (mmol/L)/22.5] [22].
2.4 Statistical analysis
Averaged data are presented as the means ± SD and frequency data are presented in percentages. The P-value <0.05 was considered as statistically significant. The Pearson Correlation Coefficient was calculated to find the direction of association between two continuous parameters. All the analyses were carried out by using SPSS 16.0 version (Chicago, Inc. USA).

3. Results
More than half (62%) of the subjects were between 20-22 years followed by >22 (21%) and <20 (17%) years. The mean age of the subjects was 21.33 years with range between 18 to 24 years (Table-1). Table-3 represents the distribution of the subjects according to anthropometric parameters. The average height of the subjects was 163.08 (±7.21) cm. with weight 60.53 (±8.74) kg. The Body mass index (kg/m^2) was 22.71 (±2.72) with minimum of 16.40 and maximum of 30.43. The mean of Hip circumference (cm) and Waist circumference (cm) were 91.25 (±6.87) and 81.93 (± 7.87) respectively. The mean of Waist-hip ratio and Waist-Height ratio were 0.89 (±0.09) and 0.50 (±0.05) respectively. Similarly, the mean of Fasting blood sugar (mg/dl), Fasting serum insulin (μU/ml) and HOMA- IR were 88.39 (±9.23), 9.83 (±6.53) and 2.18 (±1.39) respectively. The correlation analysis reveals that the Body mass index, Waist circumference, Waist-hip ratio and Waist-Height ratio were positively correlated with HOMA-IR an index of insulin resistance.

Table-1: Age and gender distribution of the subjects

Age in years	No. (n=100)	%
<20	17	17.0
20-22	62	62.0
>22	21	21.0
Gender		
Male	55	55.0
Female	45	45.0

Table-2: Distribution of the subjects according to anthropometric parameters.

Parameters	No. (n=100) (Mean±SD)	Minimum	Maximum
Height (cm)	163.08±7.21	149	178
Weight (kg)	60.53±8.74	42	89
Body mass index (kg/m^2)	22.71±2.72	16.40	30.43
Hip circumference (cm)	91.52±6.87	65.00	110.00
Waist circumference (cm)	81.93±7.87	64.00	101.00
Waist-hip ratio	0.89±0.09	0.65	1.16
Waist-Height ratio	0.50±0.05	0.38	0.65
Fasting blood sugar (mg/dl)	88.39±9.23	76.00	152.00
Fasting serum insulin (μU/ml)	9.83±6.53	0.22	59.05
HOMA- IR	2.18±1.39	0.05	11.95

Table-3: Correlation between anthropometric parameters and HOMA-IR

parameters	HOMA- IR	
	r-value	p-value
Body mass index (kg/m^2)	0.30	0.002*
Hip circumference (cm)	0.13	0.29
Waist circumference (cm)	0.39	0.0001**
Waist-hip ratio	0.26	0.008*
Waist-Height ratio	0.39	0.0001**

*Significant p<0.05, p=0.0001

4. Discussion

It is a established fact that obesity, especially central obesity, induces insulin resistance because excessive free fatty acids and inflammatory substances alter insulin receptor signaling in different organs[23,24]. Furthermore, insulin resistance causes the metabolic alterations that finally results in metabolic syndrome (MetS)[23-27] and prevalence of MetS is directly proportional to the obesity[28-30]. A recent study in Medellin on 851 adolescents aged between 10 to 18 years old revealed rates of 25%, 4.1%, and 4.9% for overweight, MetS, and insulin resistance respectively[26]. The biological findings associated with this disease suggest that the β-pancreatic cells of these adolescents are forced to produce more insulin to maintain normoglycaemia, which predisposes them to hyperglycaemia and Diabetes Mellitus type 2[27,31,32]. Therefore an early detection of insulin resistance amongst obese adolescents may prove to better preventive measures to reduce the incidence of such chronic diseases [33].

Thus, the purpose of this study was to evaluate which of the following anthropometric parameter, i.e. body mass index, hip circumference, waist circumference, waist hip ratio and Waist height ratio, were more strongly related to insulin resistance among the north Indian population. Using Pearson correlation coefficient, present results showed that, body mass index, waist circumference and Waist height ratio were positively correlated with insulin resistance. However, the waist circumference and Waist height ratio were more strongly associated with insulin resistance compared to the other anthropometric parameter in our study population. Additionally the hip circumference had no correlation with the insulin resistance in our study population. There are few studies which have examined the associations between anthropometric measures of obesity and insulin resistance in children or adolescents[34-39]. Our findings are partially in line with those of other researchers.

In a study that focused on Brazilians from Sao Paulo, which examined body mass index, waist circumference, and waist height ratio, it was found that Waist height ratio was an acceptable method to determine insulin senstivity; however, their results were based on a gender-mixed sample[40]. The Manios *et al*. have also reported a stronger association of Waist height ratio and waist circumference with insulin resistance compared to waist hip ratio, among Greek populations[34,35]. However, in a Turkish population based study, both body mass index and waist circumference were identified as better predictors of insulin resistance compared to waist hip ratio[41]. Similar results have been observed in adults, where a small number of

studies have dealt with comparing the correlations between different anthropometric and insulin resistance. On the other hand, most studies have focused on identifying the best obesity-related indicator of Type 2 Diabetes and waist circumference has emerged as the best predictor compared to body mass index, waist hip ratio and Waist height ratio[42,43]. According to Yang L, a new significant indicator of insulin resistance is the neck circumference which is correlated with visceral adiposity in WHO grade III obesity[44].

Besides some important findings this study has some potential limitations. Firstly this is a cross-sectional study and may not be appropriate for cause–effect relationships. Secondly, the sample size is very small so that the findings are may not be applicable for any generalized population.

5. Conclusion

On the basis of our results we concluded that the waist circumference, waist hip ratio, body mass index and waist height ratio are good surrogate marker of insulin resistance among which waist circumference and waist height ratio are better predictor of insulin resistance in apparently healthy Indian subjects. However, to achieve more confirmatory results further studies on larger sample size are needed in Indian population as well as in other worldwide population.

Conflict of interest

Authors declare no Conflict of interest.

Acknowledgement

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